

WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

OPAG ON INTEGRATED OBSERVING SYSTEMS

**WIGOS WORKSHOP ON DATA QUALITY MONITORING AND INCIDENT
MANAGEMENT**

10-12 December 2014, Geneva, Switzerland

FINAL REPORT

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GENERAL SUMMARY

1 OPENING INTRODUCTIONS & CONTEXT

The WIGOS Workshop on Data Quality Monitoring and Incident Management, commenced at the WMO Secretariat, Geneva Switzerland at 9:00am on 10th December, 2014. The workshop was opened by the chair (Chairperson), Mr Stuart Goldstraw, who was also the current chair of the Commission for Basic Systems (CBS), Expert Team on Surface Based Observations (ET-SBO). Mr Goldstraw welcomed all participants (Participants) to the workshop.

A list of workshop participants is provided in [Annex I](#) of this document. The schedule for the meeting is provided in [Annex II](#).

Mr Goldstraw provided the Participants with a brief outline of the historical background and events leading up to the holding of the workshop and also the aims, deliverables and expected outcomes from the workshop which were developed prior to the workshop and are provided as [Annex III](#) of this document. The Participants were informed that the primary purpose of the workshop was to undertake a review of the current international quality monitoring system for the WMO Global Observing System (GOS), with a particular focus on the land surface observing systems and with an emphasis on both its modernization and the establishment of practices associated with incident management. This activity was seen to be a very important aspect of the WIGOS Framework Implementation Plan (WIP) and was of interest to several WMO and other CBS teams, including the Inter-Commission Team on WIGOS (ICT-WIGOS) and its Task Team on WIGOS Quality Management (TT-WQM), the CBS Inter-Programme Expert Team on WIGOS Framework Implementation Matters (IPET-WIFI) and its Sub-Group on Quality Management (SG-QM) and the Implementation and Coordination Team on the Data Processing and Forecast System (ICT-DPFS). Additionally, while the focus for the workshop was to be quality monitoring and incident management associated with observing systems of the GOS, it was expected that the procedures and the supporting framework that might be devised and proposed during the course of the workshop could be more widely applicable across WIGOS component observing systems. In undertaking this review of quality monitoring practices, Participants were advised to be mindful of the varying requirements and technical capabilities of different WMO Regions and Members and endeavor to take this into consideration when proposing methodologies and solutions.

The process of revising monitoring requirements and capabilities of NWP had already begun in some forums, including at a recent EUMETNET and ECMWF workshop on quality that was held in May 2013 and also under the work plan of CBS ICT-DPFS, which has undertaken to revise the requirement for monitoring of observational data by NWP as defined within the WMO Manual on the Global Data Processing and Forecasting System (GDPFS) – WMO-No. 485.

The Chairperson explained that the review of quality monitoring (QM) and incident management (IM) practices for the land surface component of the GOS was motivated by the fact that the current operational structure and practices, defined chiefly under the Global Data Processing and Forecast Systems of the World Weather Watch Programme, were developed several decades ago and that technical capabilities of Numerical Weather Prediction (NWP) systems and the computing and information technologies that support the operation of monitoring and feedback systems and tools had changed markedly since then. Modern NWP systems were capable of monitoring both the quality and the availability of a much wider array of observational variables and also providing QM information to observations systems operators and other relevant stakeholders at a much higher frequency. Modern information technologies also offered the opportunity to modernize and strengthen feedback and incident management systems, tools and practices. While the current CBS structure of regional Lead Centers on Quality Monitoring of land surface observations was in place and might be built upon, the requirements and practices associated with their operation require revising, updating and reinforcing. The Chairperson also advised that the workshop should consider and take advantage of available examples of QM best practice practices already in operation, such as under the marine observation community.

The Participants were also reminded of the requirement to ensure that updated practices, once approved, were regulated within the appropriate WMO technical regulations, with suitable guidance

also provided to ensure Members were able to comply with such regulations as a component of their national and regional observational practices and Quality Management Systems. A foundation for this had already been laid in relation to quality and incident management within the current draft Manual on WIGOS.

Dr Lars Peter Riishojgaard, WMO WIGOS Project Manager, also addressed the workshop on the relationship of the workshop with the WIGOS Framework Implementation Plan (WIP) and identified quality management as one of the Key Areas to be addressed, regulated and standardized. Some of the key points that Dr Riishojgaard identified that should be considered throughout the course of the workshop were:

- To ensure that both quantity (availability) and quality of observational data were addressed, noting that NWP, being by far the most universal and prolific in their use of data, were best placed to offer high resolution QM information in support and mutual interest of observational QM.
- There was a clear need to increase the resolution of QM reporting and to ensure that Incident Management (IM) becomes an integrated component of the practices of Members. At the current time it was not possible to obtain a near-real-time (e.g. daily) snapshot of the current status of the GOS in terms of availability and data quality.
- There was effectively an absence of feedback mechanisms and practices associated with the international QM systems, with many problems and issues taking months to be reported and then months or years to be resolved. Silent stations were a significant problem in some areas and regions.

The following additional points were made in discussion:

- A critical component of sound QM practice was the requirement of monitoring centers and observational data managers to have a definitive and reliable source of sites and station metadata.
- Different monitoring centers can provide differing and contrasting QM information and results and the QM system should cater for and take advantage of such differences.
- It should be noted that NWP systems are not infallible and not all comparison differences should be assumed to be the result of observing system faults – for this reason, a QM System that receives and utilises information from multiple monitoring sources should or might be considered when developing the QM structural framework.
- The further development of the Observing Systems Capability, Analysis and Review (OSCAR) system associated with the CBS Rolling Review of Requirement process would facilitate much improved management of access to international observational metadata, including WMO Volume A.

Dr Jochen Dibbern, Co-chair of the CBS Open Programme Group on Integrated Observing Systems and Chair of IPET-WIFI addressed the workshop, providing a context for the workshop in terms of CBS activities related to WWW and GOS integration into WIGOS development. Dr Dibbern advised that the Sub-Group on Quality Management under IPET-WIFI would have primary responsibility for CBS-related QM revision and developing practices associated with WIGOS. The workshop was advised that, for EUMETNET observing systems, a fault management system with feedback mechanisms had been established and this had a demonstrated positive impact on the quality of data from EUMETNET Composite Observing System (EUCOS) observing systems. It was therefore important that a fault or incident management system with feedback mechanisms between WMO Members and its Lead

Centers should be considered a critical component of a modernized quality monitoring system for the GOS and for WIGOS observing systems.

2 NATIONAL & INTERNATIONAL QM - CURRENT STATUS AND ISSUES

The workshop was informed on the current status of national, regional and international observational quality monitoring processes and practices with a series of presentations by participating experts.

2.1 Monitoring practices undertaken by NWP Centers

Mr David Richardson (ECMWF) provided a presentation regarding current quality and reporting practices undertaken by and available from ECMWF. The key points made in the presentation and subsequent discussion was:

- ECMWF routinely provides a suite of availability and quality reports and diagnostics that are made available on its website. These reports, which include maps and time series graphics already form the basis for a comprehensive quality monitoring system in support of many GOS observing systems.
- However, due to the large and growing number of observations and observing systems, finding and isolating particular errors and issues can be somewhat difficult and time-consuming. Therefore, ECMWF has developed an alerting system with the aim of being able to automatically and routinely identify and isolate errors based on various factors including observing system and message origin. While the system was developed for satellite data initially, the alerting system has now been extended to meteorological parameters derived from all standard observations types, including SYNOP, METAR, TEMP, SHIP, aircraft, etc, and based on 9 geographical areas and three upper air (pressure) layers.
- The ECMWF alert system outputs are based on comparison with both the analysis and first guess fields and departure from historical time series of statistics, including counts, means and standard deviations of model/observation differences. Combined with a suitable and tunable set of thresholds, automated checking procedures generate alarms and lists of suspect observations or stations that are made available on a website at a suitable frequency of update (daily at present) and could be distributed by email (though it should be noted the system is intended primarily for internal use).
- ECMWF currently maintains a list of blacklisted stations which is updated on a monthly basis, based on the continued monitoring of the blacklisted station, even while it is removed from the assimilation process. This allows determination of when station observing system faults have been rectified so that it can be reintroduced and removed from the blacklist.
- While the tools and diagnostics required to implement such a system were under development for internal use, in order to utilise them as part of an international data quality monitoring system, it would be necessary to develop and put in place a structural and procedural framework to define: formats of reports; responsibilities for dissemination and reception of reports; follow-up responsibilities and procedures, etc.
- Many errors and observational data issues are associated with metadata quality or accuracy and its frequency of update. Having a reliable source of accurate metadata is a vital component of a QM system and it is important that all entities involved in the QM system have access to the same metadata. Comparison of metadata at different NWP or

monitoring centers could be a useful activity, although having a definitive and well-maintained international metadata source would alleviate many issues.

- In order to ensure that identified faults were rectified at the national level, it would be vital to ensure that national focal points were appointed with responsibility for receiving and acting upon issues and incidents that were identified by monitoring centers. The workshop was informed that it was expected that national focal points with responsibility for OSCAR metadata maintenance would eventually be appointed and that these focal points might also have responsibility to act upon data quality issues. It was also expected that WIGOS Regional Centers might in the future be established to take responsibility for regional coordination and management of observing system quality issues and provide technical support to regional members.
- It was identified that there was value in having multiple monitoring centers providing quality information and reports, given that models performed differently in different geographical areas and with respect to different parameters and observing systems. However, to readily formulate and utilise these outputs, it would be necessary to standardise the reporting formats.
- In addition to alerting reports and diagnostics, it would be important to offer observing system managers and QM focal points passive online tools and diagnostics to facilitate analysis of identified faults and determine their source. For example, if data is missing, where is the break in the communications chain?
- Rather than rigidly regulate or specify the requirements for the various practices and thresholds for QM diagnostics provided by NWP monitoring centers, it might be better to allow the centers to develop their own practices and tune them to their own operations but provide online detailed descriptions of how the monitoring is undertaken and performed.
- While NWP centers could take responsibility for monitoring of observational data availability, the additional work required to implement a comprehensive incident management function would likely require significant changes to NWP center operations and monitoring practices and would require significant resource input.
- The workshop was informed that NOAA, USA had developed quite specific and varying monitoring practices for different observing system types and primary responsibility for determination of the quality of observations usually lay with the forecasting senior meteorologist.

Dr Lars Peter Riishojgaard briefly addressed the workshop on the issue of satellite data quality monitoring and availability and, in light of the recent unavailability of USA satellite data to data users and centers outside the USA, requested participants from NWP centers if monitoring practices and feedback loops with satellite data providers were in place and adequate. It was established that, while good communications generally existed between large NWP data centers and data users and satellite data providers, there appeared to be a lack of communications channels for the reporting to the wider user community and WMO national membership of such issues. It was agreed that the establishment of one or more WMO Member focal point groups with responsibility for observational quality would be a suitable means for communicating issues like this, such as large-scale planned and unplanned observational data outages.

2.2 Current monitoring procedures undertaken by Global and Lead Monitoring Centers

Mr Leon Mika (Region V, Australia), Mr Yukinari Ota (Region II, Japan) and Mr Henry Karanja (Region I, Kenya) made presentations to the workshop on current practices and issues relating to the operation of WMO Lead Centers for quality monitoring of land surface observations. The key points made in the presentations and subsequent discussion was:

- While the Australian Bureau of Meteorology (Bureau) participated in the WMO Integrated World Weather Watch Monitoring (IWM), it had not performed for some time its function as Region V Lead Center for quality monitoring of land surface observations. This is primarily due to the significant changes and update in recent years to the Bureau's NWP systems operation.
- The Bureau's own national quality monitoring processes were quite comprehensive and multi-faceted, relying on a combination of automated real-time quality control and non-real-time manually-intensive quality monitoring, mainly associated with climate quality control and archival. However, the Bureau's incident management and feedbacks were essentially manual and ad hoc in nature.
- The Bureau intended to redevelop its NWP observations QM capability and resume its functions as a Lead Center for Region V.
- The Japan Meteorological Agency (JMA) produces 6-monthly QM reports as a function of its responsibilities as Lead Center for Region II and also makes available monthly monitoring reports to support regional quality monitoring. These two reports are published online on a website JMA operates. In addition, the 6-monthly QM reports are also provided to the WMO Secretariat which is responsible for distribution and notification to WMO Members of their availability. JMA's experts manually analyse the quality of observations and produce evidence of quality issues for suspected stations to be included in the consolidated list. However it usually takes more than three months to produce a 6-monthly QM report and more than several months for any action by NMHSs. About 30 stations still remain in the suspect list in Region II. It was recognised by the workshop that the standard and frequency of reports and quality monitoring undertaken by JMA in its role as WMO Lead Center on land surface based observations represented best practice for Lead Centers.
- Kenya utilised the UK NWP global model to generate a 6 monthly QM report for Region I for monitoring of surface pressure only based on the criteria in the Manual on the GDPFS.
- The workshop was informed that, due to changes to the global NWP model at the Lead Center and reorganisations of responsibilities, the Lead Center for Region VI had not undertaken monitoring functions for the region for several years.

2.3 Review of current monitoring practices undertaken by other centers and programmes

Marine Observations

Mr Mathieu Belbeoch (JCOMM) made a presentation to the group on quality monitoring and related feedback processes for marine observing systems. Marine observing system monitoring under JCOMMOPS essentially consists of two parts: the monitoring of those observations (ships and buoys) submitted in real-time on the WMO GTS and the monitoring of those observations undertaken in research mode and generally not submitted in real-time (e.g. ARGO). In general, the former observations set is monitored in near-real-time and good feedback mechanisms and processes are in place to quickly rectify errors and issues. For the latter, monitoring is generally a

more manual and analytical process, which is labor intensive and expensive. For the research observing systems, the communications and feedback between data users and operators is weak or non-existent and therefore relies heavily on quality control measures at the source.

GCOS Networks

Mr Tim Oakley made a (remote) presentation to the workshop on QM & IM practices for Global Climate Observing System (GCOS) networks. The workshop was reminded that, while GCOS does not “own” or operate networks, Members operate their stations in compliance with requirements for the provision of observational data for climate applications. While GCOS defines many observational networks in support of climate monitoring, the largest and arguably most important networks are the GCOS Surface Network (GSN) and the GCOS Upper Air Network (GUAN), which are defined as sub-networks of the WMO Regional Basic Synoptic Network (RBSN). The following key points were made in the presentations and subsequent discussion:

- CBS and GCO designate both monitoring and regional lead centers, which together have responsibility for quality monitoring of GCOS observations. The requirements for quality control, monitoring and reporting by monitoring and lead centers are defined under their respective terms of reference within the GCOS regulatory material and are based on the user requirements for climate data, including availability, accuracy/uncertainty, timeliness, etc. The terms of reference of the monitoring and lead centers are quite strong and prescriptive.
- Quality control at the observing site is the first and primary source of quality management of climate observations. Downstream non-real-time data monitoring and analysis is the secondary tier. Monitoring centers provide monitoring information and diagnostics to Lead Centers that are then responsible for analysis and further dissemination to Members – usually by emails to Member network managers.
- Accurate and well maintained metadata that provide a detailed historical record of observing system and siting maintenance and issues are of critical importance to climate applications.
- Current GCOS monitoring practices focus predominantly on availability of climate data with monitoring essentially “passive” in nature, meaning that Members are obliged to access the quality monitoring information and act upon issues identified based on either the reports or their own analysis. Lead Centers have responsibility for following up on particular issues.
- GCOS has a Network Manager who has responsibility for the overall operation of monitoring practices and the monitoring system.
- GCOS would like to incorporate quality monitoring (in addition to availability) into the monitoring activities of GCOS monitoring and lead centers and expects that this might be undertaken through similar processes and tools as that employed for the wider observational networks.

GAW Networks

Dr Jörg Klausen (GAW, Switzerland) provided a presentation to the workshop on quality management practices within the Global Atmosphere Watch observations programmes. The following key points were made in the presentations and subsequent discussion:

- Owing to the complexity and nature in general of GAW observing systems, monitoring of atmospheric observations is rarely in real-time or undertaken at the global level.

- Quality management relies strongly on quality control and measurement practices at the observations source. For this reason standards established through for technical regulations and guidance are of critical importance for the operation of GAW sites.
- Quality management also relies on reliable and strong quality assurance and validation processes, such as comparison with other observing systems. Training of observing staff is also very important because most observing systems are at least partially manually operated.
- Comparison of NWP output is not currently utilised by GAW observing systems but this could conceivably become a component of quality management and monitoring practices in the future.

WIS and WWW Monitoring

Mr Steve Foreman (WMO) provided a presentation to the workshop on the current WMO procedures and practices related to monitoring associated with the WMO Information System (WIS) and the World Weather Watch Programme.

The workshop was informed that there are 4 components to the WWW quantity monitoring system:

- 1) Annual Global Monitoring: Conducted annually over 1-15 October – provides a count of reports from stations at standard hours.
- 2) Integrated WWW Monitoring: Conducted 4 times annually over 1-15 of Jan, Apr, Jul and Oct. – provides a count of reports from stations at all times.
- 3) Special MTN Monitoring: Conducted over same period as IWM and provides similar statistics.
- 4) Traffic statistics and diagnostics captured by Telecommunications Centers.

The following issues were identified with the current WWW monitoring systems:

- Processes are limited to set times and periods and do not provide a current or near-real-time assessment of the network performance.
- There is limited flexibility and limited capability for counting and including in statistics reports or messages that are submitted outside recognised reporting times.
- The increase in data volumes and types is placing an increased load on telecommunications centers and there is a risk that this will adversely affect the performance of their routine functions.
- Monitoring procedures count messages but not the content of the messages.

Procedures for the monitoring of the operation of the WIS are still under development although some practices have been implemented already. The monitoring of the WIS aims to assess the performance of the WIS on a quarterly basis to address two key aspect of the system: 1) Service availability and efficiency; and 2) Infrastructure performance. The first aspect is concerned with assessing the performance of the WIS in meeting its requirements for delivering data and delivering it on time. The second is concerned with the performance of the communications hardware and its operating performance in managing data requests. WIS monitoring will focus primarily on monitoring the exchange of data products in terms of its volume rather than in terms of what is being exchanged and will not focus on the content of messages or data files. For this

reason, quantity and quality monitoring functions for observing system requirements should in the future be shifted to designated monitoring centers that are established to provide this functionality and can analyse the contents of messages so as to be able to report on the quality of observational data parameters.

2.4 Review of current regional and national monitoring practices and procedures

Mr Stefan Klink (DWD, Germany) and Mr Henry Karanja made presentations to the workshop on national and regional quality monitoring approaches and practices. The key points made in the presentations and subsequent discussions were:

- Many of the larger national meteorological services operate modernised and sophisticated data quality control and quality monitoring systems in support of their observational networks. For example Meteo-France (France), DWD (Germany) and the Bureau (Australia) have centralised monitoring centers that use a variety of automated and manual tools and diagnostics to analyse the quality of their observational data and messages.
- In particular, Meteo-France employs both message monitoring and data quality monitoring in the form of visual and graphical tools available on a computer platform. These tools include time series of both data availability and individual parameters, neighbouring station comparison, model comparison and position monitoring as appropriate to the observation type. Interaction with other regional and international monitoring centers is also a component of national quality management procedures.
- Similarly, DWD operates a centralised quality monitoring system that supplements the more technical and immediate monitoring undertaken on-site. Generally, action is undertaken based on the results of automated quality monitoring that generates an alert or alarm, after which action is undertaken according to procedure. The workshop was informed that the quality monitoring system operated by DWD for its observing system had four distinct stages:
 - 1) Quality control (QC) at the station or system level;
 - 2) A near-real-time, automated centralized data QC system;
 - 3) A non-real-time QC system consisting of a combination of manual and automated checking and analysis with a delay of 1 to 10 days for completion; and,
 - 4) More stringent and detailed checking associated with assimilation into the climate archive.
- Quality monitoring for Kenya observing systems is largely manual in nature and based on requirements for climate monitoring of climate data. Checks employed include range checks, inter-comparison, element/parameter consistency and homogeneity. Limited quality control checking is applied to real-time data. Kenya is in the process of developing specifications for a centralised real-time quality monitoring system for its observing systems.

EUMETNET/EUCOS Quality Monitoring

The workshop was informed that DWD, Germany, has responsibility for operation of the EUMETNET/EUCOS Observations Programme, providing and maintaining the EUCOS Quality Monitoring Portal for the benefit of EUMETNET Members and in the interest of quality improvement. A separate portal is also maintained by DWD to support wider quality monitoring responsibilities for WMO Region VI. The portal provides a range of diagnostics and reports that

support monitoring of availability, timeliness and quality of observations, chiefly through comparison with NWP (ECMWF).

While there is no automated alerting system associated with the portal, identified issues and faults are followed up with Members. Quarterly quality reports are provided to Members and are structured both along system and Member country lines so that Members can identify issues relevant to their operations. EUMETNET is working on implementing a fault recognition and escalation process, which is based and prioritised on a risk and implications analysis of the EUCOS.

BUFR Migration Quality Issues

The workshop was informed that EUMETNET has some concerns over the migration to Tabled Driven Codes (TDC) and the implementation of BUFR encoding of observational data and the possibility that inhomogeneities may be introduced in the climate record for various data types as a result of discrepancies in the metadata used and the way that it is provided in BUFR. For example, there is concern that differences are evident between the metadata submitted within BUFR and that contained in WMO Volume A. Additionally, there are instances where the encoding of data in ASCII code formats has small but significant differences to that for BUFR, for example possible differences as a result of rounding or truncation. Such errors can hopefully be picked up by monitoring systems but there may be difficulties in recognizing that the differences arise from the new encoding methods and practices. It may well happen that a new encoding method is more accurate than the older one. In order to avoid a massive parallel distribution of the same data encoded in two different formats via GTS, it is recommended to provide the data encoded in the new – to be validated - format by a communications channel other than the GTS.

Based on the experience of EUMETNET in their transition to BUFR, it is advised that WMO Members should endeavor to cater for a period of some form of parallel data provision in both the old and new data formats to ensure other Members can adapt their reception and decoding systems or to allow for validation of the encoding and decoding of new formats, even if one of the data sources is provided by a communications channel other than the GTS.

3 PROPOSALS FOR MODERNISATION OF THE QM SYSTEM

3.1 Conceptualisation and proposal for a global monitoring, evaluation and feedback system

The Chairperson led an initial discussion on the general requirements and expectations for a modernized WMO quality monitoring system for the GOS that incorporates quality evaluation and feedback mechanisms between the various stakeholders and operators.

The workshop was informed that CBS/ET-SBO had developed an initial “white paper”, entitled Proposal for the Development of the WIGOS Observations Quality Improvement System, with a concept for a modernized QM & IM system. This paper had been presented to both CBS/ICT-IOIS and ICT-WIGOS in 2014, where the concepts and processes recommended in the paper had been strongly supported, leading to requests for the holding of this workshop as the first step in a longer and wider process to build on the concept and more widely apply to all WIGOS observational networks.

The workshop was also informed that, while the initial white paper had made a proposal to describe and apply the modernisation concepts to the land surface component of the GOS, ET-SBO had received from the ICG-WIGOS Task Team on WIGOS Quality Management, an update to the paper that proposes a more universal or generalized formulation of the concept applicable to the wider WIGOS. It was expected that ET-SBO would later resolve the two draft papers through a new version that addresses both the universal concept and its application to the GOS.

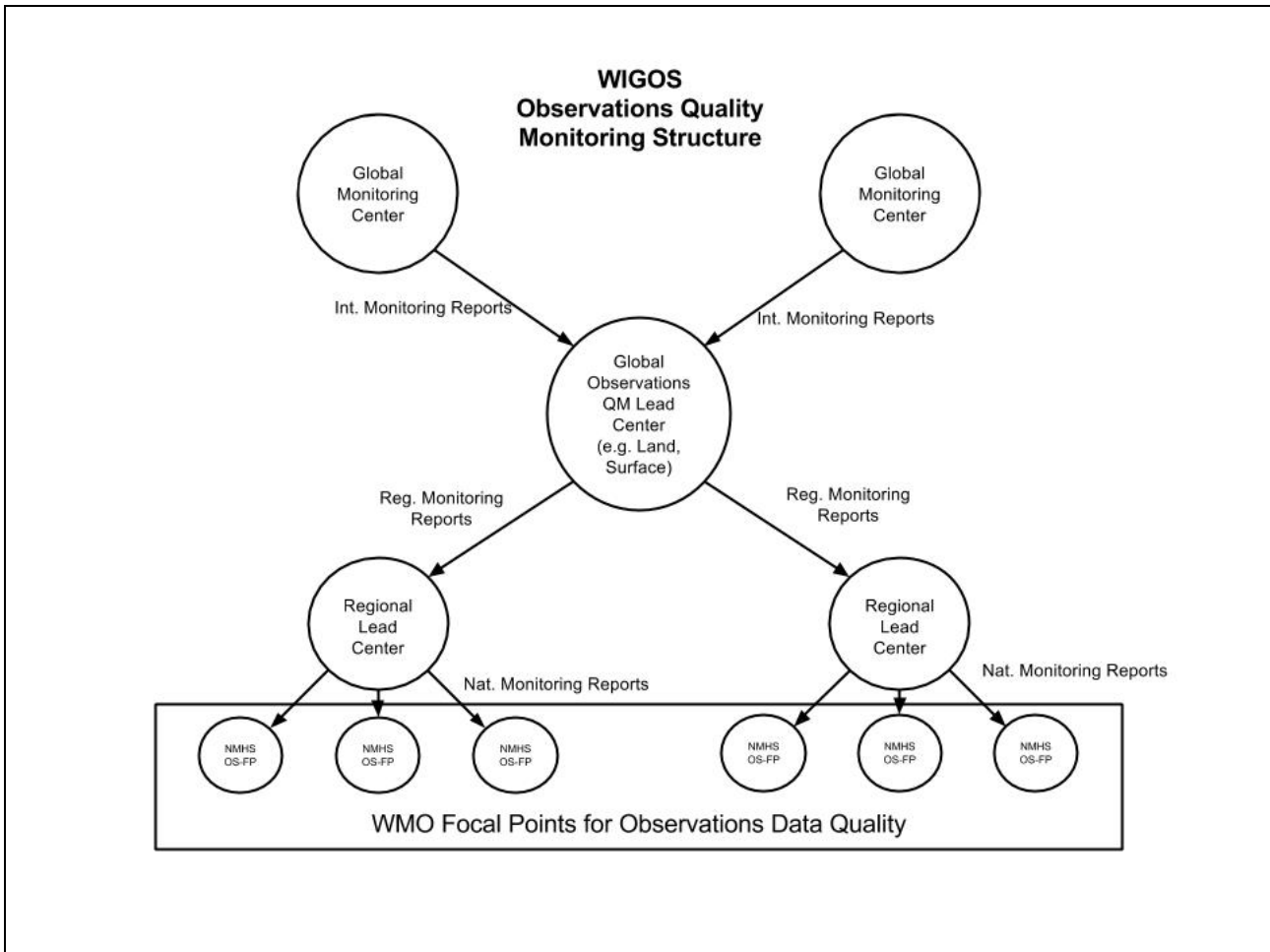
The Participants agreed that, for the purposes of the workshop and in the interests of focusing on a realizable outcome as a first step, the discussion and deliberations would focus on the land surface component of the GOS and the revision and proposal for update of the WMO

monitoring system as regulated within the Manual on the GDPFS, Attachment II.9 and as defined on the WMO World Weather Watch Programme website:

<http://www.wmo.int/pages/prog/www/DPS/Monitoring-home/mon-index.htm>

In relation to the current monitoring system and reflecting on the white paper and preceding discussions, the following points were agreed:

- The current monitoring system for land surface observations is in urgent need of modernisation and revitalisation.
- While the best practice operations and functionality of quality monitoring of WMO Members, such as EUMETNET, should be considered for emulation and application globally, it was important to ensure that all levels and types of Member technical capability and observing system design should be considered in its concept and structure.
- The requirements, perhaps formulated as terms of references, of all entities and of Members in the operation of the system should be well defined and regulated within the relevant WMO technical regulations and guides.
- The establishment of incident management and associated feedback mechanisms and procedures is an essential element to be incorporated within the new QM system and should have provisions for communications channels between all entities in the observations monitoring structure.
- The Incident Management System (IMS) should be integrated or associated with the quality monitoring system and its outputs and should facilitate feedbacks between data users, the monitoring and lead centers and observing system operators and managers. The IMS should facilitate the registering and tracking of incidents by all users and stakeholders.
- A structure for a generic quality monitoring system was discussed and agreed upon as depicted in the figure below.



3.2 – 3.4 Discussion and Proposals for Changes to Current QM & IM Practices

Based on the presentations under item 2, the Participants discussed the requirements, responsibilities and possible changes to practices for each of the 3 elements of the QM system: Monitoring centers, WMO Lead Centers and Regional and National Members. The following basic principles were agreed:

Monitoring Centers

- Monitoring Centers (MC) should provide monitoring information in standardised formats but not be highly constrained to how their monitoring systems should be implemented – rather their monitoring processes should be tailored to the NWP model utilised and centers should make available detailed information on how monitoring is performed (e.g. online on a web page).
- MC should not be limited to reporting on specific observing systems or parameters but might provide monitoring information for a range of observing systems and parameters and Lead Centers should be able to receive and process such information.
- MCs should undertake quantity monitoring at the parameter level – i.e. they should have responsibility for providing availability statistics and status for individual parameters, stratified by station, time interval, geographical location and altitude.
- Requirements or terms of reference for MCs should be well defined and they should be resourced as necessary by Members.

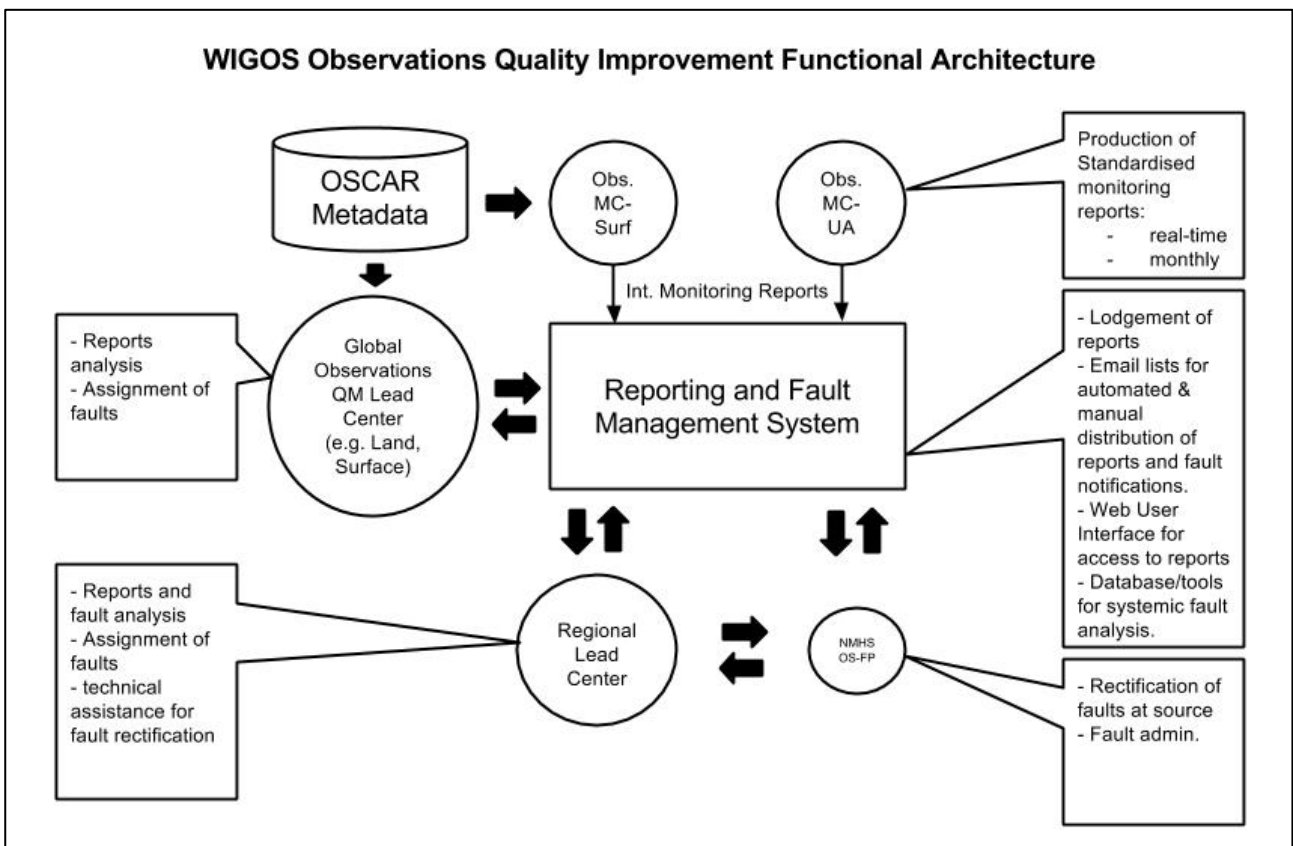
Lead Centers

- Lead Centers(LCs) should have the responsibility and authority to raise incidents and request action to rectify identified faults and issues.
- While it is likely that only a single global Lead Center for quality monitoring of land surface observations is required, regional Lead Centers might be necessary to coordinate regional monitoring practices and provide technical support for fault rectification. The global LC might be responsible for the performance and coordination of the regional LCs.
- The global LC should be responsible for the reception and processing of quality information and reports from the MCs and for the operation of the incident management system.
- Requirements or terms of reference for LCs should be well defined and they should be resourced as necessary by Members.

Regional and National Members

- Members should receive or have access to higher frequency quality monitoring information – e.g. at least daily reports and diagnostics.
- While passive information is useful and is required – particularly for quality analysis – quality reports should also consist of alerts or alarms that indicate a requirement for an active response from Members to address an issue or fault.
- Members should have access to comparative statistics from MCs to enable them to determine if they are receiving all available observational data.

Based on the above considerations the workshop agreed on a proposal for a generalized functional architecture for a generic monitoring system as depicted in the figure below.



3.5 and 4 Work of Breakout Groups

The Participants divided into two breakout groups with the following tasks:

Breakout Group 1: Develop a set of functional requirements for NWP Monitoring Centers.

Breakout Group 2: Develop a set of functional requirements for Lead Centers.

Breakout Group 1 also agreed to define the terms for a pilot project on exchange of global quality monitoring information. NCEP and ECMWF (and possibly other NWP centers) would seek to establish a trial in which formats and content of high priority quality monitoring information were defined and then routinely exchanged over a trial period.

The output from the breakout groups is provided in [Annex IV](#).

5 ROADMAP AND TIMELINE FOR AGREED ACTIONS

The Participants agreed on the following proposed actions and expected outcomes from the workshop, which might form the basis of a proposal for future action to be made to ICG-WIGOS:

1. Develop a proposal for the WIGOS Global Quality Monitoring System - Feb 2015 (TT-WQM to present to ICG-WIGOS) [J.Zimmerman]
2. Develop regulations/guidance on the WIGOS Global Quality Monitoring System (2016, TT-WRM)
3. Develop functional and technical specifications for a global Fault Management System (FMS) - 2015 [S.Klink, TT-WQM]
 - a. Identify an off-the-shelf FMS that might be applied and assessed in the FMS pilots. (TT-WQM)
4. Develop a proposal for the GOS Implementation of the WIGOS Global Quality Monitoring System (IPET-WIFI/SG-QM, ET-SBO)
5. GOS QM Pilots (SG-QM)
 - a. Pilot (2015 - ECMWF, NCEP, others?) [R.Grumbine, D.Richardson]

Participating NWP centers to agree on:

 - i. Information to exchange;
 - ii. Format for exchange;
 - iii. Feasibility and commencement.
6. Integration of GCOS networks into EUMETNET monitoring system (2015) [S.Klink]
7. GOS FMS Pilots (2015 - ET-SBO)
 - a. 2 regional pilot FMS in association with the NWP Quality Monitoring Pilot
8. Develop guidance on the GOS WIGOS Global Quality Monitoring System (SG-QM, SG-RM)

9. Produce report to ICG-WIGOS on GOS Quality Monitoring and Fault Management System pilots (2016 - TT-WQM)
10. The Secretariat to compile a Final Report for the workshop and circulate to workshop participants for review by mid-January 2015.

6 ANY OTHER BUSINESS

No other business was identified.

7 CLOSURE

The Chairperson thanked all participants for their contributions and closed the meeting at around 3pm on 12 December 2014.

ANNEX I

LIST OF PARTICIPANTS

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ANNEX II

Workshop Agenda and Schedule

Agenda Item No.	Topic / Item	Doc.	Lead/Presenter	Day	Schedule
1.	Opening Introductions & Context				
	General Welcome & Introduction to Workshop		Stuart Goldstraw	Wed	0900 to 1000
	The Workshop in the context of the WIGOS Implementation Plan & Key Activities		Lars Peter Riishojgaard		
	The Workshop in the context of CBS & WMO Monitoring Activities		Jochen Dibbern		
2.	National & International QM - Current Status and Issues				
2.1	Review of current and recently introduced monitoring practices undertaken by NWP Centres including: strengths and weaknesses; possibilities and potential for modernised QM	2.1	Lead - David Richardson with representatives from NWP Centres	Wed	1000 to 1230 (+ Break)
	Current processes for monitoring of satellite data and systems and deficiencies.		Lars Peter Riishojgaard	Wed	1230 to 1300
2.2	Review of current monitoring procedures undertaken by Global and Lead Monitoring Centres and their respective experiences of effectiveness: QM roles, functions, mechanisms and tools; effectiveness in rectifying errors or faults.	2.2	Lead - Leon Mika with representatives from RA Lead Centres	Wed	1400 to 1530
2.3	Review of current monitoring practices undertaken by other centers and programmes, such as WMO AGM-IWM-SMM, GCOS & JCOMM, including strengths and weaknesses	2.3	Representatives from other bodies (OPAG-ISS, JCOMM, GCOS) Tim Oakley Mathieu Belbéoch OPAG-ISS rep.	Wed	1600 to 1730
2.4	Review of regional and national practices and procedures on observational QM, fault rectification and feedback mechanisms.	2.4	Lead - Stefan Klink with national representatives.	Thu	0900 to 1030
3.	Proposals for Modernisation of the QM System				
3.1	Conceptualisation and proposal for a global monitoring, evaluation and feedback system.		Stuart Goldstraw	Thu	1100 to 1130
	Proposal for Development of the WIGOS Observations Quality Improvement System Posted 12 Nov 2014 Note: May be updated prior to the meeting.	INF.1	Secretariat		

	Draft WIGOS Quality Monitoring System Update to INF.1 proposed from input of ICG-WIGOS/TT-WQM	INF.2	Secretariat		
3.2	Proposal for changes to role and practices of Global NWP monitoring centers to support QM & IM system.		David Richardson	Thu	1130 to 1200
3.3	Proposal for changes to global, regional and national roles and practices for monitoring, feedback and fault resolution for the land surface observing system.		Stefan Klink	Thu	1200 to 1230
3.4	Proposal for changes to WMO Monitoring and Lead Center structure and practices for monitoring and incident management for the land surface observing system.		Leon Mika	Thu	1400 to 1430
3.5	Breakout sessions to examine each aspect and identify strengths and weaknesses in proposals – three breakout groups each for items 3.2 - 3.4.		3 Groups	Thu	1400 to 1730
4.	Revision and Refinement of Proposals				
4.1	Revision and improvements to items 3.1 to 3.4. based on the breakout sessions.		Breakout Group leads	Fri	0900 to 1130
4.2	Breakout Session for summary and documentation of proposals for 3.1 to 3.4.			Fri	1130 to 1230
5.	Roadmap and Timeline for Agreed Actions				
5.1	Identify timeline and additional activities required to enable finalised & detailed proposals for the Global QM & Incident Management System.		Stuart Goldstraw	Fri	0900 to 1130
5.2	Agree actions to enable process and activities identified in 5.1 to be delivered.			Fri	1130 to 1230
5.3	Discussion and agreed actions on satellite data and systems QM and incident management.		Lars Peter Riishojgaard	Fri	1400 to 1500
6.	Any Other Business			Fri	1500 to 1530
7.	Closure of the Session			Fri	1530

Annex III

WIGOS Workshop on Data Quality Monitoring and Incident Management

Aims and Expected Outcomes

As part of the ongoing revision of the performance monitoring for the Global Observing System and the WIGOS Quality Management activities, ECMWF and WMO propose to hold a joint Workshop on Observational Data Quality Monitoring over 10-12 December 2014 in Geneva. The workshop will focus on the modernisation of the NWP-based monitoring of data availability, observational data quality and on the development of a framework and procedures for the identification, documentation and rectification of various issues revealed by this type of monitoring.

This is considered to be a critical activity under the WIGOS Implementation Plan (Activity 5, Quality Management) and it also has relevance to the terms of reference and work plans for several WIGOS and CBS Expert and Task Teams, including: ICT-IO/ET-SBO, ICT-WIGOS and its Task Team on WIGOS Quality Management (TT-WQM), IPET-WIFI and its Sub-Group on Quality Management (SG-QM) and ICT-DPFS.

While the primary focus of this workshop is to review and modernize the NWP-based monitoring of the conventional (non-satellite) components of the GOS in relation to the production of the deliverables, this work and the resulting outcomes may serve as a model for other components of WIGOS and the GOS. Therefore, the workshop will more widely revise and consider current best practice in the area of quality monitoring and incident management for observing systems. The workshop will thus also briefly review and consider existing practices for monitoring of satellite data and mechanisms for detecting and advising faults and outages, in preparation for possible future focused efforts in this area.

Aims:

1. Revise and update the requirements of NWP centers for monitoring and reporting of data quality of surface-based observing systems of the GOS.

For land, surface-based systems of the GOS:

2. Revise and update the structure and the procedural and regulatory framework for monitoring and reporting of data availability and quality.
3. Revise and update the structure and procedural framework for incident identification, documentation and rectification.
4. Identification of a lead center (or centres) for data availability, quality monitoring and incident management.

Topics:

1. Modernization of the observational data quality monitoring system.
2. Real/near-real time reporting structures and mechanisms.
3. Quality evaluation leading to quality improvement.
4. Fault management with feedback mechanisms.

Outcomes

1. Improved and modernised monitoring and incident management system for GOS.
2. Development of a data availability and quality monitoring & management template that might subsequently be applied to other WIGOS observing system components.
3. Improved quality and availability of data derived from the GOS.

4. Improved and updated regulatory framework relating to data quality management.

Deliverables:

1. Proposed WIGOS procedures and regulations for NWP-based monitoring of data availability and data quality for the surface-based observing systems of the GOS, to be included in the relevant WMO regulatory material .

For the land, surface-based component of the GOS:

2. Proposed updated structure and procedures for monitoring by designated Centers and WMO Members.
3. Proposed structure and procedures for incident management (identification, documentation and rectification) by designated centers and Members, to be included in the relevant WMO regulatory material.
4. Road map for the implementation of the proposed framework for data quality monitoring and incident management.
5. A recommendation in relation to future action to improve outage detection and fault management associated with satellite data reception.

Possible participants:

Representatives of:

1. Existing global and regional observations monitoring centres
2. ICG-WIGOS, TT-WQM, ICT-DPFS, IPET-WIFI/SG-QM, ET-SBO, GCOS
3. Observing systems program managers
4. Lead Centers (land surface observations)
5. Representatives of other TCs: CCL, CAeM, JCOMM (SOT & DBCP)
6. Representatives of Secretariat: D/OBS, C/WPO, C/OSD, C/DRMM, SO/ARO, DWRS
7. RA Obs representatives

Annex IV

Summary of Output from Breakout Groups

Breakout Group 1 - Develop a set of functional requirements for NWP Monitoring Centers.

Requirements to be an NWP Centre providing Global Observations Monitoring Function

1. Be a GDPFS Centre participating in Global Deterministic Numerical Weather Prediction (as defined in activity 2.1.1 of the new Manual on the GDPFS)
Comments from SJG: as defined in the GDPFS Manual? If so referring to this manual would be the best reference.
2. Make modelling and monitoring methodologies publicly available
(Perhaps provide required information about methodologies to partners and members in the framework of WIGOS.)
3. [Included in general WIGOS requirements: Must commit to delivering the required monitoring products for a sustained period and Must agree to participate in audits of the monitoring procedures of the centre]
4. To make the monitoring data available to the agreed schedule, with the agreed content and in the agreed format.

Requirements of NWP Centers to Provide an Observations Monitoring Function

1. "Accurate" Volume A
 - a. what they should expect to receive
 - b. what they can utilise
2. Required format
3. Required content
4. Frequency of QM reporting (distinct from no. of observations in a period)

Content of monitoring information provided by NWP centres

For availability monitoring

Encourage NWP centres to exchange machine-processable files containing:

- For observations from stations with WMO station identifiers, received and decoded,
 - station identifier (full WIGOS identifier - use the OSCAR key), location (lat/long in decimal format), date/time of arrival (UTC, ISO 8601 format), flag of whether used in assimilation, parameters actually present (BUFR identifiers), date/time of observation (UTC, ISO 8601 format), NWP centre identifier (CCCC)
- made available as they are produced by the operational system
- machine readable in simple standard format such as csv or JSON

For quality monitoring

- blacklisted stations with reason for blacklist of each station
- for blacklisted stations, statistics (eg bias, standard deviation from analysis)
- Lower priority (noting the data volumes)
 - for all stations
 - statistics (eg bias, standard deviation from analysis)
 - with availability records, include obs-background and/or obs-analysis

For improvement of the monitoring procedures

- statistics on downloads of the files containing the statistics

Breakout Group 2 - Develop a set of functional requirements for Lead Centers

Requirements of Global Lead Center(s) on QM & FM

- 1) Quality Monitoring Functionality
 - a) Coordination and oversight of global QM.
 - b) To consolidate GQM reports into a single global report
 - c) Disseminate QM information through regional centers.
 - d) Monitor status and progress on c.
- 2) Fault Management Functionality
 - a) Coordination and oversight of the global FMS.
 - b) Follow up on issues escalated by the RLCs.
- 3) Produce an annual report to the Technical Commission on the performance of the QM and FM systems.
- 4) Monitor the status and performance of the QM and FM systems

Requirements of Regional Lead Centers

- 1) Maintain and utilise the Fault Management System for the registering and analyzing of regional observations quality issues.
- 2) On a frequent routine basis (e.g. daily) undertake obs. system health analysis:
 - a) Data availability
 - b) Data quality
 - c) Metadata availability
 - d) Metadata quality
- 3) Analyse regional fault status and put issue/errors into context for the member:
 - a) Identify error by type: communications, encoding, or obs. system data quality
- 4) Provide both routine and ad hoc feedback to GLC regarding status, issues and escalated faults.
- 5) Produce and provide routine (e.g. quarterly) summative report to regional members, Regional Associations and the GLC.
- 6) Provide technical support to national members (focal points) for fault rectification.
- 7) Maintain a technical support center for national members in :
 - a) Communications aspects relating to observing systems
 - b) Message encoding/decoding aspects related to observing systems
 - c) Quality of metadata.
 - d) (This belongs to WIS centers also - suggests collaboration between WIS and WIGOS centers?)
- 8) Make available (e.g. online) daily summative report of status and errors.
- 9) Issue automated, nationally directed, daily error/exception reports based on NWP GMC QM information - needs tuning based on obs system, variable, etc.
- 10) The routine report should contain a list of any issues that are required to be escalated to the RA and/or the Technical Commission for more urgent or authoritative action.
- 11) The RLC should develop a policy and a procedure for escalation of issues to higher authorities (e.g. RA, GLC, Technical Commission) that prioritises issues according to severity and urgency for rectification.
- 12) Notify when a NFP cannot be contacted.

Requirements by Regional Lead Centers (what they need)

- 1) Provision of information and analysis tools to support their functionality.
- 2) Access to a fault management system.
- 3) Regulations and guidance to be made available.
- 4) Accurate and up to date contact information for national observing system FPs.

Requirements of Members (What should Members do)

- 1) Act on faults/errors to rectify.
- 2) Use the FMS to report on status and rectification of faults/errors.
- 3) Maintain programmatic metadata (e.g. Volume A and OSCAR).
- 4) Take action to prevent errors reoccurring in the future.
- 5) Nominate (to WMO) active and trained Observing System Focal Points
- 6) Ensure that they are affiliated with one RLC for QM purposes.
- 7) Members should cease transmission of errant data on the GTS.
- 8) Members should be expected to rectify faults within a specified time (e.g. depending on the data/system).
- 9) Seek support from the RLC as required to rectify faults.

Requirements by Members (What do Member need to carry out the required functions)

- 1) Monitoring and fault analysis tools:
 - a) Encoding verification
 - b) Message delivery/reception diagnostics (regional/global)
- 2) WMO Regulations and guidance for operation of the GQM system.

Requirements of a Fault Management System

- 1) Fault identifier should be able to verify that the fault is rectified.
- 2) "Anyone" can raise a fault as the "Fault Identifier".
- 3) Faults are "actioned" by the Regional Lead Center or the Global Lead Center.
- 4) History of faults should be retained for analysis purposes.
- 5) Access to a FMS should be restricted and not public.
- 6) A software issue tracking tool should be employed that has the following functionality:
 - a) Email based.
 - b) Faults should have an ongoing status and the FMS should be capable of "reminding".