WORLD METEOROLOGICAL ORGANIZATION

EXECUTIVE COUNCIL WORKING GROUP ON WMO INTEGRATED GLOBAL OBSERVING SYSTEM AND WMO INFORMATION SYSTEM

Subgroup on WIGOS

Second Session

Geneva, Switzerland, 19-23 October 2009

FINAL REPORT

DISCLAIMER

Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation on behalf of the constituent body when the matter is, in his opinion, urgent, and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

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EXECUTIVE SUMMARY

The second session of the Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System Subgroup on WIGOS (EC-WG/WIGOS-WIS/SG-WIGOS-2) was held at the WMO Secretariat in Geneva, Switzerland, from 19 to 23 October 2009, and was chaired by Dr J. Nash (UK), Chair of the Subgroup and the president of CIMO.

SG-WIGOS was briefed on, and discussed:

(a) Status of the WIGOS Pilot and Demonstration Projects;
(b) WIGOS standardization areas requirements;
(c) Review of the WIGOS Concept of Operation (CONOPS);
(d) WIGOS Development and Implementation Strategy;
(e) WIGOS Introductory Publication; and
(f) SG-WIGOS Future Work Programme.

Based on the outcomes of the consideration of the individual Agenda Items, SG-WIGOS articulated its guidance, advice and recommendations regarding the further development of the implementation of the WIGOS concept, evaluation of the WIGOS Projects; it agreed on the updated version of CONOPS (Appendix III) and requested to finalize a new version of the WIGOS Development and Implementation Plan (Appendix IV). Both documents will be submitted to the third session of EC-WG/WIGOS-WIS and EC-LXI for consideration and approval.

SG-WIGOS reaffirmed that the WIGOS integrated observation approach will support WMO Members' NMHSs and other relevant Institutions in the fulfilment of their mandates including timely response to natural hazards, hydrological and environmental monitoring, climate services, adaptation to climate-change and human-induced environmental impacts, addressing requirements of the Global Framework for Climate Services (GFCS) approved by WCC-3. A joint effort of GFCS and WIGOS together with WIS would reduce a financial burden on WMO Members and Partners.

Specific attention was paid to the further implementation of the WIGOS Pilot and Demonstration Projects. SG-WIGOS noted that WIGOS Projects would provide a valuable learning experience which could validate approaches to integration, identify problematic areas, help to understand the benefits and provide clarification of the more effective ways forward. Evaluation of the lessons learned will provide valuable feedback for the WIGOS planning and development, and for other implementation projects and activities.

SG-WIGOS considered the proposals for two WIGOS operational databases: a) a standardized database providing a single access point to all the WMO observational standards, guidelines, best practices, procedures, etc.; b) a database describing all the observing systems components and respective networks contributing to WIGOS and providing end users with relevant metadata that are crucial for the WIGOS operation as well as for the WIS Data Discovery, Access and Retrieval (DAR) services. Development of such databases would be a component of the WIGOS implementation process.

SG-WIGOS further elaborated its Future Work Programme and Action Plan (Appendix VI).

GENERAL SUMMARY

1. ORGANIZATION OF THE SESSION

1.1 Opening of the meeting

1.1.1 The second session of the Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System, Subgroup on WIGOS (EC-WG/WIGOS-WIS/SG-WIGOS-2) was opened by its Chair, Dr J. Nash, Chair of SG-WIGOS, at the WMO Headquarters in Geneva, Switzerland, at 10:00 hours on Monday, 19 October 2009.

1.1.2 Following the opening of the session, Dr W. Zhang, D/OBS welcomed the participants to Geneva on behalf of the Secretary-General of WMO. He underlined that there were several demanding tasks to be addressed for the further WIGOS concept development, such as: defining WMO Members' and WMO Partners' requirements for WIGOS; analyzing possible impacts of integration processes on WMO Members and the WMO Secretariat, on the WMO Partners responsible for co-sponsored observing systems, on national agencies charged with national observing networks and systems; describing and communicating benefits of WIGOS to all concerned; elaborating a costed development and implementation strategy for WIGOS, as recommended by EC-LXI; specifying requirements for resources needed for development and implementation of WIGOS.

1.1.3 Apart from already mentioned, the meeting was expected to address the issues related to: (a) WIGOS Demonstration and Pilot Projects - review the progress status and projects implementation constraints; experiences gained and recommendations from lessons learned; (b) Review of the updated version of CONOPS; (c) WIGOS Development and Implementation Strategy - review the draft proposal for the framework of the Strategy and recommend how to develop the Strategy; and (d) WIGOS Introductory Publication - consider the draft proposal for the WIGOS Introductory Publication; for all above mentioned documents to formulate guidance how to finalize them.

1.1.4 In closing, Dr W. Zhang wished for a successful and productive session and an agreeable stay in Geneva.

1.1.5 The list of participants is given in Appendix I.

1.2 Adoption of the agenda

SG-WIGOS adopted the Agenda for the meeting, which is reproduced at the beginning of this report.

1.3 Working arrangements

SG-WIGOS agreed on its working hours and adopted a tentative work plan for consideration of the various agenda items.

2. REPORT OF THE CHAIRPERSON

2.1 The chair of SG-WIGOS summarized the activities of the Subgroup since its first session in November 2008.

2.2 He paid specific attention to the CBS Technical Conference on WIGOS, Dubrovnik, Croatia, March 2009 and underlined a very good quality of presentations on the WIGOS Pilot and Demonstration Projects.

2.3 Further, he mentioned the second session of the EC-WG/WIGOS-WIS held in Geneva, May 2009. At the meeting it was made clear that additional funding for WIGOS would have to come from

Members donating to Trust Funds. For this purpose, it is absolutely essential to present a clear vision of WIGOS to the WMO Members, how Members can benefit from WIGOS; clearly defined aims both in the short and long terms are also needed. He stressed that these aspects should have been clear when the WIGOS Projects were initiated which seems to be a major weakness in the WIGOS planning; Projects short term outcomes should be defined to give the necessary momentum in the Project. When discussing the status of the WIGOS Projects, he focused the attention to the Demonstration Project that should have been initiated by Namibia; the session should discuss and decide how to resolve this issue.

2.4 In his report he further mentioned the ad-hoc CBS-CIMO WIGOS coordination meeting, held in Geneva, August 2009, and its outcomes. In this regard, he underlined the fact that this session was the last chance for the subgroup to review in details all basic WIGOS documents to be submitted for EC-LXII (2010) and Cg-XVI (2011), such as the WIGOS Introductory Publication, CONOPS, and especially the WIGOS Comprehensive Development and Implementation Strategy, modify them and make recommendations on their further elaboration and finalization by the third session of the EC-WG/WIGOS-WIS in March 2010.

3. REVIEW OF GUIDANCE AND RECOMMENDATIONS ADOPTED BY EC-LX

3.1 SG-WIGOS was briefed on the guidance and recommendations of EC-LXI regarding the further development and implementation of the WIGOS initiative.

3.2 They were related to the implementation of the WIGOS concept, the update of the WIGOS Concept of Operations (CONOPS), a development of the WIGOS comprehensive development and implementation strategy taking WIGOS from a concept to reality; the pilot and demonstration projects initiated by relevant technical commissions (TCs) and NMHSs, respectively; the process for capturing the lessons learned as well as the projects evaluation process; and Quality Management Framework (QMF) in the context of WIGOS.

4. STATUS OF WIGOS PILOT AND DEMONSTRATION PROJECTS

4.1 SG-WIGOS considered the reports on the progress in the implementation of the WIGOS Pilot and Demonstration Projects provided by the corresponding project focal points or nominated representatives. The summaries of all Project Status Reports are reproduced in the Appendix II).

4.2 During the discussion on the individual projects, SG-WIGOS paid attention to the experiences gained, problems occurred, and projects implementation constraints taking into account the recommendations of EC-LXI as well as EC-WG/WIGOS-WIS-2.

4.3 SG-WIGOS welcomed with appreciation the good progress achieved by the majority of the Projects; it noted that they all provided useful lessons learned, feedbacks and perspectives on the potential benefits, value and impacts of the WIGOS implementation process at the national and/or regional levels. In this sense it was noted that the future success of the WIGOS integration process will strongly depend on the collaboration and cooperation among WMO Members at the regional and bilateral level as well as among WMO and its Partners.

4.4 In the case of some Projects the implementation and project work plans are still not available for the WIGOS Planning Office needed for monitoring and evaluation purposes. In this regard, SG-WIGOS encouraged the Project Focal Points to submit the above mentioned documentation as well as the regular progress reports and issues encountered to the WIGOS Planning Office for planning and monitoring purposes as well as for ensuring that appropriate support and technical assistance, if needed, is provided. The Secretariat ensures that such documentation will be available on the WIGOS web site.

4.5 SG-WIGOS acknowledged that the development of the WIGOS Projects already permitted to learn a number of lessons, and reviewed a comprehensive document “WIGOS Projects - Preliminary

Lessons Learned and recommendations" submitted by the WMO Secretariat with the inputs from the WIGOS Pilot and Demonstration Projects.

4.6 Lessons learned are important for the WIGOS planning and development, for the finalizing the WIGOS concept defined in CONOPS, for the preparation of the WIGOS Development and Implementation Plan, and for other implementation projects and activities, such as improvement of management of the operational observing systems.

4.7 The Projects also permit to validate approaches to integration, identify problematic areas, help to understand the benefits and provide clarification of the more effective ways forward. SG-WIGOS agreed that sharing the experiences and lessons learned have also significant capacity building aspect and would help WMO Members and WMO Partners to understand the WIGOS concept and its benefits. In this regard SG-WIGOS requested the WIGOS Planning Office to develop an appropriate reporting template through which the Project Focal Points could address, inter alia, critical issues, implementation constrains such as time and resources (fund and expertise) available.

4.8 SG-WIGOS considered the recommendations listed in the submitted document; based on the discussion on all WIGOS Projects, it agreed on the following:

- Some issues, such as integration of satellite and in situ data; climate aspects, including operational climate monitoring from space; and relationship with GEO, have not been addressed by the Projects;
- There is a need to clarify what will be WIGOS approach towards climate monitoring, including from space;
- It was recalled that all projects require active coordination and support from the WIGOS Planning Office; therefore a suitable project management function needs to be established. This will also allow for better interaction between the Project Team responsible for the Project and the SG-WIGOS and the respective technical commission working bodies;
- Regular updates of progress and issues encountered should be available to the WIGOS Planning Office; only when having relevant information on the status of the projects, progress achieved and issues encountered, advice and help can be provided;
- In CONOPS, the relationships between WIGOS and GEOSS should be clarified. While role of WIGOS in GEOSS (i.e. weather, climate, and water) is well understood, it is not clear what is the role of GEOSS in WIGOS;
- There should be no additional WIGOS Pilot and Demonstration Projects overseen and evaluated by the Subgroup and the WIGOS Planning Office for the purpose of testing the WIGOS concept. However, Members, Regional Associations (RAs), and Technical Commissions are welcome to initiate additional pilot/test case WIGOS related activities. Having projects or activities undertaken by each of the TCs and RAs would help move the overall WIGOS implementation process forward. This has the potential to contribute to the WIS effort by improving metadata availability and exercising WIS data exchange mechanisms. It also has a significant capacity building aspect. SG-WIGOS agreed that WIGOS related activities should be monitored centrally by the WIGOS Planning Office;
- Taking into account the role the Regional Associations should play in the WIGOS implementation, they are encourage to establish dedicated WIGOS related Task Teams as well as to initiate the regionally focused WIGOS activities. The Regional Demonstration Projects of RA IV and RA VI provide examples;
- There is a need to ensure consistency between different WIGOS documents; it is a role of the WIGOS Planning Office to review these documents and make proposals, in collaboration with Chair of SG-WIGOS and the president of CBS, how they should be adjusted accordingly;

- A primary objective of WIGOS is the improvement of the WMO owned observing systems. Additionally, there are non-WMO components of co-sponsored observing systems, where cooperation between organizations could result in improvements having mutual benefits. Care should be taken to recognize these considerations in the WIGOS documentation. Coordination with partners to promote harmonized standards and interoperability should be continued and strengthened;
- For the purpose of capturing the lessons learned (incl. a scope of the challenge; practical management and governance aspects; problems identified; and working with partners), simple evaluation process and criteria for evaluation of the Pilot and Demonstration Projects proposed by SG-WIGOS are as follows: Each WIGOS Project should document:
  (a) aims,
  (b) deliverables and key project values,
  (c) lessons learned,
  (d) benefits, and
  (e) planned Project completion date.

  Dr J. Nash and Dr J. Purdom were tasked to draft a template for the evaluation process and criteria that will be submitted to all WIGOS Projects for feedback. The evaluation process will be coordinated by WIGOS Planning Office;
- When discussing the metadata issue, it is necessary to clearly distinguish between station/platform metadata ("WIGOS metadata") and WIS metadata needed for Data Discovery, Access and Retrieval (DAR) services that WIS must provide; guidance on the generation of metadata in a standardized form (i.e. content and structure) is therefore needed. This should be a task for the WIGOS Planning and WIS Project Offices to collaborate closely with relevant TCs Expert Teams, specifically with CBS ET on Inter-Programme Expert Team on Metadata and Data Interoperability (IPET-MDI);
- WIGOS Planning Office should also serve as a central point for the sharing the information on the technical documentation, guidance available to avoid duplication of activities and efforts. For this purpose, the Office should be regularly informed on the activities under individual Projects and corresponding deliverables achieved; it allows it to serve as an information portal, as requested.

5. WIGOS STANDARDIZATION

5.1 Framework for WIGOS Standardization of the Surface-Based Observing Systems

5.1.1 SG-WIGOS considered the draft proposal of the Framework for WIGOS Standardization of the Surface-based Observing Systems developed by Dr A. Heimo, Consultant on WIGOS, in collaboration with the OBS department.

5.1.2 The framework proposes the development of a tool that would provide a single access point to all the WMO standards, guidelines, best practices, procedures, etc., addressing observations. It would enable on one hand the network managers and operators to easily access the data they need to have to set-up and run their systems and on the other hand the data users to understand the standards that were used in performing specific observations they are considering to use, providing appropriate metadata are available. It recognizes that WMO has produced a lot of guidance documents and standards addressing observing systems, but that they are not always easy to find and to access. Furthermore, this concept does not only address the access to the standards, but it also plans a harmonization of the standards (removal of duplications, inconsistencies, etc.).

5.1.3 The first key area to be addressed is standardization of observing procedures and practices, including quality assurance. However, standardization is required for all observational data and associated metadata so that the measurements from individual observing systems can be integrated into accurate and coherent data sets that allow for the development of unbiased, homogeneous long-term trends. The standardization of all relevant data and metadata management procedures and practices is also needed to improve their use in NWP.

5.1.4 A pragmatic approach was proposed: to develop the web based, user friendly, direct access to the harmonized standards, best practices, procedures and guidelines in three steps with clearly defined deliverables: 1) Proof of the Concept: Development of a web based interface which will include links to existing technical guidance documentations from a restricted number of technical commissions, e.g. CIMO and CBS; 2) Extension to a full scale system including links to the documentation of all technical commissions/observing systems; 3) Harmonization of the WMO technical regulations. SG-WIGOS recognized that this harmonization would need to be carried out in close cooperation with the WMO Quality Management Framework.

5.1.5 The above mentioned third step should result into the completion of the WIGOS standardization process that will encompass: the areas and issues to be addressed in the order of priority, gap analysis as well as the standard approval process. This would include addressing several critical issues such as the ownership of the standard and the level of the standard (mandatory - shall or recommendation - should). The implementation of the standards at the NMHS level would require capacity building and outreach activities as well as additional resources for technical infrastructure innovation and expertise.

5.1.6 The proposed concept represents a very challenging task, which will require:

- enhanced collaboration, cooperation and coordination, and a firm long-term commitment of all parties concerned;
- clear working agreement with third parties owning standards;
- significant financial resources, manpower, expertise;
- development of relevant technical documentation; determining standards, procedures, practices and protocols;
- adaptation of existing operational procedures to WIGOS standards: step-by-step implementation of sets of standardization, interoperability and data compatibility arrangements into operational observing networks and systems;
- implementation of QMS for an observing system/network;
- significant capacity building activities (technical assistance for standard implementation);
- systematic and rigorous performance monitoring and evaluation of WIGOS capabilities.

5.1.7 SG-WIGOS was of the opinion that a model similar to a WIS DCPC could be used for this purpose. When completed, this web-tool with its content would correspond to an electronic version of the Manual and Guide on WIGOS.

5.1.8 Some members of SG-WIGOS were concerned about the implications this concept would have for Members if they would be requested to provide all the metadata on the standards and procedures that were used in carrying out any observation. SG-WIGOS agreed that it would be a very challenging task for Members and the Organization to provide and collect all the instruments and stations metadata.

5.1.9 SG-WIGOS supported this proposal and recommended that the proposal be further elaborated including its implementation plan. The meeting agreed to include this proposal into the new version of the WIGOS Development and Implementation Plan to ensure commitment by the organization before embarking on its development as it would have significant financial implications. SG-WIGOS recommended EC-WG on WIGOS/WIS to consider development of such a database.

5.2 Development of a template for a description of all observing networks contributing to WIGOS

5.2.1 The Secretariat presented a comprehensive draft proposal for the development of a WIGOS Observing Systems' components description database.

5.2.2 SG-WIGOS reviewed the different steps proposed to (i) undertake necessary developments

of the database, (ii) operate and maintain the database, (iii) consider mechanisms for feeding information from the different component observing systems in the database, and (iv) analyzing information in the view to make appropriate recommendations.

5.2.3 SG-WIGOS agreed that developing such a database would be valuable resource for the success of WIGOS development and implementation, and would enable to understand contributions of relevant WIGOS systems' component, help develop and refine WIGOS implementation strategy and make clear and concrete recommendations to appropriate groups and bodies as well as to Members in terms of (i) governance, (ii) systems' components and network design, optimization, and (iii) system and network management, implementation, operations, and monitoring, by addressing the three areas of standardization (instrument and methods of observation, data exchange, and quality management). SG-WIGOS recommended EC-WG/WIGOS-WIS to consider development of such a database. In this regard, the WIGOS Planning Office was tasked to prepare a relevant document to be submitted to EC-WG/WIGOS-WIS.

5.2.4 SG-WIGOS agreed that information collected would permit answering specific questions and identifying strengths and weaknesses, gaps, duplication, uncertainties, ascertaining what standards are being promoted, and whether they are being followed. It will also permit to address the potential for data exchange, and to make recommendations for improving usefulness, and cost-effectiveness of these networks for addressing the requirements of WMO programmes and co-sponsored programmes. Thanks to the information collected, it will be possible to make concrete proposals regarding the most efficient ways WMO could cooperate with national, regional, and international partners within the WIGOS framework.

5.2.5 The meeting agreed with the proposal and the following added considerations:

- Information on satellite observing systems need to be considered when developing such a WIGOS database; the WMO Space Programme is requested to review the draft proposal and provide corresponding information;
- If EC-WG/WIGOS-WIS agrees with the development of such a database, detailed specification for the database should be agreed upon before the next Congress so that development of the database could start afterwards with approval and proposed funding from Cg-XVI;
- It is essential that the database be properly resourced and sustained. It is estimated that the cost for developing the database could be as high as USD 200k;
- It is preferable that the database reside at the WMO Secretariat;
- Once operational, it is estimated that at least two full-time dedicated persons will be required at the WMO Secretariat to operate the database, seek input from the various component observing systems, ingest information, and monitor the content activate remedial actions when needed;
- Prioritization of specifics must be proposed. As an initial step, the database should include general information about the component observing systems that is relatively straight forward to collect;
- Some hierarchy must be included to collect information at the national level, the sub-regional level (e.g. ASECNA, EUCOS), the regional level, and the global level;
- WIGOS Demonstration and Pilot Projects may consider building their own databases and report on their experiences.

5.2.6 The meeting recommended that the different catalogues maintained by WMO (e.g. WMO-No. 9, Volume A, WMO-No. 47) and partners should be made interoperable, and agreed on the following:

a) The dynamic parts of the relevant WMO Publications (i.e. the lists of platforms, and their metadata) should eventually be included into the WIS as data products;

b) The regulatory parts of the relevant WMO Publications (e.g. description of the databases, responsibilities of Members, procedures for submitting information, formats, etc.) should be included into the WIGOS manual.

c) The corresponding WMO Publications (e.g. No. 9 Volume A, No. 47) should then be declared obsolete;

d) Partner Organizations should be invited to document the data-sets present/maintained in their relevant databases, and provide for the corresponding discovery metadata (using WIS metadata profile) and access information;

e) Partner Organizations should be invited to provide information about how their own observing system/platform description databases are regulated so that appropriate references can be made in the future WIGOS manual.

5.3 Status of Implementation of the WIS Project and Implementation Plan

5.3.1 SG-WIGOS was briefed on the status of implementation of the WIS Project and Implementation Plan. It noted that the planning and implementation of WIS is progressing on schedule and will be able to support the development and implementation of WIGOS in time.

5.3.2 Noting WIS implementation is in two parts:

- Part A being the continued improvement of GTS and opening up access to the GTS for all WMO programmes, and
- Part B being the new functionality provided by WIS such as the Information Discovery, Access and Retrieval;

SG-WIGOS was pleased to see that the utilization of both the existing and the new functionality of WIS are being addressed across the WIGOS Pilot and Demonstration Projects. SG-WIGOS supported the suggestion of the ICG on WIS that WIGOS pilot and demonstration projects would benefit from WIS training workshops aimed at building capacity of participating Members, especially in the creation and management of the necessary metadata and how to benefit from the new functionality of WIS.

5.3.3 SG-WIGOS was also briefed on the key activities milestones, such as consolidation of the WIS plans, development of the WIS regulatory material, development of the metadata standard, implementation of the first operational GISC and DCPCs, as well as about the current WIS implementation priorities. The session was also brief on the involvement of the WIS Project Office in the implementation of WIGOS Demonstration and Pilot Projects.

6. WIGOS REQUIREMENTS AND EXPECTATIONS

6.1 A comprehensive analysis of WIGOS functional requirements and expectations were presented by the WMO Secretariat. At the WIGOS level, WMO defines organizational requirements that are required in order to ensure that these observing systems can be integrated in a framework of observing systems meeting the aims and expectations of the WIGOS concept as specified by CONOPS. The key WIGOS requirements can be defined in the following areas:

- Integrated governance and collaboration (oversight, partnership, data policy/ownership);
- Quality management (user focused, quality assurance/quality control, traceability, documentation, capacity building, monitoring, evaluation, feedback, remedial actions, improvement);
- Observing system interoperability and data compatibility through data sharing and three levels of standardization;
- Optimization (coordinated planning, platform opportunities, innovation);

to meet the objective of enhanced integration of the WMO observing systems and enhanced coordination with observing systems of partner organizations.

6.2 The information presented under this Item provided a very solid background for the development of the draft proposal for the Framework of the WIGOS Comprehensive Costed Development and Implementation Strategy (Item 8).

7. WIGOS CONCEPT OF OPERATIONS (CONOPS)

7.1 Following the recommendations of EC-WG/WIGOS-WIS-2, the CONOPS document was further elaborated by the Secretariat with the help of Dr A. Karpov, the OBS Department consultant.

7.2 SG-WIGOS welcomed with appreciation the draft for an updated version of CONOPS. It further revised the draft and agreed on the version as reproduced in Appendix III.

7.3 For the finalization of the document that will be submitted to EC-WG/WIGOS-WIS-3 for its consideration and approval, SG-WIGOS recommended to ensure consistency between CONOPS and the other WIGOS documentation.

8. WIGOS DEVELOPMENT AND IMPLEMENTATION STRATEGY

8.1 The schematic approach and concept of a draft framework of Comprehensive Costed Development and Implementation Strategy for WIGOS (Strategy) was presented by the Secretariat.

8.2 SG-WIGOS agreed that the Strategy must be focused on the implementation of more effective management of the WMO observing systems, including improved governance, as well as establishment of the mechanism and framework for enhanced collaboration and cooperation with WMO Partners. The Strategy must specify and cover all activities and steps to implement the WIGOS concept of operations as defined and specified in CONOPS.

8.3 When developing the Strategy, there is a need to differentiate between two WIGOS Phases:

- WIGOS Development and Implementation Phase (Project Phase) aiming at development and implementation of the WIGOS organizational global framework for integration, coordination and optimization of multiple observing systems owned by WMO and its partners (co-sponsors) expected to be conducted principally between Cg-XVI and Cg-XVII; and
- WIGOS Operational Phase (that will follow for decades and during which the implementation of WIGOS constituent observing systems / networks will evolve continuously to expand and improve services delivery and decision making, in response to evolving users' needs and opportunities

8.4 The Strategy will focus on the WIGOS Development and Implementation Phase (Project Phase). In this context, "implementation" refers to the implementation of the global organizational framework rather than implementation of the observing capabilities.

8.5 When preparing the draft proposal for such a strategy, a number of sources were drawn upon, including the draft framework presented by the Secretariat, WIGOS CONOPS, the WIS Project and Implementation Plan, the WIGOS Test of Concept Development and Implementation Plan, as well as the Draft Position Paper on the WMO Contribution to the implementation of the Global Framework for Climate Services, presented at the session of EC WG on Climate and Related Weather, Water and Environmental Matters (Geneva, 21-23 October 2009).

8.6 SG-WIGOS agreed that such a document, to be presented to Cg-XVI, will be a preparatory step towards the more detailed WIGOS Project and Implementation Plan. A new version of the WIGOS Development and Implementation Plan (WDIP) as reproduced in Appendix IV was drafted by Dr J. Purdom, Senior Consultant on WIGOS, during the week after the session. This draft will be finalized by the consultant and it will be submitted to EC-WG/WIGOS-WIS-3 for consideration and approval.

9. WIGOS BENEFITS AND CAPACITY BUILDING STRATEGY

9.1 SG-WIGOS considered the draft proposal for the WIGOS Capacity Building Strategy developed by Dr J. Purdom, Senior Consultant on WIGOS, in collaboration with the OBS and ETR Departments. The draft addressed the requirement specified by the TECO-WIGOS statement to outline the WIGOS capacity building strategy to ensure the benefits of WIGOS would reach all WMO Members.

9.2 SG-WIGOS agreed that the text of the proposal will be incorporated into the new version of the WIGOS Development and Implementation Plan.

9.3 Availability of the World Bank`s official estimation of WIGOS benefits for the countries would be the important argument for the governments of many countries for providing required support and resources to them and would allow to reduce time for receipt of such resources.

10. WIGOS INTRODUCTORY PUBLICATION

10.1 The second session of EC Working Group on WIGOS and WIS (May 2009) recommended that an informative concise introductory document on WIGOS should be develop that would lead to a Guide on WIGOS and provide the background of WIGOS and its aims for the purpose of understanding WIGOS and its implications on WMO Members and Partners.

10.2 SG-WIGOS considered the draft proposal for such WIGOS Introductory Publication developed by Dr J. Purdom, Senior Consultant on WIGOS, in collaboration with the OBS Department.

10.3 Based on the comments from the participants of the session the draft was further adjusted and is reproduced in Appendix V. The document will be further elaborated by Dr J. Purdom and submitted to EC-WG/WIGOS-WIS-3 for consideration and approval. The text was already significantly used in the CONOPS and WDIP.

11. FUTURE WORK PROGRAMME AND ACTION PLAN OF SG-WIGOS

11.1 Based on its Terms of the reference as well on the results from discussion, SG-WIGOS specified the major tasks for its work plan until the next session of EC-WG/WIGOS-WIS-3, March 2010.

11.2 When considering the Action Plan, SG-WIGOS took into account the guidance of EC-WG/WIGOS-WIS-2 and agreed to concentrate on those activities that are absolutely necessary for the preparation of guidance to EC-LXII and Cg-XVI on the WIGOS concept and for the preparation of the new version of the WIGOS Development and Implementation Plan.

11.3 Deadlines of actions were proposed on the assumption that the draft WDIP should be submitted to EC-WG/WIGOS-WIS-3, March 2010, for consideration and then to EC-LXII (June 2010) for approval and submission to Cg-XVI. The WIGOS Planning Office will regularly monitor the progress achieved and inform chairs of EC-WG/WIGOS-WIS and SG-WIGOS to take actions as appropriate.

11.4 The approved WIGOS Implementation Activities listed in the Appendix VI constitutes the Future Work Programme and Action Plan of SG-WIGOS until March 2010.

12. ANY OTHER BUSINESS

No item of business requiring the attention of the SG-WIGOS, not covered above, was submitted for consideration.

13. CLOSURE OF THE SESSION

The session closed at 16.45 hours on Friday, 23 October 2009, at 17.00 hours.

Appendix I

LIST OF PARTICIPANTS

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Appendix II

PROGRESS REPORT OF THE WIGOS PILOT AND DEMONSTRATION PROJECTS

1. STATUS REPORTS OF THE WIGOS PROJECTS

1.1 WIGOS-WIS Pilot Project GAW-IDOA

Improvement of Dissemination of Ozone (total column, profiles and surface) and Aerosol observations through the WIS

The expansion of the GTS into WIS will lead to easier data discovery and data access. Through WIS, data will be accessible to a much wider community than just the National Meteorological and Hydrological Services. Data delivered in NRT can be used in data assimilation models and for validation of such models. Data delivered in NRT can help to reveal problems with data quality at an early stage so that the problems can be fixed. Moreover, data delivered in NRT can be used in bulletins such as the WMO Antarctic Ozone Bulletin. A number of Antarctic stations deliver data in NRT, but the data is in many cases submitted by e-mail and in many different formats. A more rational system is needed where data is submitted to the GTS/WIS in a standardized format.

A WIS-WIGOS Pilot Project entitled “Improvement of Dissemination of Ozone (total column, profiles and surface) and Aerosol observations through the WIS” (GAW-IDOA) has been approved by EC-WG on WIGOS and WIS.

This pilot project aims at improving the availability of ozone and Aerosol Optical Depth (AOD) and surface Particulate Matter (PM) observations to the user community and prepares documentation to help other communities make their observing practices compatible.

AOD data is collected in NRT from a small number of global GAW stations by the World Optical depth Research and Calibration Centre in Davos, CH.

NILU is collecting ozonesonde and PM data from a number of European stations. The ozonesonde data is passed on to ECMWF in CREX format and can be made available to the GTS/WIS. The aim is now to have more stations submitting data in this way. Individual station managers will be contacted by WMO with a request to provide the ozonesonde data in NRT to NILU. These requests will be carried out during November and December 2009.

Some total ozone stations in Canada, Czech Republic and Japan submit data to the GTS on a daily basis. Submission of total ozone data to the GTS/WIS was discussed at the last Ozone SAG meeting in June/July 2009 and there is agreement to move forward. There has already been significant progress: Software packages have been developed and located as freeware at: http://www.o3soft.eu/

Examples of CREX messages of total ozone data can be found at: http://www.wmo.int/pages/prog/www/WMOCodes/TemplateExamples.html#OtherTemplates

Now the key task is to summarize these products with comments and guidance and then to use the authority of WMO to make the WMO Members realise that providing ozone data in NRT is as important as the current non-real time data practice.

CHMI suggests including this activity into a project proposal entitled “Long-term changes of the ozone layer over the Czech territory”. In late December 2009 one will know whether the project is accepted or not. The NRT activities must be covered by the umbrella of the WIGOS project that gives it an international dimension and acknowledgement and allows the CHMI to assign personnel inside the Institute. On the condition that the above mentioned project proposal receives funding work will be carried out during the spring of 2010, with the aim to have 10-20 stations submitting total ozone data in NRT by the end of June 2010.

Some GAW stations have provided surface ozone data to the GEMS project

(Zugspitze/Hohenpeissenberg (DE), Mt. Cimone (IT), Izaña and Santa Cruz (ES), Cape Point (ZA), Tamanrasset/Assekrem (DZ), Neumayer (Antarctica) and Moussala (BG)).

A joint GAW/MACC meeting was held in Garmisch-Partenkirchen early Oct. 2009 to discuss rapid delivery of surface ozone carbon monoxide data. An agreement between GAW stations and the MACC project is underway. Data will be delivered to an ftp server at DWD. The intention is also that DWD submit the data to the GTS/WIS, but not with open access. The data should be discoverable, though.

It would facilitate the data submission process if a gateway (e.g. an ftp server) could be set up and where stations can submit data. Ozonesonde data and surface ozone are already taken care of by NILU and DWD, respectively, but for the other data, (i.e. total ozone, AOD and PM) it would simplify the process if an ftp server could be identified.

It would also help the project if the WIS would be accessible so that investigators can see the functionality and wealth of data available through WIS. At least one GISC and a few DCPCs ought to come on-line as soon as possible in order to demonstrate the existence of WIS.

1.1 Pilot Project 1 - WIGOS-WIS Pilot Project GAW-WDC

Improvement of Interoperability of GAW World Data Centres with WIS and Establishment of Prototype Services to Facilitate User Access to GAW Data

A WIS-WIGOS Pilot Project entitled “Improvement of Interoperability of GAW World Data Centres with WIS and Establishment of Prototype Services to Facilitate User Access to GAW Data” (GAW-WDC PP) has been approved by EC WG on WIGOS-WIS. The aims of this project are:

a) To improve the possibility for machines to discover data archived at the individual WDCs,

b) To improve the dissemination of data archived at the WDCs, establish tailored services for the GAW global stations allowing them comfortable access to data and information products.

The aim of this pilot project is to make the GAW World Data Centres compliant with WIS so that they can become so-called DCPCs.

WIS will be able to meet its objectives only if data discovery and retrieval (DAR) can be improved globally. The GAW-WDC pilot project aims at making metadata on the observations performed in GAW available in a WIS-conformant way. Further, it aims at developing prototype services that will help users to make best use of the data available at dedicated World Data Centres.

The GAW Station Information System (GAWSIS), hosted by EMPA in Dübendorf, plays a central role in this pilot project since they can act as a gateway between WIS and the data centres.

A report has been prepared by the GAWSIS manager, Jörg Klausen, and there has been good progress so far. The report can be found here: http://www.wmo.int/pages/prog/www/WIGOS-WIS/meetings/WIGOS-2_Geneva2009/Doc-4-1-1.pdf

Tasks 0-6 of the work plan have been accomplished and there is good progress on Task 7. Work on Task 8 (Prototype client tool to facilitate extraction of GAW data across multiple WDCs) has begun and a web service has been set up. However, this service works only with data from one data centre so far. More data centres will be added to this service as soon as possible. Task 9 (Toolkit providing details of satellite overpasses, trajectories etc. to help increase use of data) is in the hands of DLR who host the WDC-RSAT data centre. This task is planned to take 2-3 years to accomplish.

There is some reluctance among the individual GAW World Data Centre managers due to the extra work involved in becoming WIS compliant. These data centres are kept alive despite limited resources and it is difficult to take on new tasks, especially when the task is of a certain complexity. Hence, it would be very useful if some resources would be made available in order to help these data centres to implement ISO 19115 metadata standards and other necessary changes in order to become WIS compliant. This is not necessarily a question of money but rather a question of one-to-one help to implement the necessary changes.

In order to have further progress EMPA feels a need for assistance from the WMO secretariat on the following issues:

- Choice of vocabularies for ISO 19115/WIS-compliant metadata representations for naming of chemical compounds, analytical methods used in atmospheric composition monitoring and physical principles used in atmospheric composition monitoring

- Establishment of a web service and registration of this web service as a DCPC in WIS

1.2 Pilot Project II

Integration of SADC HYCOS and the FFGS as a WIGOS/WIS Pilot Project

The integration of hydrological data from these two projects: the real time data from the SADC-HYCOS project, the FFGS outputs, and the NWP products from the SWFDP would enhance the effectiveness of both the projects and provide a show-case of the benefits of the integrated system of observations as well as the new WMO Information System. The hydrological information collected through the SADC HYCOS, integrated into the meteorological and other information provided through the FFGS would not only help provide flash flood guidance benefits but also provide improved flood forecasting and warning services for different river basins in the SADC Region.

To ensure successful integration of the Hydrological data from SADC-HYCOS and SARFF into WIS, WMO plan to organize a meeting during the first week in December 2009 in Maputo, Mozambique, to bring together SADC-HYCOS and SARFF focal points with WIS experts to discuss the type information to be contributed by the two project and the modalities for integrating such data in WIS. During the meeting in Maputo, the most important decisions as for the CHy's WIGOS projects will be taken.

1.3 Pilot Project III - AMDAR

Integration of AMDAR into WIGOS

1. Through the WIGOS Pilot Project for AMDAR a new Standardized BUFR Template for AMDAR, 3 11 010 version 4 has now been developed that include a number of new elements, including a new AMDAR quality element. Resulting from the second session of the WIGOS PP for AMDAR the new Standardized BUFR Template for AMDAR was provided to the AMDAR Community and major NWP Centres for review and comments. Following the review and comments received the standardized version 3 AMDAR BUFR Template was made available to IPET-DRC for approval. IPET-DRC-1 discussed this template, in particular the representation of quality information, and finally approved 3 11 010 version 4 and the new descriptors, provided that the proposed usage of an additional descriptor is found feasible to the AMDAR users. Following the approval from IPET-DRC-1 the new Standardized BUFR Template for AMDAR, 3 11 010 version 4, will go through a validation process using independent processing centres. The validation procedure being completed, the template would then be again submitted to IPET-DRC for approval by the chairperson of the IPET-DRC, to the chairperson of the OPAG-ISS and to the president of the CBS. The new Standardized BUFR Template version 4 will then be declared preoperational (this is expected to be accomplished by April 2010).

2. The second session for the WIGOS Pilot Project for AMDAR also discussed Objective 3, the Development of a Standardized Procedure for Quality Management of AMDAR data. The meeting noted that with the ever increasing amount of AMDAR data there is now a real need to improve the overall quality of AMDAR data disseminated on the GTS. The meeting agreed that a set of minimum standards for AMDAR data monitoring, including evaluation criteria and procedures, needs to be developed. The meeting agreed that the next step would be to evaluate the current criteria and procedures used by all national and regional AMDAR programmes in order to develop a set of minimum quality standards for AMDAR data.

3. The third session for the WIGOS Pilot Project for AMDAR was held at KNMI HQ in De Bilt, The Netherlands, from 1 to 2 July 2009. The meeting discussed Objective 2, Application of WMO Metadata relevant to AMDAR. The meeting identified metadata needed for describing data and products, metadata needed for usage of data and metadata needed for the operation of the AMDAR observing system. The meeting also examined how meta data could be used for quality control, administration purposes and the issues associated with the sharing and usage of the metadata, data and products. Using WMO profile of ISO 19115 to ensure appropriate compatibility with WIS and WIGOS, the meeting developed metadata that would cover both the aircraft and the airport. It was also agreed that this particular objective would be tested on a single airline participating in the E-AMDAR Programme, before finally being distributed to other operational AMDAR Programmes.

4. The AMDAR Panel has also had initial discussions with the WMO Secretariat and the CIMO President regarding Objective 4, Validation and Preparation for Intercomparison of Available Water

Vapour Sensor Performance. It was agreed that before a preparatory meeting between the AMDAR Panel and CIMO takes place to define the rules and procedures for the intercomparison of AMDAR and other upper-air data, the water vapour sensor (currently the WVSS-II v3 sensor) would have to complete USA and European trials and to answer pre-defined quality requirements. Field trials with this sensor are due to be completed in the second quarter of 2010.

5. The AMDAR Ad-hoc Steering Group believed that the Pilot Project and the Sub Projects would not achieve their expected results without appropriate funding. The success of the WIGOS Pilot Project for AMDAR can only be guaranteed if some of the activities are accomplished through a short term contract with appropriate experts. The Terms of Reference to the AMDAR Panel Trust Fund do not allow the use of funds for this type of activities and funding is expected from the Secretariat, especially from WIGOS/WIS Trust Fund. WMO was requested to commit the required funding for these activities.

6. The AMDAT Pilot Project has gained so far the following experience and lessons learned:

- the AMDAR community is lacking sufficient experienced persons who could actively contribute to the objectives of the Pilot Project; contracting expertise, e.g. for the definition of the AMDAR metadata base, is highly needed;
- the lack of external funding has reduced the support to the Pilot Project to participation from Europe and the US, where participation from other regions is really needed for a wider acceptance of the concept;
- support to the Pilot Project from NMHSs is suffering from a lower priority given to this task so that insufficient time was made available to effectively work on the Objectives;
- due to required upgrades to see the sensor performing within the specified quality boundaries, the availability of a reliable water vapour sensor has been delayed, causing the need for additional development, certification and (expensive) laboratory testing and flight trials.

Because of these issues, the dead line for the short term Objectives can not be met and need to be extended.

1.4 Pilot Project IV - CIMO

Elaboration of the underpinning/crosscutting role and responsibilities of the Instruments and Methods of Observation Programme in the context of WIGOS

1. Pilot Project Summary and Status

The CIMO Pilot Project aims at elaborating the underpinning/crosscutting role and responsibilities that CIMO would have in WIGOS and in testing it by collaborating with other pilot and demonstration projects. It consists of 3 phases:

1. The **first phase** and main goal of the project is to make a proposal for revised terms of reference for CIMO within WIGOS. This part was finalized taking into account the result of the consultation of other technical commissions and selected pilot projects. The final proposal is reproduced below.
2. The **second phase** was to reach out to other pilot projects to see whether CIMO assistance would be required to support their pilot projects. CIMO decided to assist in priority the JCOMM and AMDAR Pilot Project and the Demonstration Projects of Morocco, Brazil and possibly Kenya, should they wish the support of CIMO. CIMO also started to collaborates with the GRUAN pilot project
3. The **third phase** consists in carrying the needed activities to demonstrate the process by which CIMO fulfils its role with the WIGOS framework and supports other pilot projects. Therefore, CIMO decided on one hand to nominate individuals responsible for the coordination/support with specific pilot projects and, on the other hand, decided to provide a significant contribution to the development of WIGOS by putting more emphasis in its work program on activities of cross-cutting nature, like radars and siting of meteorological stations for example. Corresponding activities were started.

2. Project Activities

2.1 The collaboration with the JCOMM Pilot Project consisted mainly in providing advice on the draft terms of reference for the Marine Regional Instrument Centre and on training on metrology and in collaborating in the revision of the CIMO Guide chapter on Marine Observations.

2.2 Collaboration with the AMDAR Pilot Project will aim at testing the new AMDAR water vapour sensor once it will be ready.

2.3 Collaboration with the GRUAN Pilot Project aims at streamlining the efforts of both communities to carry out instrument intercomparisons to provide advice to Members on a selection of radiosondes suitable for RBSN/RBCN and its GUAN sub-network as well as advice to GCOS on a selection of systems suitable for GCOS Reference Upper-Air Network (GRUAN).

2.4 CIMO organized an expert meeting in view of agreeing on a siting classification for meteorological stations that would allow different user communities to assess whether the data provided by the various stations meet their operational needs. This was done in collaboration with CBS experts.

2.5 CIMO decided to put a stronger focus of its activities to weather radars. As the output of radars is not necessarily always comparable, CIMO decided to support an intercomparison of radar algorithms. First step were done in trying to find a host for the comparisons. Stronger collaboration was sought in organizing a joint CIMO/CBS expert team meeting that would address this subject

3. Lessons Learned, Constraints and Problems

3.1 The nomination of a pilot project manager, who was tasked with representing CIMO in the first meeting of each of the pilot projects and to coordinate pilot projects activities has proven to be a very effective and was likely more effective than inviting representatives of the other pilot projects to attend a CIMO pilot project meeting to develop collaboration.

3.3 A constraint in the implementation of the project appeared in the number of experts available to provide the support and having relevant WIGOS knowledge. There is a need to widen the pool of experts available to provide this support to lower the load on the individual experts.

4. Role and Responsibilities of the Commission for Instruments and Methods of Observation (CIMO) within the framework of the WMO Integrated Global Observing Systems (WIGOS) *(Draft Terms of Reference for CIMO)*

Within the framework of the WMO Integrated Global Observing Systems (WIGOS):

The Commission shall be responsible for matters relating to international standardization, compatibility and sustainability of instruments and methods of observation of meteorological, climatological, hydrological, oceanographic, and related geophysical and environmental variables.

This responsibility underpins all observations within WIGOS, and will be carried out in close consultation with relevant WMO partner organizations that co-sponsor, own and/or operate some of the observing systems.

This shall include in particular (priority to be defined at later stage):

(a) Respond to the requirements for standardized and compatible observations, including data content, quality and metadata;

(b) Provide advice, and recommendations, and promote studies concerning effective and sustainable use of instruments and methods of observation, including quality management procedures such as methods for testing, calibration and quality assurance;

(c) Conduct and / or coordinate global and regional intercomparisons and performance testing of instruments and methods of observation;

(d) Promote the development of measurement traceability to recognized international standards, including reference instruments and effective hierarchy of world, regional, national and lead centres for instrument calibration, development and testing;

(e) Promote compatibility, inter-calibration, integration and inter-operability with respect to both, and between, space-based and surface-based (in situ and remote-sensing) observations, including conducting testbed observing experiments;

(f) Encourage research and development of new approaches in the field of instruments and methods of observation of meteorological, climatological, hydrological, oceanographic, and related geophysical and environmental variables;

(g) Promote the appropriate and economical production and use of instruments and methods of observation with particular attention to the needs of developing countries; and

(h) Support training and capacity-building activities in the area of instruments and methods of observation.

(i) Liaise with the scientific research community and HMEI in introducing new observing systems into operations

1.5 Pilot Project V - JCOMM

Background
The Pilot Project is implemented jointly by WMO and IOC through JCOMM and has identified three key deliverables: (i) document and integrate instrument best practices and related standards, (ii) build marine data systems that are interoperable with WIS, and (iii) implement quality management and standards. The Project recognizes and respects the ownership of all partner organizations as well as the WMO and IOC data policies. JCOMM, as a joint technical commission, has proven an effective tool in promoting WIGOS.

Progress
Much of the success of the Pilot Project has been due to the following:

- Intergovernmental cooperation mechanism in place through JCOMM
- Effective working relationships between the WMO and IOC Secretariats
- Dedicated staff in each organization
- Funding made available by WMO and IOC that complemented existing JCOMM funding and permitted to work out the synergies between JCOMM Groups and Expert Teams in the best interest of both JCOMM activities, and WIGOS developments.
- Well understood benefits of WIGOS in the JCOMM community

A final report of the Pilot Project will be prepared for the next EC WG WIGOS-WIS meeting and will include a comprehensive development and implementation strategy for moving from a concept to reality. The report will address the following:

i. Details about the Pilot Project activities and its main achievements and deliverables;
ii. Lessons learned from the Pilot Project;
iii. The legacy of the Pilot Project and recommended integration of marine and other appropriate observations as part of the WIGOS framework, in terms of instrument practices, data exchange, quality management, and governance.

Some preliminary recommendations from the Pilot Project are:

- The existing governance with JCOMM, with WIGOS related functions under the JCOMM Observations and Data Management Programme Areas, should be preserved;
- JCOMMOPS, which provides support for the implementation, and monitoring of marine observing networks on a day to day basis should be strengthened;
- A review of WMO/IOC Technical Publications should be conducted to address a number of issues including Quality Control, the collection of instrument/platform metadata, instrument standards and inter-comparisons, and satellite data telecommunication issues;
- Promote establishing an international forum of users of satellite data telecommunication systems to address user requirements, and making recommendations on deficiencies and gaps related to the use of such systems;
- A communication strategy should be promoted to address (i) integration of in situ and satellite observations, (ii) benefits & rationale for data exchange, (iii) benefits and rationale for collection

and sharing of instrument/platform metadata.

Legacy
The Pilot Project will rationalize documentation on instrument best practices and standards, promoting the establishment of regional or specialized marine instrument centres, integrating several marine datasets in the WIGOS framework through interoperability arrangements with the WIS, and addressing quality management issues and how specific centres could implement Quality Management Systems (QMS). The Pilot Project will propose the governance through which the principles developed under WIGOS will permit continued progress and managing the sustainability of the integrated observing system.

The Pilot Project will provide a proof of concept for the following:

- Establishment of RMICs, and organization of a metrology workshop;
- Updating the marine chapter of the CIMO guide;
- Providing WIS and/or ODP interoperability for certain ocean data sets;
- Providing interoperability between the WIS and the ODP;
- Promoting standards through the JCOMM/IODE standards process.

1.6 Pilot Project VI - GSICS

The GSICS Pilot Project for WIGOS aims to address the issues related to the integration of space-based observations from different satellite missions and instruments. The Global Space-based Inter-calibration System (GSICS) is a joint initiative of WMO and the Coordination Group for Meteorological Satellites (CGMS), implemented along the GSICS Implementation Plan adopted in April 2006. Nine organizations are currently participating (CMA, CNES, EUMETSAT, JMA, KMA, NASA, NIST, NOAA, and WMO).
The Pilot Project addresses all the functions of GSICS, but limited to the intercalibration of infrared imagers. It has the following deliverables:

(i) Documents on best practices for pre-launch instrument characterization and SI traceability;
(ii) Agreed-upon algorithms, data management practices and deliverables for on-orbit satellite data intercomparison;
(iii) Implementation of WIS-compatible data description and designation standards for satellite data intercomparison;
(iv) Distributed operational infrastructure (software modules, data servers, web servers);
(v) Routine availability of “GSICS Correction”;
(vi) Assessment of the consistency of data sets originated from different satellite systems, enabling their merging for the derivation of climate products or other applications.
(vii) End-user evaluation of the benefit of GSICS results in 2 key applications.

As of September 2009, the project has completed the definition of common intercalibration methods for infrared imagers, and implemented data management and exchange procedures and tools. This has enabled starting routine production of intercalibration results for Geostationary and operational Polar-Orbiting satellite infrared sensors, which are made openly available through the GSICS website. The GSICS workshop was an important milestone where a first direct interaction could take place with current and potential users, and representative users have agreed to serve as beta-testers of GSICS products.

The lessons learned from this Pilot Project will include:

- The definition of an Algorithm Theoretical Baseline Document (ATBD) structure applicable to all satellite intercalibration activities,
- Data management principles, coding and format conventions and infrastructure for intercalibration datasets,
- Engagement of representative users for the use and evaluation of GSICS products. The timeframe of the Pilot Project is however very short to collect feedback on GSICS calibration products and to refine the product specifications accordingly.

The SG-WIGOS acknowledged the progress of GSICS Pilot Project and stressed the need to ensure that GSICS products will be accessible through WIS Data Access and Retrieval (DAR) functionalities, which entails adherence to WIS metadata standards and registration in relevant DCPC and GISC catalogues.

1.7 Pilot project VII - GRUAN

Background

The GCOS Reference Upper-Air Network (GRUAN) is intended to provide long-term high quality climate records of upper-air temperature, water vapour, and other key essential climate variables, particularly in the troposphere and in the lower stratosphere, by a combination of balloon borne and remote sensing state of the art instrumentation, and will constrain and calibrate data from more spatially-comprehensive global observing systems, including satellites and current radiosonde networks. Its over-arching aim is to create an unimpeachable record of changes in atmospheric column characteristics on multi-decadal timescales to support climate monitoring activities and climate dataset development.

GRUAN is in its early stage of implementation. Major milestones achieved so far include, the designation of the GRUAN Lead Centre at the Lindenberg Observatory (Germany), the definition of major requirements for reference measurements, the appointment of initial GRUAN stations, and the publication of the GRUAN Implementation Plan 2009-2013 (GCOS-134). The strategy to implement GRUAN in the next five years is described therein and complemented by the short- and medium-term GRUAN work plans which are updated on an annual basis following the Implementation-Coordination Meetings. More information, in particular on the previous GRUAN meetings in Lindenberg (2008) and Norman / Oklahoma (2009) are available from www.gruan.org.

Progress against the GRUAN-WPP Implementation Plan

i) An over-arching GRUAN Implementation Plan was completed in early summer of 2009, reviewed by members of the WG-ARO, endorsed by its sponsor bodies, and published as a GCOS Report / WMO TD. It provides a comprehensive five-year plan whereby the final network with all necessary supporting documentations and protocols is planned to be in place by 2013.

ii) A revised GRUAN-WPP documentation including an abridged Implementation Plan was submitted to the WIGOS Planning Office in August 2009.

iii) A document describing what will constitute a GRUAN measurement has been prepared by a writing team and is to be distributed shortly to the WG-ARO members for formal review. Following any necessary redraft it will be submitted for publication in the peer-reviewed literature.

iv) The GRUAN Lead Centre is developing a concept for the flow of heterogeneous data and metadata satisfying the needs of multiple stakeholders in the management of a heterogeneous network. In September 2009, GRUAN Lead Centre staff visited the US to meet with staff from the NOAA/National Climatic Data Center (NCDC) and the Atmospheric Radiation Measurement Programme (ARM) Climate Research Facility (ACRF). ACRF and NCDC staff discussed a working model for data collection, analysis and onward dissemination. Both institutions have substantial experience in data dissemination and data processing and have expressed interest in sharing this capability with GRUAN. A report mapping out a pathway forwards will be forthcoming and considered at the ICM-2 meeting.

v) Strong collaboration with CIMO has resulted in GRUAN-WPP inclusion in the 2010 CIMO radiosonde intercomparison campaign and the head of the GRUAN Lead Centre being a member of its international organizing committee. The Lead Centre head also went on a site visit to China. Communications between likely GRUAN participants in the field aspect, WG-ARO chair, Lead Centre and the overall CIMO project coordinator have been very successful. All indicators augur well for a successful campaign that will bring additional benefits to both GRUAN-WPP and CIMO by bringing these activities together in a strongly

coordinated fashion. In September 2009, the Lead Centre also held an analysis meeting to the 2008 LUAMI („Lindenberg Upper Air Methods Intercomparisons“) campaign which has delivered valuable lessons for the CIMO intercomparison.

Experiences gained

i) Working with CIMO on the intercomparison campaign has been an effective mechanism to communicate with manufacturers and interface with the operational community.

ii) The over-arching Implementation Plan has given a better sense of direction to the GRUAN activity as a whole.

iii) Working with multiple sites, members, and sponsors takes time to settle down. We recognize that communication is still not as good as it could be. More explicit guidance on reporting expectation and structures (preferably a template) would be an undoubted help for GRUAN-WPP (and perhaps other WPPs') reporting activities.

Implementation constraints

i) Some stations are facing severe funding problems and so far GRUAN has a certain misbalance towards northern hemispheric mid-latitude stations.

ii) Within the WG-ARO, the Lead Centre and the GCOS Secretariat there is neither the relevant expertise nor the resource to undertake the substantial effort of preparation of the Manual of Operations and other regulatory materials necessary for formal roll-out of GRUAN as a WMO affiliated network. Financial and/or in-kind resource and guidance is needed (the latter in particular from CIMO and CBS) to meet these ends. In this context, it should be noted that the CBS Management Group at its 10th session in June 2009 “stressed the importance of developing a GRUAN Manual and encouraged the Lead Centre and the WIGOS Planning Office to support such a development.“ It also “recommended to WMO CBS to establish an expert team on the GRUAN by the end of 2010 (at the next CBS session) to ensure good liaison of GRUAN implementation with existing WMO networks.”

iii) The GRUAN Implementation Plan, including aspects not within GRUAN-WPP but of relevance to WIGOS sponsors, is stretching and requires substantially more than the dedicated resource of the Lead Centre to be achieved. It is hoped that much of this can be geared from existing funding streams, but there is a substantial risk that this will not be the case.

Thus far there has been little formal involvement from WIS, but given recent progress this needs to be included shortly if the data dissemination aspect is to be congruent with WIS.

2. STATUS REPORTS OF THE WIGOS DEMONSTRATION PROJECTS

2.1 WIGOS Demonstration Project Kenya

The WIGOS Demonstration Project being undertaken by the Kenya Meteorological Department (KMD) has planned to improve and integrate the national environmental observational systems in Kenya including land, sea, and upper air observations. In so doing KMD wishes to involve other national partners to expand the range of observations and reduce the cost of such expansion. The project further is aimed at Standardization of Instruments and methods of observation in Kenya, Develop a Metadata catalogue for Interface with the WMO Information System (WIS), Improve Availability of National and Regional data through the WIS and Provide End-product quality assurance.
In Implementation of the Project, KMD gives preference to Improvement of National observational network through installation of new stations for surface, sea and upper air observations. Already 24 possible partners who have environmental data networks have been identified and an inter-ministerial committee is in the process of formation in order to discuss the way forward in the integration including taking an inventory of the all environmental data in Kenya. Software for coding data into Table Driven

Code Format (TDCF) has been developed and training is going on for the use of the software. Training for the trainers is already concluded. Development of Meta data catalogue is scheduled to start once the metadata standard has been understood. A metadata working group has been formed. Through the cost sharing effort of Finland VCP (through WMO) and the Government of Kenya, KMD will modernize the WMO Regional Instrument Centre (RIC) by installing calibration standards for humidity, temperature and wind sensors. KMD has signed a Memorandum of Understanding (MOU) with Meteo France International (MFI) to assist KMD to successfully realize the Implementation of WIGOS and WIS within the implementation timeframe.

During the Initial phase of Implementation of the Project, KMD has faced some experiences, problems and implementation constraints. Among them are difficulties in educating the targeted partners on the benefits of data integration, lack of knowledge on the existence of measurement standards, funding problems for implementation and procurement procedures. Consequently the implementation plan is slowed down. Presently KMD is trying to get more allocation in the supplementary budget in January 2010.

The Demonstration Project is estimated to cost USD 6,000.000 (six Million US Dollars) and is expected to be realized by the year 2011.

2.2 WIGOS Demonstration Project Morocco - Strengthening Moroccan RIC Capacities

In accordance with WIGOS CONOPS aiming to improve quality, traceability and consistency of observations for better products and services, the WIGOS Demonstration Project of Morocco was set up to test, at national level, the integration of an operational approach aiming to improve quality of measurements and to ensure traceability of the Moroccan Surface Observing Network.

The design of the demonstration project based on two WIGOS concepts related to standardization and traceability has led to the two axis of development:

- Strengthening material capacities and human knowledge of the Moroccan Regional Instrumentation Center (RIC) for AR-I and improving its technical procedures to allow it to accomplish its task of calibration in link to recognized Metrological International chain ,
- Establishment of Metadata catalogues of the National Surface observing Network.

The present state of progress of the DP is in concordance with timescale proposed and most of the actions of the Implementation Plan are in their final stages.

In order to strengthen RIC material capabilities, the NMHSs provide sufficient budget to acquire the necessary standards and calibrating equipment for pressure, temperature and humidity.

The NMS of Morocco provide training in matter of pressure metrology to RIC staff and will hold the French session of the WMO course on metrology for AR-I addressed to West and Central African French speaking countries (30 November to 03 December 2009 in Casablanca).

In terms of quality insurance, the quality approach of the NMS was extended to cover support processes like maintenance and calibration and quality circles are expected for RIC staff in matter of 17025 requirements.

While conducting the DP and being convinced that WIGOS offer a real benefit, the NMS of Morocco has adopted some WIGOS concepts such as accessibility and interoperability in various recent projects such as the implementation of a new real time automated observing network. For this project, the example of the Demonstration Project of Brazil was followed.

Some difficulties raises during the implementation of the demonstration projects and concerned basically the need of technical assistance during the development of calibrating software (A technical assistance was provided by RIC of AR VI) and the lack of practical procedures organizing the movement of sensors between the surface network and laboratory (NMS provides a number of digital barometers and temperature/humidity sensors to be used for replacement).

As first lessons learned, it seems clear that WIGOS should help in creating partnership frameworks between developing and developed countries. This cooperation should lead to a real knowledge

transfer.

2.3 WIGOS Demonstration Project Republic of Korea - Building a System for Shared Access to Meteorological Observation Data

The Korean National Assembly wanted to integrate and share meteorological observation data produced by 3,658 observation sites of diverse domestic agencies. The most agencies have the insufficient infrastructure, experience, and human resource to complete that. Additionally, there were many problems. Various agencies installed instruments for a number of purposes and used the data produced from the uncontrolled management of meteorological instruments and observation environment. Most agencies did not follow the WMO observation standards like as representativeness, calibration, adequate management of instruments etc. Even they did not know the exits of standards. The Korean National Assembly hoped that KMA (Korean Meteorological Administration) not only solve this problem and complete building a system but also execute government-driven initiative for meteorology observation standardization in according to WMO standards. For this reason, the federal law, which is called by Metrological Observation Standardization Law, was born and KMA started the project.

Progress of demonstrative project in 2009

- KMA has built system connecting 5 local governments and Korea Railroad. This system collects the data and also monitors the present state of sensors.
  - http://oss.kma.go.kr (Korean page only)
- Launching website of WIGOS DP for on-line demonstration on Aug 2009
  - http://web.kma.go.kr (English)
- Improvement of metadata website to carry out QA
  - http://naobs.kma.go.kr (Korean page only)

Project Funding

- The budget of KMA in 2010 is decided on US$5,300,000 for the metrological observation standardization, which is including the improvement of the calibration LAB and comparison sites for field test including rainfall intensity, snow fall, wind, extreme weather etc. Additionally, US$3,300,000 supported by Ministry of Public Administration and Security will be used for quality control of observation data and co-use of observation data.
- The budget of participating institutions in 2010 is decided on US$6,000,000 for the improvement of their observation sites and websites.

Lesson Learned

- Getting fund from the government was not very difficult in case of KMA because every people hope that the law and WMO standards are observed. Consequently, we realized the importance of Law and WMO standard.

Not solving problem

- The change of the observation environment as a consequence of industrialization.
- Lack of connection stability: The line is sometimes broken when the security policy of the partners is changed or the site is moved.
- Lack of partner's budget: We do not have the regal basis to support the participating institutions like as the calibration.

2.4 WIGOS Demonstration Project Brazil

Project Name	System for Meteorological Information and Quality Control Centro de Controle da Informação Meteorológica
Acronym	CCIM – II
Project Type	Demonstration Project in RA-III, Brazil
Project Status	Phase I of the system implemented and functioning. Review the specification for the second phase to meet WIGOS/WIS minimum requirements

Project Overview	The project started as a tool to control the status of INMET´s observing network, including communication links, installation and maintenance teams. The idea is to include in phase II of the system additional specifications to meet WMO developments and guidance, such us standard catalogue of products, availability of metadata to server DAR requirements. New types of data will be included in the data bank.
Project Aim(s)	To implement a data catalogue, create and populated a database, manage the data base and catalogue Possibility to include other types of data Coexist and Interact with the existent systems
Partners/Participants	National Meteorological Institute (INMET) and a partner private company
Funding Source(s)	Government budget allocated to INMET
Overall Project	Estimated at US$ 1.5 million
Project Timescale	2009 – 2011
Expected key Deliverables	Operationally available by 2011 (1) Control the status of the observational network (2) control the status of the communication links (3) provide access to data archived (4) provide meteorological bulletins in standard BUFR format (5) provide to the Region, our experience dealing with the metadata (6) publish document regarding the project implementation
Project Links	Not available at the moment
Project Summary	The main objectives of the project is to demonstrate the: 1) Effective use of the WIS standard forms for exchange meteorological information. 2) Generation of products from data types of different sources, with quality control and monitoring capability. 3) Use of GIS interface. The system was structured under the following subsystems: 1) Recovery and Exchange Information System - Data classification, using metadata, in order to facilitate data recovery and exchange of information between organizations through a unique and consistent way. - Establishment of a data catalogue from information extracted out of the GTS traffic and also from partner organizations or other centres. - Provide a pilot project with two other Brazilian organizations to demonstrate recovery of data not collected by or existent at INMET. 2) Quality Control System on Product Generation - Management of a Catalogue of products not generated at INMET. - Control and monitoring of the generation process of routine products. - Survey and planning of maintenance teams. - Alerts and warnings based on the quality of the data received. - Preparation of the catalogue of products available for visualization. 3) Web Portal - Data Discovery mechanism to allow search, visualization and download of data and information. - WebGIS interface with filters.

	- User interface to allow selection of specific products for customers. The system is based on web technology with an open source platform. It is planned to be multi-lingual (Portuguese, English and Spanish). It will be integrated with existent INMET Web Portal.
Date Last Updated	October 2009
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2.5 Demonstration Project US - Regional WIGOS Implementation

The Task Team (TT) will report to the Management Group (MG) of RA IV and will be accountable for assisting Members in the Region in developing and implementing WIGOS to meet WMO and Regional goals as identified by the (MG). The TT will also provide guidance for RA IV Members in assist them in developing their national WIGOS strategies.

Members will be asked to identify potential experts by the end of January 2010.

The President of RA IV will review the list and select a chair by the end of February 2010.

The TT chair, in consultation with the RA IV Management team, will assemble a small team of experts selected from this list.

The TT chair will report quarterly to the RA IV Management Group and represent the Team to (list of WMO coordinating bodies).

The TT will work closely with the WMO Secretariat through the Sub Regional Office in San Jose, with the Commission for Basic Systems, Commission for Instruments and Methods of Observation, and other WMO bodies as needed (e.g. the EC Working Group on WIGOS-WIS and its Sub-group) to:

- Review the evolving WIGOS requirements and strategies to complete an RA IV WIGOS Implementation Plan including an Operations Plan which will be the basis to mange future regionally coordinated observation requirements and operations.
- Participate in the larger WMO WIGOS development process to ensure RA IV needs are represented.
- Develop and guide regional implementation of RADAR data as an initial phase of WIGOS in RA IV.
- Seek funding for projects through the WMO Resource Mobilization Office, through direct contact with donor countries and through other avenues
- Development Regional WIGOS observing requirements for input to the CBS RRR process.
- Develop a regional instrument calibration strategy.

Future Project Activities:

Informal meetings between U.S., Canada and select others to develop and plan initial steps/strategies

RA-IV mtg week of 18 Oct – Review and accept Charge

Letter from the President to Members

Draft RA-IV WIGOS Plan exists – needs considerable work although major structure and concepts in place.

Strong tie in to improvement of operational exchange/availability of existing data/products in initial stages with a focus on RADAR

Follow up during U.S. AMS meeting in January

Initial dedicated TT meeting first half of 2010

Consideration to linking RA-III and RA-IV efforts

Several AMDAR initiatives also being worked

Dynamic management of upper-air observing needs in real or near real time – all obs forms, ground, air, space, in situ, remote

What are climate monitoring needs – how to address

Develop Regional based requirements process that will feed into RRR and will draw from as well as feed into national planning

Instrument standards, calibration, QC, - improvement of data utilization

Develop an operations plan with a similar approach to existing Hurricane Operations plan

Blur the line between research and operations both to improve early data utilization and shortening to transition

RA-IV approach is process oriented with focus on changing the way all observational data and product producers and users work, coordinate, collaborate and execute to meet national, regional and global needs

2.6 Demonstration Project Australia

The WIGOS web page provides access to the original summary description of this DP, the subsequent Implementation Plan, as well as a report describing the Bureau's Composite Observing System (BCOS) and some of the background and progress achieved. That report provides an expanded description of the presentation provided to TECO-WIGOS in March 2009.

The guidance for DPs includes an indication that “at this early stage of WIGOS development, the Demonstration Projects should aim to be focused on specific aspects of WIGOS and not be overly ambitious.” With that in mind, the scope of the Australian DP includes provision of commentary on the implementation of the BCOS, not necessarily a complete implementation of all aspects of the still-evolving WIGOS concepts.

Some key elements of progress were outlined:

- The basic drivers for change in observing systems include the need to meet evolving user requirements, to best utilize new and automated technology, while living within available resources. The implementation of the BCOS aims to make a longer term strategic response to these drivers rather than the ad hoc responses that might otherwise be made;
- A major component is reconfiguration of the upper air network, which has big impacts in terms of staff numbers and expenditure on consumables. Wind profilers will replace manual balloon release programs at nine stations and two more stations will change to automatic balloon release operations. Staffing at about half of the 50 upper air stations is progressively being reduced to one station manager supported by a pool of “leave relief” staff across the network. Associated changes in collection of upper air observations include improvements to the AMDAR network (with a significant increase in the number of planes reporting and implementation of a data optimization system) and installation of three X-band satellite ground reception facilities;
- Procurement of new systems is well underway;
- Internally across the Bureau, better linkages are being fostered to tackle all areas of standardization described in the WIGOS concept of operations. The Bureau is already actively

progressing the WIS information infrastructure however there is some work to be tackled in the area of introducing the WMO quality management framework;
- Opportunities are being explored to share information and find linkages with the RA V Working Group for Planning and Implementation of the WWW, and with the JCOMM Pilot Project;
- The internal structure of the Bureau's Observations and Engineering Branch was recently reorganised in a manner that aligns with and facilitates the WIGOS concept. The previous Sections for surface-based observations, space-based observations and atmosphere-watch observations have been replaced by a functional structure emphasising policy and strategy development for the composite system, data quality and improvement, engineering and project management support, and the management of operations.

Further, a number of experiences, problems and constraints encountered were identified:
- Strategic network planning is an ongoing process and needs to be informed by an ongoing process of assessing user requirements, current capabilities and outputs, options and priorities. With a view to the future, a regular "rolling review of requirements" process will now be developed in the Bureau;
- Declining staff numbers is a long term challenge. In Australia the number of field observers was about 300 in the mid 1980's but is now around 150 and declining. A period of delay in deciding and adopting permanent changes to the upper air network configuration required a period of less optimal ad hoc changes;
- NWP impact studies and observing system experiments are difficult to obtain but helpful;
- Procurement can be a complex and time consuming activity. Standards, specifications and experiences shared amongst WMO Members are helpful;
- Industrial relations and staff management can be a significant factor in determining what changes are feasible. BCOS implementation has involved an extended period of consultation about the movement of staff and introduction of new rosters. Assurances have been given that there is no intention to reduce the overall package of pay, penalties and overtime for affected individuals and that nobody will be forcibly transferred to a new geographical location.

Further reports on the progress of this DP will provide additional commentary on alignment with the WIGOS concepts and lessons learnt.

2.7 Demonstration Project Russian Federation

This Demonstration Project was designed to present practice in establishing and implementing an integrated meteorological and hydrological network (IMHN) in the Russian Federation. Traditionally, Roshydromet establishes and maintains operational functioning of the uniform meteorological and hydrological observing network.

Some preliminary results

The Russian Federation integrated meteorological and hydrological network (IMHN) has been improved at almost all levels identified for the WMO WIGOS;
- Integrated instruments and methods of observations have progressed most of all;
- Observing networks are modernized and Roshydromet organizational and management framework is strengthened under the International Bank for Reconstruction and Development (IBRD) project on modernization and technical re-equipment of Roshydromet entities and institutions;
- Volume of contracts on improved observing systems equals to $60 mln.;
- Special focus is placed on standardization and instrument calibration;
- Training curriculum has been developed.

Modernized observing system and data quality

Equipment delivery has begun (approximately 160 sets are planned to deliver at the first stage);
- Delivered equipment includes:
  - 28 mobile automated test laboratories (fig.2);
  - 14 stationary test laboratories (fig.3);
  - 12 automated test systems for hydrometric reels (fig.4);

    - 16 mobile hydrological laboratories (fig.5).
- A project on establishment of Regional Training Centres (RTCs) has been developed;
- Arrangements have been conducted to establish a set of regulatory documents (i.e. recommendations on observations, including re-equipment of Roshydromet meteorological and hydrological networks).

Services for users

Methods to calculate losses prevented through the use of hydrometeorological information in the weather dependent economic branches;

- Six workshops have been held with the major information users, responsible for preventive measures to maintain safety for the public and economy;
- Monitoring and assessment system has been implemented for users of services provided by Roshydromet entities and institutions.

Response to emergencies

Three mobile systems have been delivered for hydrometeorological services in emergency;

- Hazard detection, forecasting and information system has been analyzed and recommendations on its modernization have been developed, including interactions with emergency agencies;
- Text material and public reminders have been developed to provide regulations on how to behave during hazardous (adverse) hydrometeorological events.

Major outcomes

- increasing the number of stations including in the international data exchange through GTS (WIS);
- resuming observations in formerly blocked and newly opened points of observations;
- Improving quality and reliability of measurements;
- increasing the share of automated and automatic ground points of observation;
- increasing the number of automated communication facilities at remote stations;
- improving the working conditions of the staff at stations and posts, especially in severe weather conditions;

The special attention is given for providing the observational data quality and the establishing of training facilities for staff and students.

Conclusions

Integration provides the best and cost efficient management.

There are not yet some strong recommendations and prescriptions, but in process of project realization they will be formulated

There is a possibility of expansion of the DP

Resources of the WB – a potential source for modernization for many NMHSs.

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Appendix III

WORLD METEOROLOGICAL ORGANIZATION

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

CONCEPT OF OPERATIONS (CONOPS)

Version 4.0

(Colour code: Text from the CONOPS (Version 3.0) approved by EC-LXI)

October 2009

APPROVAL PAGE

WIGOS CONOPS intends to contribute to the implementation activities under the following WMO STRATEGIC THRUSTS:

I. Improving Service Quality and Service Delivery

II. Advancing Scientific Research and Applications as well as Development and Implementation of Technology

III. Strengthening Capacity Building

IV. Building and Enhancing Partnerships and Cooperation

V. Strengthening Good Governance

and specifically, to the implementation of the Organization-wide Expected Result 4:

Enhanced capabilities of Members to access, develop, implement and use integrated and interoperable surface-based and space-based systems for weather, climate and hydrological observations, as well as related environmental observations, based on world standards set by WMO and partner organizations.

WIGOS CONOPS RELEASE APPROVAL (Date): *DD-MM- 2010*

BODY: WMO EXECUTIVE COUNCIL (EC- LXII, paragraph *XYZ* **of the General Summary)**

DOCUMENT VERSION CONTROL

Version	Author(s)	Date	Description
1.0	Ondras, Dombrowsky	December 2007	First draft for review by the first session of the EC WG on WIGOS and WIS
1.0			Feedback from of the EC WG on WIGOS and WIS (No further changes)
1.0		June 2008	First draft for review by the EC-LX
1.0			Feedback from of the EC-LX (No changes)
2.0	Karpov, Zahumensky	November 2008	Second draft for the review by the first session of the EC WG on WIGOS and WIS Subgroup on WIGOS
2.1			Feedback from of the EC WG on WIGOS and WIS Subgroup on WIGOS (A deep review)
2.2	Zahumensky	May 2009	Third draft for review by the second session of the EC WG on WIGOS and WIS
2.3		May 2009	Feedback from of the EC WG on WIGOS and WIS (Part 5.4 elaborated)
3.0		June 2009	Third draft for review by the EC-LXI
3.0			Feedback from the EC-LXI (No changes)
4.0	Karpov, Zahumensky	October 2009	Fourth draft for the review by the second session of the EC WG on WIGOS and WIS Subgroup on WIGOS (Significant change of the structure based on standards and guidelines; addition of new text)
4.1	Karpov, Zahumensky	October 2009	Feedback from of the EC WG on WIGOS and WIS, Subgroup on WIGOS

CONTENTS

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

CONCEPT OF OPERATIONS (CONOPS)

1. SCOPE OF DOCUMENT

1.1 Identification of CONOPS

In accordance with international standards, the Concept of Operations (CONOPS) is a user-oriented document that describes characteristics of the to-be-delivered system from an integrated viewpoint. The CONOPS document also describes user needs for and expectations from the proposed system and how the system should operate to fulfil those needs.

The ideas expressed in this WIGOS Concept of Operations document are the results of analyzing the challenges involved in the implementation of the WMO integration strategy endorsed by the Fifteenth World Meteorological Congress in 2007.

In addition to CONOPS, the WIGOS Development and Implementation Plan (WDIP) will be provided for a logical transition of WIGOS from initial to full operational capabilities. To fully understand the WIGOS concept, these two principal documents must be considered together. Following the approval of WIGOS Concept by Cg-XVI the WIGOS Project and Implementation Plan will be developed.

1.2 CONOPS Document purpose

The purpose of this CONOPS document is to describe the WIGOS concept and relevant arrangements for its implementation. It serves as a basic means to communicate the high-level quantitative and qualitative characteristics of WIGOS to the user community within and outside of WMO and other stakeholders at the national and international levels.

Users might read the CONOPS document to determine whether their needs and expectations have been correctly identified, while the developers will typically use this document as a basis for WIGOS development and implementation activities.

1.3 WIGOS overview

1.3.1 Background

Various observing systems throughout WMO Programmes and WMO partner organizations have been developed, funded, managed and operated to meet their own specific purposes. By adopting the WIGOS strategy, the Fifteenth World Meteorological Congress wished to establish a comprehensive, coordinated and sustainable system of observing systems in order to satisfy evolving observational requirements of all WMO and WMO co-sponsored Programmes in a cost-effective manner.

1.3.2 Vision

WIGOS will establish an integrated, comprehensive and coordinated observing system to satisfy in a cost-effective and sustained manner the evolving observing requirements of WMO Members for their weather, climate, water and related environmental services and will enhance coordination of WMO observing systems with those of partner organizations for the benefit of society.

WIGOS will enable the evolution and integration of observing systems of WMO and enhance collaboration with its partner organizations. This will allow access to an expanded set of environmental data and products resulting in increased knowledge and enhanced services in a cost effective manner.

1.3.3 Purpose

The purpose of WIGOS is to establish an effective and sustainable organizational, programmatic, governance and procedural structure that will significantly improve the availability,

usefulness**,** quality and utilization of observational data and products through 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.

It will facilitate step-by-step integration of the WMO observing systems into a coordinated worldwide composite observing system, to satisfy in a cost-effective and sustained manner the evolving observing requirements of the WMO Members, and will enhance coordination of the WMO observing systems with those of partner organizations for the benefit of society. WIGOS will allow WMO Members' NMHSs and other relevant national and international institutions to better fulfil their mandates, including response to natural hazards, hydrological and environmental monitoring, climate observation, and adaptation to climate-change and human-induced environmental impacts.

1.3.4 Integration

Following the guidelines by Cg-XV, integration in the context of WIGOS should be defined as joint efforts by data users and data producers at the national and international levels to establish a comprehensive, coordinated and sustainable system of observing systems, ensuring interoperability between its component systems. It will be an organizational framework facilitating standardization and interoperability and ensuring availability and utilization of, and access to, good-quality data and products, and associated metadata. The integration process should encompass the following:

(a) Addressing the needs of the atmospheric, hydrologic, oceanographic, cryospheric and terrestrial domains within the operational scope of a comprehensive integrated system through standardization and network optimization;

(b) Increasing interoperability between systems with particular attention given to space-based and *in-situ* components of the systems;

(c) Ensuring that broader governance frameworks (e.g. inter-agency co-sponsored systems) and relationships with other international entities are sustained and strengthened;

(d) Improving WMO management and governance (use of resources, planning, institutional and programme structures, and monitoring).

1.3.5 General characteristics

Resolution 30 (Cg-XV) recognized WIGOS as a major effort of the Organization. Its development should proceed concurrently 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 Members' capability to effectively provide a wide range of high quality services and to better serve all WMO Programmes requirements.

Congress stressed that this endeavour would have an impact on the structure and functions of WMO, the WMO Programme structure, roles, terms of reference and working arrangements of technical commissions, the WMO Technical Regulations, and the WMO Secretariat.

WIGOS will build on and add value to the WMO's existing observing systems by coordinating their efforts, addressing shortcomings, and supporting their interoperability, while satisfying the observational requirements of all WMO and WMO co-sponsored Programmes in a cost-effective manner.

WIGOS will provide a mechanism for interaction and cooperation with the WMO co-sponsored observing systems, respecting partnership, ownership and data-sharing policies of all observing components and partner organizations. WMO will work with partner organizations to achieve maximum commonality of standards and practices across the co-sponsored observing systems.

1.3.6 Benefits

Across all WMO domains of activity, WMO Member countries and partner organizations will benefit from WIGOS:

- WIGOS will enable the evolution and integration of observing systems of WMO and enhance collaboration with its partner organizations. This will allow access to an expanded set of environmental data and products resulting in increased knowledge and enhanced services in a cost effective manner.

- WIGOS will better enable WMO Members' to meet expanding national mandates and achieve higher national visibility with other environment related agencies. In doing so, WMO Members will be able to better respond to natural hazards, improve environmental monitoring, and adapt to climate change and man-made environmental impacts. In this regard, WIGOS together with WIS will greatly enhance operational components of WMO Programs, especially in Developing and Least Developed Countries.
- WIGOS will provide a mechanism for enhanced integration between its surface, sub-surface and space based components.
- Integration will lead to efficiencies and cost savings that can be reinvested to overcome known deficiencies and gaps in the observing system. In this way WIGOS will provide capabilities to better utilize existing and emerging observational capabilities.

2. REFERENCED DOCUMENTS

The following documentation was used to support the generation of this document.

2.1 Reports of WMO Constituent bodies

- Fifteenth World Meteorological Congress, Abridged final report with resolutions (WMO-No. 1026)
- EC-LVIII, Abridged final report with resolutions (WMO-No. 1007)
- EC-LIX, Abridged final report with resolutions (WMO-No. 1027)
- EC-LX, Abridged final report with resolutions (WMO-No. 1032)
- EC-LXI, Abridged final report with resolutions (WMO-No. 1042)
- CBS-XIV, Abridged final report with resolutions and recommendations (*in press*)
- Final report of the 1st session of the EC WG on WIGOS-WIS (December, 2007)
- Final report of the 2nd session of the EC WG on WIGOS-WIS (May, 2009)
- Final report of the 1st session of the Subgroup on WIGOS of the EC WG on WIGOS-WIS (November, 2008)
- Final report of the 2nd session of the Subgroup on WIGOS of the EC WG on WIGOS-WIS (October, 2009)

2.2 WMO regulatory material and International Standards

- Basic Documents, No. 1, 2007 edition (WMO-No. 15)
- Technical Regulations (WMO-No. 49)
- Manual on the Global Observing System (WMO-No. 544)
- Manual on the Global Telecommunication System (WMO-No. 386)
- Manual on Codes (WMO-No. 306)
- Manual on the Global Data Processing and Forecasting System (WMO-No. 485)
- Weather Reporting, Volume A (WMO-No. 9)
- Guide to the Global Observing System (WMO-No. 488)
- Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8)
- Global Atmosphere Watch Guide (WMO/TD-No. 553)
- Global Atmosphere Watch Measurements Guide (WMO-No. 143)
- Guide to Marine Meteorological Services (WMO-No. 471)
- Guide to Agricultural Meteorological Practices (WMO-No. 134)
- Guide to Climatological Practices (WMO-No. 100)

- Guidelines on the Role, Operation and Management of National Hydrological Services (WMO-No. 1003)
- WHYCOS Guidelines (WMO/TD-No. 1282)
- ISO 14001 Environmental Management Systems
- ISO 9001 2008 Quality Management Requirements

2.3 Other relevant documentation

- WIS Project and Implementation Plan (v. 1.1, April, 2009)
- Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (GCOS-92, WMO/TD-No. 1219)
- GCOS Reference Upper-Air Network (GRUAN): Justification, requirements, siting and instrumentation options (GCOS-112, WMO/TD-No. 1379)
- WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008-2015 (WMO/TD No. 1384)
- Implementation Plan for Evolution of Space-and Surface-based Subsystems of the Global Observing system (WMO/TD-No. 1267)
- CBS TECO-WIGOS Conference Statement (March, 2009)
- WIGOS as a Challenging Initiative of WMO, Keynote by T. Sutherland, Second Vice-President of WMO (CBS TECO-WIGOS, March 2009)
- The first U.S. Integrated Ocean Observing System (IOOS) Development Plan, Washington, DC, January 2006
- Global Earth Observation System of Systems GEOSS 10-Year Implementation Plan (GEO 1000, February 2005)
- GEO 2009-2011 Work Plan (January 2009)
- IEEE Guide for information Technology- System Definition –Concept of Operations (CONOPS) Document, 1988
- NOAA Concept of Operations (CONOPS) for NPOESS Data Exploitation (NDE), 2006
- Concept of Operations (CONOPS) for the National Archives and Records Administration Electronic Records Archives Program Management Office (NARA ERA PMO), 2004
- EUCOS programme management documentation
- THORPEX International Research Implementation Plan (WMO/TD-No.1258)
- Third WMO Workshop on the Impact of Various Observing Systems on NWP, Alpbach, Austria, 9-12 March 2004
- JCOMM Observing System Implementation Goals for Building a Sustained Global Ocean Observing System in Support of the Global Earth Observation System of Systems (2009).

3. CURRENT WMO AND CO-SPONSORED OBSERVING SYSTEMS

3.1 Description of Existing Systems

Currently, WMO and co-sponsored observing systems are organized as multiple systems comprising of:

(a) The surface-based component of the Global Observing System (GOS) of the World Weather Watch (WWW) Programme;

(b) Space-based component of the GOS, including the geostationary meteorological satellite constellation, the core polar-orbiting meteorological constellation and R&D earth observation satellites;

(c) Aircraft Meteorological Data Relay (AMDAR) systems including expansions of aircraft

measurement capabilities for atmospheric composition constituents;

(d) Marine meteorological and relevant oceanographic observing networks contributing to GOOS;

(e) The relevant components of atmospheric, oceanographic and terrestrial observing systems contributing to GCOS;

(f) Relevant terrestrial network of GTOS;

(g) Regional, river basin and global hydrological networks such as WHYCOS;

(h) The Global Atmosphere Watch (GAW) networks and systems for observation of atmospheric chemical composition and related environmental parameters;

(i) The various radiation networks;

(j) The observing component of the proposed Global Cryosphere Watch approved by the fifteenth WMO Congress;

3.2 Operational Policies

Current WMO and co-sponsored observing systems are generally designed to meet the need for monitoring the state and composition of the atmosphere, land and ocean on global, regional and national scales. The resulting data and information, as well as the forecasts and warnings generated are internationally exchanged. Such information is required to improve understanding of the behaviour of the atmosphere and its interaction with land, oceans and biosphere to enable prediction of the future states of the Earth system.

With respect to the implementation of the above WMO and co-sponsored observing systems, the guiding principle is that all activities and facilities connected with the establishment and operation of observing network(s) on the territories of individual countries are the responsibility of the countries themselves and should be met to the extent possible from national resources. Where this is not possible, assistance may be provided through multilateral (regional) or bilateral cooperation programmes.

Implementation of certain observing systems outside the territories of individual countries (e.g. outer space, the oceans and the Antarctic) is based on the principle of voluntary participation of countries that desire and are able to contribute by providing facilities and services either individually or jointly from their national resources or through collective financing.

3.3 Classes of Users and Application areas

NMHSs continue to be the principal owners/operators and major users of data and information generated by the existing observing systems mentioned above. However, the user community is also represented by a growing diversity of stakeholders and decision makers, including national agencies, academia, non-governmental organization, public and private sectors and other societal areas. Depending on the observational data requirements and services provided, the end-user is affiliated to and represents the following application areas:

- Weather analysis and forecast, including early warning
- Agriculture and food production
- Aviation
- Land transport
- Marine resources and shipping services
- Hydrology and water resources
- Industry
- Environmental monitoring
- Disaster mitigation and prevention, emergency response
- Energy
- Public weather services, health and safety
- Climatology and climate services

Furthermore, the Statement of Guidance (SoG) for each of the application areas below has been developed and updated by the CBS OPAG IOS through the RRR process (see section 5.2.5):

- Global Numerical Weather Prediction
- Regional Numerical Weather Prediction
- Synoptic meteorology
- Nowcasting and Very Short Range Forecasting
- Seasonal and Inter-annual Forecasts
- Atmospheric chemistry
- Aeronautical Meteorology
- Ocean Applications
- Climate
- Hydrology
- Agricultural meteorology

It is expected that above application areas will be expanded to cover evolving WIGOS user requirements.

4. JUSTIFICATION FOR INTRODUCTION OF WIGOS AND DESCRIPTION OF CHANGES NEEDED

4.1 Justification of changes

An increasingly complex society and sophisticated user community, reflected by rapid economic and industrial development, coupled with increased knowledge of the planet as an integrated system and the changing Earth's climate has resulted in greater vulnerability of nations to extreme weather events and climate change. This has resulted in the need for more extensive and advanced information for WMO Members so that they can continue to improve service quality and service delivery. To meet the demands of the future, WMO Members must continue their legacy of contributions by taking full advantage of advances in observation and telecommunication technologies and to increase our science based understanding of the Earth and its environment: the end result being better prediction and assessment of potential impacts of weather and climate related events to provide the required information for the public and policy and decision makers.

Historically however, various observing systems throughout WMO and WMO co-sponsored Programmes have not been developed in a coordinated, integrated manner but being managed, funded and operated separately to meet their own purposes and goals. Under these arrangements it was not possible to standardize different observing practices including dissemination and processing of data which is now crucial to effectively respond to rapidly evolving user requirements mentioned above. At the WMO arena, lack of a single focus on the management of WMO-owned observing systems resulted in overlapping and duplication of work of expert teams governed by Technical Commissions responsible for different observing networks. Also, WMO regulatory material was not harmonized accordingly to assure clear and transparent guidance for Members. These factors seriously hampered the evolvement of WMO observing systems in a cost-effective manner. Coordination of observing programmes with partner organizations was also not sufficient.

In the view of the above, a proposed integration of existing observing systems is a necessary prerequisite to allow WMO Members to realize the modern organization's strategic thrusts which are:

- Improve service quality and service delivery.
- Advance scientific research and application as well as development and implementation of technology.
- Strengthen capacity building.
- Build and enhance partnerships and cooperation.
- Strengthen good governance.

The WMO Integrated Global Observing System, endorsed by the Fifteenth WMO Congress is a major contribution of WMO to this challenge. The WMO Congress decided that the enhanced integration of the WMO observing systems should be pursued as a strategic objective of WMO and identified this as a major expected result of the WMO strategic plan.

4.2 Description of expectations and desired changes

WMO and co-sponsored observational programmes aim to improve and sustain environmental observations (see Chapter 3). However, along with the progress in accomplishing general tasks mentioned in Section 4.1, current efforts in some regions are still limited by the following:

- Uncertainty about continuity of observations
- Large spatial and temporal gaps in specific data sets
- Lack of relevant processing systems to transform data into useful information
- Insufficient long term data archiving
- Eroding technical and organizational infrastructure
- Inadequate user involvement
- Lack of access to data and associated benefits, especially in least developed countries
- Inadequate data integration and interoperability
- Insufficient coordination and data sharing among Members, Organizations and Programmes

Therefore, to bring the current observing systems in line with the evolving requirements, the desired changes should encompass activities to address the above factors with a goal to minimize their effects. In this way WIGOS will provide the opportunity to better utilize existing and emerging observation capabilities, thus facilitating accomplishment of required changes. In particular, it is expected that WIGOS will:

- Develop strategies to guarantee systems interoperability, including meeting documented standards for data quality of observing systems and instruments;
- Evaluate existing and emerging capabilities before developing, acquiring, and/or deploying new observing systems or sensors, and in the design of cost-effective composite observing systems;
- Develop strategies to satisfy observational requirements of WMO Programmes and international partners through the WMO Rolling Requirements Review (RRR) Process;
- Develop a strategy for the production, editing and management of metadata, including instrumentation/platform and data discovery;
- Promote exploitation of existing platforms and employment of the multi-sensor platform concept to the maximum possible extent; and
- Coordinate the response to requirements, plans and activities with all WMO technical commissions, regional associations and Programmes.

Within the WIGOS framework, observational data, metadata and processed observational products from WMO and co-sponsored observing systems will:

- Adhere to WIGOS standards for instruments and methods of observation as well as standard observing network practices and procedures;
- Be exchanged via WIS using agreed upon data and metadata representation forms and formats;
- Use WIGOS compatible hardware and software;
- Be archived in compliance with WIGOS/WIS requirements.

WIGOS will consolidate the responsibilities of WMO observing systems. However, it should be well recognized and understood that WIGOS is not a consolidation of the responsibilities of WMO partner observing systems, but a framework for recognition and agreement of WMO and its partners concerning each observing system's contributions and responsibilities.

4.3 Priorities among changes

Classifying the changes and new features into *essential and desirable* categories is important to guide the decision making process during the development and implementation of WIGOS.

4.3.1 Essential changes

Features that ***shall*** be provided by the new or modified system(s) are as follows:

- Enhanced capability to meet all WMO Programmes' requirements in the most cost-effective approach, reducing the financial burden on Members while maximizing administrative and operational efficiency and effectiveness.
- Ensured observing systems interoperability, data compatibility and traceability of observations from all WIGOS constituent observing systems;
- QMS implemented according to WMO Programme requirements by data producers/owners of observing systems/networks;
- Improved access in real-time, near-real-time and delayed mode to wider range of observations required to meet the needs of Members through WMO and WMO co-sponsored programmes, as well as relevant international conventions;
- Improved metadata, data management, archival and data retrieval capabilities;
- More efficient delivery of observational data and products to users;
- Strengthened capability of all Member countries to access and utilize observations from all WMO and co-sponsored observing systems;

4.3.2 Desirable changes

Features that ***should*** be provided by the new or modified system(s) are as follows:

- The optimum integration of the various components of all observing programmes;
- Capability to effectively adjust and respond to changing requirements;
- Facilitated technological innovation opportunities;
- Improved collaboration with instrument manufacturers and scientific/research institutes in the development and testing of next generation observation instruments.
- Improved production, use and application of data and information from across all WMO and co-sponsored observing systems, in a seamless way, to satisfy user requirements;
- More rapid and effective assimilation of technological advances and their application across all observing programmes;
- Sharing observing platforms as far as practical to reduce redundancies.

4.4 Consolidation and Cost savings

WIGOS will support the establishment of an evolving optimized observing network(s) within a region(s) which results in a shared work load for the participating NMHSs along with enhanced capabilities and a fair cost allocation. WIGOS, inter-alia, will use experiences gained by regional observing programmes such as the EUCOS (EUMETNET Composite Observing System) Programme, which has helped eliminate duplications of effort in the upper air and surface observing components operated by NMHSs and ensured that the quality of all data delivered by the EUCOS networks has been maintained at a high level. In doing so, the WIGOS framework will significantly enhance capabilities of Members which they would not have been able to deliver on an individual uncoordinated national basis. To move WIGOS forward in a cost-effective manner and to overcome differences in levels of development of national and regional systems and services, it would be required to develop Regional WIGOS Implementation Strategies that considered, among other things, how Members within Regions can most effectively work together. Also, it is expected to develop regional cooperation programmes like EUCOS which has already demonstrated very promising results for the testing of new observing strategies and indicated ways towards optimization. For the benefit of WIGOS, it will be also of great importance to exploit the lessons learned from the International Ocean Buoy Programme, where WMO and IOC as co-sponsors worked together to coordinate a more robust and cost-effective observing system.

4.5 Technology improvements

Technological advances will be a crucial factor leading to improvement in sensors and system capabilities to withstand severe climate and environmental conditions and to improvements in sensor capability to accurately measure the whole range of meteorological, climatological, hydrological and environmental variables with high accuracy and repeatability. Progress in technology will continue to provide a basis for further improvements in the reliability and quality of observations, thus more fully satisfying user needs. Based on the above, within the WIGOS framework, the following areas need to

be addressed: Standardization, Automation, Testing, and Networking.

Standardization will address best procedures and practices, including quality assurance, data and metadata formats for new and emerging technologies. Standardization is necessary for all data and associated metadata so that the measurements from individual systems can be integrated into accurate and coherent data sets that allow for the development of unbiased, homogeneous long-term trends.

Automation will enable growth at reduced costs by allowing for increases in data frequency and consistency while avoiding coincident increases in labour costs. Further development of integrated surface-based remote sensing systems will make it possible to provide observations of key atmospheric variables and processes relevant to weather, water and climate with high time resolution.

Long-term ***testing*** at instrument "test-beds" will be used to judge instrument design, performance, reliability, capability, and cost-effectiveness for a full integration into WIGOS.

Networking will be addressed through a coordinated data acquisition effort of NMHSs and other data providers to minimize duplication and by optimization of the observing network design and its flexibility to incorporate new observing systems after their successful testing and evaluation.

In addition, development in data assimilation techniques will allow the observations to be fully exploited in numerical models in an integrated manner. Assimilation will provide the means for data to be combined with other data in a cohesive and scientific way, as in NWP.

5. WIGOS CONCEPT

5.1 Objectives and scope

Nowadays it is well recognized that rapid assessments of the current state of the Earth system and the timely detection and prediction of changes in it, depend on the establishment of an integrated operational observing system that routinely, reliably and continuously provides required information in forms and rates specified by various users.

Objectives

The Fifteenth World Meteorological Congress envisaged that WIGOS should encompass four broad objectives:

(a) Improving management and governance (use of resources, planning, institutional and programme structures, and monitoring);

(b) Increasing interoperability between the various systems with particular attention given to the complementarity between the space-based and *in-situ* components of the systems;

(c) Addressing the domains (atmospheric, oceanic and terrestrial, including hydrological) as a comprehensive total system;

(d) Ensuring that broader governance frameworks (e.g. inter-agency co-sponsorship of systems) and relationships with other international initiatives (e.g. GEO) are respected, sustained and strengthened.

Scope

To achieve its objectives, WIGOS will:

- Build upon the existing observing components of WWW GOS, GAW, and WHYCOS, and will capitalize on existing, new and emerging technologies.
- Improve access to and utilization of surface-based observations and products from co-sponsored systems such as GTOS, GOOS and GCOS through enhanced coordination with partner organizations.
- Introduce data quality standards to improve quality management to satisfy user requirements.
- Improve its space-based component by enhanced collaboration through partnerships such as the Coordination Group for Meteorological Satellites (CGMS) and the Committee on Earth Observation Satellites (CEOS).
- Enhance integration between its surface- and space-based components.

- Provide a mechanism to meet new observational requirements of its Members.
- Make a major and unique contribution to United Nations agencies that are focused on environmental stewardship.
- Be a core contribution of WMO to the GEOSS.

5.2 Key elements of the operational WIGOS

Following the guidance by Cg-XV, WIGOS will build on and add value to WMO's existing observing systems by coordinating their efforts, addressing shortcomings, supporting their interoperability, while meeting user requirements.

The list of current observing networks as the key elements of the future operational WIGOS is given in Chapter 3. Integration, as a prerequisite to WIGOS implementation is described in Section 1.3.4. Congress also identified that the progress with the WMO Information System (WIS) will be essential element for the WIGOS framework. The WIGOS standardization process and quality management procedures will ensure that user requirements for various application areas are met at national, regional and global levels.

5.2.1 Integration, Standardization and Interoperability

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 enabling integration.

Key areas of standardization

A key requirement for integration is the standardization in three key areas as shown schematically in Figure 1:

- Instruments and methods of observation;
- WIS information infrastructure;
- Quality management framework.

5.2.2 Standardization of instruments and methods of observation

WIGOS should encompass homogeneity, interoperability, compatibility and traceability 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 observation by the Instrument and Methods of Observation Programme (IMOP) and related programmes of partner organizations within WIGOS constituent networks, including tests, calibration and intercomparisons.

5.2.3 WIS Information infrastructure

In order for WIGOS to effectively and efficiently respond to user data needs, WIGOS will use the WMO Information System (WIS) as a data exchange, discovery, access, and retrieval mechanism. Observational data and products generated by all WIGOS constituent networks, as well as associated metadata, shall meet a comprehensive, standardized set of WIS data and metadata exchange requirements.

Technologically, the key action leading to the desired integrated networks will be the generation of data and information from WIGOS constituent networks using comprehensive, standardized data representation in compliance with WIS information exchange requirements for all WMO Programmes. More specifically, the role of WIS will be as follows:

- It will be used in the collection and sharing of information for all WMO and related international programmes;
- It will provide a flexible and extensible structure that will allow participating centres to enhance their capabilities as their national and international responsibilities grow;
- It will provide communication networks based on communication links used within the World Weather Watch (WWW) for distribution of high priority real-time data;
- It will utilize international agreed-upon standards for protocols, hardware and software.

Detailed description of WIS is presented in the WIS Project and Implementation Plan (Section 2.3).

5.2.4 Quality Management Framework

The third key area of standardization for WIGOS should embrace a quality management framework (QMF) and the development, use and maintenance of the relevant WMO technical regulations to ensure that:

- observations, records and reports on weather, water, climate and the natural environment are of documented quality for international exchange through the WMO coordinated systems and relevant joint standards with other international organizations,
- the best possible products and services are delivered to end users. This should be based on agreed-upon quality assurance and quality control standards, with the goals of developing and implementing an integrated quality management system that delivers reliable and timely data streams with adequate quality control and relevant metadata.

The corresponding activities shall be compliant with Resolution 31 (Cg-XV), Implementation of Quality Management Systems by National Meteorological and Hydrological Services and Resolution 32 (Cg-XV), WMO Quality Management Framework.

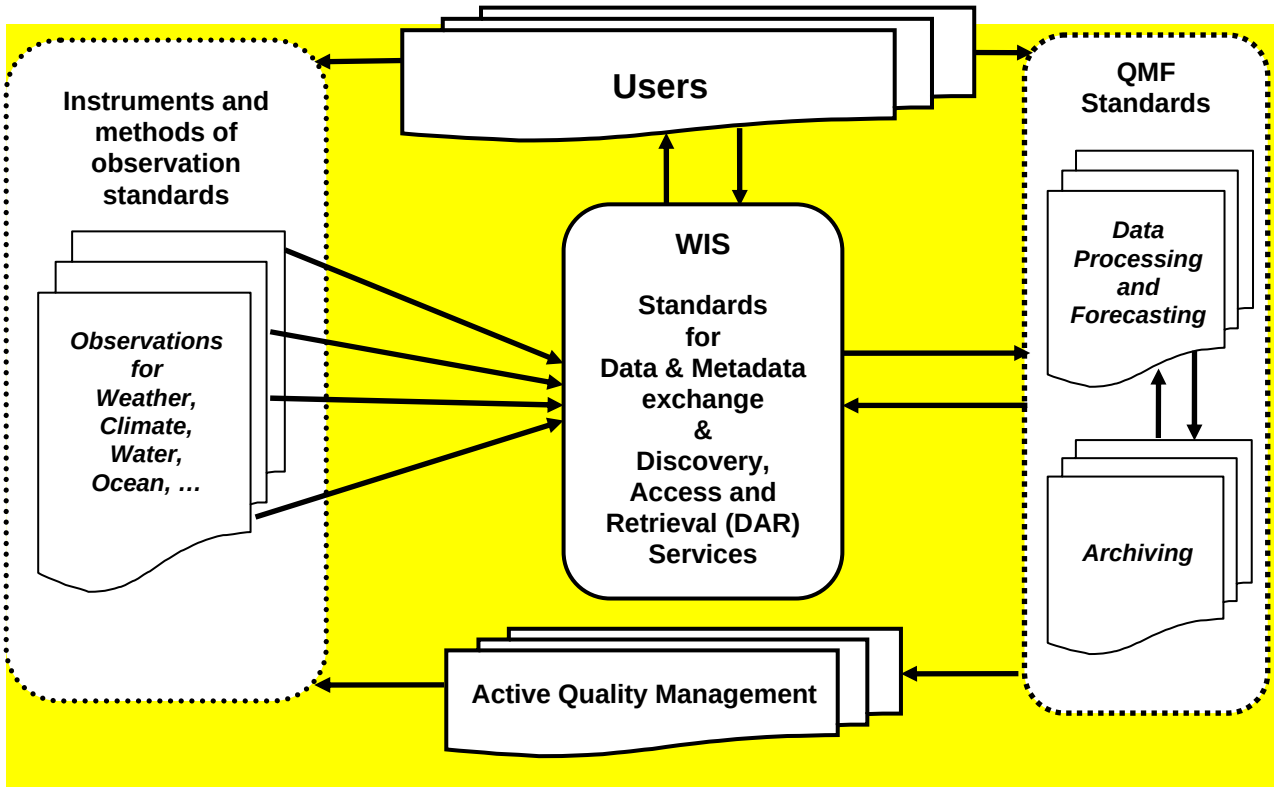

Figure 1: Key areas of WIGOS standardization

5.2.5 Rolling review of Requirements (RRR) process and Statement of Guidance (SOG)

To ensure continuous review of the requirements placed on the current observing systems and to have the capability to effectively adjust and respond to evolving needs, WIGOS will be using the RRR process defined by the Manual on the Global Observing System (WMO-No. 544). In the RRR process schematically shown in Figure 2, user requirements for observations are compared with the capabilities of present and planned surface-and space-based observing systems to objectively indicate the feasibility of achieving the stated requirements for a given Application area (see Section 3.2). The resulting Statements of Guidance (SOG) provide an assessment of the adequacy of the observations to fulfil requirements and suggests areas of progress towards improved observing systems. Within the WIGOS framework the most significant variables for each Application area will continue to be analyzed in the SOGs. Both user requirements and observing system capabilities are collated in a

comprehensive, systematic and quantitative way in the WMO/CEOS database, which is accessible at: http://www.wmo.int/pages/prog/sat/Databases.html.

Using the above RRR process defined by the Manual on the Global Observing System (WMO-No. 544) (Part II, Requirements for observational data), user requirements for observations are compared with the capabilities of present and planned observing systems to provide them. Both user requirements and observing system capabilities are collated in a comprehensive, systematic and quantitative way in the WMO database, which attempts to capture observational requirements to meet the needs of all WMO programmes. The comparison of user requirements with observing system capabilities for a given application area is called a **Critical Review**. The output of the Critical Review process is reviewed by experts in the relevant application and used to prepare a Statement of Guidance (SOG), the main aim of which is to draw attention to the most important gaps between user requirements and observing system capabilities, in the context of the application. A wide range of applications within WMO programmes have already been addressed. Further information is available at: http://www.wmo.int/pages/prog/sat/Databases.html.

As directed by Congress, it is essential to implement a Rolling Review of Requirements (RRR) Process to ensure that WIGOS will address and meet stakeholders' needs. Therefore, it is also essential that user requirements are kept continuously under review.

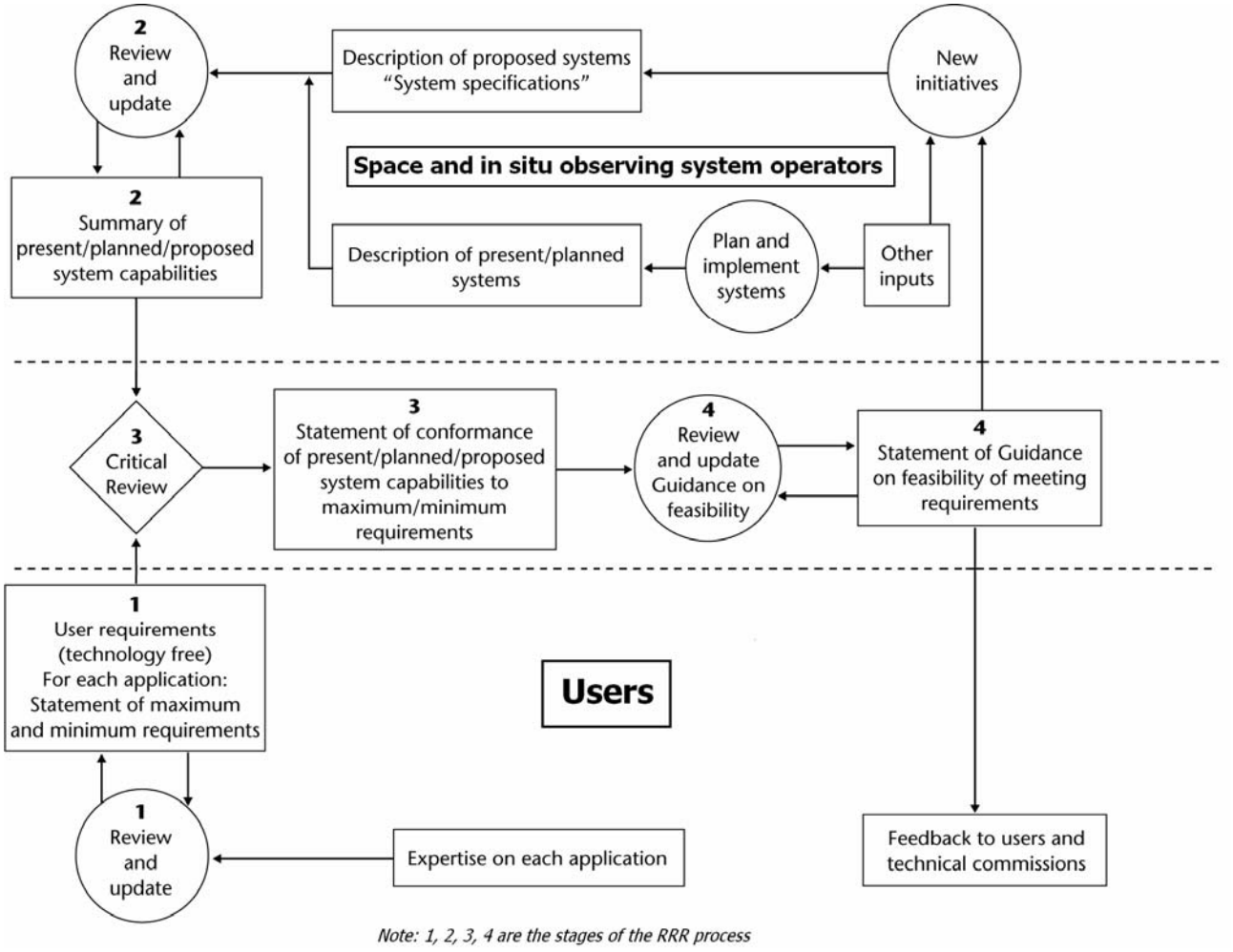

Figure 2: Rolling Review of Requirements Process

5.2.6 Pilot and Demonstration Projects

The following Pilot and Demonstration Projects will be used for lessons learned to be submitted to Cg-XVI as a part of the WIGOS Development and Implementation Plan.

Pilot Projects

In accordance with recommendations by Cg-XV, seven Pilot Projects were initiated by the relevant technical commissions during the WIGOS test-of-concept phase:

- Pilot Project I: Improvement of Dissemination of Ozone (total column, profiles and surface) and Aerosol observations through the WIS;
- Pilot Project II: Hydrological Applications Runoff Network;
- 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 Oceanographic Observations into the WMO Integrated Global Observing System,
- Pilot Project VI: Global Space-based Intercalibration System as a joint initiative of WMO and the Coordination Group for Meteorological Satellites, and
- Pilot Project VII: Project for the implementation of the GCOS Reference Upper-Air Network.

Pilot Projects played an essential role in addressing major issues of the integration process: testing the WIGOS concept, identifying problem areas, emphasizing the role and contributions to be made by the technical commissions and relevant partners in applying the WIGOS concept to integration within a system of systems framework, and contributing to the development of the WIGOS Development and Implementation Plan.

Demonstration Projects

In accordance with recommendations by EC-LX to support the involvement of NMHSs and regional associations in the implementation of the WIGOS concept and to help Members to understand and fully explore WIGOS, several demonstration projects in the selected WMO Member Countries were initiated. At least one 'test-bed' Demonstration Project was identified within each of the Regional Associations with various levels of progress. They were as follows: Kenya, Morocco and 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).

Feedback and lessons learned from these NMHSs were beneficial for WMO Members and Partners in understanding expectations from the WIGOS concept at national and regional levels, including significant capacity building possibilities.

The status of implementation of WIGOS Pilot and Demonstration Projects is posted on the WIGOS Web page at www.wmo.int/pages/prog/www/wigos/.

Other WIGOS Activities

It is recognized that other WIGOS related activities may be initiated before Cg-XVI and those will be taken into account when developing the WIGOS Project and Implementation Plan.

5.2.7 Operational Database

A database (DB) describing all the observing systems components and respective networks contributing to WIGOS should be developed to provide end users with relevant metadata, crucial for the operation of WIGOS and for the WIS Data Discovery, Access and Retrieval (DAR) services. A database should allow users to make relevant recommendations in terms of network design, evaluation and optimization; system governance and management and all other aspects dealing with observing system operation and performance.

For the purposes of developing such a database, data producers will be fully responsible for providing adequate and sufficiently detailed metadata related to all parts of their observing systems and networks. Generally, the WIGOS operational database should include the following:

- Basic observing network/system characteristics (governance, management, observing programme, standard compliance information, data policy, etc.);
- Basic station characteristics (name, number/identifier, geographical coordinates, observing programme, etc.);
- Basic instrument characteristics (siting, exposure, sensor type, principle of operation, instrument performance); data-processing, handling, transmission, quality assurance information, etc.).

5.2.8 Standardization Database

A database of standards should be developed. It would provide a single access point to all the WMO standards, guidelines, best practices, procedures, etc., addressing all aspects of observations (instruments, methods of observation, metadata format, coding, etc.).

Such a database would enable on one hand the network managers and operators to easily access the information they need to set-up and run their systems and on the other hand the data users to understand the standards that were used in performing specific observations they are considering to use providing appropriate metadata are available.

5.2.9 Roles and Responsibilities

Cg-XV urged Members and invited international partner Organizations and Programmes to collaborate actively in, and give all possible support to, the development and implementation of the WIGOS initiative. It is also recognized that full implementation of WIGOS requires firm long-term commitments from all partners and mutual understanding by all partners to accomplish their current and planned observational activities in coordinated fashion. Further, WIGOS development and implementation is especially challenging, involving significant effort and time and will require consensus of all involved on numerous issues.

In order to commence efforts towards achieving full WIGOS operations, the entities listed below are considered to have essential roles and should assume, along with their general terms of reference defined in Basic documents (see Chapter 2), the following responsibilities:

Members and Organizations operating WMO and relevant parts of the co-sponsored observing systems will:

- Ensure quality control at point of observation generations and document the quality;
- Provide all relevant metadata in accordance with WMO regulatory material;
- Implement quality management systems (QMS) at all points of their observing system (i.e. planning, installation, operations, maintenance, inspection, field testing, calibration, training, data processing, dissemination, management, archiving; performance monitoring, evaluation, feedback and follow-up actions);
- Implement relevant observing system interoperability and data compatibility arrangements.

Executive Council will:

- Steer and monitor the WIGOS development and implementation activity, and achieve the broadest possible collaboration, cooperation and coordination all of stakeholders;
- Ensure coordination of WIGOS and WIS plans and activities;
- Ensure active participation and representation of the principal bodies concerned and also the participation, as appropriate, of technical experts and representatives of agencies undertaking co-sponsored observing initiatives;
- Ensure that this mechanism is closely coordinated with the institutional arrangements for planning and overseeing the WMO Information System;
- Provide advice, guidance and support for the implementation of WIGOS.

Regional associations will:

- Be fully engaged in the WIGOS development and implementation, through appropriate working structure, incorporating relevant standardization, integration, capacity building and outreach activities in their strategic plans and work programmes;
- Make appropriate recommendations for, provide advice and feedback on WIGOS related activities reflecting specific regional aspects;
- Encourage active involvement of Members in regional WIGOS implementation activities;
- Provide assistance to Members with specific implementation needs and promote sharing experiences and collaboration of Members in all WIGOS standardization areas.

Technical commissions will:

- Conduct and coordinate their activities, through appropriate working structure, that could contribute to the further development and implementation of WIGOS;
- Monitor the progress in the development and implementation of the relevant WIGOS activities, collaborate , and provide technical guidance and assistance on further WIGOS development and implementation;
- Provide quality management related technical guidance, advice and assistance.
- Closely collaborate with other relevant TCs in reviewing, updating and harmonizing technical publications and guidance relevant to the observing practices, procedures;

WMO Secretariat will have to:

- Strengthen coordination and collaborate closely with relevant international partner organizations and programmes in pursuing this endeavour;
- Provide necessary secretariat support and take appropriate initiatives for the implementation of WIGOS;
- Arrange with Members for adequate resources to support WIGOS design and implementation;
- Adapt the structure of the Secretariat as and when appropriate, so as to ensure optimal management of and support to the initiative.

Partner organizations will:

- Collaborate and coordinate with WMO to develop common standard practices and procedures for improving availability, access and quality of observational data and associated metadata that will be interoperable with the WIS;
- Adhere to defined quality management principles to improve data management including archival and data retrieval capabilities;
- Within the framework of WIGOS, develop and promote common standards for the data policy and governance.

5.2.10 Capacity Building

Implementation of WIGOS will require Members to focus on:

- Institutional mandates and policies;
- Infrastructure establishment and/or strengthening;
- Human skills development and training.

Where possible, WIGOS will be built using those existing elements (above) that are either in place or are in the process of being established. However, it needs to be recognized that in many Member countries the existing elements in themselves would require strengthening. In many cases the primary networks are already owned and run by the NMHSs or at least coordinated with them; however this is not the case for all Members.

In order for WIGOS to succeed, governments should give high priority to financing their NMHSs, communications, power and other infrastructure. Those countries that are able to help others, particularly the Organization for Economic Co-operation and Development (OECD) members, could do so through bilateral arrangements and through WMO and other UN initiatives. Wherever possible, existing and proposed projects and observation-related initiatives aimed at building capacity should be harmonized with the activities within the WIGOS. In view of the benefits that would follow for society as a whole around the world, Members could encourage the funding and development agencies their countries support (e.g. World Bank and others), to give high priority to WIGOS implementation and ongoing operation (infrastructure, communications, etc.).

Beginning with the detailed development of the WIGOS Implementation Plan, close collaboration, should be established with implementing and financing agencies such as the World Bank, regional development banks, the European Commission, the United Nations Development Programme

(UNDP), the Global Environmental Facility and other bilateral and multilateral development agencies. To ensure the implementation and sustainability of WIGOS components, collaboration and partnerships should be sought with regional economic groupings, including the United Nations Economic Commission for Africa, ASEAN, the International Group of Research Funding Agencies (IGFA) and other national agencies with funding capacity. Alignment would be sought with other institutional programmes related to climate change, such as the AU-ECA-led ClimDev-Africa.

The Regional WIGOS Implementation Plans will incorporate the training needs necessary to develop capacity at national and regional levels and for identifying user requirements for education and training and for information-sharing techniques. Human skills in taking observations, maintaining equipment and utilizing national, regional and global data and products would be developed through access to education and training utilizing appropriate methodologies such as traditional and online education and training, manuals, guidance documents, technical papers, fellowships and workshops. Members will also be encouraged to utilise education and training resources within the countries such as Universities and Technical colleges as well as accessing WMO Regional Training Centres, WMO Regional Instrument and Radiation Centres and other partner training organizations. At a Regional and global level the challenge will be to develop partnerships such as the WMO Virtual Laboratory for Satellite Education across the realm of WMO application areas that bring together the science community, the major global production centres and the training institutes. This would enable the flow of good science into operations with associated user level training to allow the global community to benefit from their investment in the national, regional and global observing and product creation infrastructure.

5.2.11 Governance

As underlined by the Cg-XV, the integration is a long-term complex undertaking, which will comprise policy as well as technical issues and will require the full support of all Members to be successful. The integration within a WIGOS framework will actively involve and eventually depend on the expertise and inputs from the technical commissions and regional associations. It is also recognized that close and effective collaboration with several of WMO's partner organizations and co-sponsors of observing systems will be one of the key elements of the process (see section 6.2).

In implementing WIGOS, it will be necessary to ensure that the governance and support activities are aligned with the strategic thrusts of WMO, including results based management. Furthermore, the development of an effective and efficient system of governance will require adequate scientific and technical advisory mechanisms to develop, monitor and evaluate the WIGOS process. WMO Executive Council through its Working Group on WIGOS-WIS (EC WG on WIGOS and WIS) will continue to steer and monitor WIGOS activities and ensure the broadest possible collaboration and cooperation (see 5.2.9 Roles and Responsibilities of Executive Council). In the process of WIGOS implementation, adjustments to the WMO Programme structure, working structure, function and terms of reference of relevant technical commissions, and to the WMO Secretariat will be required. Accordingly, WMO regulatory material will have to be adjusted as appropriate.

Congress also stressed the significance of cross-cutting coordination and collaboration among the technical commissions and regional associations, and agreed that steps be taken to ensure the programme-wide nature of integration initiative would be accommodated in their work programmes. Accordingly, for WIGOS to succeed it will be necessary to form task teams at the regional, commission and partner levels:

- Regional task teams will need to coordinate planning and implementation for WIGOS on the regional level in coordination with WIS implementation, with a goal of optimizing regional and national observing system(s);
- An Inter-Commission Task Team will be needed to address standards, observing system integration and governance;
- The task team composed of experts of WMO and Partner observing systems will need to address issues such as governance, data sharing policy, standards, etc.

Terms of reference of the above bodies should be developed, coordinated and eventually approved by RAs and TCs concerned and also by WMO partner organizations.

5.2.12 Resources

WIGOS operational activities will require additional resources and support at the national, regional and global levels as well as within the WMO Secretariat. It will also require additional resources within observational programmes of WMO partner organizations.

It is recognized that WIGOS operations will be carried out in accordance with the principle that these activities are within the responsibility of the Members themselves and should be borne by national resources (see section 3.2). Therefore, most of the resources will be provided through existing national and international mechanisms, and by voluntary contributions to special WIGOS projects. To assure a baseline funding for WIGOS operational activities, the following resources should be considered:

- National/international funds for current observing systems operations and management;
- Regular WMO budget, covering costs for the WIGOS related activities in RAs and TCs, including selected meetings, the WIGOS staff in the Secretariat, WIGOS consultant/expert services, and related general services, such as publication of technical guidance;
- Special WMO Trust Funds maintained by WMO Members and other Partners;
- Regular WMO budget for Voluntary Co-operation Programme, specially used for technical cooperation and capacity-building activities.

As it follows from the above, the resources needed for operational WIGOS include additional funds, staff, facilities (infrastructure), and expertise. The funding strategy should foresee the Member's federal agency (presumably NMHS or other entity operating the observing network) budget submissions for WIGOS activities and anticipated governmental approval. It is expected that WIGOS operational elements will be funded for extended periods based on user needs, whereas WIGOS Pilot and Demonstration projects will have specific objectives and will be funded only for finite periods.

5.3 Assumptions and Constraints

The proposed WIGOS concept relies on a set of assumptions that are derived from WMO operational policies or are inherent in an environment of co-sponsored systems. The implementation of WIGOS assumes that:

- The WIGOS integration process will be a complex, evolving and not risk-free undertaking; it will require significant support of WMO Members to be successful.
- 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 co-sponsored observing systems. Strong cooperation and collaboration is needed among all partners to achieve maximum commonality of standards and practices across the co-sponsored observing systems.
- 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 will be guaranteed.
- WIGOS development and implementation will cause no harm or limitation to the existing WMO or co-sponsored observing systems;
- Significant technical innovation and capacity-building activities will be essential to take advantage of WIGOS benefits, especially in the case of developing countries and LDCs.

The following constraints should be taken into account:

- Different levels of development as well as diversity of Member's capabilities, needs and available resources will have to be taken into account;
- Acquisition of additional funding and resources will require continuous efforts on national and international levels.

6. OPERATIONAL POLICY CONSIDERATIONS

Many of the building blocks (see Section 5.2) of the future operation of WIGOS already exist and are of high value to current users. It is recognized that proper interaction between constituent systems of WIGOS with respect to data management and standardization necessitate an unprecedented level of coordination and collaboration among the owners of the observing systems.

6.1 Data policy

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.

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.

Since there are differences among existing policies of partner organizations, it may not be possible to integrate them into one single Data Policy. In this connection WIGOS Data Policy should be preferably composed of two main parts, the first defining common policies and the second specifying individual data sharing principles and practices of all WIGOS partners.

Common WIGOS Data Policies

- The common policies could be seen as a minimum set of commonly agreed principles, adopted by consensus of all partners. In this way WIGOS partners would retain their full autonomy.
- Major commonality of WIGOS partners’ data policies relate to the provision of data (and metadata) for non-profit, scientific and/or educational purposes. Special consideration to research and education could be described in this part of WIGOS Data Policies.
- Many partners’ data policies also refer to the full and open access (exchange) of data and metadata with minimum time delay, free of charge or at the cost of no more than the cost of reproduction and delivery. There may be, however, partners that do not fully recognize these principles but may be willing to reconsider and expand their current policies. This would require appropriate level of negotiation with partners.
- ***Individual data sharing principles and practices***
- It would be counter-productive to enforce or otherwise make mandatory any policy by WIGOS to its partners. The participation in WIGOS is voluntary, however, all partners taking part in WIGOS should do all they can to improve availability and delivery of their observational data and products.
- Some partners have generic policies while others have quite specific policies and also practices. Some other partners also refer to policies of other organizations or groupings that make their data policies less easy to be understood. This will require significant work effort to resolve.

6.2 Relation with the WMO and co-sponsored observing systems

Effective implementation and operation of WIGOS will require close ongoing collaboration with several of WMO’s partner organizations (UNESCO and its IOC, UNEP, FAO, and ICSU) with whom it co-sponsors the Global Ocean Observing System (GOOS), the Global Terrestrial Observing System (GTOS) and the cross-domain Global Climate Observing System (GCOS). Collaboration will be necessary in order to ensure essential interoperability and mutual support while also respecting and reinforcing the individual identities and mandates of both the partners and their co-sponsored observing systems. It will also require a clear understanding, at both international and national levels, as to how WIGOS, GOOS, GTOS and GCOS fit together within the overall framework of GEOSS.

By virtue of WMO’s co-sponsorship of the IOC-led GOOS and the FAO-led GTOS, those parts of these systems which contribute to, or support, WMO research and service programmes**,** are appropriately regarded as contributions to WIGOS. Every effort should be made, therefore, to achieve

full interoperability and mutually supportive advisory and coordination arrangements with both GOOS and GTOS.

Similarly, the jointly-sponsored, cross-cutting GCOS, which is made up primarily of the climate-relevant components of WIGOS, GOOS and GTOS, will need to be implemented and operated on the basis of maximum possible complementarity and mutual support between GCOS and its component systems, including WIGOS.

Coordination will be needed at policy, technical and governance levels. Policy and technical coordination will be facilitated through cross representation at sessions of the advisory/steering committees and implementation bodies of the various systems supported by joint working groups and the like. The principal mechanism for inter-Secretariat coordination will be the WMO-UNESCO-UNEP-FAO-ICSU Interagency Coordination and Planning Committee for Earth Observations (ICPC), which was established to ensure a well-coordinated UN system contribution to GEOSS.

The policy, technical and Secretariat coordination mechanisms may also need to be supported by a higher-level reconciliation mechanism defined through the WMO-UNESCO-IOC-UNEP-FAO-ICSU Memoranda of Understanding (MOU) in order to resolve possible conflicts on data policy, product delivery and other governance issues.

These interagency and inter-observing system coordination mechanisms at the international level will need to be complemented and supported through similar cooperation and coordination arrangements between NMHSs and their counterpart national implementation mechanisms for GOOS, GTOS, GCOS and GEOSS.

6.3 Science Support

New technology and scientific knowledge is required to enable WIGOS user requirements to be met. Both hypothesis-driven and mission-driven research is of fundamental importance to the evolution of WIGOS as a fully integrated system. Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) carried out by leading NWP centres will be key factors to support advances in operational capabilities of WIGOS related to the best mix of observing systems and to give advice to WMO Members on ways forward.

WMO's science experiments, such as THORPEX, are providing insights into the value of targeted observational strategies and observing system considerations which are important to the design and implementation of WIGOS.

7. IMPACTS AND IMPLICATIONS

Congress emphasized that integration in the context of WIGOS would have an impact on the structure and functions of WMO, on international collaboration, cooperation and coordination as well as direct consequences to national programmes and activities. Therefore, awareness of potential impacts would be essential for NMHSs and other national/international agencies operating observing networks to ensure understanding and accepting the WIGOS design and its implementation.

7.1 Impacts on WMO

For the purpose of integration in the context of WIGOS, appropriate organizational, programmatic, procedural, and governance structures will enable a common standardization approach and uniform implementation of WMO regulations and practices. This will ensure data integration and interoperability across all WMO observing systems.

The potential impacts will be considered in details with respect to:

1. WMO Secretariat (WIGOS supporting organizational structure);
2. WMO Programmes (WIGOS supporting programmatic structure);
3. WMO Technical Commissions (WIGOS supporting governance structure); and
4. WMO Technical Regulations (WIGOS supporting procedural structure).

A set of organizational, programmatic, governance and procedural arrangements for sustainability and reliability of the operational observing networks/systems (structure and function improvements) will be implemented successively.

7.2 Operational impacts

Operational impacts will comprise step-by-step implementation of:

- Standardization, interoperability and data compatibility arrangements in operational observing networks and systems.
- Procedures for improved quality, traceability and consistency of observations (recommendations on instruments and methods of observation);
- Procedures for the generation of observational data, products and associated metadata from WIGOS constituent networks using comprehensive, standardized data and metadata representation in compliance with WIS information exchange requirements for all WMO and co-sponsored Programmes.
- Quality management system and data/metadata management procedures;
- Procedures and processes of performance monitoring, evaluation, feedback and corrective actions.

Anticipated operational impacts may also include introducing new modes of operation based on emergency, disaster or accident conditions and changes in the operational budget.

Other impacts will include:

- The commitment of additional resources (funding, staff, time) by Members, partner Organizations and the WMO Secretariat to efforts addressing WIGOS development and implementation;
- Adjusting relationships between WMO and co-sponsored observing systems (e.g. changes in MOUs etc.).
- User involvement in extended capacity building activities and technology transfer.

7.3 Challenges

Challenges and needs associated with embarking upon integration of the WMO and co-sponsored observing systems include but are not limited to:

- Active collaboration, improved cooperation and coordination of all partners;
- Firm long-term commitments of all concerned;
- The timely and effective implementation of the integration concept by individual Members;
- Differences in levels of development of national and regional systems and services;
- The need to complete the full functionality of WIS so that WIGOS can exploit new data access and retrieval facilities;
- The importance of engaging the hydrological community in WIGOS activities;
- The need to clarify and communicate the relationship and intersection of WIGOS with the co-sponsored observing systems, (GOOS, GTOS and GCOS) and with GEOSS;
- Finding ways to demonstrate the opportunities of WIGOS to all potential partners and users to build their ongoing support, trust and collaboration;
- Finding a way to more effectively incorporate all WMO observing activities into WIGOS and address their different requirements and priorities, especially the need to ensure WIGOS effectively supports all WMO applications programmes;
- Documenting and validating requirements for operational weather, climate, water and related environmental observations (building on Rolling Requirements Review);
- Specifying relevant processes, procedures and relationships;
- Determining standards, procedures, practices and protocols;
- Step-by-step implementation of sets of standardization, interoperability and data compatibility arrangements into operational observing networks and systems;
- Systematic and rigorous performance monitoring and evaluation (PM&E) of WIGOS capabilities; and
- An adequately structured and resourced WMO Secretariat.

7.4 Risks

Cg-XV recognized that the integration process would be a complex undertaking that would not be risk-free. Risks identified at various stages of the development and implementation of WIGOS are as follows:

- Resources will be a critical risk factor in achieving timely completion of WIGOS goals.;
- Effective and constructive cooperation, collaboration and coordination is not achieved;
- Long-term commitments by all partners are not achieved;
- The concept of WIGOS is not properly understood;
- The timeframe for implementation of WIGOS is not achieved;
- Adequate resources and support are not available to all stakeholders to achieve key elements of WIGOS implementation;
- Resource, coordination etc. requirements for ongoing operation of WIGOS are inadequately understood and/or provided for;
- Prompt delivery of WIS is not ensured, and
- Full implementation of agreed-upon standards, procedures and practices is not achieved across all WMO observing systems.

8. LIST OF ACRONYMS

AMDAR	Aircraft Meteorological Data Delay
BSRN	Basic Surface Radiation Network
CBS	WMO Commission for Basic systems
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CONOPS	Concept of Operations
EC WG	Executive Council Working Group
EUCOS	EUMETNET Composite Observing System
EUMETNET	The network of European National Meteorological Services
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FAO	Food and Agriculture Organization
GAW	Global Atmospheric Watch
GCOS	Global Climate Observing System
GEOSS	Global Earth Observation System of Systems
GOOS	Global Ocean Observing System
GOS	Global Observing System
GRUAN	GCOS Reference Upper-Air Network
GTOS	Global Terrestrial Observing System
ICG WIS	Inter-Commission Coordination Group on WIS
ICPC	Interagency Coordination and Planning Committee for Earth Observations
ICSU	International Council for Science
IOC	Intergovernmental Oceanographic Commission
ISO	International Standards Organization
JCOMM	WMO/IOC Joint Commission for Marine Meteorology
MOU	Memorandum of Understanding
NMHS	National Meteorological and Hydrological Service
NWP	Numerical Weather Prediction
OPAG IOS	CBS Open Programme Area Group on the Integrated Observing System
QA	Quality Assurance
QC	Quality Control
QMF	Quality Management Framework
QMS	Quality Management System
R&D	Research and Development
RRR	Rolling Review of Requirements
RRR	Statement of Guidance
TC	Technical Commission
THORPEX	The Observing System Research and Predictability Experiment

UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WDIP	WIGOS Development and Implementation Plan
WHYCOS	World Hydrological Cycle Observing System
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WWW	World Weather Watch

Appendix IV

WORLD METEOROLOGICAL ORGANIZATION

WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)

DEVELOPMENT AND IMPLEMENTATION PLAN (Conceptual WDIP)

Version 3.0

October 2009

Purpose, Outline and Authority of document

Purpose of this Document

The purpose of this document is three fold.

- to provide a plan for the further development and testing of the concepts of cost effective, comprehensive and sustainable observing system (referred to as the WMO Integrated Observing System)

- to provide an implementation strategy for the implementation of WIGOS from concept to operations

- to describe the project structure and resource requirements necessary to facilitate development and implementation of WIGOS by Member and the collaboration agencies

Outline of this Document

The document consists of the following main sections:

DOCUMENT VERSION CONTROL

Version	Author(s)	Date	Description
1.0	EC-WG/WIGOS-WIS	Dec 2007	*First* draft for review by the first session of the EC WG WIGOS-WIS (December 2007)
1.1	SG-WIGOS	Oct 2008	Feedback from SG WIGOS
2.0	EC-WG/WIGOS-WIS	May 2008	Feedback from EC-WG/WIGOS-WIS
3.0	SG-WIGOS	Oct 2009	Significantly restructured and incorporated refinements from CONOPS and other recent documentation exploring WIGOS concepts, such as capacity building as well as strategic plan for beyond 2011.

CONTENTS

EXECUTIVE SUMMARY

DEVELOPMET PLAN

1 INTRODUCTION

This document is the evolution of the WIGOS Development and Implementation Plan as mandated by the Fifteenth WMO Congress (Cg-XV) and developed by the EC/WG/WIGOS-WIS. The document provides a plan for the further development, and testing of the concepts of cost effective, comprehensive and sustainable observing system (referred to as the WMO Integrated Observing System); an implementation strategy for WIGOS from concept to operations, and describes the project structure and resource requirements necessary to facilitate development and implementation of WIGOS by Members and the partners.

The project for moving WIGOS from concept to reality has two parts:

Part 1: Development and test of concept
This included development of the initial concepts in conjunction with partners of co-sponsored observing system and the testing of those concepts through pilot and demonstration projects which involved WMO technical commissions, Members, regional associations and partner organisations.

Part 2: Implementation.
This includes the organizational activities needed to bring WIGOS to fruition, bearing in mind the objective to meet the WMO Quality Management Framework (QMF) principles.

This version of the WDIP focuses on the transition from part 1 to part 2 while identifying major issues to be addressed during part 2. This version is developed with a structure similar to the WIS Project and Implementation Plan so that it might be easily carried forward into Part 2.

Within this plan several important generic areas (or pathways toward their realization) are addressed that should help bring clarity to the WIGOS. They are:

- WMO Member and partners requirements for WIGOS (challenge and RRR)
- Potential impacts of WIGOS on WMO Members and the WMO Secretariat (organizational)
- Possible impacts on WMO partners responsible for co-sponsorship (…)
- Possible impacts on WMO Members charged with national networks and observing systems
- Benefits of WIGOS for Members and partners;
- Development and implementation strategy for WIGOS;
    - Requirements for resources needed for the development and implementation of WIGOS.

1.1 BACKGROUND

The development and implementation strategy is developed on the basis of the decision of Cg-XV to enhance integration of the WMO observing systems, WIGOS relevant outcomes of EC sessions 2007, 2008, and 2009, as well as outcomes of EC-WG/WIGOS-WIS-2.

Since its establishment as a UN Specialized Agency almost 60 years WMO through its Members has advanced the observing and monitoring of the Earth's weather, water and climate systems. This has led to better understanding of the Earth's environmental system and resulted in the delivery of improved and expanded services such as weather, hydrological and air quality forecasts, climate outlooks and expanded advice and services to society. These services extend across timescales from severe weather warnings to weekly forecasts to seasonal climate prediction with broad applications across social and economic sectors world wide.

The challenge drives the need for change: An increasingly complex society and sophisticated user community, reflected by rapid economic and industrial development, coupled with increased knowledge of the planet as an integrated system and the changing Earth's climate has resulted in

greater vulnerability of society to extreme weather events and climate change. This has resulted in the need for more extensive and advanced information for WMO Members so that they can continue to improve service quality and service delivery. To meet the demands of the future, WMO Members must continue their legacy of contributions by taking full advantage of advances in observation and telecommunication technologies and to increase our science based understanding of the Earth and its environment: the end result being better prediction and assessment of potential impacts of weather and climate related events to provide the required information for the public and policy and decision makers.

The WMO Integrated Global Observing System (WIGOS), endorsed by the Fifteenth WMO Congress is a major contribution of WMO to this challenge. Indeed, WMO Congress decided that the enhanced integration of the WMO observing system should be pursued as a strategic objective of the WMO and identified this as a major expected result of the WMO strategic plan. Specifically, those observing systems are, as addressed in the CONOPS, the current WMO and WMO co-sponsored observing systems: the surface and space based components of the GOS; the AMDAR; the GAW, the WHYCOS, the BSRN; and relevant components of GOOS, GCOS, GTOS, and the Global Cryosphere watch.

In appendix L, addressed through the **WMO Strategic Thrust areas**, it is shown how WMO can build upon existing capabilities and partnerships to bring WIGOS to fruition. It should be noted that integration with its coinciding benefits is not new, and some stellar achievements will be included in the text that follows to help place WIGOS in the proper context.

1.2 THE WIGOS VISION

WIGOS will establish an integrated, comprehensive and coordinated observing system to satisfy in a cost-effective and sustained manner the evolving observing requirements of WMO Members for their weather, climate, water and related environmental services and will enhance coordination of WMO observing systems with those of partner organizations for the benefit of society.

WIGOS will enable the evolution and integration of observing systems of WMO and enhance collaboration with its partner organizations. This will allow access to an expanded set of environmental data and products resulting in increased knowledge and enhanced services in a cost effective manner.

1.3 SCOPE AND BENEFITS

Scope: To achieve its objectives, WIGOS will:

- Build upon the existing observing components of WWW GOS, GAW, and WHYCOS, and will capitalize on existing, new and emerging technologies.
- Improve access to and utilization of surface-based observations and products from co-sponsored systems such as GTOS, GOOS and GCOS through enhanced coordination with partner organizations.
- Introduce data quality standards to improve quality management to satisfy user requirements.
- Improve its space-based component by enhanced collaboration through partnerships such as the Coordination Group for Meteorological Satellites (CGMS) and the Committee on Earth Observation Satellites (CEOS).
- Enhance integration between its surface- and space-based components.
- Provide a mechanism to meet new observational requirements of its Members.
- Make a major and unique contribution to United Nations agencies that are focused on environmental stewardship.
- Be a core contribution of WMO to the GEOSS.

Benefits: improved observing capability in a more cost effective manner to enable improved service delivery because:

- WIGOS will enable the evolution and integration of observing systems of WMO and enhance collaboration with its partner organizations: this will allow access to an expanded set of environmental data and products resulting in increased knowledge and enhanced services in a cost effective manner.

- WIGOS will better enable WMO Members' to meet expanding national mandates and achieve

higher national visibility with other environment related agencies. In doing so, WMO Members will be able to better respond to natural hazards, improve environmental monitoring, and adapt to climate change and man-made environmental impacts. In this regard, WIGOS together with WIS will greatly enhance operational components of WMO Programs, especially in Developing and Least Developed Countries.

- WIGOS will provide a mechanism for enhanced integration between its surface and space based components.
- Integration will lead to efficiencies and cost savings that can be reinvested to overcome known deficiencies and gaps in the observing system. In this way WIGOS will provide capabilities to better utilize existing and emerging observational capabilities.

Imperative: WIGOS is a necessary prerequisite to allow WMO Members to realize the organization's strategic thrusts which are

- Improve service quality and service delivery.
- Advance scientific research and application as well as development and implementation of technology.
- Strengthen capacity building.
- Build and enhance partnerships and cooperation.
- Strengthen good governance.

1.4 TIMELINES AND KEY MILESTONES

See Appendix K

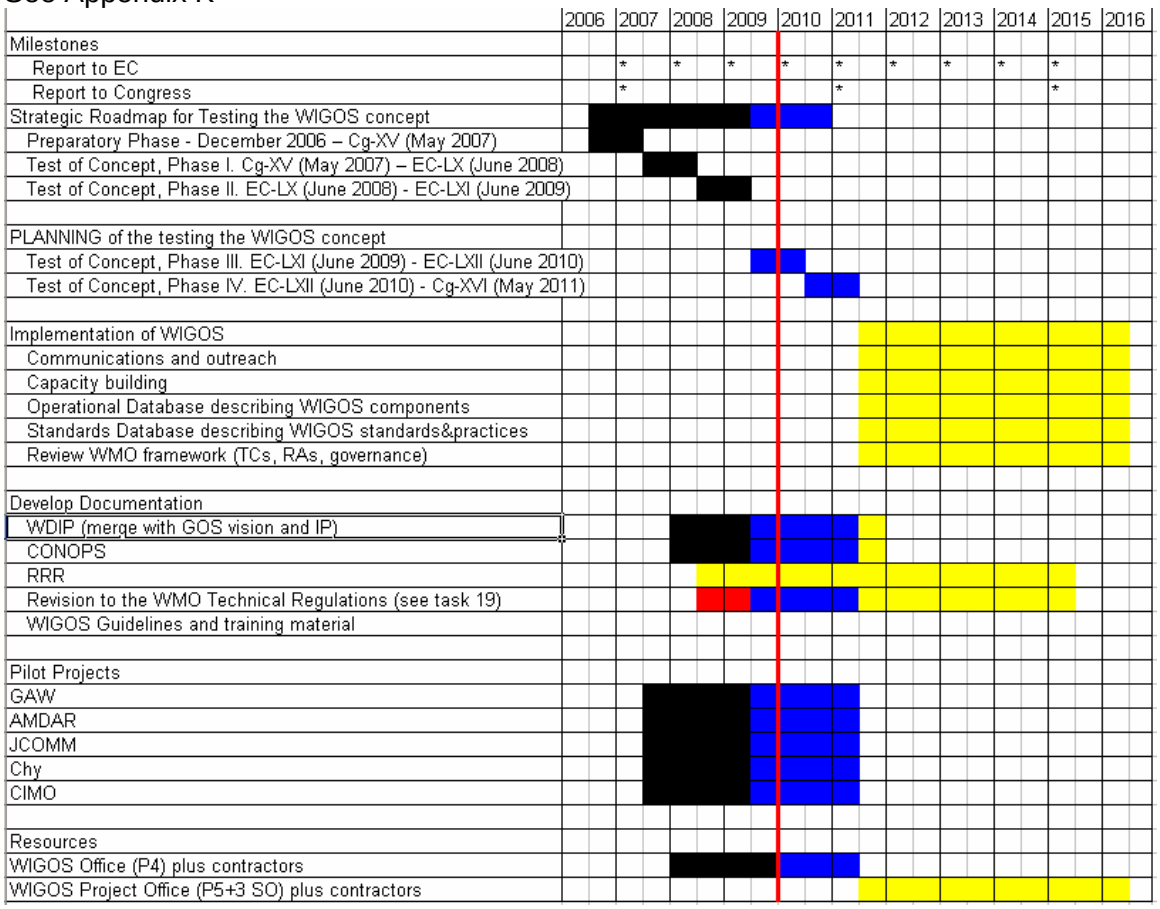

Figure 1 WIGOS Gantt Chart

The above diagram reflects the development and implementation of WIGOS in two parts. The first part is the development and testing of the concept of WIGOS to be completed between Congress 2007 and 2011. This is achieved through consultation with WMO's contributing observing systems including Members, Regional Associations, Technical Commissions and stakeholders, especially the end users

of the data. Consultation will include WMO's partner organisations and the cosponsors of observing systems, as well as other organisations that use or contribute to WMO Members activity. The principal activities are described in appendix K, and fall into various phases under the categories that relate to development of a strategic roadmap for testing, the planning of the testing, and the actual undertaking of the testing through a series of pilot and demonstration processes. The plan includes the need to establish key documentation such as the concept of operations, a development and implementation plan and a rolling review of requirements procedure. These key documents are closely related and together are the basic reference documents for WIGOS.

The second part is the implementation of WIGOS which brings in the need for revision of the technical regulations related to the observing systems and practices, along with appropriate guidelines for Members to be able to implement and benefit from the WIGOS concept. These activities have to be closely coordinated with those of WIS and the GDPFS as the technical regulations and associated guidelines relate strongly to all three areas. Key activities include the need for an effective communication and outreach program and a capacity building program.

In implementing WIGOS, it will be necessary to ensure that the governance and support activities established under WMO are reviewed to be aligned with the strategic structure of WMO which includes results based management, and to continue to provide the collaboration and consultative infrastructure that will continue to be an essential component of WIGOS. In particular, the mechanism for the coming together of Members to agree on standards and practices needs to be maintained. This is presently undertaken by the Technical Commissions and Regional Associations.

A core component of the collaborative mechanisms is the WMO secretariat support. These officers will need to continue to maintain these activities while also facilitating the WIGOS development and testing of concept, then the implementation. In order to ensure routine operations continue without detriment during this process, it is essential to provide additional secretariat support. These are described under resources and include a WIGOS support officer during the first part, then a WIGOS project office under the implementation stage. Both the WIGOS support officer and project office will need to bring in additional support in the form of contractors and seconded experts to undertake particular tasks. In today's terms, the cost of this support is of the order of one million Swiss Francs in 2007 to 2011 and 4 million Swiss Frances in 2012 to 2016. Additional funding will also be need for activities supporting the communication, outreach and capacity building of about 200,000 Swiss francs per year.

1.5 PROJECT ENVIRONMENT AND CONSIDERATIONS

Many aspects of the project environment and considerations are touched on in various portions of the CONOPS document. Certain key elements are addressed below.

1.5.1 The surface based component

Both the introductory portion of CONOPS as well as the section on justification address the overarching considerations that points to the need for WIGOS; they are quoted in the indented areas immediately below:

Background
Various observing systems throughout WMO Programmes and WMO partner organizations have been developed, funded, managed and operated to meet their own specific purposes.

Justification of changes

Historically, various observing systems throughout WMO and WMO co-sponsored Programmes have not been developed in a coordinated, integrated manner but being managed, funded and operated separately to meet their own purposes and goals.

Within WMO, these quasi-independent activities over decades resulted in a fragmentation of the WMO observing systems, with various observing systems being governed by different WMO Technical Commission and Programmes: GOS by CBS with WWW; GAW and BSRN by CAS with AREP; and, WHYCOS by CHy and the Hydrology and Water Resources Program; and AMDAR with CAeM and

Aeronautical Meteorology Program. As a result of this fragmentation, activities to standardize observing practices, dissemination and processing of data were not effectively coordinated among different Technical Commissions and Programmes. Lack of a single focus on the management of WMO observing systems led to an overlapping and duplication of work of expert teams governed by different Technical Commission. As a result, standard WMO regulatory material has not been harmonized in a way that is needed for a clear and transparent guidance to Members. Because of this, WMO observing systems did not evolve in a cost-effective manner. When viewed in an historical context, the development of the WMO observing systems along different pathways seemed logical, i.e., with the GOS being focused more on operational needs and the GAW/BSRN focused more on research activities. This evolution took place in an era when weather (operational) and climate (research) were viewed by and large as independent areas of environmental science. Today, we recognize that a complex Earth environmental system requires that weather and climate, as well as their observing components should be addressed as a continuum, i.e. a seamless system with complex feed-back loops.

Similar fragmentation has occurred at the partner level. While coordination mechanisms were in place that addressed high level working arrangements and goals, this was not the case at the technical level. This technical level problem was in large part because of different governance for the various WMO observing systems. Communication at the technical level, while sound, tended to only address issues relevant to a particular observing system, furthering fragmentation. Matters of coordination were further exacerbated because the various technical commissions operate on different decision time-lines (Commission meeting cycles, etc.). Finally, it should be realized that interactions with different partners tended to focus on different applications and theme areas, making coordination difficult with components of an already fragmented WMO Observing System.

The WIGOS Pilot and Demonstration Projects are addressing many of the above issues and lessons learnt from them will affect the final version of the WIGOS Implementation Plan.

1.5.2 The space based component

The space-based component of the WMO Observing System contains operational polar-orbiting and geostationary satellites and also R&D environmental satellites complementing ground-based global observations. The support of WMO Members by various operational space agencies evolved differently over time and under different circumstances than the surface based component. From the outset the space based component recognized the importance of governance in their coordination mechanisms. Coordination groups such as the Coordination Group on Meteorological Satellites (CGMS) who meet in plenary annually and who from the outset decades ago recognized the importance of WMO as can be seen from their charter's terms of reference for membership and their objectives appear below (redone to recognize the contribution of research satellite operators in 2006) :

MEMBERSHIP

- CGMS Membership is open to all operators of meteorological satellites, to prospective operators having a clear commitment to develop and operate such satellites, and to the WMO, because of its unique role as representative of the world meteorological data user community. Further CGMS Membership is open to space agencies operating R&D satellite systems that have the potential to contribute to WMO and supported programmes.

OBJECTIVES

- CGMS provides a forum for the exchange of technical information on geostationary and polar-orbiting meteorological satellite systems and research & development missions, such as reporting on current meteorological satellite status and future plans, telecommunications matters, operations, intercalibration of sensors, processing algorithms, products and their validation, data transmission formats and future data transmission standards.

- CGMS harmonises to the extent possible meteorological satellite mission parameters such as orbits, sensors, and data formats and downlink frequencies.

- CGMS encourages complementarity, compatibility and possible mutual back-up in the event of system failure through cooperative mission planning, compatible meteorological data products and services and the coordination of space and data related activities, thus complementing the work of other international satellite coordinating mechanisms.

Current and future plans of the CGMS Members to support WMO requirements are reflected in the CBS 2009 "Vision for the GOS to 2025." However, while CGMS adequately reflects needs for Meteorological activities, there is a weakness in planning for climate applications. The lack of leadership in climate observing from space is clearly recognized in the CEOS response to the GCOS Implementation Plan (which represents a solid and accurate assessment of satellite capabilities for selected Essential Climate Variables (ECVs)). In section 2.1 of that response CEOS recognizes the contribution of CGMS to the meteorological community while pointing to the climate observing problem: "There presently exists no process for identifying, prioritizing, and implementing cross-agency actions to ensure user community needs are satisfied – with the exception of meteorology where CGMS plays an important role." There is no international agreement on monitoring climate from space**:** this is a major problem because there are no clear roles and responsibilities. As with meteorology, WMO should work with space agencies to overcome this deficiency. A few ideas are outlined below:

1. Development of a framework document developed that addresses "operational monitoring of climate from space." The framework document would recognize:
    a. the need for leadership;
    b. the role of GCOS, which is co-sponsored by WMO and has quasi-UN affiliate status since its sponsors are all UN affiliate;
    c. the success of WMO and CGMS in the operational meteorological satellite arena;
    d. the value of CEOS response to the GCOS climate monitoring principles;
    e. the difference between operational monitoring of climate from space and process monitoring (which is the role of research agencies)
    f. the need for Research to Operations (RTO) planning;
    g. the link to GEO.

Concerning a few specific points on possible roles of major players that can help move forward climate monitoring from space:

WMO SP: Bring the need for operational monitoring of climate from space into focus and take a leadership role in coordinating activities, as addressed above. Work closely with main players in CGMS and bring to recognition that an international coordinated effort is required.
GCOS*:* Realizing the CEOS response points to the need for a strategy and the need for operational monitoring of climate from space with robust RTO program while recognizing the new generation of operational satellite instruments will make climate quality measurements.
GEO*:* Use GEO as a conduit for making very high level policy makers aware of the need for operational monitoring of climate from space and funding to do so with RTO support.
CEOS*:* Research arena main forum – partners with CGMS to develop international RTO strategy.
CGMS*:* Operational arena main forum - partners with CEOS to develop international RTO strategy.

1.5.3 The move towards seamless and integrated observing system

Today, we recognize that a complex Earth environmental system requires that weather and climate, as well as their observing components should be addressed as a continuum, i.e. a seamless system with complex feed-back loops. Section 4.1 of the CONOPS rightly points out:

An increasingly complex society and sophisticated user community, reflected by rapid economic and industrial development, coupled with increased knowledge of the planet as an integrated system and the changing Earth's climate has resulted in greater vulnerability of society to extreme weather events and climate change. This has resulted in the need for more extensive and advanced information for WMO Members so that they can continue to improve service quality and service delivery. To meet the demands of the future, WMO Members must continue their legacy of contributions by taking full advantage of advances in observation and telecommunication technologies and to increase our science based understanding of the Earth and its environment: the end result being better prediction

and assessment of potential impacts of weather and climate related events to provide the required information for the public and policy and decision makers.

WIGOS is a necessary prerequisite to allow WMO Members to realize the organization's strategic thrusts which are:

- Improve service quality and service delivery.
- Advance scientific research and application as well as development and implementation of technology.
- Strengthen capacity building.
- Build and enhance partnerships and cooperation.
- Strengthen good governance.

For WMO Members this means that future services will have based on our understanding the Earth's environmental system and will extend across timescales from severe weather warnings to weekly forecasts to seasonal climate prediction with broad applications across social and economic sectors world wide. Indeed user requirements are involving to include seasonal to inter-annual forecasting as well as providing climate outlooks. In some sectors environmental forecasts as they affect health, agriculture and a variety of societal benefit areas.

To achieve its objectives WIGOS will

- Build upon the existing observing components of WWW GOS, GAW, and WHYCOS, and will capitalize on existing, new and emerging technologies.
- Improve access to and utilization of surface-based observations and products from co-sponsored systems such as GTOS, GOOS and GCOS through enhanced coordination with partner organizations.
- Improve its space-based component by enhanced collaboration through partnerships such as the Coordination Group for Meteorological Satellites (CGMS) and the Committee on Earth Observation Satellites (CEOS).
- Enhance integration between its surface- and space-based components.
- Provide a mechanism to meet new observational requirements of its Members.
- Make a major and unique contribution to United Nations agencies that are focused on environmental stewardship

1.6 RISK ASSESSMENT

This section deals with both opportunities and threats. First, high level risks for the organization and its Members as well as partner organizations will be addressed. When the final implementation plan is developed, the risk assessment should be done so that risks are identified at various points through out the implementation plan along with associated mitigation, contingency, and management responsibilities.

High level risks and impacts:

- At the highest level, WMO might decide to abandon the WIGOS concept and related activities. This risk is so extreme it might seem unthinkable; however, it should be addressed. If WMO were to decide not to move WIGOS to the implementation phase:
    - The need to establish a cost effective, comprehensive, coordinated and sustainable observing system will not be realized.
    - Many, if not most, Members will not be able to meet the expanding challenges associated with providing services for their weather, water and climate related activities. Members would become more vulnerable to extremes of weather associated with climate change which would result in unnecessary loss of life, property and commerce because less reliable information would be available for decision makers.
        - Not only will WMO Members be unable to fully meet their expanding mandate, they will find it nearly impossible to enter into new activities to expand their value to society and capture the resultant increase in funding – welcome to the land of "lost opportunities."

  - Without WIGOS, WMO will be unable to effectively take a leadership role in providing the needs associated with climate services which might have catastrophic consequences to the organizations future, resulting in Members not being able to serve society's needs.
  - The gap of capabilities of Members to provide services to users, between developed and developing and least developing countries, will grow because the more developed countries have abilities to establish alternative collaborative mechanisms outside of WMO.
- Failure to establish necessary cooperation with partners.
  - Fragmentation with co-sponsored and partner systems continues. Many partner observing systems were and are developed and maintained for research purposes yet they are filling gaps where some of the greatest observing challenges exist with respect to WMO Member needs. Through collaboration with WMO observing system mechanisms migrate essential observations into operational system providing sustainability for their research programs. Within WIGOS there is a need to develop a research to operations transition.
  - Opportunities lost for partners as well as WMO.
  - Loss of compatibility and differing quality of data
- Failure to address critical gaps in observing systems as they relate to WMO's weather, water and climate mandate.
- Integration of surface and space based components of WIGOS.

2 DEVELOPMENT PHASE MANAGEMENT

2.1 DEVELOPMENT PHASE FRAMEWORK

The development phase framework is in two parts: the principal being the organisational framework set up by the WMO Executive Council (EC) in order to facilitate the wishes of WMO Congress to develop and implement WIGOS. The second part is the structure within WMO Secretariat to support the principal framework.

2.1.1 Organizational Structure

In implementing WIGOS, it will be necessary to ensure that the governance and support activities established under WMO are reviewed to be aligned with the strategic structure of WMO which includes results based management, and to continue to provide the collaboration and consultative infrastructure that will continue to be an essential component of WIGOS. In particular, the mechanisms for the coming together of Members to agree on standards and practices needs to be maintained: this is presently undertaken by the Technical Commissions and Regional Associations. As the implementation plan is refined those roles may evolve. For WIGOS to succeed it will be necessary to form task teams at the partner, commission and regional levels. The task team composed of WMO and partner observing systems will need to address issues such as governance, data sharing policy, standards, etc. An Inter-Commission Task Team will be needed to address standards, observing system integration and governance. Regional task teams will need to coordinate planning and implementation for WIGOS on the regional level in coordination with WIS implementation, with a goal of optimizing regional observing networks.

2.1.2 Secretariat Structure

In order to ensure routine operations continue without detriment during the WIGOS development and implementation phases, it is essential to provide additional secretariat support. WMO secretariat will require support in the form of a WIGOS technical officer, secondments, experts and consultants during the development phase and a WIGOS project office during the implementation phase. These are described under resources and include a WIGOS support officer during the first part, then a WIGOS project office under the implementation stage.

2.1.3 Resources and funding

Both the WIGOS support officer and project office will need to bring in additional support in the form of contractors and seconded experts to undertake particular tasks. In today's terms, the cost of this support is of the order of one million Swiss Francs in 2007 to 2011 and 4 million Swiss Frances in 2012 to 2016. Additional funding will also be need for activities supporting the communication, outreach and capacity building of about 200,000 Swiss francs per year.

2.2 COMMUNICATIONS AND OUTREACH

A communications and outreach strategy is essential for the development of WIGOS, with the stakeholders and contributors spread across the globe. This was identified as a high risk area in the risk assessment described above. The strategy communications and outreach is divided into the following core areas:

- Participation and representation of WIGOS in WMO programmes, Technical Commissions or major projects (i.e. GCFS) planning and strategic processes. This may be achieved by ensuring that the WIGOS project manager is able to participate in appropriate meetings or by ensuring other secretariat staff or WIGOS affiliated members can do so.
- As recognized by CG-XV, it is essential to implement a Rolling Review of Requirements (RRR) to ensure that WIGOS continues to be relevant to stakeholders needs. This will insure that key decisions in WIGOS implementation take into consideration current and future user needs.
- Cg-XV identified it is essential to ensure the engagement of Regional Associations as well as the Technical Commissions. A part of the implementation plan includes establishment of Regional WIGOS task teams to participate in the development and implementation of WIGOS in conjunction with WIS, taking particular note of the needs of Members from least developed countries.
- Similarly, the secretariat has the flexibility to initiate special implementation and coordination meetings, normally achieved by having a joint meeting of a Commission expert team and a Regional Association Working Group. This ensures cross fertilisation between Technical Commissions and Regional Associations.
- The WIGOS project manager's terms of reference (appendix E) identify a key role of the project manager is to create and maintain an up to date and useful web site to facilitate communication between developers and also to provide WMO members with a place to monitor and engage in WIGOS development and implementation.
- An important part of the communications and outreach strategy will be the capacity building and training which will be closely tied to the development of appropriate guidelines and documentation on WIGOS.
- As WIGOS evolves, there is a need to be proactive in identifying potentially new users. WIGOS should couple with WIS in this activity.

2.3 DEVELOPMENT PHASE MONITORING AND REVIEW

3 EXISTING AND FUTURE OBSERVING SYSTEMS

For WIGOS, the observing system integration process will focus on three levels:

1. Enhanced integration inside the WMO Global Observing System:
   1.1. Integration of the surface-based observing systems,
   1.2. Integration of the space-based observing systems to more thoroughly address climate, climate and other related terrestrial observations,
   1.3. Integration of the space- and surface-based components of the GOS;
2. Enhanced Integration of the WMO Global Observing Systems (resulting in WIGOS as the integration of GOS, GAW, HYCOS);

3.1 EXISTING OBSERVING SYSTEMS AND COMPONENTS

Current WMO and co-sponsored observing systems are addressed in section 3 of the CONOPS. That section describes existing systems, their operational policies and classes of users and applications areas.

3.2 DIAGRAMS OF WIGOS

4 RELATED PROJECTS

4.1 WIS
4.2 GEOSS

5 IMPLEMENTATION PLAN

Project is in context of the WMO and partners environment

- Distribution of obs networks across multiple tc and agencies
- Who runs the systems (owners) where the people are, nmhs, TCs and ra's.
- Governance with partners – territorial issues and ownership (see conops 5.2.8)
- High level context driving changes eg complex society, tech capability, etc
- Think of risk perspective
- Concerns driving us to wigos

5.1 INTRODUCTION

The background, scope and high-level requirements of WIGOS are laid out in the main body of the CONOPS as well as the Development Plan (Sections 1-4 of this document) and its annexes. The purpose of the implementation plan is to focus on the implementation strategy, timeline, milestones and tasks. Some further background relating to the implementation strategy, such as instructions from CBS and special requirements of Congress that impact on the implementation strategy, are repeated in section 5.2 for completeness. Lessons learned from WIGOS pilot projects and demonstration projects have been used to help formulate the implementation planning. WIGOS PP and DP are listed in appendix A.

The WIGOS project initially developed in the mid 2000's around high-level requirements with a focus on establishment of an effective and sustainable organizational, programmatic, governance and procedural structure that will significantly improve the availability, usefulness**,** quality and utilization of observational data and products through 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. A key aspect was to build on and add value to the WMO's existing observing systems by coordinating their efforts, addressing shortcomings, and supporting their interoperability, while satisfying the observational requirements of all WMO and WMO co-sponsored Programmes in a cost-effective manner. Since its conception, the concept of WIGOS has been refined based on an interaction with WMO partners in co-sponsored observing systems, interactions among the affected WMO programmes and lessons learnt through several demonstration and pilot projects as well as other activities.

The implementation plan may be used in isolation from the project plan for planning and sequencing tasks, however, care should be taken when considering scope and high-level requirements to ensure the CONOPS and development plan are included in total. The CONPS and development plan are based on requirements for WIGOS, the need for change and overarching processes, while the implementation plan focuses on tasks and timelines. There are key tasks/documents that need to be considered as input to many other WIGOS tasks and when implementing operational components of WIGOS. In particular, these include:

- Rolling Review of Requirements (RRR);
- Functional Architecture;
- Technical Compliance Specifications of the GISC, DCPC and NC;
- Governance Procedures for nomination and selection of GISC, DCPC and NC; and

- Guidelines on WIGOS.

The results of the RRR, the Functional Architecture, the Technical Specifications and the Governance documents will be important annexes to the WIGOS Project and Implementation Plan.

The output of the RRR will be used to determine the functional scope and physical sizing of WIS.

The Functional Architecture, by describing the main functions and associated dataflows, will illustrate how WIGOS as a whole operates. This Functional Architecture will also be used to define the minimum functional scope of an NC, DCPC and GISC.

The Technical Specifications, by making reference to the dataflows identified in the Functional Architecture, will describe the implementation requirements that must be observed in order to secure the interoperability of the various WIS components.

The Governance Procedures will describe the arrangements for the nomination and selection of NCs, DCPCs and GISCs; making reference, as appropriate, to the Architectural Design and Technical Specifications.

The Guidelines on WIS will describe the operational arrangements for WIS; containing both a description of the operational processes and the responsibility of contributors. In order to provide the appropriate context, the Guidelines will incorporate the relevant elements of the RRR, the Functional Architecture, Technical Specifications and Governance Procedures. The Guidelines on WIS will be a key contribution to the review of WMO Technical Regulations that will be required once WIS and other integration strategies such as WIGOS begin to mature.

Because of the dependence of other tasks, these key tasks have been identified as priority deliverables and although it would be ideal to complete them before progressing with other tasks, the requirements to deliver on WIS as an operational system (i.e. a functional GISC in 2008) mean these tasks have to be done in parallel to tasks that are dependant on them.

5.2 SPECIAL INSTRUCTIONS FROM CBS AND CONGRESS

Special instructions from Congress, Executive Council and CBS with regards to WIGOS are presented below in a chronological order beginning with EC-LVIII, then CG-XV, then EC-LIX – EC-LX, CBS-XIV and lastly EC-LXI.

EC-LVIII concluded that the enhanced integration between the WMO observation systems should be pursued as a strategic objective of WMO and proposed it as one of the 11 major expected results for the fifteenth financial period (2008–2011) as reflected in the WMO Strategic Plan, WMO Secretariat Operating Plan and the Results-based Budget. With resolution 13 EC-LVIII established the Executive Council Task Team on the Integration of WMO Observation Systems and charged it with developing a report to the present session of Congress on the subject.

Cg-XV placed a high priority on enhanced integration between the WMO Observing Systems and adopted Resolution 30 (Cg-XV) – Towards enhanced integration between WMO observing systems. In that resolution Congress Decides to embark on enhancing the integration between the WMO observing systems; Urges Members and Invites international partner organizations and programmes to collaborate actively in, and give all possible support to, the development and implementation of this initiative; and requested the following:

(1) The Executive Council to:

(a) Establish a mechanism to steer and monitor the activity and to achieve the broadest possible collaboration and cooperation;

(b) Ensure the active participation and representation of the principal bodies concerned and

also the participation, as appropriate, of technical experts and representatives of agencies undertaking co-sponsored observing initiatives;

(c) Ensure that this mechanism is closely coordinated with the institutional arrangements for planning and overseeing the WMO Information System;

(d) Submit a comprehensive report on the integration between the WMO observing systems to Sixteenth Congress;

(2) The regional associations and technical commissions to include this activity in their work programmes in order to fully accommodate the cross-programme nature of the integration initiative;

(3) The Secretary General to:

(a) Strengthen coordination and collaborate closely with relevant international partner organizations and programmes in pursuing this endeavour;

(b) Arrange for adequate resources to support the integration initiative;

(c) Adapt the structure of the Secretariat as and when appropriate, so as to ensure optimal management of and support to the initiative.

EC-LIX, in response to Cg-XV, adopted resolution 3, established an Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System with terms of reference as follows:

(1) Provide advice and guidance in the preparation of an overarching 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 the development and implementation of WIGOS/WIS “Pilot Projects”, as suggested by Fifteenth Congress, to test concepts, identify problem areas, and to help in elaborating the Development and Implementation Plan;

Requests:

(1) Regional associations and technical commissions to provide input into an overarching Development and Implementation Plan and to include relevant activities in their strategic plans and work programmes, in particular those activities that require joint actions by regional associations and/or technical commissions for “Pilot Projects”;

(2) The Working Group on WIGOS/WIS to report to subsequent sessions of the Council on the progress in the development and implementation of WIGOS/WIS;

Further requests the Intercommission Coordination Group on WIS (ICG-WIS) to report to the working group to ensure the coordination of the respective WIGOS and WIS Development and Implementation Plan, especially as regards WIS meeting WIGOS data collection, exchange and access requirements;

Authorizes:

(1) The Executive Council Working Group to establish sub-groups and task teams as and when required;

(2) The working group to undertake intersessional activities that require urgent action while keeping the President immediately informed of such actions and in providing specific descriptions of such activities to the next session of the Executive Council;

Decides further:

(1) That a high-level representative from each regional association and technical commission, to be designated by its president, participates in relevant activities of the working group or its sub-groups;

(2) That the WMO/IOC/UNEP/ICSU Steering Committee for the Global Climate Observing System (GCOS), the WMO/ICSU/IOC Joint Scientific Committee for the World Climate Research Programme (WCRP), the WMO/FAO Joint Scientific Committee for the Global Terrestrial Observing System, and WMO/IOC/UNEP/ICSU Steering Committee for the Global Ocean Observing System participate in the working group or its sub-groups;

(3) That the chairperson may seek advice from, or invite experts, in particular from satellite operators, as necessary;

Requests the Secretary-General to provide the necessary assistance and Secretariat support for this working group, within the available budgetary resources.

EC-LX 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 comprising the following:

(a) Planning and implementation phases – that provided a strategic roadmap for integration through annual phases timed according to sessions of the Executive Council;

(b) Pilot projects – that referred to the status of five pilot projects identified by Fifteenth

Congress related to the integration into WIGOS of GAW, hydrological network, AMDAR, marine observations and the CIMO underpinning/cross-cutting role in the WIGOS.

Primarily the role of pilot projects was to emphasize the role and contributions of technical commissions into WIGOS;

(c) Demonstration projects – that referred to the status of eight demonstration projects initiated by Kenya, Morocco and Namibia (RA I), the Republic of Korea (RA II), Brazil (RA III), the United States (RA IV), Australia (RA V) and the Russian Federation (RA VI). Primarily the role of pilot projects was the involvement of regional associations and certain NMHSs in the implementation of the WIGOS concept to help other Members to more fully understand WIGOS and keeping them current on its practical development;

(d) WIGOS and WMO Technical Regulations – that referred to the revision and updating in the context of WIGOS the WMO regulatory material including Technical Regulations, Manuals and Guides;

(e) WIGOS and WMO technical commissions – that referred to the activities on restructuring and adjustment of the WMO Programme structure and technical commission terms of reference in the context of WIGOS implementation;

(f) Integration levels within WIGOS – that referred to three major WIGOS integration levels comprising: standardization of instruments and methods of observations instruments and methods of observation level); common information infrastructure (WIS data level); and end-product quality assurance (quality management/quality assurance/quality control product level).

The Council stressed that implementation of the WIGOS concept should offer unprecedented opportunity to include all WMO and WMO-sponsored networks and subsystems in the integration process thus allowing WMO to more effectively respond to new challenges and evolving user requirements. The Council also reiterated that integration should ensure the continued partnership and participation of the bodies responsible for those observing systems, as they became part of an integrated system of systems with sustained sense of ownership. The Council emphasized the leading role of CBS in the implementation of the WIGOS concept.

Taking into account that integration was a complex and evolving process, the Council 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 policymakers. In that connection the Council agreed with the WIGOS Concept of Operations developed by the Executive Council Working Group on the WMO Integrated Global Observing Systems and the WMO Information System, which contained goals, objectives, major characteristics, operational framework, data policy and benefits of WIGOS. The Council agreed that the principal WIGOS documents, that is, the

WIGOS Development and Implementation Plan and the WIGOS Concept of Operations, should be updated on a regular basis. The Council also stressed the need to prepare a standardized description of all observational networks contributing to WIGOS, including information on the owners of the WIGOS components and generated data.

3.4.45 The Council also agreed that all WMO-related components of the multi-domain GCOS were part of WIGOS.

3.4.46 Recognizing different conditions and possibilities in WMO Regions, the Council supported the involvement of NMHSs and regional associations in the implementation of the WIGOS concept as crucial to ensure important benefits for all Members. To help Members to more fully understand WIGOS and keeping them current on its practical development, the Council agreed to launch demonstration projects in selected NMHSs. Those NMHSs would 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. The Council accepted the willingness of Kenya, Morocco and Namibia (RA I), the Republic of Korea (RA II), Brazil (RA III), the United States (RA IV), Australia (RA V) and the Russian Federation (RA VI) to carry out demonstration projects in their countries and requested the Secretary-General to provide the necessary support for the efficient implementation of their activities and keeping other Members informed. The Council also recognized that the experience gained by the EUMETNET Composite Observing System in the integration of various observing systems should be taken into account in the implementation of the WIGOS concept. The Council stressed the need to foresee a sustainable training effort especially for developing and least developed countries to allow them to efficiently participate in the implementation of WIGOS. The Council summarized its recommendations on the implementation of WIGOS pilot projects involving the technical commissions: *CIMO pilot project on WIGOS, JCOMM pilot project on WIGOS, WWW and GAW pilot project, AMDAR pilot project, Global Hydrological Network pilot project.*

CBS-XIV responded with relevant adjustment of the CBS future working structure and by adopting new Terms of Reference (TOR) of its OPAGs, Expert Teams (ETs) and rapporteurs addressing requirements of WIGOS for integration, interoperability, standardization and homogeneity. In this regard, the Commission requested the chairs of OPAGs, ETs and relevant rapporteurs to include into their work plans, relevant tasks and activities that contribute to the further development and implementation of the WIGOS initiative.

10.4 In a spirit of having the leading role in WIGOS, the Commission agreed that the CBS president be directly responsible for overall coordination of Commission's WIGOS activities. The Commission recommended that the CBS president be, ex-officio, a member of the Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System (EC-WG/WIGOS-WIS) as well as its Subgroup on WIGOS.

10.16 The Commission … also supported the development of a proposal for the Global Space-based Intercalibration System (GSICS) as a new WPP.

10.17 The Commission welcomed that the GCOS considered a new WPP for GRUAN and affirmed its willingness to work with GCOS to develop it following the example given by other WPPs. The Commission felt this to be a particularly important activity because of the important contribution of GUAN stations to the GOS and the collocation of many GRUAN sites with the GUAN stations.

CBS Technical Conference on WIGOS

10.35 The Commission noted the need for a comprehensive, costed development and implementation strategy for taking WIGOS from a concept to reality and that this strategy should address, inter alia, the technical and coordination challenges and the associated roles and responsibilities; the process for capturing the lessons-learned from WIGOS projects and other activities; capacity building requirements to ensure WIGOS benefits each all Members; and designation of clear responsibilities across the WMO system for the further development of WIGOS. The Commission agreed to contribute to the preparation of such a strategy under the

auspices of the EC-WG/WIGOS-WIS.

EC-LXI in accordance with recommendation of CBS-XIV, the Council agreed that the CBS president be, ex officio, a member of EC-WG/WIGOS-WIS, as well as its Subgroup on WIGOS, reflecting the CBS leading role in the further development and implementation of the WIGOS initiative.

3.4.43 Considering the importance of the participation of all Members in WIGOS activities, the Council urged the Secretary-General and the relevant technical commissions to provide the Members with information on specific expected benefits for Members and with guidelines on WIGOS related activities to be implemented by Members. The Council also noted challenges that the developing countries and LDCs were facing when implementing WIGOS and underlined the need for relevant capacity building activities.

WIGOS Concept of Operations and Development and Implementation Plan

3.4.44 The Council adopted the updated versions of the WIGOS Concept of Operations (CONOPS) and the WIGOS Development and Implementation Plan (WDIP). It reiterated that Members, regional associations and technical commissions should actively collaborate in testing, developing, and implementing the WIGOS concept, and provide their input to WDIP.

3.4.45 The Council underlined the need for a comprehensive costed development and implementation strategy for taking WIGOS from a concept to reality and that this strategy should address, inter alia, the technical and coordination challenges and the associated roles and responsibilities; the process for capturing the lessons learned from WIGOS projects and other activities; capacity-building requirements to ensure that WIGOS benefits reach all Members; and designation of clear responsibilities across the WMO system for the further development of WIGOS.

3.4.46 The Council requested that the WIGOS implementation strategy clearly indicate that it complements rather than duplicates implementation plans of WIGOS systems, such as GOS, WHYCOS and GAW. Furthermore, the strategy should clearly distinguish between GCOS which is a “system of systems for Climate” and WIGOS which is the integration of observing systems need to meet WMO’s requirements in this area of activity.

WIGOS Demonstration (WDP) and Pilot Projects (WPP)

3.4.47 The Council emphasized the importance of the participation and leadership of regional associations in WIGOS. …

3.4.48 The Council urged Members and technical commissions responsible for WDP and WPP to elaborate a detailed project implementation plan and work plan with specified tasks, activities, and achievable deliverables taking into account the guidance provided by EC-WG/WIGOS-WIS.

3.4.50 The Council welcomed new WPPs, namely: (a) the Global Space-based Intercalibration System as a joint initiative of WMO and the Coordination Group for Meteorological Satellites; and (b) project for the implementation of the GCOS Reference Upper-Air Network.

3.4.51 The Council expressed its concern regarding the available time frame for testing the WIGOS concept due to late initiation of some WIGOS projects, very limited resources provided through contribution to the WIGOS Trust Fund to support limited funds available in the regular budget, and lack of staff support from the WIGOS Project Office. It was noted that there is a high risk that lack of funds will not allow for the completion of some WPPs/WDPs as planned for the timely development and testing of the WIGOS concept. In this regard, the Council requested Members to support WIGOS WPPs/WDPs by contribution to the WIGOS Trust Fund, and to support the Planning Office by secondment of experts to speed up WIGOS development and implementation.

Guidance for the future development of WIGOS

3.4.52 In light of its review of the advice from the EC-WG/WIGOS-WIS, the Council reaffirmed its strong support for the further development of the WIGOS concept and its implementation,

following Cg-XVI endorsement, in collaboration with WMO's partner organizations and their observing systems. It requested the Secretary-General to provide all possible support and resources for the actions needed to progress WIGOS from concept to reality, including the necessary support for the WIGOS Planning Office.

3.4.53 It stressed the importance of close alignment of GCOS and WIGOS planning to ensure that the climate components of WIGOS are effectively integrated with those of GOOS, GTOS, and other climate-relevant global observing systems.

3.4.54 The Council reiterated that the ownership and data-sharing policies of all observing components and partner organizations must be respected and ensured.

3.4.55 The Council further requested the Secretary-General to initiate and promote preparations for specific WIGOS-related WMO publications (in particular the Vision for GOS in 2025, the Implementation Plan for the Evolution of the Space and Surface-based Sub-systems of the GOS) in all WMO official languages to enhance and proliferate critical programmes on WMO observing systems at various levels, in particular decision and policy-makers.

QMF in the WIGOS context

3.4.56 The Council stressed that the further development of the WMO QMF is essential for the future of WIGOS operations. In this regard, strategic recommendations are sought from the EC Intercommission Task Team on Quality Management Framework as to how the quality management framework should be developed and implemented in operational practice and used for WIGOS. The Council also stressed the role of the technical commissions in the development and implementation of quality management systems that are necessary for the improvement of meteorological and hydrological observations.

3.4.57 Quality of data and benefits which will be received from WIGOS should be analyzed and carefully investigated by the scientific and operational community through Observing System Experiments, Observing System Simulation Experiments and various test-beds for the verification of impacts on various forecasting models in different application areas.

5.3 TASKS

Appendix K, part VIII

5.4 BUILD CAPACITY AND CONDUCT TRAINING

Appendix M addresses capacity building and training in more detail. With respect to capacity building and training, implementation of WIGOS will require Members to focus on:

- Institutional mandates and policies;
- Infrastructure establishment and/or strengthening;
- Human skills development and training.

Where possible, WIGOS will be built using those existing elements that are either in place or are in the process of being established. However, it needs to be recognized that in many Member countries the existing elements in themselves would require strengthening. In many cases the primary networks are already owned and run by the NMHSs or at least coordinated with them; however this is not the case for all Members.

5.5 MINIMUM CRITICAL SUCCESS INDICATORS

1) Completion of integration of WMO systems
2) Completion of integration of WMO and partner co-sponsored systems
3) Integration changes are fully reflected in WMO TRs
4) Adoption of agreement to work within technical regulations by contributing observing systems

6 RESOURCE CONSIDERATIONS

Lead In statement

Resource consideration is for management of the implementation within WMO. Individual Members and partner resource requirements will depend on their existing level of integration and complexity of their own systems.

Given the extensive role of the project manager identified in the implementation plan, as well as undertaking the tasks in the TOR, a dedicated unit of four people is required to manage the overall WIGOS project for at least five years. This will include the following:

- Establishment of a long term Project Manager position under the current project manager TOR to lead the WIGOS project office, manage and review the implementation of WIGOS, undertake the necessary liaison within the secretariat and stakeholders and to oversee all the projects within WIGOS;
- A supporting professional officer is essential to assist with general duties, such as outreach activities and maintenance of the WIGOS web pages. This support role will also assist in keeping tasks progressing while the project manager is addressing more urgent issues. An important role of this position will be to maintain the project register on activities in collaboration with other secretariat staff and task leaders;
- An experienced officer is needed to undertake the preparation of the initial WIGOS guidelines and to support the expert teams in production of other guidance material such as those needed on the preparation and maintenance of metadata. This officer will also play a key role in the review of technical regulations in coordination with WIS;
- Although the size of the task has yet to be established, there is a need to have a project officer to assist with capacity building in Member countries and to work with Education and Training (ETR) and Development Cooperation and Regional Activities (DRA) to ensure Members, especially in least developed countries, reap the full benefits of WIGOS;
- A new component led by the WIGOS project manager and involving all in the WIGOS project office will be the coordination with WIS to ensure WIS is able to provide the collection and information exchange requirements of WIGOS.

Each officer in the project office would have their own portfolio of projects in which they take the lead. However, each will assist other projects within the office so that if one project's leader is unavailable there will always be another officer who can address any issues and keep the individual projects flowing.

Detail in the implementation of WIGOS will depend on changes in the secretariat associated with integration processes. However, there will need to be provision allowed for WIGOS staffing and support in WMO budgets and especially in the Strategic Plan 2012-2016 and beyond as WIGOS will be major projects throughout this period.

7 APPENDICES

APPENDIX A – PILOT AND DEMONSTRATION PROJECTS AND DEVELOPMENT ACTIVITIES

(abstract description from project, key contact)

APPENDIX B – ROLLING REVIEW OF REQUIREMENTS

APPENDIX C – TERMS OF REFERENCE EC/WG/WIGOS-WIS

APPENDIX D – TERMS OF REFERENCE FOR Inter commission EXPERT TEAMS

APPENDIX E – TERMS OF REFERENCE FOR WIGOS PROJECT MANAGER

APPENDIX F – RISK MANAGEMENT SUMMARY

APPENDIX G – RELATED WMO TECHNICAL REGULATIONS AND PUBLICATIONS

The three volumes of the WMO Basic Document Series are supplemented by Annexes called Manuals, which have the same status as the Basic Documents (i.e. Manual on the GTS, WMO No.386). 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 on the World Weather Watch data management, WMO No. 788). The purpose of the Guides is to provide practical information on the development, organization, implementation and operation of the system, subsystem or service in order to enhance both the participation of individual Members in the activity and the benefits they may obtain from it. Guides often supplement regulatory material contained in Technical Regulations and their annexes. There is also a set of Technical Document publications (i.e. WMO/TD No.72 The role and operation of national hydrological service) that are basically technical reports rather than a specific guide.

Most of WMO technical regulations, manuals and guides related to WIS as per the following tables

Table 1 WMO Technical Regulations (WMO- No.49)

World Weather Watch	Global Observing System (GOS)	Volume I. Section A.1.
	Global Data Processing System (GDPS)	Volume I. Section A.2.
	Global Telecommunication System (GTS)	Volume I. Section A.2.
General Standards and Recommended Practices	Climatology	Volume I. Section B.1.
	Global Atmospheric Watch (GAW)	Volume I. Section B.2.
	Meteorological bibliography and publications	Volume I. Section B.3.
	Education and training	Volume I. Section B.4.
	Meteorological research	Volume I. Section B.5.
Meteorological Services	Meteorological services for marine activities	Volume I. Section C.1.
	Meteorological services for agriculture	Volume I. Section C.2.
	Meteorological Services for Air Navigation	Volume II.
	Meteorological Services for Hydrology	Volume III.

Table 2 WMO Manuals

Weather reporting		WMO No.9
	Observing stations	WMO No.9 Volume A
	Catalogue of meteorological bulletins	WMO No.9 Volume C1
	Transmissions schedules	WMO No.9 Volume C2
	Information for shipping	WMO No.9 Volume D
Manual on the GTS	Volumes I & II	WMO No.386
Manual on the GDPFS	Parts 1, 2 & 3	WMO No.485
Manual on the GOS	Volumes I & II	WMO No.544
International list of Selected, Supplementary and Auxiliary ships	Metadata fields & descriptions, exchange formats and code tables	WMO No.47

Table 3 WMO Guides

Guide to meteorological instruments and methods of observation	WMO No.8
Guide to climatological practices	WMO No.100
Guide to agricultural meteorological practices	WMO No. 134
Guide to hydrological practices	WMO No. 168
Guide on the Global Data-processing System	WMO No. 305
Guide to marine meteorological services	WMO No. 471
Guide on the Global Observing System	WMO No. 488
Guide on the automation of data-processing centres	WMO No. 636
Guide to wave analysis and forecasting	WMO No. 702
Guide to practices for meteorological offices serving aviation	WMO No. 732

Guide on meteorological observation and information distribution systems at aerodromes	WMO No. 731
Guide to moored buoys and other ocean data acquisition systems	WMO No. 750
Guide on World Weather Watch data management	WMO No. 788
Guide to public weather services practices	WMO No. 834

There are many other publications providing catalogues and gazetteers that are important to WIGOS, some of these such as vocabulary catalogue come from outside of the WMO community. The IPET-MI produced a list of such needs in the IPET-MI Final Report to their meeting in September 2005.

APPENDIX H – BIBLIOGRAPHY

The following documentation was used to support the generation of this document.

2.1 Reports of WMO Constituent bodies

- Fifteenth World Meteorological Congress, Abridged final report with resolutions (WMO-No. 1026)
- EC-LVIII, Abridged final report with resolutions (WMO-No. 1007)
- EC-LIX, Abridged final report with resolutions (WMO-No. 1027)
- EC-LX, Abridged final report with resolutions (WMO-No. 1032)
- EC-LXI, Abridged final report with resolutions (WMO-No. 1042)
- CBS-XIV, Abridged final report with resolutions and recommendations (*in press*)
- Final report of the 1st session of the EC WG on WIGOS-WIS (December, 2007)
- Final report of the 2nd session of the EC WG on WIGOS-WIS (May, 2009)
- Final report of the 1st session of the Subgroup on WIGOS of the EC WG on WIGOS-WIS (November, 2008)
- Final report of the 2nd session of the Subgroup on WIGOS of the EC WG on WIGOS-WIS (October, 2009)

2.2 WMO regulatory material and International Standards

- Basic Documents, No. 1, 2007 edition (WMO-No. 15)
- Technical Regulations (WMO-No. 49)
- Manual on the Global Observing System (WMO-No. 544)
- Manual on the Global Telecommunication System (WMO-No. 386)
- Manual on Codes (WMO-No. 306)
- Manual on the Global Data Processing and Forecasting System (WMO-No. 485)
- Weather Reporting, Volume A (WMO-No. 9)
- Guide to the Global Observing System (WMO-No. 488)
- Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8)
- Global Atmosphere Watch Guide (WMO/TD-No. 553)
- Global Atmosphere Watch Measurements Guide (WMO-No. 143)
- Guide to Marine Meteorological Services (WMO-No. 471)
- Guide to Agricultural Meteorological Practices (WMO-No. 134)
- Guide to Climatological Practices (WMO-No. 100)
- Guidelines on the Role, Operation and Management of National Hydrological Services (WMO-No. 1003)
- WHYCOS Guidelines (WMO/TD-No. 1282)
- ISO 14001 Environmental Management Systems
- ISO 9001 2008 Quality Management Requirements

2.3 Other relevant documentation

- WIS Project and Implementation Plan (v. 1.1, April, 2009)
- Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (GCOS-92, WMO/TD-No. 1219)
- GCOS Reference Upper-Air Network (GRUAN): Justification, requirements, siting and instrumentation options (GCOS-112, WMO/TD-No. 1379)
- WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008-2015 (WMO/TD No. 1384)
- Implementation Plan for Evolution of Space-and Surface-based Subsystems of the Global Observing system (WMO/TD-No. 1267)
- CBS TECO-WIGOS Conference Statement (March, 2009)
- WIGOS as a Challenging Initiative of WMO, Keynote by T. Sutherland, Second Vice-President of WMO (CBS TECO-WIGOS, March 2009)
- The first U.S. Integrated Ocean Observing System (IOOS) Development Plan, Washington, DC, January 2006
- Global Earth Observation System of Systems GEOSS 10-Year Implementation Plan (GEO 1000, February 2005)
- GEO 2009-2011 Work Plan (January 2009)
- IEEE Guide for information Technology- System Definition –Concept of Operations (CONOPS)

Document, 1988

- NOAA Concept of Operations (CONOPS) for NPOESS Data Exploitation (NDE), 2006
- Concept of Operations (CONOPS) for the National Archives and Records Administration Electronic Records Archives Program Management Office (NARA ERA PMO), 2004
- EUCOS programme management documentation
- THORPEX International Research Implementation Plan (WMO/TD-No.1258)
- Third WMO Workshop on the Impact of Various Observing Systems on NWP, Alpbach, Austria, 9-12 March 2004
- JCOMM Observing System Implementation Goals for Building a Sustained Global Ocean Observing System in Support of the Global Earth Observation System of Systems (2009).

APPENDIX I – GLOSSARY

AMDAR	Aircraft Meteorological Data Delay
BSRN	Basic Surface Radiation Network
CONOPS	Concept of Operations
EC WG	Executive Council Working Group
FAO	Food and Agriculture Organization
GAW	Global Atmospheric Watch
GCOS	Global Climate Observing System
GEOSS	***Global Earth Observation System of Systems***
GOOS	Global Ocean Observing System
GOS	Global Observing System
GTOS	Global Terrestrial Observing System
ICG WIS	Inter-Commission Coordination Group on WIS
ICPC	Interagency Coordination and Planning Committee for Earth Observations
ICSU	International Council for Science
IOC	Intergovernmental Oceanographic Commission
QA	Quality Assurance
QC	Quality Control
QMF	Quality Management Framework
QMS	Quality Management System
R&D	Research and Development
UNEP	***United Nations Environment Programme***
UNESCO	United Nations Educational, Scientific and Cultural Organization
WDIP	WIGOS Development and Implementation Plan
WHYCOS	World Hydrological Cycle Observing System
WIGOS	World Integrated Global Observing System
WIS	WMO Information System
WWW	World Weather Watch

APPENDIX J – ACKNOWLEDGEMENTS

APPENDIX K – WIGOS TEST OF CONCEPT DEVELOPMENT AND IMPLEMENTATION PLAN (WDIP, V.2)

2.1 Cg-XV agreed that planning and implementation of the WIGOS test of concept should proceed in phases defined by the annual sessions 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 would be considered at Cg-XVI (2011), and the WIGOS Implementation Plan for the next intersessional period would be determined.

2.2 EC-LIX, by its Resolution 3 (EC-LIX), established the EC Working Group on the WMO Integrated Global Observing System and the WMO Information System (EC-WG/WIGOS-WIS) with terms of reference as follows:

(1) Provide advice and guidance in the preparation of an overarching 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 the development and implementation of WIGOS-WIS “Pilot Projects”, as suggested by the Fifteenth Congress, to test concepts, identify problem areas, and to help in elaborating the Development and Implementation Plan.

2.3 As authorized by EC-LIX, EC-WG/WIGOS-WIS established its Subgroup on WIGOS with following terms of reference:

(1) To provide overall technical guidance, assistance and support for the implementation of the WIGOS concept based on strategic directive of the Fifteenth WMO Congress;

(2) To elaborate in detail the three areas of integration of WIGOS including standard practices to be applied to the different areas of WIGOS integration; integration areas being as follows and further described in the WIGOS Concept of Operations:

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

(3) To work with each WIGOS component, propose new components and coordinate agreed inter-actions with other partners (e.g. co-sponsored systems, international initiatives’ systems, etc.);

(4) To refine the concept of WIGOS operations, including its basic definitions;

(5) To address major issues identified by the EC Working Group on WIGOS and WIS;

(6) To develop a mechanism for the inclusion of the regional aspects of WIGOS through involvement of the presidents of regional associations;

(7) To coordinate the WIGOS planning phases (including the Pilot Projects) according to the over-arching WIGOS Development and Implementation Plan;

(8) To coordinate WIGOS implementation with the planning and implementation of the WMO Information System (WIS);

(9) To advise the EC Working Group on WIGOS and WIS on aspects related to management, governance and interoperability;

(10) To report to the EC Working Group on WIGOS and WIS.

2.4 The WIGOS Test of Concept Development and Implementation Plan (WDIP), should take into account the WIS Development and Implementation Plan, and will be updated annually during the four-year period 2008-2011. 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 benefit from experience

gained from the various Pilot Projects, Demonstration Projects and inputs from the technical commissions, regional associations and the advisory/steering bodies of WMO co-sponsored programmes. 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 of 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, Demonstration 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 observing 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 WDIP needs to address this from the aspect of improving data access across these boundaries. Data dissemination practices must be capable of respecting the data-sharing policies as designated by the owners of the observing systems including authorization of users.

2.5 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 of the Preparatory Phase that occurred prior to Cg-XV is reproduced as well. The preparation of Version 1.0 of WDIP (WDIP V.1.0) that was endorsed by the EC in June 2008 was a crucial first step. WDIP V.1.1, and its subsequent revisions, will be important for informing the technical commissions, regional associations and the steering committees of GCOS, GOOS, GTOS and WCRP on WIGOS and WIS planning activities and to encourage their input into the process. Scheduling of as many regular sessions of technical commissions and regional associations as possible 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. Essential to taking this process forward will be the staffing of a WIGOS planning office in the WMO Secretariat as was proposed in III. (3) and IV. (3).

STATUS of the testing the WIGOS concept

II. Strategic Roadmap for Testing the WIGOS concept

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), February 2007; (Status: Completed);

(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); (Status: Completed);

(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. (Status: Not completed.

IV. Test of Concept, Phase I. Cg-XV (May 2007) – EC-LX (June 2008)

(1) Establish and update as appropriate the WIGOS Concept of Operations (CONOPS); (Status: Completed);

(2) Cg-XV through the EC-LIX establishes the EC-WG/WIGOS-WIS to oversee the development of WIGOS and WIS; (Status: Completed);

(3) Full time WIGOS Planning Unit organized in the WMO Secretariat (June 2007); (Status: Partially done);

(4) Coordinate with IOC regarding the WIGOS-WIS initiatives; (Status: Completed);

(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; (Status: Completed);

(6) Initiate first Pilot Projects:

(a) Joint GOS-GAW Pilot Project to accelerate implementation of WIGOS-WIS; (Status: Initiated);

(b) Initiation of Global Hydrological Network addressing a GCOS Requirement; (Status: Still in planning process);

(c) Integration of AMDAR into WIGOS; (Status: Initiated);

(d) Elaborating the underpinning/crosscutting role and responsibilities of the Instruments and Methods of Observation Programme; (Status: Initiated);

(e) Integration of marine meteorological and other appropriate oceanic observations into the WMO Global Observing System; (Status: Initiated);

(7) Adjust draft WDIP and CONOPS v.1.0 as guided by EC-WG/WIGOS-WIS and present draft WDIP and draft CONOP v.1.1 to EC-LX; (Status: Completed);

(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; (Status: done);

(9) At the Meeting of Presidents of Technical Commissions a major agenda item should be the WDIP to which the EC-WG/WIGOS-WIS would provide input. (Status: Partly completed);

(10) Initiate planning for the eight Demonstration Projects (see paragraph IX.); (Status: Done in the case of six);

V. Test of Concept, Phase II. EC-LX (June 2008) - EC-LXI (June 2009)

(1) EC-LX provides guidance for this phase; (Status: done);

(2) Review and update as appropriate the WIGOS CONOPS and WDIP; (Status: done);

(3) Initiate planning for the Pilot Projects concerning the integration of marine meteorological and oceanographic observations with WIGOS-WIS; (Status: done);

(4) The Pilot Projects (PP) begun in Phase I evaluated by corresponding Project Teams and SG-WIGOS; adjustments to the WDIP may arise from the evaluations; (Status: ongoing with a good progress: PP-I: Implementation Plan is missing; PP-II: change of the project; PP-III: Ongoing; PP-IV: Ongoing; PP-V: Ongoing);

(5) Coordinate with GTOS regarding terrestrial initiatives of relevance to WIGOS; (Status: pending, waiting for GCOS proposal on new PP);

(6) Additional Pilot Projects may be identified; (Status: done: EC-WG: reviewed and agreed with new proposals for GRUAN and GSICS Pilot Project);

(7) Demonstration Projects begun in Phase I evaluated by SG-WIGOS; adjustments to the WDIP may arise from the evaluations; (Status: Ongoing; project implementation plans to be submitted);

(8) Schedule possible concurrent sessions of CAS and CBS with joint agenda items regarding the integration of GAW and GOS into WIGOS; (Status: not feasible; Coordination underway; issue to be addressed/presented at CAS by appropriate WIGOS representative);

(9) Initiate work on the proposed revision to the WMO Technical Regulations; (Status: noted that some actions are required on Technical Regulations to be accomplished upon completion of Pilot and Demonstration Projects; initial discussion on the technical regulations is needed considering lessons learned);

(10) Revise WDIP and CONOPS and submit to EC–LXI for review and guidance; (Status: done);

(11) The agendas of technical commissions and regional associations should include an item relating to the Integration of WMO Observing Systems (including relevant components of co-sponsored observing systems) and should seek their "consensus inputs" to the WDIP to which the EC-WG/WIGOS-WIS would provide input; (Status: done at CHy-XIII, XIV-RA II, CBS TECO-WIGOS; XV-RA IV, CBS-XIV);

(12) Coordinate a way that RA working bodies can be involved into WIGOS activities in the Region (Status: started: initiated for two RAs (II, IV) that met during the period);

(13) Develop a reporting mechanism for Pilot and Demonstration projects; (Status: Ongoing);

(14) Elaborate basic definitions of WIGOS operations; (Status: Ongoing);

(15) Elaborate three areas of integration; (Status: done; significant revision achieved);

(16) Elaborate guidance on Demonstration Projects; (Status: Ongoing);

(17) Organize a workshop to facilitate the use of DCPCs in Pilot and Demonstration Projects; (Status: Pending);

PLANNING of the testing the WIGOS concept

VI. Test of Concept, Phase III. EC-LXI (June 2009) - EC-LXII (June 2010)

(1) EC-LXI provides guidance for this phase (note this is the last period for active planning before specific proposals are prepared for submission to Cg-XVI);

(2) Review and update as appropriate WIGOS CONOPS and WDIP;

(3) Agreed activities of Pilot and Demonstration Projects begun in Phase I and II should be completed and evaluated for viability of the WIGOS concept. Experiences from Pilot and Demonstration Projects to be reflected in the draft Implementation Plan for WIGOS;

(4) SG-WIGOS meets in 2009 to consider status of Demonstration and Pilot Projects, updates of CONOPS and WDIP and formulate recommendations for EC-WG/WIGOS-WIS;

(5) EC-WG/WIGOS-WIS meets in 2010 to elaborate draft recommendations for EC-LXII;

(6) The agendas of technical commissions and regional associations should include an item relating to the WIGOS and should seek their “consensus inputs” to the WDIP;

(7) Finalize elaboration of areas of integration;

(8) Elaborate standardized description of all observing networks contributing to WIGOS;

(9) Develop WIS component (e.g. DCPC) for each Demonstration and Pilot Project when needed;

(10) Develop Guidance for NMHSs why and how to optimize their observing network by integration of their observing systems;

(11) Coordinate with GCW regarding cryospheric initiatives of relevance to WIGOS;

(12) Further WIGOS implementation activities for the period May 2009 – March 2010 were considered by the second session of the Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System (EC-WG/WIGOS-WIS-2), 6 - 8 May 2009, and were included in the Future Work Programme and Action Plan of EC WG (Reference: Final Report of EC-WG/WIGOS-WIS-2, Appendix IV).

VII. Test of Concept, Phase IV. EC-LXII (June 2010) - Cg-XVI (May 2011)

(1) EC-LXII to agree on the content of the submission to Cg-XVI regarding the implementation of WIGOS. This will include the proposed changes to the Technical Regulations, the revised roles and Terms of References of the various technical commissions, the adjustments to the WMO Programme structure, and the impact on the Secretariat budgets and personnel, proposed actions of Cg-XVI how to implement WIGOS;

(2) Subgroup WIGOS meets in 2010 to formulate advice and recommendations to EC-WG WIGOS-WIS;

(3) EC-WG WIGOS-WIS considers matters relating to the revision of the Technical Regulations, the TORs of technical commissions, and proposals regarding WMO Programme structure and content, and the WMO Secretariat structure will be addressed in this Phase;

(4) Coordinate a way that RA working bodies can be involved into WIGOS activities in the Region;

(5) Pilot and Demonstration Projects will be evaluated for sustained legacy within WIGOS if appropriate. Experiences from Pilot and Demonstration Projects should be reflected in the draft Implementation Plan for WIGOS;

(6) Test of concept WDIP and CONOPS are completed and draft WIGOS Implementation Plan is prepared;

EC-WG WIGOS-WIS submits its final report and recommendations to Cg-XVI.

VIII. Implementation phase, Major tasks, Cg-XVI (May 2011) – Cg-XVII (May 2015)

Implementation of WIGOS

1. Participate in review of WMO constituent bodies (assumes Cg-XVI institutes such a review with respect to WIGOS and WIS impact on the organization)
2. Communications and outreach
3. Capacity building
4. Operational Database describing WIGOS components
5. Standards Database describing WIGOS standards & practices
6. Review WMO framework (TCs, RAs, governance)
7. Plan integration of framework for climate services
8. Space based strategy for operational climate monitoring

Review and Develop Documentation

1. WDIP (merge with GOS vision and IP)
2. CONOPS
3. RRR
4. Revision to the WMO Technical Regulations in coordination with WIS and the review of the WMO constituent bodies
5. WIGOS Guidelines and training material

APPENDIX L – PARADIGMS FOR SUCCESS

By learning from the past, as well as from current precursor activities to WIGOS such as the WIGOS Demonstration and Pilot Projects, WMO and its partners can build a more effective, robust, sustainable and cost effective integrated observing system – the WIGOS. But first: one story of successful integration that has positively affected every WMO Member.

An overarching example of success: Across the globe, NMHSs benefit from the output of today's Numerical Weather prediction models. Improvements in model forecast skill have increased dramatically over past decades and today's model forecasts for the southern hemisphere have become as accurate as those from the more data rich northern hemisphere. The key to a good forecast has its basis in observations and their assimilation; and, NWP on time scales from 1 to 14 days requires observations from all parts of the globe. Those observations are provided by a Global Observing System comprised of a variety of in-situ and satellite observations: the system is continually evolving and all of those data are valuable. However, one can unequivocally point to the successful integration of data from sophisticated space-based observations with data from in-situ systems, made possible by advanced data assimilation systems that led to this breakthrough. Why? Satellites do not directly measure geophysical parameters such as temperature and pressure but rather observe radiances. At first when satellite data were used in NWP it was natural to try and make the satellite measurement resemble the geophysical variable that the model was designed to use, vertical profiles of temperature and moisture. This assimilation of satellite data using optimal interpolation schemes of the 1980s resulted in satellite data having little, or even negative impact on NWP forecasts, and in the late 1980s satellite retrievals were blacklisted by many NWP centers. In the 1990s variation analysis schemes were introduced into data assimilation systems by many of the larger NWP centers, and by the end of the 20th Century the direct assimilation of satellite radiances had dramatically raised the importance of satellite data importance to NWP. Advances in NWP and science also played a major role in this breakthrough, but it was the successful integration of satellite with in-situ observations through advanced assimilation that brought success.

Into the future: The way forward with enhanced capability from NWP, from a data integration point of view clearly lies in the area of assimilation. Every few years WMO sponsors a Workshop on the Impacts of Various Observation Systems on NWP. Those workshops are attended by leading experts from the NWP and observations communities and look at impacts from various observing systems through Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) and give advice to WMO Members on ways forward. For example, while satellite data integration has provided for major advances forward in NWP forecast capability challenges remain to improve utilization of those data; those challenges, identified at the Impact Workshops are being addressed in a priority order by NWP centers. Furthermore, results from science experiments such as WMO's THORPEX are providing insights into the value of targeted observational strategies and observing system considerations which are important to the evolution of the WIGOS. In the future, as we improve in seasonal-to-interannual forecasts, integration of information from oceans and land will take on ever increasing importance, as pointed out in the WMO statement of guidance for seasonal-to-interannual forecasting "The time and space scales associated with seasonal-to-interannual variability suggest the key information for forecasts will derive mostly from the slow parts of the climate system, in particular the ocean, but also the land surface. When considering impacts such as rainfall deficiencies or increased temperatures over land, however, there are very good reasons for considering variables associated with the land surface conditions. In particular, land surface moisture and vegetation should be specified and predicted. The models should also include up-to-date radiative forcing (e.g., greenhouse forcing), which are important for maximizing skill in forecasts of land-surface air temperature anomalies relative to recent historical reference-normal periods." Clearly the demands of climate modeling require an integrated and comprehensive environmental observing system that can only be provided by WMO and its partners.

STRATEGIC THRUST: Improve Service Quality and Service Delivery

Our common goal:

1. Enhanced capabilities of Members to deliver and improve access to high quality weather,

climate and water and related environmental predictions, information and services in response to users' needs and to enable their use in decision-making by all relevant societal sectors
2. Enhanced capabilities of Members to reduce risks and potential impacts of hazards caused by weather, climate and water and related environmental elements

Example of success: Severe Weather Forecasting Demonstration Project. While NMHSs in more advanced countries have benefited from the integration observations through advanced assimilation into NWP, developing and least developed countries have lagged behind. Recognizing the benefits of integration and the resultant products in improving forecasting capabilities, in 2006 WMO initiated the Severe Weather Forecast Demonstration Project (SWFDP) in six South African countries that were highly impacted by Indian Ocean tropical cyclones. This highly successful project encompassed specialized training. It was underpinned by the Global Data-Processing and Forecasting System through improved access to, and effective use of outputs of numerical weather prediction products from advanced NWP centers, and was undertaken in collaboration with the Public Weather Services to improve the delivery of warning services. Tangible results included more reliable warnings and improved relationships between NMHSs and disaster managers and the media. In the context of the SWFDP, EC-LXI noted "… that in the SWFDP in southern Africa, in addition to the expansion into all sixteen countries of the region, RSMC Pretoria intended to extend its regional guidance role to include marine forecasting and to consider future incorporation of additional aspects, such as for aviation and flood forecasting, and a Web-based system for exchange and display of warnings in the region."
Into the future: The first regional project, which started in 2006, is being expanded to include all 16 countries of southern Africa and will span all seasons. One next step is to identify gaps in the observing system to improve verification of the warnings. A second project is in its early stage of implementation for the South Pacific Islands will address heavy rains, strong winds and damaging waves. No doubt others will follow along similar lines in other regions. It should be expected that in the future similar projects will extend across the major WMO applications areas served by the CBS's Rolling Review of Requirements: Climate Monitoring; Global NWP, Regional NWP, Synoptic Meteorology, Nowcasting and Very Short Range Forecasting, Seasonal to Inter-annual Forecasts, Aeronautical Meteorology, Atmospheric Chemistry, Ocean Applications, Agricultural Meteorology and Hydrology. Indeed, the Rolling Review of Requirements process, when viewed in the context of the WIGOS and coupled with information gathered through the WIGOS Demonstration and Pilot Projects, will help identify gaps in the WIGOS. Those gaps can then be filled in a cost effective manner, assimilated and provided to WMO Members to further improve services. It is also clear that common demands across the applications areas require an integrated and comprehensive environmental observing system that can only be provided by WMO and its partners. For WMO Members, WIGOS is the foundation of an end-to-end process that begins in observing and continues through service delivery.

STRATEGIC THRUST: Advance Scientific Research and Application as well as Development and Implementation of Technology

Our common goal:
1. Enhanced capabilities of NMHSs to produce better weather, climate, and water and related environmental information, predictions and warnings to support in particular climate impact and adaptation strategies.
2. Enhanced capabilities of Members to access, develop, implement and use integrated and inter-operable Earth- and space-based systems for weather, climate and hydrological observations, based on world standards set by WMO, as well as related environmental observations.
3. Enhanced capabilities of Members to contribute to and draw benefits from the global research capacity for weather, climate, water and environment science and technology development

Most of the realization of WIGOS will come through this particular strategic thrust and can be viewed as three levels of integration: a) Standardization of instruments and methods of observation; B) WIS information infrastructure; and, C) End-product quality assurance.

Examples of success: the following examples will be considered: 1) instrument level; 2)

observing system optimization; 3) satellites as an integrated system; and, 4) atmospheric chemistry.

Advances in instrumentation: Bringing a level of standardization in instrumentation is a major WMO accomplishment that has fostered integration at a number of levels. It would be difficult to imagine a network for meteorological and hydrological purposes that did not strive to meet the WMO guidelines for platform and instrument specifications, siting, measurement techniques and quality assurance and management of observing systems. Technological advancements have led to improvements in sensor and system capability to withstand severe climate and environmental conditions and to improvements in sensor capability to accurately measure the whole range of meteorological, climatological, hydrological and environmental variables with high precision and reproducibility. These factors significantly improved reliability and availability of observations. These all resulted in more sustainable and robust WMO observing systems providing data in all weather, climate and environmental conditions according to all users' requirements. Over the past 25 years, advances in micro-processing and communications technology, coupled with advances in instrumentation and standardization have made it possible to automate many measurements and remotely control acquisition systems, thus introducing cost-effectiveness into the GOS. Today AWSs are located in remote locations to fill gaps in the surface based observing system. While significant improvements have been realized much remains to be done.

Into the future: Five areas need to be addressed: standardization, automation, testing, networking and assimilation. The first key area to be addressed is standardization of best practices including quality control, metadata and data formats for new and emerging technologies. Standardization is required for all data so that the measurements from individual systems can be integrated into accurate and coherent data sets that allow for the development of unbiased long term trends. Automation will enable growth at reduced costs by allowing for increases in data frequency and consistency while avoiding coincident increases in labor costs. Further development of integrated ground-based remote sensing systems will provide key atmospheric variables such as clouds, winds, temperature and humidity. These systems will observe at high time resolution providing observations of atmospheric processes relevant to climate and weather. Long term testing at instrument "test-beds" will be used to judge their design, effectiveness and cost-efficiency for a full integration into WIGOS. Development in data assimilation techniques will allow the observations to be fully exploited in numerical models in an integrated manner. Assimilation will provide the means for data to be combined with other data in a cohesive and scientific way, as in NWP, that will allow data to be exploited as part of an integrated observing system where mutual benefits are derived from complimentary data.

Cost effective composite networks: Imagine an evolving optimized observing network within a region which results in a shared work load for the participating NMHSs along with enhanced capabilities and a fair cost allocation. Actually, one needs look no further than the EUCOS (EUMETNET Composite Observing System) Programme which is responsible for the evolution of the terrestrial component of the European observing system required to improve regional numerical weather prediction in the 24 to 72 hour period. EUCOS helped eliminate duplications of effort in the upper air and surface observing components operated by NMHSs, with a Quality Monitoring Portal built to ensure that the quality of all data delivered by the EUCOS networks was maintained at a high level. The EUCOS Operational Programme has brought significantly enhanced capability to the European NMHSs which they would not have been able to deliver on an individual uncoordinated national basis. Those tangible benefits are:

- Delivering more observations over the Ocean, optimized aircraft measurements over Europe and new data from European wind profiler systems and Weather Radar wind profiles;
- Delivering a centralized quality monitoring service with increased network performance and improved efficiency and cost-effectiveness through the centralized QM service allowing EUCOS Members to reduce their national quality monitoring efforts.

Over the oceans, EUCOS, through the E-SURFMAR buoy program has worked to optimize their buoy observation program by re-evaluating observational needs through integration with the space-based observations. The E-SURFMAR buoy program is coordinated with WMO and IOC via JCOMM and the Data Buoy Cooperation Panel. E-SURFMAR provides the link to GOOS and EURO-GOOS, where the

network design activities are coordinated. It was recognized that while the requirements for high quality winds for Regional NWP could be provided by the space segment the same was not true for air pressure: thus the decision was made to rely on the space segment for sea surface winds and deploy drifting buoys with only air pressure and sea surface temperature measuring capabilities. At the beginning of the project in 2003 there were 52 buoys with an annual system cost of around 474,000 €/year, in 2010 there will be 110 drifting buoys with a cost of 366,000 €/year: increased observing capability and decreased costs through integration. The reasons for the decreased cost: 1) unit cost for the buoy drifter became cheaper as no more buoys with wind measurement capabilities were deployed; and, 2) associated with this was a significant reduction in communications costs.

Into the future: the development of cooperative networks within Regions and with WMO and its partners. Activities with respect to WIGOS will have commonality in certain regards across WMO, however, it must be recognized that users, requirements, capabilities and services vary from WMO Region to Region as well as within Regions. To move WIGOS forward in a cost efficient manner will require Regional WIGOS Implementation Strategies as well as strategies of how Members within Regions can most effectively work together. At the Regional level, cooperation programs like EUCOS which allow for the testing of new observing strategies and ways toward optimization should be developed. Further, the lessons learnt from the ocean buoy program is one of great importance, where WMO and IOC Members worked together to coordinate a more robust and cost effective observing system. While integration of more conventional networks and observing systems is underway in developed and some developing countries this is not the case across all WMO. In some developing and least developed countries observing capabilities have diminished over time. This must be addressed as part of the WIGOS strategy.

Satellites as an integrated system: From a meager start almost 50 years ago when satellite images were uncalibrated photographs of clouds and the earth, growth in remote sensing technology and computer capabilities have led to the high resolution, multi-spectral digital renderings that satellite data are today. From both polar and geostationary orbits, meteorological and oceanographic satellites are now used by WMO Members for a variety of applications that span scales from nowcasting to climate, and include land, ocean, atmosphere and ecological applications. Simultaneously, new instruments on research satellites have provided insights into future satellite systems while selected data from those instruments are used on a routine basis for operational purposes by WMO Members. For example, historically winds over oceans, sea level altimetry and ocean color (health) have been in the remit of research satellites and have been provided in a transparent manner to WMO. Indeed, hyperspectral sounding data from the research Atmospheric InfraRed Spectrometer (AIRS) was the first of its type to be used in operational NWP. Meteorological satellites providing essential data for weather forecasting to NMHSs' across the globe; indeed it would be difficult to find an area of operational meteorology that has not been positively affected by meteorological satellites.

Into the future: The next two decades present exceptional challenges for WMO Members with respect to satellites, their data and exploitation of that data. Over the next ten years, Members will experience a transformation in space-based observing that is massive and unparalleled. Research satellite data will become available to WMO Members at a time when every operational space system of the past decades is undergoing major upgrades: data volumes are about to increase dramatically. This will offer unprecedented opportunities for the development of variety of sophisticated products and services. As capabilities of data and product providers evolve individual Members receiving all the data and products all the time makes no sense: that would constrain a delivery system while stressing a user's ability to cope with information overload. Availability of data and products must be based on the user's requirements. As we take advantage of the future's promise, marked changes will occur in the ways we approach data handling, science, product development, training and utilization. To prepare for the daunting task of monitoring and understanding the earth-atmosphere system from these new data, and ensuring their full utilization, we must work together in global science and operational partnerships.

Atmospheric Chemistry: Aerosols, ozone and longer-lived greenhouse gases are well recognized as "essential climate variables." The importance of including the effects of these atmospheric constituents in model projections and analyses of future climate change on time scales of decadal to century is now well recognized by the science community. The WMO GAW coordinates the Integrated Global Greenhouse Gas Observing System as part of the Integrated Carbon Observing

System. Since 1975 WMO has promoted the systematic and reliable observations of greenhouse gases on a global scale by establishing the world reference standard and ensuring the observations and their attendant meta-data are traceable and meet data quality objectives. Requirements are updated biennially using the rolling review process. The data on the mixing ratios of greenhouse and related reactive gases in the atmosphere and the ocean are collected and distributed by the World Data Center for Greenhouse Gasses in Japan. These measurements have played a critical role in the work of groups such as IPCC in examining climate change and climate adaptation. The effect of aerosols, because of their role in direct radiative forcing and precipitation formation, must be included in regional and global NWP models. Aerosols are highly variable in time and space in the troposphere, with typical residence times of 3 to 14 days; they cannot be represented by climatological distributions.

Into the future: The demands for accurate data by the climate community will continue during the next decade. In addition, incorporation of aerosols and ozone in next generation operational weather analysis and forecasting systems will place increased demands on those data's real time distribution. With the inclusion of aerosols and chemical variables in these advanced modeling systems we can expect the development of new products and services such as air quality predictions and sand and dust forecasts. Recognizing this impending need, WMO developed a WIGOS pilot project that will improve availability of ozone and Aerosol Optical Depth (AOD) and surface Particulate Matter (PM) observations to the user community via WIS and prepare documentation to help other communities make their observing practices compatible. The data will be used for ingestion into assimilation systems for atmospheric modeling; to support improved forecasts of weather, surface ultraviolet radiation and air quality; and, verification of models. Institution of a Rolling Review of requirements will help determine the need for dissemination on timescales appropriate to the applications. An important activity within this WIGOS pilot project includes supporting training and capacity building as necessary.

STRATEGIC THRUST: Strengthen Capacity Building

Our common goal:

1. Enhanced capabilities of NMHSs, in particular in developing and least developed countries, to fulfill their mandates.

Examples of success: A recent example of this holistic approach to capacity development was the aid project in Mozambique following the devastating floods in 2000. This project provided infrastructure (radars, AWSs), forecast systems to improve services and training to enable the equipment to be properly used and maintained. The Severe Weather Forecast Demonstration Project (SWFDP) is also an excellent example of what can happen when capacity building is undertaken from an end-to-end approach that begins with observations and their assimilation at DPFSs and ends in user services. Along a different vein (but with some interesting intersections to SWFDP) WMO and its space partners developed the Virtual Laboratory for Satellite Training and Data Utilization (VL) that was designed to enhance Members ability to utilize satellite data and products. The VL is a collaborative effort joining the major operational satellite operators with WMO "centers of excellence," COEs, in satellite meteorology. Those COEs serve as the satellite-focused training resource for WMO Members, and there is now at least one COE serving every official WMO language. Shared resources and training materials coupled with modern communications technology has enabled VL training in every WMO Region to be undertaken as a matter of routine; indeed, several COEs have formed Regional Focus Groups (RFGs) where a COE and the WMO Members it serves enter into routine discussions using real-time satellite data by employing internet for both communications and satellite data and product display. The RFG in Central America is very active, and in one instance where hurricane Wilma was threatening Central America the RFG met four times to provide insight into that storm's strength and rainfall potential – one member of the RFG was particularly concerned about whether or not to advise its water resources department to empty a water storage reservoir: loss of water or potential reservoir breach with flooding and loss of life! As a direct result of information gained from consultation through the RFG the decision was made not to empty a water storage facility: that decision saved millions of gallons of water while not placing the country's citizens in harms way.

Into the future: Capacity building for developing and least developed countries was addressed in the Implementation Plan for the Evolution of the GOS, WMO-TD 1267. Areas focused on in that

document are equally important for WIGOS. They address issues including public infrastructure, upgrading and restoring of equipment and capabilities, sustainability, the use of new technologies, and human resources.

The virtual lab will continue to grow and help all WMO Members realize benefits from satellite data. In a similar manner, WMO will encourage other major applications areas (global and regional NWP for example) to develop ways to mimic the success of the VL by major NWP centers sponsoring centers of excellence at WMO Training Centers in different Regions. Essentially this is a small extension of the mechanisms that have been demonstrated in the SWFDP where major NWP centers interacted with a RSMC who then coordinated with Members in their region. This extension would link the NWP center with the RSMC and the local training provider(s) to take full advantage of the various WMO partnerships.

STRATEGIC THRUST: Build and Enhance Partnerships and Cooperation

Our common goal:
1. New and strengthened partnerships and cooperation activities to improve NMHSs' performance in delivering services and to increase the value of contributions of WMO within the UN System, relevant international conventions and national strategies.

Examples of success: there are numerous examples of success where WMO has worked with its partners to improve our ability to monitor the Earth's environment. The GCOS climate monitoring principles were developed through coordination between WMO, CEOS, CGMS, IOC, UNEP, ICSU, and international conventions (UNFCCC). The growth in our ability to observe the ocean has increased dramatically over the past 25 years. This growth in the global ocean observing system's growth is due to the joint efforts of its sponsors: WMO, IOC of UNESCO, UNEP and ICSU. The GOOS serves as a platform for international cooperation for sustained observations of the oceans, generation of oceanographic products and services and interaction between research, operational, and user communities. Oceanographic researchers, coastal managers, parties to international conventions, national meteorological and oceanographic agencies, hydrographic offices, marine and coastal industries, policy makers and the interested general public benefit from the GOOS.

Into the future: In the case of marine observations, parts of the future have been outlined in the WIGOS Pilot Project for Marine Observations, focusing on the integration of in-situ and space based ocean observing systems. These will be implemented and sustained by the WMO and IOC Members through JCOOM in order to make appropriate data sets available in real-time and delayed mode to WMO and IOC applications through interoperability arrangements with the WMO Information System. Those data sets will be produced according to agreed upon standards and the quality control procedures documented according Quality Management Standard principles. This integration will enhance the coherence and consistency of the data sets and the availability of relevant instrument/platform metadata. More timely and better quality data will be expected while duplicates will be minimized. Similarly, as well as enhancing marine observations through space based observations, sharing of information from traditionally diverse observing systems will also be essential. This has been demonstrated with the work of the Hydrological community in making their rainfall runoff data available through the Global Runoff Data Centre as a part of WIS. This hydrological information can be used for a number of applications including modeling of salinity and with remote sensing data for improved ocean color products. Furthermore, other societal areas such as marine biology can access selected observations and products through the WIGOS interoperability layer of WIS.

Example of success: The space-based sub-system of the WMO serves a great range of activities that extend into all areas of environmental monitoring. In the early days of WWW the major space agencies formed the Coordination Group for Geostationary Meteorological Satellites which later dropped "Geostationary" from the title to become today's CGMS. The primary function of CGMS in its early days was backup in the geostationary orbit, and through that contingency planning activity and good will of the major operators, WMO Members have seen backup instituted on at least three occasions so that coverage from geostationary orbit was not lost over a particular WMO Region. In addition, at the request of WMO through CGMS, EUMETSAT has operated a spare METEOSAT to provide enhanced coverage over the Indian Ocean and NESDIS has operated a spare GOES from 60 West to provide coverage over South America. CGMS, along with WMO, also established three

science working groups that deal with winds (atmospheric motion vectors (AMVs)), precipitation and sounding. Through those working groups, quality standards and formats have been instituted for AMVs, multi-satellite and multi-sensor algorithms have been developed for estimating precipitation, and advanced atmospheric sounding derivation packages have been made available for use by WMO Members. It should be noted that all three science working groups both advise and provide assistance at various levels within the WMO through VL and major data assimilation centers. The satellite agencies that comprise CEOS have worked with WMO to investigate various theme areas which include carbon, oceans and others and have defined the concept of a CEOS constellation where satellite and surface-based observation systems address the various CEOS themes.

Into the future: Building partnerships and enhanced cooperation is an activity that must encompass the interests of collaborating partners. In the case of WMO and space agencies enhanced cooperation provided a venue for testing satellite concepts, providing examples of success for space agency data and helping define future needs for the space based portion of the GOS – this will easily be evolved to the WIGOS through existing mechanisms. WMO benefited greatly through enhanced access to satellite data and the advanced products and services that those data made available. With JCOMM similar mutual benefits helped forge a positive relationship. Mutual benefits such as this point to ways for WMO to strengthen its interaction with its co-sponsored observing system partners to provide a cohesive environmental data interface for United Nations Agencies that are focused on environmental stewardship as well as GEOSS. Integration of networks across different disciplines will become a necessary bridge for WMO and future partners to cross if we are to meet the grand challenge of Climate Services – Climate Services will require enhanced integration of observations as is pointed out in the GFCS. The potentially devastating impacts of climate change alone and the complexity of that issue justify the need for a coherent WIGOS.

Strategic Thrust: Strengthen Good Governance

Our common goal: An effective and efficient Organization

WIGOS will consolidate the responsibilities of WMO observing systems. However, it should be well recognized and understood that WIGOS is not a consolidation of the responsibilities of WMO partner observing systems, but rather a framework for recognition and agreement of WMO and its partners concerning each observing system's contributions and responsibilities.

Examples of success: Within the WIGOS framework, governance will occur at a number of levels. For example, within the EUCOS governance is established in a regional manner through agreements between Members participating in the program, and as was mentioned previously, the E-SURFMAR buoy program is coordinated with WMO and IOC via JCOMM and the Data Buoy Cooperation Panel which gives the link to GOOS and EURO-GOOS.

Into the future: Integration as a complex undertaking, which will comprise policy as well as technical issues, stretch over several years, and will require the full support of all Members to be successful. The integration will actively involve and eventually depend on the consensus inputs from the technical commissions, regional associations and the Steering Committees of the Global Climate Observing System, Global Ocean Observing System, Global Terrestrial Observing System and the Joint Scientific Committee of the World Climate Research Programme. It would require the approval of the Executive Council, and eventually of Congress, for major phases.

Within WMO: The development of an effective and efficient system of governance to guide and implement WIGOS will require 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. To develop a truly integrated WMO global observing system adjustments will need to be made in WMO Technical Regulations and will likely be required in the WMO Programme structure, the working structure and function of the Technical Commission, and of the WMO Secretariat.

Partners and data policy: 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).

The ownership and data-sharing policies of all observing components and partner organizations must be respected and ensured; however, it is important that WMO and its partners review their respective data policies with regard to the impending urgencies brought forward by climate change and climate monitoring; the potential for new and improved services to society offered through enlightened data sharing policies and agreements; and, the danger of lost opportunities to better serve society and policy makers when data are not available on a timeframe compatible with need.

APPENDIX M – OUTREACH AND CAPACITY BUILDING

Institutional mandates and policies

WMO Members will need to have clear national policies on roles and responsibilities for data gathering, archive, quality control and sharing: this affects the implementation of WIGOS at a national, regional and global level. Members will be expected to resolve these issues themselves, and it is anticipated that they will seek examples of good practice from WMO and in some cases may need assistance in developing the institutional frameworks to assure long term sustainability. WMO and its Members are already working with a number of developing and least developed countries to assist them in restructuring their NMHSs and introduce quality management principles to make them more sustainable in the long term. To get the full benefits from the implementation of WIGOS it will be necessary for Members to work through WMO Regional and Technical Structures to set up regional WIGOS implementation groups that foster the regional planning, funding, communication and development of the observing systems.

Infrastructure establishment and/or strengthening

Adequate financial support for maintaining and strengthening the capacity of NMHSs and for establishing and strengthening national, regional and global observation and communication networks would rely on Member support. Members themselves must accept a major share of the challenge of implementing WIGOS and strengthening their own capacity. Developed and developing countries alike would need to commit to providing adequate support to maintain their national data collection, archiving and sharing networks. To enable global access to national and regional data and products through the WMO Information System (WIS) will require the NMHSs to have robust Internet Technology (IT) and telecommunication facilities. These improvements would come at a cost. Particular emphasis should be placed on the needs of developing and least developed countries including Small Island Development States (SIDS,) and particularly vulnerable regions such as Africa, as highlighted by UNFCCC and its Bali Action Plan. WIGOS would aim to strengthen the capacity of NMHSs to deliver a complete suite of data and products to the national sectoral agencies with a view to mainstreaming weather, water and climate information into development decision-making.

In order for WIGOS to succeed, governments should give high priority to financing their NMHSs, communications, power and other infrastructure. Those countries that are able to help others, particularly the Organization for Economic Co-operation and Development (OECD) members, could do so through bilateral arrangements and through WMO and other UN initiatives. Wherever possible, existing and proposed projects and observation-related initiatives aimed at building capacity should be harmonized with the activities within the WIGOS. In view of the benefits that would follow for society as a whole around the world, Members could encourage the funding and development agencies their countries support (e.g. World Bank and others), to give high priority to WIGOS implementation and ongoing operation (infrastructure, communications, etc.).

Beginning with the detailed development of the WIGOS Implementation Plan, close collaboration, should be established with implementing and financing agencies such as the World Bank, regional development banks, the European Commission, the United Nations Development Programme (UNDP), the Global Environmental Facility and other bilateral and multilateral development agencies. To ensure the implementation and sustainability of WIGOS components, collaboration and partnerships should be sought with regional economic groupings, including the United Nations Economic Commission for Africa, ASEAN, the International Group of Research Funding Agencies (IGFA) and other national agencies with funding capacity. Alignment would be sought with other institutional programmes related to climate change, such as the AU-ECA-led ClimDev-Africa.

Human skills development and training

The Regional WIGOS Implementation Plans will incorporate the training needs necessary to develop capacity at national and regional levels and for identifying user requirements for education and training and for information-sharing techniques. Human skills in taking observations, maintaining equipment

and utilizing national, regional and global data and products would be developed through access to education and training utilizing appropriate methodologies such as traditional and online education and training, manuals, guidance documents, technical papers, fellowships and workshops. Members will also be encouraged to utilise education and training resources within the countries such as Universities and Technical colleges as well as accessing WMO Regional Training Centres, WMO Regional Instrument and Radiation Centres and other partner training organizations. At a Regional and global level the challenge will be to develop partnerships such as the WMO Virtual Laboratory for Satellite Education across the realm of WMO application areas that bring together the science community, the major global production centers and the training institutes. This would enable the flow of good science into operations with associated user level training to allow the global community to benefit from their investment in the national, regional and global observing and product creation infrastructure.

ATTACHMENT N – PROJECT GANTT CHART

Appendix V

Future Observing of the Earth and its Environment: The WIGOS Imperative

Since its establishment as a UN Specialized Agency almost 60 years WMO through its Members has advanced the observing and monitoring of the Earth's weather, water and climate systems. This has led to better understanding of the Earth's environmental system and resulted in the delivery of improved and expanded services such as weather, hydrological and air quality forecasts, climate outlooks and expanded advice and services to society. These services extend across timescales from severe weather warnings to weekly forecasts to seasonal climate prediction with broad applications across social and economic sectors world wide.

The challenge drives the need for change: An increasingly complex society and sophisticated user community, reflected by rapid economic and industrial development, coupled with increased knowledge of the planet as an integrated system and the changing Earth's climate has resulted in greater vulnerability of society to extreme weather events and climate change. This has resulted in the need for more extensive and advanced information for WMO Members so that they can continue to improve service quality and service delivery. To meet the demands of the future, WMO Members must continue their legacy of contributions by taking full advantage of advances in observation and telecommunication technologies and to increase our science based understanding of the Earth and its environment: the end result being better prediction and assessment of potential impacts of weather and climate related events to provide the required information for the public and policy and decision makers.

The WMO Integrated Global Observing System (WIGOS), endorsed by the Fifteenth WMO Congress is a major contribution of WMO to this challenge. Indeed, WMO Congress decided that the enhanced integration of the WMO observing system should be pursued as a strategic objective of the WMO and identified this as a major expected result of the WMO strategic plan.

Vision: WIGOS will establish an integrated, comprehensive and coordinated observing system to satisfy in a cost-effective and sustained manner the evolving observing requirements of WMO Members for their weather, climate, water and related environmental services and will enhance coordination of WMO observing systems with those of partner organizations for the benefit of society.

Scope: To achieve its objectives, WIGOS will:

- Build upon the existing observing components of WWW GOS, GAW, and WHYCOS, and will capitalize on existing, new and emerging technologies.
- Improve access to and utilization of surface-based observations and products from co-sponsored systems such as GTOS, GOOS and GCOS through enhanced coordination with partner organizations.
- Introduce data quality standards to improve quality management to satisfy user requirements.
- Improve its space-based component by enhanced collaboration through partnerships such as the Coordination Group for Meteorological Satellites (CGMS) and the Committee on Earth Observation Satellites (CEOS).
- Enhance integration between its surface- and space-based components.
- Provide a mechanism to meet new observational requirements of its Members.
- Make a major and unique contribution to United Nations agencies that are focused on environmental stewardship.
- Be a core contribution of WMO to the GEOSS.

Benefits: improved observing capability in a more cost effective manner to enable improved service delivery because:

- WIGOS will enable the evolution and integration of observing systems of WMO and enhance collaboration with its partner organizations: this will allow access to an expanded set of environmental data and products resulting in increased knowledge and enhanced services in a cost effective manner.

- WIGOS will better enable WMO Members' to meet expanding national mandates and achieve higher national visibility with other environment related agencies. In doing so, WMO Members will be able to better respond to natural hazards, improve environmental monitoring, and adapt to climate change and man-made environmental impacts. In this regard, WIGOS together with WIS will greatly enhance operational components of WMO Programs, especially in Developing and Least Developed Countries.
- WIGOS will provide a mechanism for enhanced integration between its surface and space based components.
- Integration will lead to efficiencies and cost savings that can be reinvested to overcome known deficiencies and gaps in the observing system. In this way WIGOS will provide capabilities to better utilize existing and emerging observational capabilities.

Imperative: WIGOS is a necessary prerequisite to allow WMO Members to realize the organization's strategic thrusts which are

- Improve service quality and service delivery.
- Advance scientific research and application as well as development and implementation of technology.
- Strengthen capacity building.
- Build and enhance partnerships and cooperation.
- Strengthen good governance.

In the sections that follow, addressed through the WMO Strategic Thrust areas, it will be shown how WMO can build upon existing capabilities and partnerships to bring WIGOS to fruition. It should be noted that integration with its coinciding benefits is not new, and some stellar achievements1 will be included in the text that follows to help place WIGOS in the proper context. By learning from the past, as well as from current precursor activities to WIGOS such as the WIGOS Demonstration and Pilot Projects, we, WMO and its partners can build a more effective, robust, sustainable and cost effective integrated observing system – the WIGOS. But first: one story of successful integration that has positively affected every WMO Member.

An overarching example of success: Across the globe, NMHSs benefit from the output of today's Numerical Weather prediction models. Improvements in model forecast skill have increased dramatically over past decades and today's model forecasts for the southern hemisphere have become as accurate as those from the more data rich northern hemisphere. The key to a good forecast has its basis in observations and their assimilation; and, NWP on time scales from 1 to 14 days requires observations from all parts of the globe. Those observations are provided by a Global Observing System comprised of a variety of in-situ and satellite observations: the system is continually evolving and all of those data are valuable. However, one can unequivocally point to the successful integration of data from sophisticated space-based observations with data from in-situ systems, made possible by advanced data assimilation systems that led to this breakthrough. Why? Satellites do not directly measure geophysical parameters such as temperature and pressure but rather observe radiances. At first when satellite data were used in NWP it was natural to try and make the satellite measurement resemble the geophysical variable that the model was designed to use, vertical profiles of temperature and moisture. This assimilation of satellite data using optimal interpolation schemes of the 1980s resulted in satellite data having little, or even negative impact on NWP forecasts, and in the late 1980s satellite retrievals were blacklisted by many NWP centers. In the 1990s variation analysis schemes were introduced into data assimilation systems by many of the larger NWP centers, and by the end of the 20th Century the direct assimilation of satellite radiances had dramatically raised the importance of satellite data importance to NWP. Advances in NWP and science also played a major role in this breakthrough, but it was the successful integration of satellite with in-situ observations through advanced assimilation that brought success.

Into the future: The way forward with enhanced capability from NWP, from a data integration point of view clearly lies in the area of assimilation. Every few years WMO sponsors a Workshop on the Impacts of Various Observation Systems on NWP. Those workshops are attended

1 The achievements are by no means all of those that have occurred, they are only meant to serve as example; omission of some by no means reflects priority or contributions of those other activities.

by leading experts from the NWP and observations communities and look at impacts from various observing systems through Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs) and give advice to WMO Members on ways forward. For example, while satellite data integration has provided for major advances forward in NWP forecast capability challenges remain to improve utilization of those data; those challenges, identified at the Impact Workshops are being addressed in a priority order by NWP centers. Furthermore, results from science experiments such as WMO's THORPEX are providing insights into the value of targeted observational strategies and observing system considerations which are important to the evolution of the WIGOS. In the future, as we improve in seasonal-to-interannual forecasts, integration of information from oceans and land will take on ever increasing importance, as pointed out in the WMO statement of guidance for seasonal-to-interannual forecasting "The time and space scales associated with seasonal-to-interannual variability suggest the key information for forecasts will derive mostly from the slow parts of the climate system, in particular the ocean, but also the land surface. When considering impacts such as rainfall deficiencies or increased temperatures over land, however, there are very good reasons for considering variables associated with the land surface conditions. In particular, land surface moisture and vegetation should be specified and predicted. The models should also include up-to-date radiative forcing (e.g., greenhouse forcing), which are important for maximizing skill in forecasts of land-surface air temperature anomalies relative to recent historical reference-normal periods." Clearly the demands of climate modeling require an integrated and comprehensive environmental observing system that can only be provided by WMO and its partners.

STRATEGIC THRUST: Improve Service Quality and Service Delivery

Our common goal:

1. Enhanced capabilities of Members to deliver and improve access to high quality weather, climate and water and related environmental predictions, information and services in response to users' needs and to enable their use in decision-making by all relevant societal sectors
2. Enhanced capabilities of Members to reduce risks and potential impacts of hazards caused by weather, climate and water and related environmental elements

***Example of success*:** Severe Weather Forecasting Demonstration Project. While NMHSs in more advanced countries have benefited from the integration observations through advanced assimilation into NWP, developing and least developed countries have lagged behind. Recognizing the benefits of integration and the resultant products in improving forecasting capabilities, in 2006 WMO initiated the Severe Weather Forecast Demonstration Project (SWFDP) in six South African countries that were highly impacted by Indian Ocean tropical cyclones. This highly successful project encompassed specialized training. It was underpinned by the Global Data-Processing and Forecasting System through improved access to, and effective use of outputs of numerical weather prediction products from advanced NWP centers, and was undertaken in collaboration with the Public Weather Services to improve the delivery of warning services. Tangible results included more reliable warnings and improved relationships between NMHSs and disaster managers and the media. In the context of the SWFDP, EC-LXI noted "… that in the SWFDP in southern Africa, in addition to the expansion into all sixteen countries of the region, RSMC Pretoria intended to extend its regional guidance role to include marine forecasting and to consider future incorporation of additional aspects, such as for aviation and flood forecasting, and a Web-based system for exchange and display of warnings in the region."

Into the future: The first regional project, which started in 2006, is being expanded to include all 16 countries of southern Africa and will span all seasons. One next step is to identify gaps in the observing system to improve verification of the warnings. A second project is in its early stage of implementation for the South Pacific Islands will address heavy rains, strong winds and damaging waves. No doubt others will follow along similar lines in other regions. It should be expected that in the future similar projects will extend across the major WMO applications areas served by the CBS's Rolling Review of Requirements: Climate Monitoring; Global NWP, Regional NWP, Synoptic Meteorology, Nowcasting and Very Short Range Forecasting, Seasonal to Inter-annual Forecasts, Aeronautical Meteorology, Atmospheric Chemistry, Ocean Applications, Agricultural Meteorology and Hydrology. Indeed, the Rolling Review of Requirements process, when viewed in the context of the WIGOS and coupled with information gathered through the WIGOS Demonstration and Pilot Projects,

will help identify gaps in the WIGOS. Those gaps can then be filled in a cost effective manner, assimilated and provided to WMO Members to further improve services. It is also clear that common demands across the applications areas require an integrated and comprehensive environmental observing system that can only be provided by WMO and its partners. For WMO Members, WIGOS is the foundation of an end-to-end process that begins in observing and continues through service delivery.

STRATEGIC THRUST: Advance Scientific Research and Application as well as Development and Implementation of Technology

***Our common goal*:**

1. Enhanced capabilities of NMHSs to produce better weather, climate, and water and related environmental information, predictions and warnings to support in particular climate impact and adaptation strategies.
2. Enhanced capabilities of Members to access, develop, implement and use integrated and inter-operable Earth- and space-based systems for weather, climate and hydrological observations, based on world standards set by WMO, as well as related environmental observations.
3. Enhanced capabilities of Members to contribute to and draw benefits from the global research capacity for weather, climate, water and environment science and technology development

Most of the realization of WIGOS will come through this particular strategic thrust and can be viewed as three levels of integration: a) Standardization of instruments and methods of observation; B) WIS information infrastructure; and, C) End-product quality assurance.

Examples of success: the following examples will be considered: 1) instrument level; 2) observing system optimization; 3) satellites as an integrated system; and, 4) atmospheric chemistry.

Advances in instrumentation: Bringing a level of standardization in instrumentation is a major WMO accomplishment that has fostered integration at a number of levels. It would be difficult to imagine a network for meteorological and hydrological purposes that did not strive to meet the WMO guidelines for platform and instrument specifications, siting, measurement techniques and quality assurance and management of observing systems. Technological advancements have led to improvements in sensor and system capability to withstand severe climate and environmental conditions and to improvements in sensor capability to accurately measure the whole range of meteorological, climatological, hydrological and environmental variables with high precision and reproducibility. These factors significantly improved reliability and availability of observations. These all resulted in more sustainable and robust WMO observing systems providing data in all weather, climate and environmental conditions according to all users' requirements. Over the past 25 years, advances in micro-processing and communications technology, coupled with advances in instrumentation and standardization have made it possible to automate many measurements and remotely control acquisition systems, thus introducing cost-effectiveness into the GOS. Today AWSs are located in remote locations to fill gaps in the surface based observing system. While significant improvements have been realized much remains to be done.

Into the future: Five areas need to be addressed: standardization, automation, testing, networking and assimilation. The first key area to be addressed is standardization of best practices including quality control, metadata and data formats for new and emerging technologies. Standardization is required for all data so that the measurements from individual systems can be integrated into accurate and coherent data sets that allow for the development of unbiased long term trends. Automation will enable growth at reduced costs by allowing for increases in data frequency and consistency while avoiding coincident increases in labor costs. Further development of integrated ground-based remote sensing systems will provide key atmospheric variables such as clouds, winds, temperature and humidity. These systems will observe at high time resolution providing observations of atmospheric processes relevant to climate and weather. Long term testing at instrument "test-beds" will be used to judge their design, effectiveness and cost-efficiency for a full integration into WIGOS. Development in data assimilation techniques will allow the observations to be fully exploited in numerical models in an integrated manner. Assimilation will provide the means for data to be combined with other data in a cohesive and scientific way, as in NWP, that will allow data to be

exploited as part of an integrated observing system where mutual benefits are derived from complimentary data.

Cost effective composite networks: Imagine an evolving optimized observing network within a region which results in a shared work load for the participating NMHSs along with enhanced capabilities and a fair cost allocation. Actually, one needs look no further than the EUCOS (EUMETNET Composite Observing System) Programme which is responsible for the evolution of the terrestrial component of the European observing system required to improve regional numerical weather prediction in the 24 to 72 hour period. EUCOS helped eliminate duplications of effort in the upper air and surface observing components operated by NMHSs, with a Quality Monitoring Portal built to ensure that the quality of all data delivered by the EUCOS networks was maintained at a high level. The EUCOS Operational Programme has brought significantly enhanced capability to the European NMHSs which they would not have been able to deliver on an individual uncoordinated national basis. Those tangible benefits are:

- Delivering more observations over the Ocean, optimized aircraft measurements over Europe and new data from European wind profiler systems and Weather Radar wind profiles;
- Delivering a centralized quality monitoring service with increased network performance and improved efficiency and cost-effectiveness through the centralized QM service allowing EUCOS Members to reduce their national quality monitoring efforts.

Over the oceans, EUCOS, through the E-SURFMAR buoy program has worked to optimize their buoy observation program by re-evaluating observational needs through integration with the space-based observations. The E-SURFMAR buoy program is coordinated with WMO and IOC via JCOMM and the Data Buoy Cooperation Panel. E-SURFMAR provides the link to GOOS and EURO-GOOS, where the network design activities are coordinated. It was recognized that while the requirements for high quality winds for Regional NWP could be provided by the space segment the same was not true for air pressure: thus the decision was made to rely on the space segment for sea surface winds and deploy drifting buoys with only air pressure and sea surface temperature measuring capabilities. At the beginning of the project in 2003 there were 52 buoys with an annual system cost of around 474,000 €/year, in 2010 there will be 110 drifting buoys with a cost of 366,000 €/year: increased observing capability and decreased costs through integration. The reasons for the decreased cost: 1) unit cost for the buoy drifter became cheaper as no more buoys with wind measurement capabilities were deployed; and, 2) associated with this was a significant reduction in communications costs.

Into the future: the development of cooperative networks within Regions and with WMO and its partners. Activities with respect to WIGOS will have commonality in certain regards across WMO, however, it must be recognized that users, requirements, capabilities and services vary from WMO Region to Region as well as within Regions. To move WIGOS forward in a cost efficient manner will require Regional WIGOS Implementation Strategies as well as strategies of how Members within Regions can most effectively work together. At the Regional level, cooperation programs like EUCOS which allow for the testing of new observing strategies and ways toward optimization should be developed. Further, the lessons learnt from the ocean buoy program is one of great importance, where WMO and IOC Members worked together to coordinate a more robust and cost effective observing system. While integration of more conventional networks and observing systems is underway in developed and some developing countries this is not the case across all WMO. In some developing and least developed countries observing capabilities have diminished over time. This must be addressed as part of the WIGOS strategy.

Satellites as an integrated system: From a meager start almost 50 years ago when satellite images were uncalibrated photographs of clouds and the earth, *growth in remote sensing technology and computer capabilities* have led to the high resolution, multi-spectral digital renderings that satellite data are today. From both polar and geostationary orbits, meteorological and oceanographic satellites are now used by WMO Members for a variety of applications that span scales from nowcasting to climate, and include land, ocean, atmosphere and ecological applications. Simultaneously, new instruments on research satellites have provided insights into future satellite systems while selected data from those instruments are used on a routine basis for operational purposes by WMO Members. For example, historically winds over oceans, sea level altimetry and

ocean color (health) have been in the remit of research satellites and have been provided in a transparent manner to WMO. Indeed, hyperspectral sounding data from the research Atmospheric InfraRed Spectrometer (AIRS) was the first of its type to be used in operational NWP. Meteorological satellites providing essential data for weather forecasting to NMHSs' across the globe; indeed it would be difficult to find an area of operational meteorology that has not been positively affected by meteorological satellites.

Into the future: The next two decades present exceptional challenges for WMO Members with respect to satellites, their data and exploitation of that data. Over the next ten years, Members will experience a transformation in space-based observing that is massive and unparalleled. Research satellite data will become available to WMO Members at a time when every operational space system of the past decades is undergoing major upgrades: data volumes are about to increase dramatically. This will offer unprecedented opportunities for the development of variety of sophisticated products and services. As capabilities of data and product providers evolve individual Members receiving all the data and products all the time makes no sense: that would constrain a delivery system while stressing a user's ability to cope with information overload. Availability of data and products must be based on the user's requirements. As we take advantage of the future's promise, marked changes will occur in the ways we approach data handling, science, product development, training and utilization. To prepare for the daunting task of monitoring and understanding the earth-atmosphere system from these new data, and ensuring their full utilization, we must work together in global science and operational partnerships.

Atmospheric Chemistry: Aerosols, ozone and longer-lived greenhouse gases are well recognized as "essential climate variables." The importance of including the effects of these atmospheric constituents in model projections and analyses of future climate change on time scales of decadal to century is now well recognized by the science community. The WMO GAW coordinates the Integrated Global Greenhouse Gas Observing System as part of the Integrated Carbon Observing System. Since 1975 WMO has promoted the systematic and reliable observations of greenhouse gases on a global scale by establishing the world reference standard and ensuring the observations and their attendant meta-data are traceable and meet data quality objectives. Requirements are updated biennially using the rolling review process. The data on the mixing ratios of greenhouse and related reactive gases in the atmosphere and the ocean are collected and distributed by the World Data Center for Greenhouse Gasses in Japan. These measurements have played a critical role in the work of groups such as IPCC in examining climate change and climate adaptation. The effect of aerosols, because of their role in direct radiative forcing and precipitation formation, must be included in regional and global NWP models. Aerosols are highly variable in time and space in the troposphere, with typical residence times of 3 to 14 days; they cannot be represented by climatological distributions.

Into the future: The demands for accurate data by the climate community will continue during the next decade. In addition, incorporation of aerosols and ozone in next generation operational weather analysis and forecasting systems will place increased demands on those data's real time distribution. With the inclusion of aerosols and chemical variables in these advanced modeling systems we can expect the development of new products and services such as air quality predictions and sand and dust forecasts. Recognizing this impending need, WMO developed a WIGOS pilot project that will improve availability of ozone and Aerosol Optical Depth (AOD) and surface Particulate Matter (PM) observations to the user community via WIS and prepare documentation to help other communities make their observing practices compatible. The data will be used for ingestion into assimilation systems for atmospheric modeling; to support improved forecasts of weather, surface ultraviolet radiation and air quality; and, verification of models. Institution of a Rolling Review of requirements will help determine the need for dissemination on timescales appropriate to the applications. An important activity within this WIGOS pilot project includes supporting training and capacity building as necessary.

STRATEGIC THRUST: Strengthen Capacity Building

Our common goal:

1. Enhanced capabilities of NMHSs, in particular in developing and least developed countries, to fulfill their mandates.

Examples of success: A recent example of this holistic approach to capacity development was the aid project in Mozambique following the devastating floods in 2000. This project provided infrastructure (radars, AWSs), forecast systems to improve services and training to enable the equipment to be properly used and maintained. The Severe Weather Forecast Demonstration Project (SWFDP) is also an excellent example of what can happen when capacity building is undertaken from an end-to-end approach that begins with observations and their assimilation at DPFSs and ends in user services. Along a different vein (but with some interesting intersections to SWFDP) WMO and its space partners developed the Virtual Laboratory for Satellite Training and Data Utilization (VL) that was designed to enhance Members ability to utilize satellite data and products. The VL is a collaborative effort joining the major operational satellite operators with WMO "centers of excellence," COEs, in satellite meteorology. Those COEs serve as the satellite-focused training resource for WMO Members, and there is now at least one COE serving every official WMO language. Shared resources and training materials coupled with modern communications technology has enabled VL training in every WMO Region to be undertaken as a matter of routine; indeed, several COEs have formed Regional Focus Groups (RFGs) where a COE and the WMO Members it serves enter into routine discussions using real-time satellite data by employing internet for both communications and satellite data and product display. The RFG in Central America is very active, and in one instance where hurricane Wilma was threatening Central America the RFG met four times to provide insight into that storm's strength and rainfall potential – one member of the RFG was particularly concerned about whether or not to advise its water resources department to empty a water storage reservoir: loss of water or potential reservoir breach with flooding and loss of life! As a direct result of information gained from consultation through the RFG the decision was made not to empty a water storage facility: that decision saved millions of gallons of water while not placing the country's citizens in harms way.

Into the future: Capacity building for developing and least developed countries was addressed in the Implementation Plan for the Evolution of the GOS, WMO-TD 1267. Areas focused on in that document are equally important for WIGOS. They address issues including public infrastructure, upgrading and restoring of equipment and capabilities, sustainability, the use of new technologies, and human resources.

The virtual lab will continue to grow and help all WMO Members realize benefits from satellite data. In a similar manner, WMO will encourage other major applications areas (global and regional NWP for example) to develop ways to mimic the success of the VL by major NWP centers sponsoring centers of excellence at WMO Training Centers in different Regions. Essentially this is a small extension of the mechanisms that have been demonstrated in the SWFDP where major NWP centers interacted with a RSMC who then coordinated with Members in their region. This extension would link the NWP center with the RSMC and the local training provider(s) to take full advantage of the various WMO partnerships.

STRATEGIC THRUST: Build and Enhance Partnerships and Cooperation

Our common goal:

1. New and strengthened partnerships and cooperation activities to improve NMHSs' performance in delivering services and to increase the value of contributions of WMO within the UN System, relevant international conventions and national strategies.

Examples of success: there are numerous examples of success where WMO has worked with its partners to improve our ability to monitor the Earth's environment. The GCOS climate monitoring principles were developed through coordination between WMO, CEOS, CGMS, IOC, UNEP, ICSU, and international conventions (UNFCCC). The growth in our ability to observe the ocean has increased dramatically over the past 25 years. This growth in the global ocean observing system's growth is due to the joint efforts of its sponsors: WMO, IOC of UNESCO, UNEP and ICSU. The GOOS serves as a platform for international cooperation for sustained observations of the oceans, generation of oceanographic products and services and interaction between research, operational, and user communities. Oceanographic researchers, coastal managers, parties to international conventions, national meteorological and oceanographic agencies, hydrographic offices, marine and coastal industries, policy makers and the interested general public benefit from the GOOS.

Into the future: In the case of marine observations, parts of the future have been outlined in

the WIGOS Pilot Project for Marine Observations, focusing on the integration of **in-situ** and space based ocean observing systems. These will be implemented and sustained by the WMO and IOC Members through JCOOM in order to make appropriate data sets available in real-time and delayed mode to WMO and IOC applications through interoperability arrangements with the WMO Information System. Those data sets will be produced according to agreed upon standards and the quality control procedures documented according Quality Management Standard principles. This integration will enhance the coherence and consistency of the data sets and the availability of relevant instrument/platform metadata. More timely and better quality data will be expected while duplicates will be minimized. Similarly, as well as enhancing marine observations through space based observations, sharing of information from traditionally diverse observing systems will also be essential. This has been demonstrated with the work of the Hydrological community in making their rainfall runoff data available through the Global Runoff Data Centre as a part of WIS. This hydrological information can be used for a number of applications including modeling of salinity and with remote sensing data for improved ocean color products. Furthermore, other societal areas such as marine biology can access selected observations and products through the WIGOS interoperability layer of WIS.

Example of success: The space-based sub-system of the WMO serves a great range of activities that extend into all areas of environmental monitoring. In the early days of WWW the major space agencies formed the Coordination Group for Geostationary Meteorological Satellites which later dropped “Geostationary” from the title to become today’s CGMS. The primary function of CGMS in its early days was backup in the geostationary orbit, and through that contingency planning activity and good will of the major operators, WMO Members have seen backup instituted on at least three occasions so that coverage from geostationary orbit was not lost over a particular WMO Region. In addition, at the request of WMO through CGMS, EUMETSAT has operated a spare METEOSAT to provide enhanced coverage over the Indian Ocean and NESDIS has operated a spare GOES from 60 West to provide coverage over South America. CGMS, along with WMO, also established three science working groups that deal with winds (atmospheric motion vectors (AMVs)), precipitation and sounding. Through those working groups, quality standards and formats have been instituted for AMVs, multi-satellite and multi-sensor algorithms have been developed for estimating precipitation, and advanced atmospheric sounding derivation packages have been made available for use by WMO Members. It should be noted that all three science working groups both advise and provide assistance at various levels within the WMO through VL and major data assimilation centers. The satellite agencies that comprise CEOS have worked with WMO to investigate various theme areas which include carbon, oceans and others and have defined the concept of a CEOS constellation where satellite and surface-based observation systems address the various CEOS themes.

Into the future: Building partnerships and enhanced cooperation is an activity that must encompass the interests of collaborating partners. In the case of WMO and space agencies enhanced cooperation provided a venue for testing satellite concepts, providing examples of success for space agency data and helping define future needs for the space based portion of the GOS – this will easily be evolved to the WIGOS through existing mechanisms. WMO benefited greatly through enhanced access to satellite data and the advanced products and services that those data made available. With JCOMM similar mutual benefits helped forge a positive relationship. Mutual benefits such as this point to ways for WMO to strengthen its interaction with its co-sponsored observing system partners to provide a cohesive environmental data interface for United Nations Agencies that are focused on environmental stewardship as well as GEOSS. Integration of networks across different disciplines will become a necessary bridge for WMO and future partners to cross if we are to meet the grand challenge of Climate Services – Climate Services will require enhanced integration of observations as is pointed out in the GFCS. The potentially devastating impacts of climate change alone and the complexity of that issue justify the need for a coherent WIGOS.

Strategic Thrust: Strengthen Good Governance

Our common goal: An effective and efficient Organization

WIGOS will consolidate the responsibilities of WMO observing systems. However, it should be well recognized and understood that WIGOS is not a consolidation of the responsibilities of WMO partner observing systems, but rather a framework for recognition and agreement of WMO and its

partners concerning each observing system's contributions and responsibilities.

Examples of success: Within the WIGOS framework, governance will occur at a number of levels. For example, within the EUCOS governance is established in a regional manner through agreements between Members participating in the program, and as was mentioned previously, the E-SURFMAR buoy program is coordinated with WMO and IOC via JCOMM and the Data Buoy Cooperation Panel which gives the link to GOOS and EURO-GOOS.

Into the future: Integration as a complex undertaking, which will comprise policy as well as technical issues, stretch over several years, and will require the full support of all Members to be successful. The integration will actively involve and eventually depend on the consensus inputs from the technical commissions, regional associations and the Steering Committees of the Global Climate Observing System, Global Ocean Observing System, Global Terrestrial Observing System and the Joint Scientific Committee of the World Climate Research Programme. It would require the approval of the Executive Council, and eventually of Congress, for major phases.

Within WMO: The development of an effective and efficient system of governance to guide and implement WIGOS will require 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. To develop a truly integrated WMO global observing system adjustments will need to be made in WMO Technical Regulations and will likely be required in the WMO Programme structure, the working structure and function of the Technical Commission, and of the WMO Secretariat.

Partners and data policy: 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).

The ownership and data-sharing policies of all observing components and partner organizations must be respected and ensured; however, it is important that WMO and its partners review their respective data policies with regard to the impending urgencies brought forward by climate change and climate monitoring; the potential for new and improved services to society offered through enlightened data sharing policies and agreements; and, the danger of lost opportunities to better serve society and policy makers when data are not available on a timeframe compatible with need.

Appendix VI

Work Programme and Action Plan of SG-WIGOS
WIGOS Implementation Activities
(October 2009 – March 2010)

No	Activities	Responsibility	Target
1	Submit the missing WIGOS Project Implementation and Work Plans	Project Focal Points	XI. 2009
2	Analyse the replies to WIGOS Project Questionnaire	WIGOS PO	XI. 2010
3	Develop WP Reporting Template	WIGOS PO	XI. 2009
4	Develop WP Evaluation Template	J. Nash, J. Purdom	XI. 2009
5	Submit WP Status Report	Project Focal Points	II. 2010
6	Generate report on lessons learned from the WPs	WIGOS PO, J. Nash	III. 2010
7	Submit final CONOPS and WDIP to EC-WG/WIGOS-WIS-3	J. Nash, J. Purdom	III. 2010
8	Ensure consistency of the WIGOS Documentation	WIGOS PO, J. Nash	III. 2010
9	Regularly inform WIGOS PO on the activities under individual WPs and corresponding deliverables achieved	Project Focal Points	III. 2010
10	Develop a document for the test case study initiation of the WIGOS observing systems' components database, and a presentation for EC-WG/WIGOS-WIS-3	WIGOS PO WIS PO	III. 2010

Note:
1) WIGOS PO: WIGOS Planning Office
2) WP: WIGOS Project (Demonstration or Pilot)
3) WIS PO: WIS Project Office