WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR CLIMATOLOGY

EXPERT GROUP MEETING
ON
QUALITY MANAGEMENT FOR CLIMATOLOGY

GENEVA, SWITZERLAND

21- 23 SEPTEMBER 2011

Final report of the first meeting

of the CCl Expert Group on Quality Management for Climatology (EG-QMC)

CONTENTS

EXECUTIVE SUMMARY

The First meeting of the CCl Expert Group for Climatology was held in Geneva, 21 - 23 September 2011 to review the terms of reference, set priorities and develop an outline for a strategy for the implementation of Quality Management for climatology including at global, regional and national levels as well as for the work of commission itself.

The meeting being held in Geneva provided a formidable opportunity for other WMO technical commissions to provide QMS status in their relevant area of responsibilities. Presentations were made by the relevant WMO staff. Experiences of QMS at National levels were also discussed.

The meeting recommended some actions to be undertaken for the rest of CCl intersession period in particular collecting information in the WMO six regions on current practices for QMS at NMHSs, prospect the possibility of hosting a dedicated web site on QM for climatology and work on the development of QM strategy based on the outline which the group developed at the meeting. The meeting identified reference documents or practices as potential candidates for a joint WMO/ISO standardization.

1. OPENING

1.1. The first meeting of the CCl Expert Group on Quality Management for Climatology (EG-QMC) was opened by its Chairperson, at 09.00 hours on Wednesday, 21 October 2011, at the WMO Headquarters, in Geneva, Switzerland.

1.2. Dr. Barbara Ryan, Director of the WMO Space programme welcomed the participants on behalf of the Secretary General of the WMO. She stressed on the importance of Quality Management System for the whole organization. She referred to the various relevant decisions made on the WMO Quality Management Framework (QMF) in view of not only improving services but also performing increased transparency for the user community. She noted that the inclusion in the agenda of issues like certification of competencies and the presentation of other technical commissions and programs QMF activities are very relevant to this meeting. For example Aeronautical Meteorology services are already subject to ISO certification under international binding commitments (ICAO), whereby meteorological services to aviation shall comply to QMS. This evolution will affect other services in the future. She underlined that the requirements of the Global Framework for Climate Services (GFCS) for high quality climate data and prediction products will evolve quite rapidly in the next four years, and again applying QMS in climatology will also evolve accordingly. She commended CCl interest to start working on QMS as it is timely due to do so in the context of the GFCS. She noted that the CCl Guide to Climatological Practices and other technical documents produced by CCl experts are other pieces of evidence that climatology as an applied science produces practical tools for delivering products and services based on common understanding and procedures. International recognition of these technical documents as legitimate candidates for ISO certification in the future is another part of strategy that CCl has correctly put in its priority of actions.

1.3. Mr. Sensoy, CCl Vice President and Chair of the CCl/EG-QMC explained that Quality Management (QM) is an emerging issue in all disciplines and many sectors have been implementing QM for their products and services since the last ten years. Implementing QM increases product and service quality, provides added value for their products, improves customer confidence and satisfaction. He reminded that improving service quality and service delivery is the 1st Strategic Thrust in the 2012-2015 WMO Strategic Plan. WMO Congress at its sixtieth session agreed that each NMHS should make efforts to improve its service through the implementation of the Plan-Do-Check-Action (PDCA) cycle in the QMS. At the fifteenth session in February 2010, WMO Commission for Climatology decided to develop a strategy for implementing QM in climate observations (including in-situ and remote sensing), data exchange, Database and services delivery, publications, capacity building and research. In pursuing CCl-XV decision (Resolution 2), the CCl MG established an Expert Group on QM for Climatology.

1.4. Dr. Mannava Shivakumar, Director of the Climate Prediction and Adaptation branch (CLPA) emphasized the important role of Quality Management in Climatology as well as in other technical commissions like the Commission for Agriculture Meteorology. He reminded that WMO Commission for Climatology Management Group decided to set-up an Expert Group on Quality Management for Climatology during its first session held in Geneva in May 2010. He informed that the output of the current meeting will be an important input to the upcoming CCl Management Group meeting which will be held in Denver, USA, 26-29 October 2011.

2. ORGANIZATION OF THE MEETING

2.1. Adoption of the agenda

The meeting adopted the agenda after considering an additional item relevant to a presentation of Manola Brunet titled “Some thoughts on QMS for CCl” and an item on WIS Metadata.

2.2. Working arrangements

The meeting agreed on the organization of its work.

3. INTRODUCTORY SESSION

3.1. CCl-XV decision on QMF

Omar Baddour, reported on CCl XV decision on Quality Management for Climatology. He described the content of CCl-XV Resolution 1 defining the vision and mission of the Commission for Climatology and CCl-XV-Resolution 2 concerning Quality Management Implementation Strategy for Climatology. He recalled that CCl-XV decided to develop a strategy for implementing quality management in climatology including in the main areas as follows:

(a) Climate observations, including in situ and remote-sensing measurements;

(b) Climate data exchange, including time-critical and non-real-time exchange through the WMO Information System;

(c) Climate database development and maintenance, including global, regional and national databases and homogenized datasets;

(d) Climate product generation and development, including climate analysis, climate predictions and climate watch advisories;

(e) Climate service delivery, user interaction and promotional activities;

(f) Publications including Guidelines and the *Guide to Climatological Practices* (WMO No. 100);

(g) Capacity-building, including educational and training material, curricula and e-learning;

(h) Applied climate research;

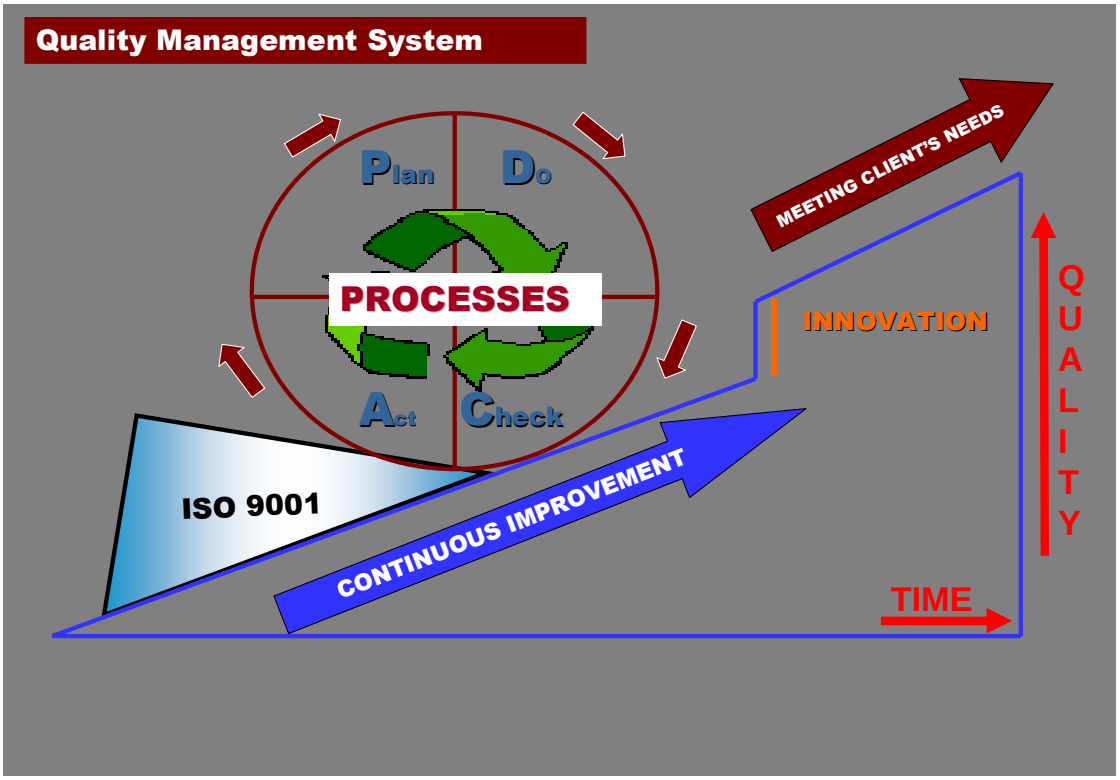
In addition he recalled the CCl-MG decision to establish the Expert Group on Quality Management for Climatology (CCl-EG-QMC)

3.2. WMO Quality Management Framework (QMF)

Herbert Puempel, presented the WMO Quality Management Framework (QMF) which relies on the ISO 9001 Quality Management Standards and principles. He mentioned that implementing QMS within NMHSs is progressively driven by the need for compliance to regulatory requirements, the need for the development of sound

management practices, the increasing pressure from the stakeholder (client) and the need for meeting the accountability requirements. He described the 8 Principles of a Quality Management System which include:

1. Existence of a leadership to lead QMS in the organization;
2. Existence of a mutually beneficial supplier-costumer relationship;
3. Continued improvement;
4. Factual approach to decision-making;
5. Focusing on client;
6. Process approach;
7. Involvement of people;
8. System approach to management;



Quality Management System

He informed the group on the three guidelines which have been published by WMO as Quality Manuals including:

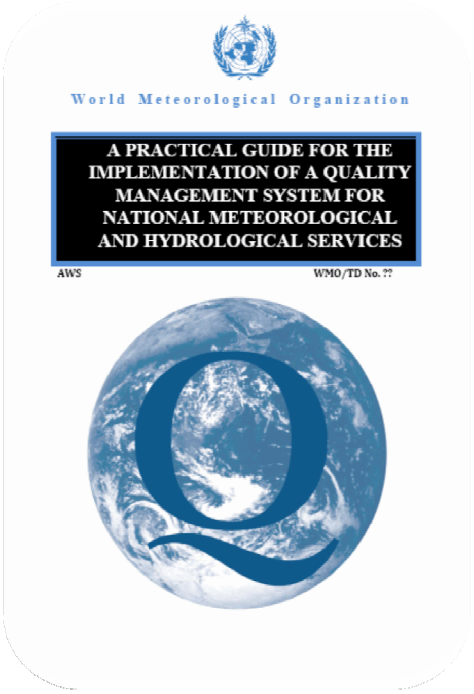
- Quality manual for ocean and marine weather services;
- Quality manual for weather services and disaster mitigation;
- Quality manual for aeronautical weather services.

On the certification side he mentioned the main benefits from ISO certification as it allows among other things:

- To provide a powerful tool to establish credibility & accountability (case of external audit by a third party);
- To provide a sound & proven management framework;
- To set up Quality Manuals - providing a good induction tool;
- To imbed continual improvement processes;
- To facilitate prompt & effective action on complaints;
- To enhance teamwork & communication;
- To raise quality awareness within the organization;
- To improve documentation procedures significantly;
- To ensure staff training;
- To enhance client confidence & satisfaction
- To assist in capturing corporate knowledge

In addition it is a powerful tool to ensure that important issues are highlighted at the appropriate organizational level.

On WMO QMF status, he mentioned that a new QM web page is now set up and can be accessed through: http://www.wmo.int/pages/prog/amp/QMF-Web/home.html. He informed the meeting on the publication of volume IV of the Technical Regulations (WMO-No.49) on Quality Management as well as the practical guide for the implementation of QMS for National Meteorological and Hydrological Services (NMHSs) (WMO/ TD No.77).



Regulatory material on QMS, WMO/TD No. 77 and Volume IV of the WMO technical regulations WMO-No49

3.3. Certification of competencies

Jeffery Wilson made a presentation on competencies including the ongoing WMO activities in this domain. He pointed out some lessons learned and examples from the Aviation sector and the definition of competencies in Aeronautical Meteorology. He suggested that classification of competencies should not be linked to job tasks or roles (Meteorologists are weather forecasters) and to consider developing tiered competency statements (generic high level, clarifying second level, adapt second level to national situation) and to build education and training around the competencies. For example the generic high level definition of a meteorologist is "**Meteorologist** – a person who has successfully completed the Basic Instruction Package for Meteorologists (BIP-M) requirements at university degree-level". CCl can build on this approach. The first step includes identification and clarification of the key tasks or roles of interest to CCl with the underlying knowledge, skills and behaviors. He offered that ETR office and EC Panel on Education and Training can help CCl in this matter.

3.4. CCl-MG actions

Serhat Sensoy recalled CCl MG decision on QMF. He indicated that at the fifteenth session in February 2010, WMO Commission for Climatology decided to develop a strategy for implementing QM in climate observations (including in-situ and remote sensing), data exchange, database and services delivery, publications, capacity building and research.
In pursuing CCl-XV decision (Resolution 2), the CCl MG established an Expert Group on QM for Climatology with T.o.R to be fulfilled in the intersession period. He emphasized on the priorities to be undertaken with particular emphasis on selecting some CCl reference documents or guidelines as candidates for ISO certification.

4. QMS SHOWCASES AND INITIATIVES WITHIN OTHER TECHNICAL COMMISSIONS

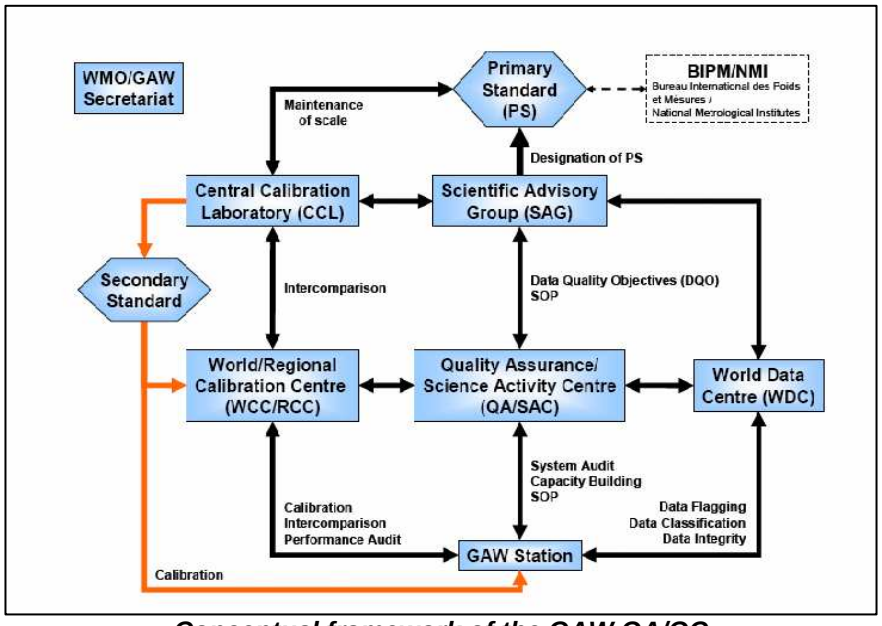
4.1. Herbert Puempel informed on the status of QM undertaken under the auspices of the Commission for Aeronautical Meteorology (CAeM). National Meteorological and Hydrological Services are seen as service providers to the public and to the industry. These services are enforced in aviation by national or international regulations as they constitute an essential component of safety and risk management systems in Aviation. Another key driver is that Aeronautical Meteorology service providers are now operating in a competitive and user driven environment. In pursuing QM implementation within the Members, CAeM with WMO is carrying out several initiatives including Twinning Arrangements between Members with advanced QMS and "Beginners". There have been unprecedented efforts in capacity building (>10 workshops in last 2 years). There is hope to have around 100-120 Members ready by November 2012, which is the deadline for NMHSs to apply QMS for Aeronautical Meteorology services. CAeM has successfully completed a Pilot Project on the implementation of QMS in a developing country (United Republic of Tanzania) for services to aviation.

4.2. Roger Atkinson informed on the Commission for Instruments and Methods of Observation (CIMO) perspective in QM. CIMO is the WMO technical body responsible for matters related to international standardization and compatibility of instruments and

methods of observation of meteorological, related geo-physical, and environmental variables. CIMO undertakes QM on two levels:
On operational level through the establishment of Test Beds / Lead Centres, establishment of common ISO/WMO Standards (E.g. Surface observation site classification, reviewing (audit) Regional Instrumentation Centres (RICs) and carrying out Metrology training workshops.
On regulatory level CIMO Guide is an important reference manual providing guidance to the Members on instruments and methods of observation. There is a plan for the CIMO Guide to be a living document, with a section on QM. CIMO is also seeking a potential for reissuing parts of the Guide as common ISO/WMO Standards.

4.3. Stephen Foreman briefed on the WMO Information System (WIS). He elaborated on the concept of WIS Metadata for the Discovery, Access and Retrieval (DAR) of data and products. Because DAR metadata must be homogeneous in form and in content, ISO 191xx standards are to be used for the description of discovery metadata. This is quite different from the Metadata concept in climatology which focuses on describing the history of the data sets in addition to the Station metadata. Detailed information on WIS can be accessed through the WIS web page at http://www.wmo.int/pages/prog/www/WIS/.

4.4. Oksana Tarasova informed on the Commission for Atmospheric Science (CAS) perspective in QM. Quality Management Framework is particularly highlighted for the Global Atmospheric Watch (GAW) programme (calibration, measurement guidelines, audits and inter-comparisons). GAW focuses on global integrated observations and analysis for GHGs, Ozone, UV, Aerosols, selected Reactive gases, and Precipitation chemistry. GAW is a partnership involving contributors from 80 countries. GAW QM applies to documentation including the internal programme protocols, procedures, agreements with Calibration Facilities and "assignment letters" for Stations. Training is an important element for ensuring QM, including for example training for operators of Stations. Twinning is also included as part of CAS strategy for QM



Conceptual framework of the GAW QA/QC

4.5. Igor Zahumensky made a presentation on the WMO Integrated Observing System (WIGOS) as an improved management of current and emerging observing systems based on meeting user requirements derived from a services delivery perspective utilizing WMO QMF principles and implemented through a continuous improvement process. There is an emphasis within WIGOS on the quality of the observations, metadata and joint standardisation with other international organisations and QMS implementation.
A mechanism on QMS for WIGOS is under-consideration by the Inter-Commission Group on WIGOS (ICG-WIGOS). Such mechanism is likely to be a Task Team on QMS with representatives of the WMO Technical Commissions and partner organizations.

4.6. Edgard Cabrera indicated that the Joint WMO/IOC Commission for Ocean and Marine Meteorology (JCOMM) is actively taking steps to implement QMS for MET-OCEAN data, products and services (Recommendation 8 (JCOMM-III)). He described the perspective of Marine Meteorology and Oceanography programme (MMO) which is guided by JCOMM. MMO activities addresses Maritime safety, search and rescue, navigation, polar regions; offshore industry; coastal safety and management; recreation; marine environmental protection; fisheries; climate research, forecasting and adaptation; marine accident response and emergency support; interface with the maritime services user community and quality management system.
Safety is an important driver for QM in MMO, particularly for the service side.
JCOMM is undertaking a QMS pilot project which is run by the Australian Bureau Of Meteorology (B.O.M) on Marine Weather, Tsunami Warnings and Ocean Services. A new WMO web page on QMS was set up by BOM. Twining is also part of JCOMM strategy for QMS.

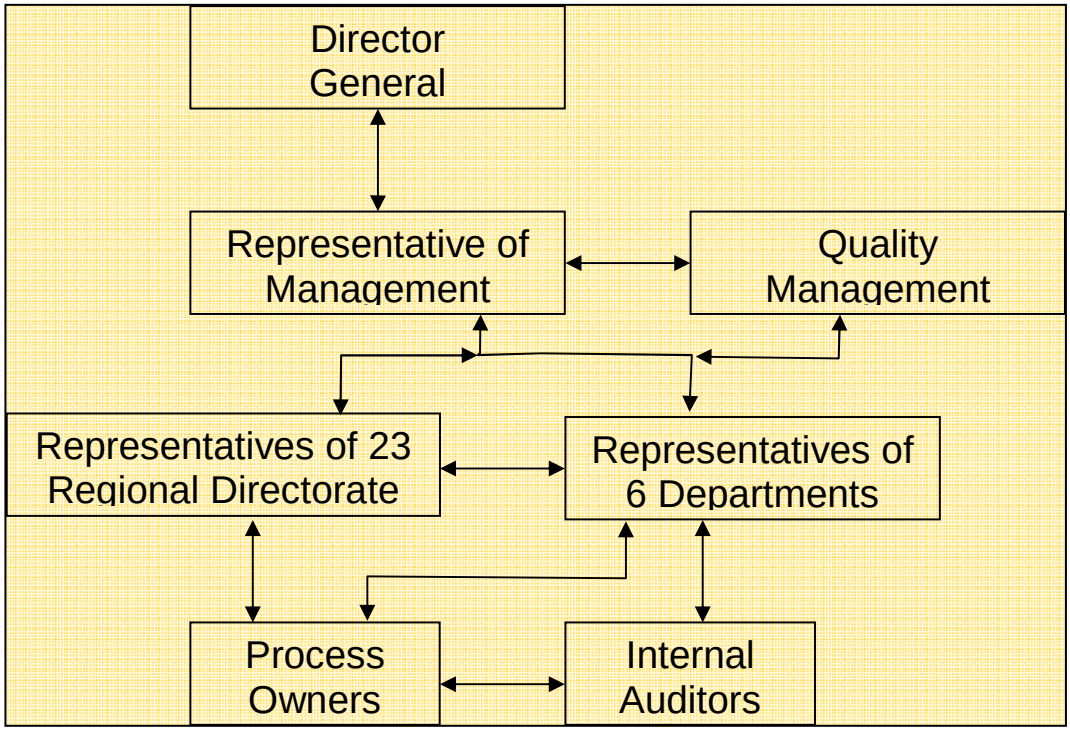
4.7. Robert Stefanski made a presentation on the outcome of the fifteenth session of the Commission for Agriculture Meteorology (CAgM) held in Brazil, July 2010. Among other priorities CAgM includes in its strategic planning inter-alia ‘’..focusing on more guidance materials on best practices in the use of climate information for climate adaptation and risk management in agriculture, the development of user-targeted products, and a better understanding of the impacts of climate variability and change on agriculture and water resources..” These priorities are of great relevancy to CCl focus as well. He informed that CAgM is moving toward producing more guidance materials and that there are ongoing discussions within CAgM management group on QMS issues.

4.8. Bruce Stewart presented the status in QMF for the Commission for Hydrology (CHy). He pointed out that the main focus is improving the quality of the processes from observations to products, including the quantification of uncertainties. CHy has chosen both standardization of measurements and observations and the status of regulatory and guidance documents/manuals as priority areas of their QMS initiatives. He also underlined the necessity for the continuous updates to key sections of the Guide to Hydrological Practices (WMO No.168) on an as required basis.

5. REPORTS FROM NMHSs

5.1. Turkish State Meteorological Service (TSMS)

Murat Altınyollar reported on TSMS accomplishments in QMS. He indicated that TSMS has received ISO 9001:2000 Quality Management System Certificate in 5 July 2007 for 3 years. The scope of the certificate consists of the whole TSMS organization: The 6 Departments of the Headquarters and 23 Regional Directorates. The certificate was renewed in 2 August 2010. The QMS includes 20 documented procedures, definition of 19 processes, 182 instructions and 367 forms. A Quality Manual as well as an Organization Manual is currently in operation.



Organization Structure of QMS at TSMS

A username and password protected portal is used to reach all the related documents such as, Quality manual, Organizational Manual, Procedures, Processes, Instructions, Forms, Audit Reports, Management Review Reports. The portal is also used to conduct staff satisfaction questionnaires, document revision requests, and Corrective and Preventive Action Requests.

Future plan on QMS as explained by Mr. Altınyollar are the following:

- **To simplfy the QMS**
  - Reducing number of processes
  - Revising procedures/working instructions

- **To appoint a Quality Manager under the Senior Management**
  (directly connected to General Director/Deputy General Director)

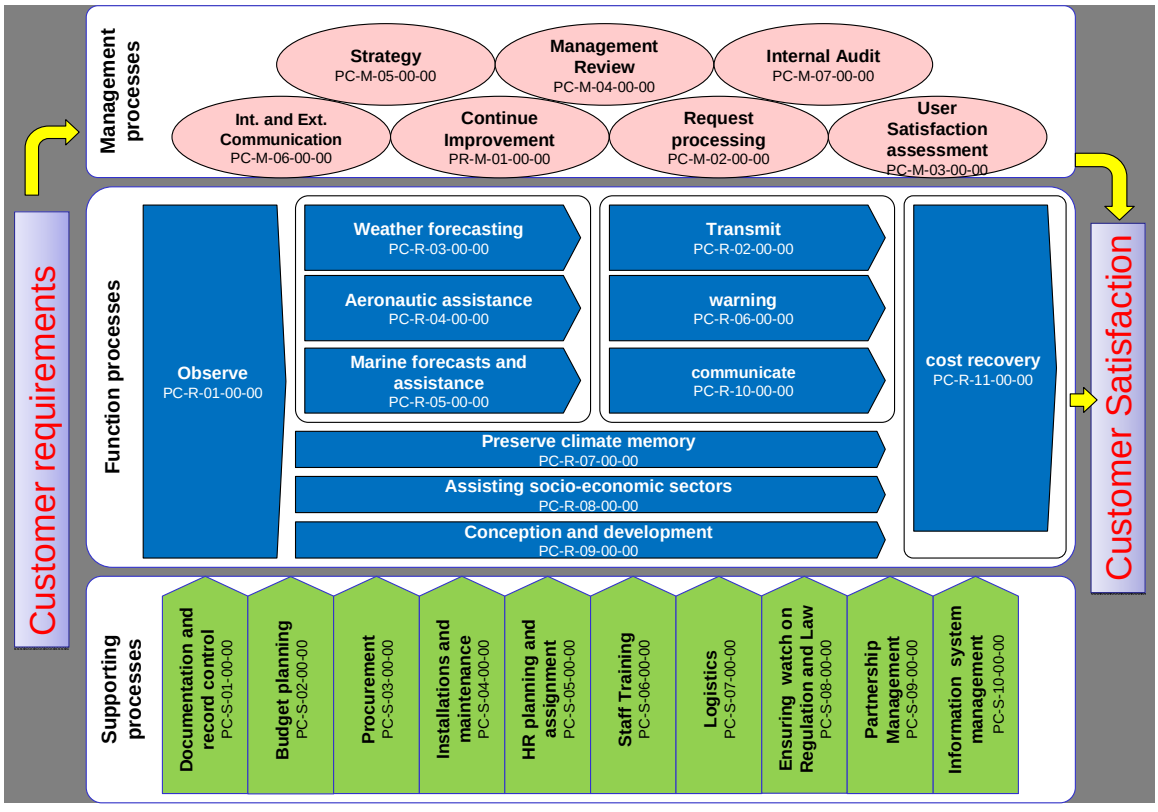
- **To Reduce internal audits expenses**
  -Performing effective audits by well-trained/skillful auditors
  -Performing audits once per two years

- **To impliment other management systems in the frame of QMS**
  -ISO 14001, Environmental Management System
  -OHSAS 18001 Occupational Health and Safety Management System

5.2. Direction de la Météorologie Nationale (DMN of Morocco)

Fatıma Driouech made a presentation of the current status of QMS at the Direction de la Météorologie Nationale of Morocco. She underlined that QMS addresses four main quality components: quality planning, quality control, quality assurance and quality improvement.

She described the approach taken by DMN in dealing with QMS based on the description and formalization of the identified processes which are used for product generation and services. Three main product processes have been defined including Observation products, Forecasting products and Climatology products. The later have been given a process title as ''preserving climate memory''. The purpose of this process is described as to preserve the climate memory by ensuring the availability of climate data base with the required updates and reliability to meet the user needs.



Processes mapping at DMN of Morocco

Managing QMS at DMN was based on involving organisation staff, training, self auditing and assigning working groups on various aspects of QMS. There were several steps followed in implementing QMS including communicating within the organization staff about the QM and the formalization of the processes, sending all relevant documents to the local and regional entities, setting up performance indicators for monitoring and evaluation and standardizing records and coding

6. QMS AND HIGH QUALITY DATA SETS

Manola Brunet from Spain provided some thoughts on QMS for CCl in the area of data rescue and high-quality dataset development. On another hand, she pointed out that best practices in Data Rescue (DARE) and High-Quality climate data and metadata development can be developed in compliance with ISO/WMO standards. In this regards, she indicated that, WMO DARE guidance (WMO/TD No. 1210) and its updates could be used to provide some practices that can be proposed for joint WMO/ISO standardization.

She mentioned relevant processes in this two areas including on one hand The methods and procedures employed for reconstructing climate time series, software/codes used, uncertainty estimates of the developed time series and on the other hand the methods used for taking into account systematic biases in climate time-series (e.g. historical changes in location, exposure, instrumentation, surroundings, environment, observational practices).

7. CCl/EG-QMC ACTION PLAN

7.1. Review of the T.o.R

The group reviewed the T.o.R and made slight amendments taking into account CG-XVI and EC-LXIII decisions by which ICTT on QMF was replaced by an EC focal point on QMF. Therefore the following changes were made in TOR 2 and TOR 5:

TOR 2. Report on best practices in QM in other disciplines and foster their adaptation to NMHSs and RCCs [adding: and other climate institutions] considering the wide spectrum of their level of competency and sophistication in climate activities;

TOR5. Liaise with the [Replacing ICTT with: EC relevant body on QMF] and other commissions;

7.2. Priorities and approaches for the development and implementation of a strategy on QMS for climatology

The Group considered the other WMO Technical Commission plans and experiences, as well as some showcases within the NMHSs. The Group proposed that the identification of QMS priorities at this stage should seek a simple approach due to the complexity of the topic and the need for a progressive approach. The group felt that it is necessary to start with the aspects of QMS that would have an immediate impact on the way climate activities are carried out in the context of the GFCS, regional and national requirements and the raising need for better management of these elements. The Group

recommended therefore the following three priorities to be considered for the development of a CCl strategy on QMS:

Priority 1 - Defining essential climatological processes at NMHSs and at regional level with the following four proposed categories: operational, development, user interface and service delivery, and capacity development. These four categories include sub-elements which underpin climate services. Therefore the Group proposed to start with defining the processes of these elements. There may be additional elements that could be added at the MG meeting and other elements that could be considered as the work on QMS evolves.

(a) Operational processes (covering national, regional and global needs)
- Data management (including exchange for regional and global requirements)
- Climate monitoring
- Climate prediction

(b) Development processes:
- DARE
- Climate time series reconstruction

(c) User interface and service delivery
- Communication (Outreach, feedbacks, surveys…forums)

(d) Capacity development
- Definition of climatological competencies (incl. training competencies)

Priority 2 - Establish a mechanism (may be rapporteurs or a TT) to assess, review and advise on the need to update key WMO Technical Documents and References relevant to climatology. This mechanism will add to the role of the rapporteur on the Guide to climatological Practices (Aryan Van Engelen). In this aspect, the Group recommended that the most urgent WMO technical documents to be assessed are:
- *WMO Technical regulation, WMO-No 49 Vol.I;*
- *WMO International Meteorological Vocabulary, WMO-No 182*

The updates should benefit from the definitions, procedures and practices already existing in the various CCl publications, such as the CCl Guide and the WCDMP Guideline series. The updates would seek to elevate the status of some given guidance in these publications to the regulatory level.

Priority 3 - Establish a web page to inform on the work of the group and on QMS resources and existing experiences. (Lead: Murat)

7.3. Reporting on best practices on QMS in other disciplines and foster their adaptation to NMHSs, RCCs and other climate institutions

In order to have a wide consensus of the definition of processes of climate activities, the Group felt that it was necessary to review the existing practices in different regions. This would contribute to a better understanding of the needs and requirements based on local climate context and the level of capacity of the NMHSs. In order to do this task the

Group recommended to assign to each member of the EG-QMC a region for conducting a wide assessment as follows:

RA-I (Fatima Driouech)
RA-II (Song Lianchun)
RA-III (Manola Brunet)
RA-IV (Albert Martis)
RA-V The group proposed to invite William Wright to complete the EG-QMC
RA-VI (Murat Altinyollar)

Furthermore, the Group recommended to task Jean Pierre Ceron to report on QMS being carried out within the regional entities and mechanisms, i.e. RCCs, RCOFs and within the Global Producing Centres (GPCs).

7.4. Proposal for CCl reference documents and practices as candidate for developing new common ISO/WMO technical standards

The Group recommended to consider two paths in parallel: one which is related to update WMO technical regulations as described in B-2. This update should reflect operational and development aspects of climatology as described in the CCl-Guide and Guidelines. The second path is to consider standardization of some of the existing or new definitions, algorithms and practices using the WMO/ISO working arrangements (ANNEX-V). For practical consideration, the Group recommended that at first stage the focus will be done on aspects which need high attention at NMHSs, RCCs, GPCs and Academia. These include the following areas:

(i) Observations and data (principles, metrics, procedures)

- Principles and methodology related QC/QA
- Definition of Essential Climate Metadata (ECM) for international exchange
- Benchmarking and metrics for climate data homogeneity
- Principles, procedures for Data Rescue and digitization of climate records

The investigation would be based on selected references (CCl Guide, WCDMP No. 53, WCDMP No. 55) (Lead: Manola)

- The list of Essential Climate Variables (Lead: Serhat)

The investigation would be based on selected references (WMO/TD No 1530, GCOS-143, 2010)

(ii) Climate Monitoring (definition, algorithms and products)

- Standard list for National Climate Monitoring Products (Lead: Fatima Driouech)
- Standard list for climate change detection indices (Lead: Serhat Sensoy)
- Normals (William Wright)
- Daily mean temperature (MG to decide on a CCl mechanism to address this issue)

The Group recommended prospecting in more details the opportunities and procedures for a WMO/ISO joint standardization and the WMO relevant channels (Murat, Omar) for submitting reference documents for this purpose.

Role of the leads:

a) Raise awareness about the need for standardization amongst the experts in the field
b) Identify individuals or teams to assist in selecting the items for standardization
c) Liaise with other stakeholders on the subject
d) Make recommendations to CCl (to be considered in CCl-XVI)

7.5. Proposed outlines for a QMS strategy for climatology

The Group recognized that a complete concept for QMS should evolve while taking already some steps as described above. In this regard, it is recommended to consider the general structure of the concept pointing out to the main elements which frame the QMS strategy for climatology. The group proposed the following outlines for this strategy comprising 6 key elements:

I- Rational

QMS-Climatology is a management tool for NMHSs, RCCs, GPCs and other climate related institutions to ensure authoritative, credible and transparent climate services to meet the GFCS requirements. There is also a need to apply QMS to fulfill international commitments for improved climate data and product generation and exchange through WMO WIS as well as the commitments to other UN bodies such as the IPCC and UNFCCC.
The rational will describe in details the need for QMS in observations and data, product generation, service delivery, capacity development and research as structured below:

I.1 Observations and data: Quality assurance, harmonization of procedures and algorithms and standards for elaborating high quality climate time series;

I.2 Product generation: Traceability, reproducibility, cost-effectiveness, transparency, service delivery: Costumer satisfaction (Quality, timeliness, trust) to be prepared for a highly competitive world;

I.3 Capacity Development (CD): Better identification of the needs for education and training (identification of competency requirement and needs);

I.4 Research and development (traceability, reproducibility, credibility)

II- Identification and documentation of processes for climatological activities within the NMHSs, Regional Climate Centres (RCCs), and Global Producing Centres (GPCs)

II.1 Documenting what to do and how to do;

II.2 Describe sub-processes and their inter-linkages;

II.3 Manual of standards and procedures for the processes and sub-processes;

II.4 Mapping processes and sub-processes with inclusion of technical references and standards

III- Evaluation and Monitoring

III.1 Auditing (Internal evaluation should be a permanent mechanism at all levels: NMHSs, RCCs, GPCs…); this would also help for improving the processes and to respond to external auditing by a third party.
III.2 Process monitoring tools, including the development of performance indicators and provision of regular performance reports including achievements compared to the goals and assessment of gaps and failures.

III.3 User satisfaction, including the development of user satisfaction indicators and conducting regular satisfaction surveys.

III.4 Review mechanisms: need to be established for climatology related processes as part of the overall review mechanisms of the organization (NMHSs, RCCs, GPCs,…)

IV- Capacity Development

IV.1 Understanding processes and related QM elements;

IV.2 Definition of competencies (including also (may be) certification and the way it is delivered);

IV.3 Reviewing the curricula for teaching and training in climatology at the WMO-Regional Training Centres (WMO-RTCs) and collaborating Universities.

V- Certification

This includes the identification of the need for certification, its justification and the context for its implementation considering the user requirements and research needs. In this aspect the Group suggested to consider the potential role of CCl in the certification of some of the processes, particularly those relevant to development, service delivery and capacity development.

VI- QMS implementation for the CCl work

The Group recommended to consider the main aspects of the commission and prospect the opportunity to apply QMS principles in these aspects. The following elements are considered to have the foundation and the need for implementing QMS for CCl work:

VI.1 Structure (Establishment, expert nomination,..);

VI.2 Meetings (harmonization in the management of the meetings, agenda, documents prior to the meeting, expected outcomes, selection of participants to workshops, seminars, (profile description, preparatory work and expected contribution during the meetings and the post-meeting work);

VI.3 Reporting, harmonize reporting format and timeliness;

VI.4 Technical documents and series: peer-review the documents before formal publication and review the WMO technical regulations to improve relevant chapters or sections to climatology;

VI.5 Propose CCl-reference documents and practices as candidate subjects for developing new common ISO/WMO technical standards;

VI.6 Set up a CCl web site as a tool for finding reference documents; migrate towards a service oriented web page with regular updates;

VI.7 Define a provider-user approach for CCl work and activities, include a user approach towards NMHSs, RCCs, GPCS, Academia, etc. as well as towards other WMO commissions and international bodies (e.g, UNFCCC, IPCC, GCOS, …)

ANNEX I Agenda

DATE	AGENDA ITEM		
21.09.2011 Wednesday	**1.**	**Opening of the Meeting** - Ryan Barbara, Director WMO Space Programme - Serhat Sensoy, CCl Vice president - Mannava V.K. Sivakumar, Director, WMO Climate Prediction and Adaptation Branch	
	2.	Adoption of the Agenda	
	3.	**INTRODUCTORY SESSION**	
	3.1.	CCl-XV decision on QMS	O. Baddour (WMO)
	3.2.	Quality Management concepts and the WMO QMF	H. Puempel (WMO)
	3.3.	Certification of competencies	J. Wilson (WMO)
	3.4.	CCl actions taken by 1st CCl MG meeting	S. Sensoy
	4.	**QMS SHOW CASES AND INITIATIVES WITHIN OTHER WMO TECHNICAL COMMISSIONS**	
	4.1.	CAeM	H. Puempel (WMO)
	4.2.	CIMO	P. Atkinson (WMO)
	4.3.	WIS	S. Foreman (WMO)
	4.4.	CAS (GAW)	O. Tarasova (WMO)
	4.5.	CBS / WIGOS	I. Zahumensky (WMO)
	4.6.	JCOMM	E. Cabrera (WMO)
	4.7.	AgM (tbc)	R. Stefanski (WMO)
	4.8.	CHY	B. Stewart (WMO)
22.09.2011 Thursday	**5.**	**SUCCESS STORIES in QMS at NMHSs**	
	5.1.	Turkish State Meteorological Service's accomplishments	M. Altınyollar
	5.2.	Morocco State Meteorological Service's accomplishments	F. Driouech
	6.	**QMS and high quality data sets**	M. Brunet
	7.	**EG-QMC ACTION PLAN**	
	7.1.	Review of EG-QMC T.oR, priorities, approaches and strategies	Group
	7.2.	Priorities and approaches for the development and implementation of a strategy on QMS for climatology	Group
	7.3.	Reporting on best practices on QMS in other disciplines and foster their adaptation to NMHSs, RCCs and other climate institutions	Group
23.09.2011 Friday	7.4.	Propose CCl reference documents and practices as candidate subjects for developing new common ISO/WMO technical standards	Group
	7.5.	Proposed outlines for a QMS strategy for climatology	O. Baddour, S. Sensoy

ANNEX II List of participants

Experts	
Mr. Serhat SENSOY (Chair) Vice-President, WMO Commission for Climatology (CCl) Turkish State Meteorological Service Kutukcualibey Cad. No.4, Ankara, Turkey Tel : +90 312 3022457 Fax : +90 312 3612371 email : ssensoy@dmi.gov.tr	**Dr. Fatima DRIOUECH** Direction de la Météorologie nationale Face Préfecture Hay Hassani B.P. 8106 Casa-Oasis Casablanca Tel: +212 66147 2352 Fax: +212 52291 3797 E-mail: driouechfatima@yahoo.fr
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Dr. Jeffrey WILSON Director, WMO Education and Training Office Tel +4122 730 8294 E-Mail: jwilson@wmo.int	**Mr. Hama KONTONGOMDE** Scientific Officer Data Management Applications WMO Information System Branch Observing and Information Systems Dept. Tel: 41 22 730 8251 Fax: 41 22 730 8042 Email: HKontongomde@wmo.int
Ms. Karolin EICHLER Junior Professional Officer Data Management Applications Division WMO Information System (WIS) Branch Observing and Information Systems Dept. *Tel.: +41 (0)22 730 8527* Email: keichler@wmo.int	

Invited Speakers:
Dr. Herbert Puempel on the Commission for Aeronautical Meteorology (CAeM)
Dr. Roger Atkinson on the Commission for Instrument and Methods of Observation (CIMO)
Dr. Stephen Foreman on the WMO Information System (WIS)
Dr. Oksana Tarasova on the Commission for Atmospheric Science (CAS)
Dr. Igor Zahumensky on the WMO Integrated Global Observing System (CBS/WIGOS)
Dr. Edgard Cabrera on the Joint WMO/IOC Commission for Ocean and Marine Meteorology
Dr. Robert Stefanski on the Commission for Agriculture Meteorology (CAgM)
Dr. Bruce Stewart on the Commission for Hydrology (CHy)

ANNEX III Resolution 2 (CCl-XV)

QUALITY MANAGEMENT IMPLEMENTATION STRATEGY FOR CLIMATOLOGY
THE COMMISSION FOR CLIMATOLOGY,

Noting:

(1) The decisions taken by the Fifteenth World Meteorological Congress and the Executive Council at its sixtieth session and the adoption of the working arrangements between the International Organization for Standardization (ISO) and WMO in accordance with Resolution 31 (Cg-XV) – Implementation of Quality Management Systems by National Meteorological and Hydrological Services, as an obligation to strive towards the implementation of quality management throughout the Organization, including technical commissions and National Meteorological and Hydrological Services,

(2) The final report of the third session of the Inter-Commission Task Team on Quality Management Framework, 2008,

(3) The report of the CCl Management Group (March 2009), emphasizing a Quality Management Framework,

(4) The outcomes of the World Climate Conference-3 including its declaration on the establishment of a Global Framework for Climate Services (Geneva, 31 August–4 September 2009),

Recognizing:

(1) That climate observations, climate data management, climate modelling and predictions
constitute a domain where a quality management system approach relies on existing foundations through technical documents, guides, manuals, technical regulations and standards,

(2) The growing needs for improved climate products and services including climate monitoring, climate assessment and prediction for risk management, adaptation to climate change and applications in socio-economic growth and sustainable development,

(3) The progress made in capacity-building through the Climate Information and Prediction Services (CLIPS) training, Regional Climate Outlook Forums training, climate data management training, regional workshops on climate change indices and regional workshops on climate monitoring including the implementation of climate watch systems,

(4) The improvement in organizational mechanisms and networking with the establishment of the Global Framework for Climate Services,

(5) The publication of a series of guidelines and brochures covering a wide range of knowledge, including the World Climate Data and Monitoring Programme guidelines on climate observations, climate data management, data rescue, climate watch systems and climate change indices, the CLIPS curriculum and a number of other related educational material in climate-related fields,

(6) That the emerging user needs for high-quality climate products and services in a competitive environment, and the evolving requirements of the Global Framework for Climate Services, require National Meteorological and Hydrological Services, Regional Climate Centres and Global Producing Centres including global climate data archiving and monitoring centres to implement a quality management system in the production and management processes of their climate-related activities and processes,

(7) The need for addressing increased demand by the users for documenting the processes involving the development and generation of climate data, products and services. Applying quality management in climatology would help to establish the required trust and transparency between the providers and users of climate information and services,

(8) The importance of paying specific attention to promote data exchange globally and regionally to make best use of the available national, regional and global climate databases,

Decides:

(1) To develop a strategy for implementing quality management in climatology including in the main areas as follows:

(a) Climate observations, including in situ and remote-sensing measurements;

(b) Climate data exchange, including time-critical and non-real-time exchange through the WMO Information System;

(c) Climate database development and maintenance, including global, regional and national databases and homogenized datasets;

(d) Climate product generation and development, including climate analysis, climate predictions and climate watch advisories;

(e) Climate service delivery, user interaction and promotional activities;

(f) Publications including Guidelines and the *Guide to Climatological Practices* (WMONo. 100);

(g) Capacity-building, including educational and training material, curricula and e-learning;

(h) Climate and applied climate research;

(2) To request the CCl Management Group to consider the decisions which will be taken by the WMO Executive Council at its sixty-second session related to Quality management Framework and the Inter-Commission Task Team on Quality Management Framework recommendations. The following activities should frame the CCl implementation strategy in quality management:

(a) Organize a technological watch on quality management developments and report on best practices in quality management in other disciplines and foster their adaptation to National Meteorological and Hydrological Services and Regional Climate Centres, considering the wide spectrum of their level of competency and sophistication in climate activities;

(b) Develop an integrated concept for implementation of quality management in the areas of climatology as defined in (1);

(c) Propose CCl reference documents and practices as candidate subjects for developing new common ISO/WMO technical standards;

(d) Report regularly to the president of the Commission and the CCl Management Group;

(3) To request the CCl Management Group to set up, at an appropriate time during the intersessional period and taking into consideration the decisions of the Executive Council taken at its sixty-second session, an Expert Group on Quality Management for Climatology comprised of co-chairs of Open Panels of CCl Experts and other experts whom the Management Group considers appropriate to call upon for their expertise in quality management. The terms of reference for this Group should be drawn up from quality management activities proposed in (2) (a) to (d). The Management Group should ensure a close interaction with other technical commissions and programmes and Executive Council subsidiary bodies on quality management framework;

Requests the president of the Commission:

(1) To interact with the presidents of the other WMO technical commissions to integrate their perspectives of QM needs of the various components of climatology to support enhanced climate services, including adequate user interface aspects;

(2) To ensure that CCl and related activities benefit from other WMO programme experience in
the accreditation and certification of services through the ISO/WMO working arrangements;

(3) To guide quality management in climatology through the CCl Management Group and any other group of the Commission as appropriate;

Requests the Secretary-General to facilitate appropriate inter-programme coordination within, and support by, the Secretariat to ensure an efficient performance of the expert group; **Urges** all Members, regional associations and relevant technical commissions, through appropriate arrangements or agreements, to:

(1) Mobilize national and regional support for the implementation of quality management in climatology;

(2) Mobilize additional resources required at the regional and national levels for this purpose;

(3) Facilitate technology transfer to developing countries in implementing quality management in the production and management processes of climate data, products and services.

ANNEX IV Congress Resolution on QMF

Res. 4.5/1 (Cg-XVI) - WMO QUALITY MANAGEMENT FRAMEWORK

THE CONGRESS,

Noting the increasingly high impact of weather, water and climate information on crucial societal decision making processes,

Noting further the increased scrutiny of the quality, reliability and accuracy of weather, water and climate products and services by critically important stakeholders,

Having considered recent developments in some application areas such as aviation or marine meteorology, where partner organizations are mandating the implementation of QMS for services to them,

Recognizing the high importance of the working arrangements between WMO and ISO including the recognition of WMO as a Standardizing Organization for Technical Standards, a rare distinction given only to three organizations worldwide,

Recommends a full integration of the QMF into the wider WMO Strategic and Operational Planning process as part of a holistic management system encompassing Quality Management, Risk Management, Results-based Management as well as Monitoring and Evaluation;

Invites Members with a well-developed QMS in place to share experiences, expertise and documentation with other Members currently developing or planning such systems;

Agrees with the conclusions of the Inter-Commission Task Team on Quality Management Framework (ICTT-QMF) and the Executive Council concerning the need for a twinning partnership system;

Requests the Executive Council to establish an appropriate mechanism with the task to promote, oversee and guide the further implementation of the Quality Management Framework in as simple and an effiicient manner as possible;

Requests the Secretary-General, in cooperation with the Executive Council to undertake an in-depth Gap Analysis of the WMO Secretariat in terms of QMS with a view of developing a business case for a Pilot Project of QMS implementation;

Urges the technical commissions to explore opportunities to develop new common Technical Standards under the Working Arrangements between ISO and WMO;

Encourages Members to provide in-kind and extrabudgetary resources to help achieve these goals; and

Further encourages Members to subject their QMS to regular monitoring and evaluation to ensure continuous improvement and sustained compliance with ISO 9001:2008

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Note: This resolution replaces Resolution 32 (Cg-XV), which is no longer in force.

ANNEX V

Working arrangements between the International Organization for Standardization and the World Meteorological Organization

Introduction

The working arrangements concluded with the International Organization for Standardization (ISO) were approved on behalf of the World Meteorological Organization by the Executive Council at its sixtieth session in June 2008 and on behalf of the International Organization for Standardization by its the Secretary General ……. on …….. on the basis of ISO Council Resolution 43/2007.

Working arrangements

1. Background

The International Organization for Standardization (ISO) and the World Meteorological Organization (WMO) have been working in close cooperation since the granting of consultative status to ISO by the WMO Executive Council at its fifth session in 1954.

ISO has recognized WMO as an international standardization body through ISO Council Resolution 43/2007.

These working arrangements between the WMO and ISO aim to strengthen the development of International Standards and to avoid duplication of work on standards related to meteorological, climatological, hydrological, marine and related environmental data, products and services.

In the text of these working arrangements the word “standard” is used with the meaning given in ISO/IEC [1] Guide 2:2004, *Standardization and related activities — General*

[1] IEC is the International Electrotechnical Commission

vocabulary. The resulting standards developed under these working arrangements are hereafter called “common standards”.

2. Generalities

The Secretary-General of WMO and the Secretary-General of ISO, with the aim of effectively attaining the objectives set forth in their respective constituent instruments, will act in close cooperation with each other and will consult each other regularly in regard to matters of common interest.

Both organizations agree to keep each other informed on current and planned activities in which there may be mutual interest.

WMO and ISO agree to exchange publications concerning these and related fields.

Suitable arrangements will be made for the participation of each Party to the working arrangements as an observer in those sessions and meetings of the other Party at which matters of common interest are discussed.

3. Scope of application

Subject to their respective rules and procedures, and within the limits of their responsibility and available resources, WMO and ISO will share with each other relevant information regarding their respective work programmes and facilitate active participation and substantive contribution to each other’s relevant meetings, appropriate workshops, seminars, working party or expert group meetings addressing standards issues associated with meteorological, climatological, hydrological, marine and related environmental data, products and services.

This cooperation includes and encourages the active participation of WMO as a liaison organization in relevant ISO technical committees (TC) or subcommittees (SC) as well as reciprocal participation by ISO in relevant WMO meetings. It more specifically addresses working arrangements between ISO and WMO in the development of standards and their subsequent publication.

These working arrangements shall apply to the following work items:

1) Publications proposed by WMO that are determined by ISO not to fall within the scope of an existing ISO committee. Such proposed WMO publications shall be submitted to the ISO Central Secretariat for consideration by the full ISO membership as indicated below.
2) Publications proposed by WMO falling within the scope of ISO/TC 146 (Air quality), ISO/TC 147 (Water quality), ISO/TC 113 (Hydrometry), ISO/TC 180/SC 1 (Solar energy, Climate - Measurement and data) or ISO/TC 211 (Geographic information/Geomatics). Such proposed WMO publications shall be treated within the work programme of the corresponding ISO technical committee or subcommittee and as indicated in Clause 4.
3) Work proposed by ISO or WMO within the scope of the ISO/TCs referred to above, when it has been determined that a new International Standard or other deliverable is required and for which ISO and WMO concur that significant

contribution in the development of the standard would be provided by ISO and WMO.

Where it has been determined that a new International Standard or other deliverable is required, and when a WMO publication exists and there is no equivalent or similar ISO standard, the WMO publication shall be taken as the basis for joint work.

4. Standards development and standards adoption modalities

The text of any common standard shall be approved by both Organizations independently.

For the approval of any proposal, there are 2 possibilities:

A) Existing WMO publication proposed for approval 'as it is' by ISO:

A.1) Publication not falling within the scope of an existing ISO committee

WMO being a recognized international standardizing body as per ISO Council Resolution 43/2007, may propose that a WMO publication (technical regulation, manual, guide or other relevant WMO normative publication) be submitted for vote as a five-month final draft International Standard within ISO (as covered by the ISO/IEC Directives, Annex F, subclause F.2.1.2).

The conditions for approval shall be that not more than one-quarter of the total number of votes cast be negative.

If the conditions of approval are met, the document shall progress to the publication stage. If not, the proposal has failed and any further action shall be decided upon by discussion between the WMO Secretariat and the ISO Central Secretariat.

A.2) Publication falling within the scope of an existing ISO committee

WMO may propose that a WMO publication (technical regulation, manual, guide or other relevant WMO normative publication) be submitted for vote as a five-month enquiry draft within ISO (as covered by the ISO/IEC Directives, Annex F, subclause F.2.1.1).

The conditions for approval shall be as specified in 2.6 of the ISO/IEC Directives for an enquiry draft (a two thirds majority of the votes cast by the P-members of the ISO committee are in favour, and not more than one-quarter of the total number of votes cast are negative).

If the conditions of approval are met, the document shall progress to the approval stage (2.7 of the ISO/IEC Directives), i.e. be submitted for vote as a two-month final draft International Standard within ISO. If not, the proposal has failed and any further action shall be decided upon by discussion between the relevant WMO body, the WMO Secretariat, the ISO committee to which the proposed publication was attributed, and the ISO Central Secretariat.

B) Joint development of a standard by WMO and an ISO technical committee or subcommittee

WMO may propose, in agreement with the appropriate ISO technical committee or subcommittee, that a draft WMO publication be submitted for vote as a five-month enquiry draft within that ISO committee, in parallel with the approbation of the responsible WMO technical commission.

The conditions for approval shall be as specified in 2.6 of the ISO/IEC Directives for an enquiry draft (a two-thirds majority of the votes cast by the P-members of the ISO committee are in favour, and not more than one-quarter of the total number of votes cast are negative). Comments and negative votes shall be referred to WMO who will take them into consideration in collaboration with the relevant ISO committee.

If the conditions of approval are met, the draft standard shall progress to the approval stage (2.7 of the ISO/IEC Directives), i.e. be submitted for vote as a two-month final draft International Standard within ISO and be submitted, in parallel, for approval to the relevant WMO constituent body. If not, the proposal has failed and any further action shall be decided upon by the ISO committee to which the document was attributed with discussion with the WMO Secretariat and the ISO Central Secretariat.

If, for the final draft International Standard, the conditions of approval are met, the document shall progress to the publication stage. If not, the proposal has failed and any further action shall be decided upon by the ISO committee to which the document was attributed with discussion with the relevant WMO body, the WMO Secretariat and the ISO Central Secretariat.

For the above possibilities, the proposal shall be received by ISO Central Secretariat, who shall take the following actions:

- Assess in consultation with WMO if an ISO technical committee/subcommittee is competent for the subject covered by the proposed document;
- Ascertain that there is no evident contradiction with other International Standards;
- Distribute the proposed document as an enquiry draft (cases A.2 and B) in accordance with the ISO/IEC Directives subclause 2.6.1, or as a final draft International Standard (case A.1) in accordance with F.2.1.2 and F.2.3, indicating (if relevant) the ISO technical committee/subcommittee to the domain of which the proposed document belongs.

The establishment of a new work item aiming at the publication of a common standard, shall result from a decision approved both by WMO and by ISO in accordance with their own procedures. A new work item may be proposed by any of the two Organizations and may include a new subject or the revision of existing WMO publications and ISO standards. Once such a decision has been approved, all existing work on similar active projects, within either Organization, should be merged to the harmonized effort. If in the course of its own consultation either WMO or ISO do not approve the new work item proposal, or later any draft being progressed, the other Organization reserves the right to continue to work separately under its normal procedures.

5. Publication

Common standards shall not be published until WMO and ISO have both provided their approval.

The resulting common standards will be published by ISO as ISO deliverables subject to ISO policies and directives and by WMO as WMO publications. Unless otherwise agreed, ISO and WMO will publish two separate documents with identical content.

WMO and ISO agree to identify their respective involvement in the development of a particular common standard and to quote the corresponding standard from the other Organization through such indications in appropriate sections of their respective publication.

6. Copyright

Copyright ownership of publications resulting from the application of these working arrangements will be held by ISO and WMO without payment of royalties to each other. ISO can transfer usual exploitation rights to the ISO member bodies without payment of any royalties to WMO.

7. Maintenance procedures

Revisions to common standards may be proposed at any time by ISO or WMO. Systematic review of common standards shall occur on a period agreed-upon between ISO and WMO, which lasts no longer than 3 years, and after the first review, no longer than every 5 years.

If no ISO committee was involved during the development of the common standard, the approval procedure set out above shall be repeated if WMO decides that changes to the common standard are required. If an ISO committee was involved during the development of the common standard, its maintenance shall be handled by WMO in consultation with the ISO committee to which the document was attributed.

Common standards shall not be revised without the approval process as described above. The revision of these common standards shall be undertaken only if a parallel investigation conducted within each Organization, according to its own internal procedures, sufficiently demonstrates that problems exist that need to be resolved. In case both Organizations do not reach the same conclusion on the need to revise a common standard, each Organization may decide to revise the common standard unilaterally. In this case the resultant standard shall not be considered as a common standard.

8. Termination

These working arrangements shall enter into force on their approval by both Organizations and shall remain in force unless terminated earlier by either party upon three months written notice. These working arrangements shall be reviewed on a four year basis and modified as necessary to enhance the cooperative relationship between the two Organizations.

For	for
the World Meteorological Organization (WMO)	the International Organization for Standardization (ISO)
Michel Jarraud Secretary General	Alan Bryden Secretary General

16 September 2008

ANNEX VI Short list of National Climate Monitoring Products

1 Monthly area-average mean temperature time series (max+min)/2. Anomaly to be defined relative to 1971-2000. (or WMO preferred alternative) with the actual normal temperature for 71-00 included in metadata. Units: degC. (Olga Bulygina)

2. Monthly area-average of total precipitation anomalies expressed as percentages. Anomalies to be defined relative to 71-00 period (or WMO preferred alternative). Units: none (A. Watkins)

3. Monthly area-average of standardized precipitation index (SPI) calculated for each station. Standardization will be to the 71-00 period (or WMO preferred alternative). Based on proposed ETCCDI index definition. Units: none (D. Arndt).

4. Monthly area-averaged percent of time Tmax > 90th percentile of daily maximum temperature 71-00 period for standardization (or WMO preferred alternative). Based on ETCCDI definitions. Units: none (P. Booneeady).

5. Monthly area-averaged percent of time Tmin < 10th percentile of daily minimum temperature 71-00 period for standardization (or WMO preferred alternative). Based on ETCCDI definitions. Units: none (P. Booneeady).

6. Significant climate and weather event relevant to the area or region. This product consists of zero or a number of these events coded from a predefined table: cold snaps, heat waves, snow storms, dust storms, wind storms, sea level or heavy swell events, flooding, heavy rainfall, volcanic ash. Referring to guidance from the WMO task team on the definition of extreme weather and climate events. (J. Kennedy, D. Arndt and A. Watkins with input from WMO Region VI monitoring)

ANNEX VII List of ETCCDI core Climate Indices

ID	Indicator name	Definitions	UNITS
FD0	Frost days	Annual count when TN(daily minimum)<0ºC	Days
SU25	Summer days	Annual count when TX(daily maximum)>25ºC	Days
ID0	Ice days	Annual count when TX(daily maximum)<0ºC	Days
TR20	Tropical nights	Annual count when TN(daily minimum)>20ºC	Days
GSL	Growing season Length	Annual count between first span of at least 6 days with TG>5ºC and first span after July	Days
TXx	Max Tmax	Monthly maximum value of daily maximum temp	ºC
TNx	Max Tmin	Monthly maximum value of daily minimum temp	ºC
TXn	Min Tmax	Monthly minimum value of daily maximum temp	ºC
TNn	Min Tmin	Monthly minimum value of daily minimum temp	ºC
TN10p	Cool nights	Percentage of days when TN<10th percentile	Days
TX10p	Cool days	Percentage of days when TX<10th percentile	Days
TN90p	Warm nights	Percentage of days when TN>90th percentile	Days
TX90p	Warm days	Percentage of days when TX>90th percentile	Days
WSDI	Warm spell duration indicator	Annual count of days with at least 6 consecutive days when TX>90th percentile	Days
CSDI	Cold spell duration indicator	Annual count of days with at least 6 consecutive days when TN<10th percentile	Days
DTR	Diurnal temperature range	Monthly mean difference between TX and TN	ºC
RX1day	Max 1-day precipitation amount	Monthly maximum 1-day precipitation	mm
Rx5day	Max 5-day precipitation amount	Monthly maximum consecutive 5-day precipitation	mm
SDII	Simple daily intensity index	Annual total precipitation divided by the number of wet days (defined as PRCP>=1.0mm) in the year	mm/day
R10	Number of heavy precipitation days	Annual count of days when PRCP>=10mm	Days
R20	N. of very heavy precipitation days	Annual count of days when PRCP>=20mm	Days
Rnn	Number of days above nnmm	Annual count of days when PRCP>=nnmm, nn is user defined threshold	Days
CDD	Consecutive dry days	Maximum number of consecutive days with RR<1mm	Days
CWD	Consecutive wet days	Maximum number of consecutive days with RR>=1mm	Days
R95p	Very wet days	Annual total PRCP when RR>95p	mm
R99p	Extremely wet days	Annual total PRCP when RR>99p	mm
PRCPTOT	Annual total wet-day precipitation	Annual total PRCP in wet days (RR>=1mm)	mm

ANNEX VIII GCOS Essential Climate Variables

The 50 GCOS Essential Climate Variables (ECVs) (2010) are required to support the work of the UNFCCC and the IPCC. All ECVs are technically and economically feasible for systematic observation. It is these variables for which international exchange is required for both current and historical observations. Additional variables required for research purposes are not included in this table. It is emphasized that the ordering within the table is simply for convenience and is not an indicator of relative priority.

Domain	GCOS Essential Climate Variables
Atmospheric (over land, sea and ice)	**Surface:**[1] Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget. **Upper-air:**[2] Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance). **Composition:** Carbon dioxide, Methane, and other long-lived greenhouse gases[3], Ozone and Aerosol, supported by their precursors[4].
Oceanic	**Surface:**[5] Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour, Carbon dioxide partial pressure, Ocean acidity, Phytoplankton. **Sub-surface:** Temperature, Salinity, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers.
Terrestrial	River discharge, Water use, Groundwater, Lakes, Snow cover, Glaciers and ice caps, Ice sheets, Permafrost, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture.

[1] Including measurements at standardized, but globally varying heights in close proximity to the surface.
[2] Up to the stratopause.
[3] Including nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6), and perfluorocarbons (PFCs).
[4] In particular nitrogen dioxide (NO_2), sulphur dioxide (SO_2), formaldehyde (HCHO) and carbon monoxide (CO).
[5] Including measurements within the surface mixed layer, usually within the upper 15m.

ANNEX IX Group photo

From left to right: J. Potter-Branco, F. Driouech, H. Puempel, M. Brunet, O. Baddour, S. Sensoy, H. Kontongomde, M. Altınyollar, K. Eichler