PROGRESS/ACTIVITY REPORTS PRESENTED AT THE FIFTEENTH SESSION OF COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

(Helsinki, Finland)

(unedited)

BACKGROUND INFORMATION

REPORT OF THE PRESIDENT OF THE COMMISSION

1. During the intersessional period the WMO Secretariat was restructured with a newly created WMO Observing Systems Division, its mandate including responsibility for marine and aircraft observations. Subsequently, it became relatively easy to have much closer working relationships with CBS, JCOMM and AMDAR. Also a new opportunity was provided to collaborate closely with the WMO Space Programme and GCOS.

2. The WMO Integrated Global Observing System (WIGOS) posed new opportunities and challenges for CIMO. The CIMO president was requested to chair the Subgroup on WIGOS of the EC Working Group on WIGOS and WIS, recognizing the CIMO role in WIGOS development and implementation. This was a very demanding task. One of the WIGOS Pilot Projects was dedicated to CIMO to assess the role and responsibilities of CIMO within WIGOS. This project went very well and as a result new Terms of Reference of CIMO were proposed for consideration. CIMO participation was envisaged also in other Pilot Projects to cross link CIMO activities with those of other technical commissions. This was successfully pursued by Mr R. Dombrowsky, at that time vice-president of CIMO.

3. WIGOS brought an emphasis to increasing the quality of products and services of NMHSs through enhanced standardization and quality of measurements. This clearly links CIMO work with the strategic thrusts of WMO and therefore CIMO should demonstrate how the quality of observations were improved by its current activities and also show were gaps exist, especially regarding the need for the establishment of relevant WIGOS standards. In this area, work was performed in collaboration with the WMO Space Programme to ensure the proposed GEOSS standards for quality were compatible with WMO requirements and suitable for surface-based instrumentation. Technical support and training in metrology to ensure traceability of measurement quality was of increasing importance and CIMO was able to respond to this need effectively.

4. WIGOS Concept of Operations and the WIGOS Implementation Strategy have been endorsed by EC-LXII, and the CIMO Management Group should decide on the details of how CIMO should support WIGOS and what are the areas where WIGOS would most benefit from CIMO activities. CIMO will then need to target expert team activities, prioritize tasks and produce a responsive Commission's working structure.

5. In addition to WIGOS, CIMO initiated actions to support other WMO high priority activities, namely Disaster Risk Reduction (DRR) and the Global Framework for Climate Services (GFCS). CIMO should be more proactive in the future and the future working structure should allow for close linkage of CIMO with the WMO high priorities.

6. During the intersessional period CIMO management further developed the mission of CIMO and the strategy that was being followed by CIMO, so that the members could better comprehend how they benefit from CIMO. Here, CIMO was to:

(a) Concentrate on initiatives where groups of countries would work together on agreed technical problems or testing of equipment, and could achieve more collectively than they could individually;

(b) Continue to develop capacity building, where it was suggested that CIMO should be more engaged in partnerships so that continuing support could be provided to the least developed countries by more developed countries, rather than conducting only individual capacity building events. Also an increased emphasis should be placed on ensuring that

the *WMO Guide to Meteorological Instruments and Method of Observations* (WMO-No. 8) provides reliable advice for all modern observing technologies and systems;

(c) Provide recommendations on system performance, improvement of instruments and methods of observation to WMO Members and instrument manufacturers.

7. The above guidance has been developed further into a CIMO Mission Statement that should help in furthering the work of CIMO and guiding future directions of the Commission.

8. The president gave thanks for all the support he had received from the vice-president, Rainer Dombrowsky and later Bertrand Calpini. With regard to the new objectives and strategic orientation of WMO, higher expectations are placed on CIMO. This comes at a time when CIMO has just been able to cope with current issues. It is clear that in the future CIMO needs to change how it conducts its business.

9. CIMO needs to be clear that it needs to bridge the gaps between research and operational observations. Therefore, the president has also been involved in the activities of European Cooperation in Science and Technology (COST) and its European Ground-based observations of essential variables for CLImate and operational METeorology (EG-CLIMET) COST Action. It will be important to improve links with research oriented programmes, such as the Global Atmospheric Watch.

10. The president expressed gratitude to those countries and instrument manufacturers who have provided funding, hosted various CIMO events and facilitated instrument intercomparisons and tests.

11. The president's special thanks are extended to the Government of the Russian Federation who hosted the technical conference in St Petersburg that was attended by more than 200 participants and to the Government of Finland for hosting the CIMO-XV, TECO-2010 and the associated exhibition of instruments.

12. On the point of retirement, the president wishes to express his appreciation to all the CIMO experts who have contributed to the great variety of activities that have been performed in recent years to ensure the ongoing quality of the observing systems in use by Members. CIMO should think very carefully about how to best continue to ensure Members get value for money from their observing systems, and that the quality of the observations is suitable for the very wide range of applications and customers.

13. It has been recognized that it is difficult for CIMO experts to perform tasks for CIMO whilst conducting their own work for their own NMHSs. There is a need to work together to identify realistic times required for CIMO activities, and to recognize when it is not possible to do the work in a timely fashion on a volunteer basis.

14. The number of meetings attended by the president has increased year by year during the intersessional period (see Annex to this paragraph). The Meetings of Presidents of Technical Commissions (PTCs) have become more important as the technical commissions have been challenged to participate in WMO strategic planning and to develop their own operating plans. These meetings are held in January or February of each year with shorter meetings at the time of Executive Councils. New proposed terms of reference for CIMO were presented and agreed at the PTC meeting in 2008, and if agreed by CIMO-XV, they will be submitted to Congress for its consideration.

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Annex: 1

Annex to paragraph 14

List of meetings attended by the president CIMO

- EC Panel on Disaster Prevention and Mitigation, Geneva, January 2007
- Task Team on Integration of Observation Systems, Geneva, January 2007
- Meeting of Presidents of Technical Commissions, Geneva, February 2007
- WMO Congress and the Executive Council, Geneva, June/July 2007
- Training Workshop for GUAN radiosonde operations in Region I (Africa), Windhoek, Namibia, September 2007
- Short-term evaluation of INTERMET radiosonde in use in Windhoek, Namibia, September 2007
- CIMO Management Group, Geneva, January 2008
- Ad hoc meeting for CIMO Pilot Project, WIGOS test of concept phase, Geneva, January 2008
- Meeting of Presidents of Technical Commissions, Geneva, February 2008
- GRUAN Implementation meeting, Lindenberg, Germany, February 2008
- GCOS AOPC-XIV, Geneva, April 2008
- Meeting of Expert Team on Upper Air System Intercomparisons, Payerne, Switzerland, June 2008
- WMO Executive Council, Geneva, June 2008
- GSICS Executive Panel, Geneva, July 2008
- Subgroup to EC Working Group on WIGOS-WIS, Geneva, November 2008
- CIMO Management Group, St. Petersburg, Russian Federation, November 2008
- Ad hoc meeting for CIMO Pilot Project, WIGOS test of concept phase, St. Petersburg, Russian Federation, November 2008
- TECO-2008, November 2008, St Petersburg, Russian Federation
- Meeting of Presidents of Technical Commissions, Geneva, January 2009
- GRUAN Implementation meeting, Oklahoma, USA, March 2009
- EG-CLIMET, COST Project workshop, Oslo, Norway, March 2009
- CBS-TECO on WIGOS, Dubrovnik Croatia, March 2009
- EC WG on WIGOS and WIS, Geneva, May 2009
- WMO Executive Council, Geneva, June 2009
- Brainstorm on future of WIGOS, Geneva, August 2009
- IOC for WMO Radiosonde Comparison, Yangjiang, China, September 2009
- COST 727 and IWAIS Icing conference, Andermatt, Switzerland, September 2009
- GEO quality assurance QA4EO, Antalya, Turkey, October 2009
- Subgroup to EC Working Group on WIGOS-WIS, Geneva, October 2009
- EG-CLIMET, COST Project meetings, Funchal, Madeira, November 2009
- Meeting of President of Technical Commissions, Geneva, January 2010
- CIMO Management Group, Geneva, February 2010
- GRUAN Implementation meeting, Payerne, Switzerland, March 2010
- Ad hoc meeting on GRUAN WIGOS Pilot Project, Fribourg Switzerland, March 2010
- WMO Executive Council, Geneva, June 2010
- WMO Radiosonde Intercomparison, Yangjiang, China, July/August 2010

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SURFACE OBSERVATION TECHNOLOGY (OPAG-SURFACE)

BACKGROUND INFORMATION

1. The working documents of the OPAG-SURFACE expert team meetings that were held since CIMO-XIV are available at: http://www.wmo.int/pages/prog/www/IMOP/meetings.html and the final reports are available at: http://www.wmo.int/pages/prog/www/IMOP/reports.html.

Activity report of the Expert Team on Surface Technology and Measurement Techniques (ET-ST&MT)

2. Following the guidance of the Management Group, ET-ST&MT prioritized its activities, as it was clear its Terms of Reference were too broad to be completed within the four years intercessional period. Furthermore, it was also clear that a number of activities would take preparations that will extend the four years intercessional period and should be continued after CIMO-XV. ET-ST&MT concentrated its work on:

(a) Siting, performance, classification and metadata standards;

(b) Standard observing methods for the automatic measurement of the traditionally 'visual observations', like present weather and clouds;

(c) Algorithms used in Automatic Weather Stations (AWSs), to be standardized;

(d) Guidelines and procedures for the transition from manned to automatic weather stations.

3. During the intercessional period the expert team met once in September 2008, during which a final workplan was adopted in line with the Management Group recommendations. Results of the work done by the ET-ST&MT are largely documentation, to be inserted in the CIMO Guide and Instruments and Observing Methods (IOM) reports. Some IOM reports are still in draft.

Standardization in instrumentation and observations

4. ET-ST&MT considered Metadata standards for instruments and a proposal was drafted. ET-ST&MT took into account relevant work of other expert teams, in particular CBS ET-AWS and the Inter-Programme Expert Team on Metadata Implementation (IPET-MI), also working on this subject, to avoid duplication in the work. It was recognized that metadata can be considered as being composed of 2 types of information: metadata required from a real-time point of view and metadata necessary for archiving. Because of the need of an up-to-date metadata catalogue the ET-ST&MT built up on the tables that had been developed by ET-AWS.

5. The expert team reviewed a proposal for siting classification of AWSs providing a characterization of the area surrounding the station. This classification provides a starting point to develop guidelines for the Siting classification of Surface Observing Stations (not only of AWS). This work was followed up by a dedicated team in the context of the CIMO pilot project for WIGOS as described further below.

6. Documentation on standard observing methods for automatic measurement of clouds, present weather and other subjective observations was reviewed and updated for modification of the relevant chapters in the CIMO Guide. Because of the improvements in performance characteristics of the techniques used to observe clouds, present weather and state of the ground

(including camera methods) ET-ST&MT suggested to consider future intercomparisons, in particular for cloud amount observations.

7. Algorithms used in AWS were discussed and a number of recommendations were made for inclusion of specific formulas in the CIMO Guide, such as formula for automatic snow depth measurement correction for ultrasonic devices, air pressure calculations, sunrise and sunset. As far as quality checks for data of subjective quantities measured automatically were concerned, ET-ST&MT agreed that existing algorithms could not be considered as a standard, but that skill factors could be developed and later used as requirements for the manufacturers.

8. ET-ST&MT recognized that standards for the interoperability of instruments hardware and software of meteorological instruments would simplify the exchange of information making it more efficient and reducing the need for sensor-specific arrangements. At present, a lack of sensor compatibility is experienced even within the instruments of one manufacturer. Therefore an inter-operability standard would be advantageous to both users and manufacturers, but present interfaces/protocols would still exist for a long time. The operation of sensors/systems in extreme conditions (such as -60ºC) and where telecommunication is not readily available would still keep up the need for special interfaces and protocols. ET-ST&MT and the Association of Hydrometeorological Equipment Industry (HMEI) agreed to collaborate to investigate the need and interest of manufacturers to work on the development of such an interoperability standard.

Automation of surface observations

9. ET-ST&MTstarted to develop Guidelines and procedures for the transition from manual to AWS intended for users who do not have detailed knowledge of such transitions, in particular developing countries. Such transitions require a high level of preparation across a wide range of topics, such as installations, measurements and management of systems and imply having skilled staff available to deliver the project and run the mature systems after the transition. A draft IOM report with guidance material was prepared. It was presented to and supported by CBS ET-AWS and should be finalized by the end of the year. Moreover a web portal on AWS is accessible via the WMO IMOP home, providing a great variety of items useful for Members for the transition from manned to automatic observing networks.

10. Over the years seven Instrument Development Inquiry (IDI) reports were published as IOM reports, providing information on progress in new surface technologies and techniques. For the last edition (2006) of the IDI, it had been decided that only those developments should be entered, which were not already available in the WMO Instrument catalogue. It was the intention to restrict the IDI to real innovative developments, to provide information to Members on new technologies rather than upgrades of currently existing commercial instruments. Due to the large amount of information now available on web links such the AWS portal (http://www.wmo.int/pages/prog/www/IMOP/WebPortal-AWS/Index.html) or the HMEI web site (http://www.hydrometeoindustry.org/) the need to continue the IDI is strongly reduced. Therefore the Management Group agreed that it was not necessary to continue this activity. HMEI should be encouraged to include more information on new products from its members in their catalogue.

Surface measurements in extreme weather conditions

11. ET-ST&MT addressed surface measurements in extreme weather conditions with particular focus to icing phenomena, wind and precipitations in cold climates. In extreme climate conditions, reliability of the electronics, data transfers and electricity supply is at least as critical as the reliability of the sensors themselves. In particular the results of the COST 727 action on “Measuring and Forecasting Atmospheric Icing on Structures” were received by the ET-ST&MT with great interest. The goals of the action were to develop the understanding of icing and to improve the potential to observe, monitor and forecast icing. It was agreed that CIMO should

closely collaborate with COST on this topic and would welcome the joint WMO/COST publication of the COST 727 Report as an IOM Report. This report would provide important information to WMO Members and would be a good base for the further development of guidelines on icing to be later published in the CIMO Guide (*e.g.* on ice detection, determinations of liquid water content and drop size distributions).

12. ET-ST&MT reviewed and made proposals for amendments of the CIMO Guide table on Operational Uncertainty Requirements and Instrument Performance, which combines the requirements of all WMO Programmes and which is regularly used for the preparation of tenders and bids. It was recommended to improve the general layout of the table, by highlighting the existence of the explanatory notes that are laid down at the end of the table, possibly by highlighting the column numbers in a separate row and using footnotes referring to the content of the notes. It was noted that some variables could be removed from the table (*e.g.* extreme temperatures), but that some other variables should be added to the table (see also Doc. 7 and BM 7).

13. CIMO-XIV requested that information be provided on alternatives for mercury-based instruments. Guidelines should be provided to address environmental concern and the worldwide recommendation to reduce the use of mercury. A webpage on this topic was introduced as part of the AWS portal on the IMOP homepage:
http://www.wmo.int/pages/prog/www/IMOP/WebPortal-AWS/Index01.html.

Activity report of the Expert Team on Surface-based Instrument Intercomparisons and Calibration Methods (ET-SBII&CM)

14. The major activities of the ET-SBII&CM were the prioritization of proposals, preparation and follow-up of instrument intercomparisons. An important task was to coordinate activities related to the organization and conduct of these intercomparisons according to the CIMO Provisional Programme of WMO Surface-based Instrument Intercomparisons (2006-2010). As foreseen in this programme focus was put on the following intercomparisons: the WMO Field Intercomparison of Rainfall Intensity Gauges (Vigna di Valle, Italy, 2007-2008) and the WMO Combined Intercomparison of Thermometer Screens/Shields in Conjunction with Humidity Measurements (Ghardaïa, Algeria, 2007-2008), the latter to be followed by a similar intercomparison in an arctic environment at Iqaluit, Baffin Island, Canada. The results of both intercomparisons have proven very interesting and provide relevant advices for Members making any decisions when preparing functional specifications to obtain new equipment.

15. A point of serious concern is that the cost incurred by host countries in carrying out instruments intercomparisons are generally very high and Members are not sufficiently aware of these costs. ET-SBII&CM recommended that for each intercomparison, the host country should be invited to communicate the costs associated with hosting the intercomparison. This information would then be included in the report to CIMO, giving them the recognition they deserve.

Field Intercomparison of Rainfall Intensity (RI) Gauges, Vigna di Valle, Italy

16. ET-SBII&CM inspected and fully approved the intercomparison site in Vigna di Valle, Italy, prior to the start of the intercomparison, made suggestions to improve its functionality and finalized the selection of instruments for the intercomparison. It also approved the procedures for the laboratory calibration phase, field installation, including the supervision and maintenance of instruments during the intercomparison period. The data acquisition and archiving, data processing, quality control procedure and data policy were also agreed upon.

17. The intercomparison started on 1st October 2007 and was originally planned to last 12 months. However, ET-SBII&CM decided to extend the intercomparison until 30 April 2009. ET SBII&CM worked towards having the results of the intercomparison published promptly following its completion. The use of teleconferences proved to be very efficient and allowed the publication of the final report only 3 months after the completion of the intercomparison. A meeting of ET-SBII&CM was organized to review and approve the final report after some exchanges with the participants. It was published in the IOM report series (IOM 99, WMO/TD 1504).

18. The report contains important conclusions, as well as a number of recommendations on rainfall intensity measurements (see Annex). They are not only directed at users, providing advice on the specific requirements of this type of measurements, their feasibility and instrument performance, but also at manufacturers and more generally at the WMO, addressing for example the need to update the CIMO Guide, and lessons learned from this intercomparison.

19. The results of the intercomparison confirmed the feasibility to measure and compare rainfall intensities on a one minute time scale, as required by users and recommended by CIMO. The intercomparison also provided information on the achievable measurement uncertainties. As rainfall intensity is highly variable from minute to minute, it was found that the time synchronization of the instruments is crucial. Consequently, the intercomparison showed that the relative uncertainty of the rainfall intensity composite working reference was below 5% for intensities above 90 mm/h. Below 90 mm/h, the relative uncertainty of the reference values was higher than the required 5% measurement uncertainty as provided in the CIMO Guide.

20. A meeting of Participants and Local Staff (Vigna di Valle, 21-22 May 2008) was organized and proved to be fundamental for the success of the intercomparison. In particular, it confirmed that the rain gauges were operated according to the recommended procedures and therefore permitted to achieve the best possible data quality and instrument synchronization.

21. A summary of the general results of the intercomparison was provided in a table to provide information on the performance of each of the participating instruments. The results confirmed that software correction is the most appropriate method for the correction of tipping bucket rain gauges. Very good results with respect to linearity, resolution enhancement and noise reduction could therefore be achieved. Disdrometers tended to overestimate the rainfall intensity despite their very different calibration procedures; they tended to agree better to each other than to the reference. The intercomparison showed that disdrometers had a good degree of precision but were not as accurate as conventional gauges. The intercomparison also showed that the microwave radar and the optical / capacitive sensor tended to underestimate the rainfall intensity.

22. ET-SBII&CM addressed related standardization activities that are particularly important in the context of the development of the WMO Global Integrated Observing System (WIGOS). Moreover these results are expected to lead to a number of standardization activities that would be very relevant to the development of the WMO Integrated Global Observing System (WIGOS), e.g. EN13798:2002 (Reference Rain Gauge Pit) of the European Commission for Normalization (CEN) and the development of a standard on the classification of rainfall intensity gauges. ET-SBII&CM envisaged that, if sufficient support from WMO Members could be achieved, that standard could be proposed to ISO for the development of a common WMO-ISO standard.

23. It should be recognized that due to the complexity of all systems offered, the whole field test was a great challenge and the successful results achieved can be directly attributed to the organizers and management staff in Vigna di Valle. It was recalled that intercomparisons represent a significant financial contribution from the host country. For this intercomparison the total was: € 157'000.00 (investments) + € 140'000.00 (activity costs).

Intercomparison of Thermometer Screens/Shields, in conjunction with Humidity Measuring Instruments, Ghardaia, Algeria

24. ET-SBII&CM inspected the intercomparison site of the WMO Intercomparison of Thermometer Screens/Shields in conjunction with the humidity measuring instruments in Ghardaïa, Algeria. It made suggestions to improve its functionality and selected additional instruments for the intercomparison. The procedures and preliminary results of the laboratory calibration phase, procedures for the field installation, including the supervision and maintenance of instruments during the intercomparison period were checked. ET-SBII&CM also agreed on the data acquisition and archiving, data processing, data policy and analysis methodology.

25. The calibration of temperature and humidity sensors was performed in the metrology laboratory of Trappes (RIC for ARVI), from January to March 2007 and a field calibration of some hygrometers was performed by Météo-France in Ghardaïa, in June 2008. Due to the complexity of local infrastructural issues, including custom procedures, some delay occurred in starting up the whole set of instruments. The intercomparison officially started on November, 1st, 2008 and lasted until 31 October 2009. The Office de la Météorologie Nationale (Algeria) and MeteoFrance collaborated to organize the database, filter the raw data, analyze the data and draft the final report. Following the positive experience made with the rainfall intensity intercomparison, a number of teleconferences were organized to review the results and the report. The first draft of the final report was made available to participating manufacturers in July 2010, which would allow for some discussion with them on the occasion of TECO 2010.

Plans for future intercomparisons

26. ET-SBII&CM also reviewed the plans for an arctic intercomparison of Thermometer Screens/Shields in conjunction with Humidity Measuring Instruments that should be held in Iqaluit, Canada. ET-SBII&CM decided to delay the start of this intercomparison to after CIMO-XV, when the report of the intercomparison in Ghardaïa will be published. The intercomparison could be started at the end of 2011 for a one year period.

27. An intercomparison on solid precipitation including snowfall and snow depth measurements at automatic weather stations had been proposed due to Members requirements for guidance on this type of measurement and their relevance in the context of climate change. To assess the present situation of practices, a survey of WMO Members was conducted, with 55 Members returning completed questionnaires. Their analysis showed that solid precipitation measurements were still mostly carried out manually. For those measurements, the results of past intercomparisons are still regarded as valid. However, for the automatic measurements, it appeared that an unexpectedly large variety of measuring principles and instruments are in use. These results were published as IOM report No. 102 (WMO/TD No. 1544).

28. Extensive use of a wide range of instruments and configurations significantly impacts the ability to derive representative results at large scale and has serious consequences for the measurement accuracy and consistency of local and global precipitation time series. In view of the expected future increase of automatic measurements and the variety of measuring principles available, ET-SBII&CM recognized that it would be an appropriate time to start an intercomparison to provide timely advice to Members that are considering changing from manual to automatic measurements in the near future.

29. The performances of rain gauges for the measurement of solid precipitations strongly depend on the climatic conditions in which they occur. Therefore, the results of an intercomparison carried out at a single site would not be regarded as representative. ET-SBII&CM therefore recommended that conditions such an intercomparison would need to be carried out at a number of sites with different climate conditions, which would significantly complicate the organization.

Manual observations would be needed at each site as verification and to assess the correlation of manual and automatic measurements. The plans to carry out such an intercomparison should be further investigated at CIMO-XV and will strongly depend on the willingness of Members to provide sufficient measurement sites and to host the intercomparison.

Activity report of the Expert Team on Meteorological Radiation and Atmospheric Composition Measurements (ET-MR&ACM)

30. ET-MR&ACM reviewed and agreed on the plans for holding the Eleventh International Pyrheliometer Intercomparison (IPC-XI) from 27 September to 15 October 2010, conjointly with Regional Pyrheliometer Comparisons (RPCs), including a pre-IPC survey on national network traceability, a tailored radiation training course during IPC for RRC participants, and two co-incident comparisons one on sun photometry and the other on infrared. ET-MR&ACM recognized that IPC provides the basis for the traceability of all meteorological radiation measurements and recommended that the cycle of 5 years between each IPC be strictly followed as it was crucial to meeting the needs of clients for traceability of radiation measurements. ET-MR&ACM recognized that this was a unique contribution of CIMO to WIGOS and to the even larger community interested in radiation measurements.

31. ET-MR&ACM reviewed the status of the stability of the instruments of the World Standard Group and provided guidance on their maintenance to Physikalisch-Meteorologisches Observatorium Davos (PMOD). Comparison between the World Radiometric Reference and the SI showed very good agreement, giving independent confirmation of the procedures used to maintain the World Radiometric Reference (WRR) over the years. PMOD is developing a Cryogenic Solar Absolute Radiometer (CSAR) that will provide a direct link to SI. In the future, the WRR could possibly be based on the CSAR.

32. The Regional Radiation Centre (RRC) of Tsukuba organized a Regional Pyrheliometer Intercomparison (RPC) that was held in Japan in 2007. A sub-regional pyranometer intercomparison was organized in Croatia for South Eastern Europe. ET-MR&ACM reviewed and endorsed the final reports of these intercomparisons that were published as IOM reports.

33. The quality of radiation data varies considerably from Region to Region and from country to country, which is partly due to the lack of guidance material suitable for maintenance of standards, calibration and propagation of traceability in a network. ET-MR&ACM therefore decided to develop and organize a training course on radiation measurements focusing primarily on the needs of RRCs in conjunction with IPC-XI. The training material developed for the course could later be used to assist the RRCs in conducting training courses in the Regions, as it would be published as an IOM report, and possibly also recorded.

34. The World Radiation Data Centre (WRDC) in St. Petersburg, Russia carries out checks of all incoming data. Dubious values are flagged in the WRDC issues, which are published quarterly as pdf files. ET-MR&ACM recommended that WRDC provides a written report to the ET about the current status of the radiation data quality in the WRDC archive up to December 2009, in particular, noting any instrument and/or measurement problems they have encountered, so that ET-MR&ACM could provide any needed help to the WRDC. ET-MR&ACM also recommended that WRDC publish the QA/QC algorithms it uses so that Members could perform their own data quality check prior to submitting the data to WRDC.

35. Substantial progress was made over the last years with respect to infrared radiation measurements. The new instruments developed at PMOD show very good agreement with the World Infrared Standard Group (WISG) and therefore provide additional confidence in the values measured by the WISG. Furthermore, the very good agreement between the calibrations obtained using

blackbodies, having completely different designs, provides additional confidence in the calibration procedure. ET-MR&ACM provided a number of recommendations related to the further development of infrared measurements and calibrations.

36. ET-MR&ACM worked on the improvement of the radiation chapters of the CIMO Guide. Further work is still needed in particular relative to chapter 8 (Sunshine), 16 (Measurement of Ozone) and 17 (Measurement of Atmospheric Composition). The latter will require collaboration with relevant GAW experts.

37. A number of ISO standards are relevant to radiation measurements and were originally based on a former version of the CIMO Guide. ISO recently started the review process of those standards. Close cooperation between WMO and ISO would be needed to ensure that these standards continue to meet the needs of WMO in the future and possibly, to develop common ISO-WMO standards when appropriate.

38. Close liaison of ET-MR&ACM with the Baseline Surface Radiation Network (BSRN) and the Global Atmospheric Watch Programme (GAW) continued by having some members of the team involved in these communities. Stronger collaboration will be particularly relevant to update the CIMO Guide on relevant observing practices for UV, Ozone and Aerosol Optical Dept measurements, in particular.

39. The expert team identified a number of problems and risks related to existing instruments (e.g. absolute cavity radiometers - ageing, number is declining, without the development of additional cavity radiometers there is a significant risk the WRR will loose discrimination by relying on a minimum set of types of radiometers), to the development of instruments (e.g. WISG is dependent on measurements of a now non-functional instrument and the black bodies at PMOD, and hence puts at risk the traceability of infrared measurements to SI units) and to the possible decrease in the quality of radiation measurements by the NMHS. The ET was also concerned about the capability of RRCs in general radiation metrology given the confused responses to an initial survey of the RRCs

Activity report of the Ad-hoc Working Group on the CIMO Pilot Project for WIGOS – Siting classification for meteorological observing stations on land

40. In the frame of the CIMO Pilot Project for WIGOS, an ad-hoc working group, established by the president of CIMO, was tasked to develop and finalize two classifications addressing the siting and maintenance of meteorological stations on land, in close collaboration with the Commission for Basic Systems (CBS).

41. The required quality of observations cannot be ensured only by the use of high-quality instrumentation supplied by manufacturers, but rely at least as much on the standard siting of the instruments and on their maintenance. These classifications are the first step towards providing a measure of the data quality to users of meteorological observations to assess whether specific observations meet the quality requirements for their applications. This is of crucial importance especially for climate change and climate variability monitoring. These classifications were developed using available scientific work, evaluating the magnitude of the errors that can be expected in each class.

42. The ad-hoc group agreed that the first classification (siting classification) was mature and should be submitted for approval to CIMO members and possibly proposed for further development as a common ISO-WMO standard if supported by Members, which was confirmed by EC-LXII. However, the ad-hoc group recommended that the second classification (maintenance classification) be further developed.

Siting classification

43. In spite of the known exposure rules for meteorological stations, it is frequent that the site selected for their installation does not fully meet the requirements because of the numerous constraints influencing the site selection procedures. This classification takes into account, the site, its surroundings and its representativeness. The classification is providing one value for each measured element (temperature, wind, precipitation,…). Several Members implemented a former version of this classification and recognized that it had lead to an improvement to their stations. The evaluation/rating of any station has to be repeated on a regular basis by network managers, ideally by personnel independent from the maintenance personnel.

44. The successful implementation of such a classification system would also require the development of guidance material on how to apply the classification and to help characterize the station. Also, guidance on how to use the classification ratings, indicating which stations of a specific class are appropriate would be beneficial. Class 1 should be considered as reference and appropriate for climate applications. Whereas Class 5 does not follow all WMO requirements, class 5-stations can have an interest for special applications.

Maintenance classification

45. The second classification addresses the maintenance (incl. calibration) of the instruments. It is of high interest in the context of data exchange originating from stations that were maintained by other entities and offers a tool to the users' community to complement the siting classification. Its classes are marked with letters to avoid confusion with the siting classification and range from A (best) to D (worst). Each class corresponds to an uncertainty (Class A corresponding to the achievable measurement uncertainty and to reference stations).

46. This classification provides information on how networks are maintained for each parameter. Therefore, generally, the rating of a kind of a station in the network would be the same for a given parameter, if the maintenance of all the stations of this kind within the network is the same. The ad-hoc group reviewed and further developed the classification. It recognized that assessing the quality of a station taking into account its maintenance was difficult to perform, but strongly needed. The maintenance classification is already well-developed, but would need further work to be acceptable as a world standard, the ad-hoc group therefore recommended that it be further developed and tested before being submitted for approval to CIMO.

Annex to paragraph 19

Recommendations published in the final report of the WMO Field Intercomparison of Rainfall Intensity Gauges, Vigna di Valle, Italy

Recommendation 1

The 1-min rainfall intensity (RI) is highly variable from minute to minute. Therefore, it is recommended that 1-min RI should only be measured in a station and used for further analysis if the following conditions are met:

- All 1-min data must be transmitted and used. (1-min RI intensity should not be used in a temporal sampling scheme, i.e. one synoptic measurement every hour or 3 hours as a single 1-min RI values is not representative of a longer period of time.);

- A very good time synchronization, better than 10 s, is achieved, both between the reference time and the different instruments of the observing station.

Recommendation 2

Some sensors with internal software provide output data telegrams with several RI related parameters, which can be used to calculate 1-min RI. The user should carefully check the manufacturer's documentation about the characteristics of these parameters and ask for additional information, if necessary, as it appeared during the intercomparison that it is not always obvious to identify the parameters that should be used.

Recommendation 3

During the intercomparison, it appeared that in some cases important information was missing in the instrument manuals and that additional information had to be requested from the manufacturers to properly use their instruments for 1-min RI measurements. It is therefore recommended to manufacturers to state as a minimum the list of technical parameters below in the user manual and to provide sufficient advice on the best choice of output values to use for different applications:

- measurement range
- resolution
- linearity
- measurement uncertainty (for the whole measurement range)
- threshold
- dead time
- delay time
- time constant
- internal calculation or update cycle
- possible output cycles.

Recommendation 4

It is recommended to manufacturers and to users that tipping bucket rain gauges be corrected to compensate for underestimation of high RI. Software correction methods that take into account the timestamp of each tip provide the best results.

Recommendation 5

Due to the increased noise level of catching-type gauges that do not use a funnel it became evident that a fast response measurement of RI and an accurate measurement of rainfall accumulation (RA) are contradictory goals. If a consistency between RI and RA outputs degrades the performance of one of them, it is recommended to manufacturers that they separate the calculation of RI and RA and that they report both values.

Recommendation 6

If real-time output is not needed, software induced delay times are less critical than longer time constants or any other effects, because delay times can easily be corrected to retrieve the original RI information. It is recommended to manufacturers that they avoid the use of algorithms that increase the time constant.

Recommendation 7

Some sensors, or physical principles, provide a real-time measurement uncertainty or quality information for each RI value which can be used to assess the quality of the measurements. As an example the measurement uncertainty of RI could be derived from the raw values of a weighing gauge. It is recommended that the manufacturers provide this quality information in the output data telegram.

Recommendation 8

Although this intercomparison had its emphasis on high RI, it became obvious that most instruments needed to be improved in the lower RI range. It is recommended to manufacturers to improve the design of their instruments to reduce the uncertainty of 1-min RI measurements at intensities below 20mm/h.

Recommendation 9

Chapter 1, Annex 1.B (operational measurement uncertainty requirements and instrument performance) of the CIMO Guide (WMO-No. 8) includes a column for the achievable measurement uncertainty, based on sensor performance under nominal and recommended exposure that can be achieved in operational practice. This information is not currently documented for RI. It is recommended that the following changes be made to the CIMO Guide Table:

- Precipitation intensity (liquid):
    - Achievable measurement uncertainty: Under constant flow conditions in laboratory, 5% above 2 mm/h, 2% above 10 mm/h;
    - In field conditions, 5 mm/h, and 5% above 100 mm/h.
- Split column 8 (Achievable measurement uncertainty) to account for the different achievable measurement uncertainties under both laboratory and field conditions.

Recommendation 10

It is recommended that RI measurements be further standardized based on the advances in knowledge obtained from this intercomparison to allow the users to obtain homogeneous data sets. This should be based on the achievable RI measurement performance (accuracy) rather than on the involved measuring principle or the gauge design/technical solutions. It is recommended that:

- The procedure adopted for performing calibration tests in the laboratory should become a standard method to be used for assessing the instruments' performance. In particular it is recommended that specific procedure to perform the step response tests in the laboratory be further developed and proposed as a standard in order to better evaluate their time constant. Acceptance tests could be based on the adopted laboratory procedures/standard;
- Classification of instrument performance is developed. This could be based on the results of laboratory tests and on user application requirements. The different classes of instruments would help users in selecting the proper instrument for their applications. Different classes may also apply to different ranges of rainfall intensity;
- The necessary steps are made towards common WMO-ISO international standard(s).

Recommendation 11

It is recommended that the procedure developed for field calibration of the catching type gauges be accepted as a standard procedure for operational assessment of instrument's performance in the field. The procedure allows reproducing in the field the same calibration method as is used in the laboratory. Standardization of the field calibration method would help developing proper quality control procedures based on periodic checking of the instruments in the field.

Recommendation 12

As a guideline for future Intercomparison initiatives involving instruments that can not be directly compared to a primary, secondary or reference standard, it is recommended that a "composite working reference" is derived using more than one instrument to provide the best estimate. This concept is based on the experience of the present Intercomparison of RI gauges, by selecting a number of instruments with the best observed/expected performance under independent assessment (e.g. from laboratory tests, or other available information) and to derive a "composite" measure from the combination of their respective measures using suitable statistic and/or conceptual tools.

Recommendation 13

Throughout the intercomparison, the International Organizing Committee (IOC) held regular teleconferences to monitor the progress of the intercomparison, to provide advice to the local host and to develop the final report. This proved to be extremely effective. It is therefore recommended that the IOC of future intercomparisons considers having regular teleconferences.

Recommendation 14

It is recommended that for future intercomparisons, a test period be held before the official start of the intercomparisons. After this test period a meeting with all participants could be organized to confirm and verify the setting of the instruments and data acquisition. If the data analysis procedure is already known at this time, it could also be presented to the participants for comments.

Recommendation 15

It is recommended that the developed expertise and the infrastructure at the Intercomparison sites (both the field and the laboratory components) and any related available facilities be further exploited within WMO beyond the time limits of this intercomparison.

Recommendation 16

Few events with intensities above 100 mm/h were measured during this intercomparison. It would therefore be of interest to consider a follow-up of this intercomparison to address higher intensities. It is recommended that future work on the subject be conducted in other climatological regions (tropics) and/or conducted over a much longer time period to increase the chance of measuring very high rainfall intensity events.

Recommendation 17

The Intercomparison data set (1-min rainfall intensity data) constitutes an important resource that should be considered as a valuable product of this intercomparison and that could possibly be exploited beyond the objectives of the present data analysis. Additional investigations from this data set would be possible and it is recommended that further use of this information be made with various possible objectives.

Recommendation 18

Heavy rainfall is generally the origin of flash floods. In view of the very high variability of the rainfall intensity, measurements at a 1-minute time scale are crucial to enable proper measures be taken to mitigate the impact of such events and save lives, property and infrastructures. As the return period of heavy rainfall events is large long-term records of rainfall intensity data are needed to estimate the probability of occurrence of heavy rainfall at a given location and time. It is therefore recommended to Members to carry out 1-minute rainfall intensity measurements in critical areas to allow proper action for disaster risk reduction. Such measurements would also be used for better design of structures (building, construction works) and infrastructure (drainage) to mitigate severe weather impact.

BACKGROUND INFORMATION

INSTRUMENTS AND METHODS OF OBSERVATION FOR UPPER-AIR MEASUREMENTS AND REMOTE SENSING

Activity report of the Expert Team on Upgrading the Global Upper-air Networks (ET-UGUN)

1. The membership and terms of reference of the ET are available at: http://www.wmo.int/pages/prog/www/CIMO/WorkingStructure/membership.html. ET-UGUN conducted its activities only by correspondence and no meeting was held during the intersessional period.

2. The Catalogue of Radiosondes and Upper-air wind systems can be located at: http://www.wmo.int/pages/prog/www/ois/volume-a/vola-home.htm and provides essential information on operational use of radiosondes. With the lack of an appropriate expert with extensive knowledge in the field of radiosondes, upper-air wind systems and with access to various global monitoring centres, such as ECMWF, the current version of the Catalogue of Radiosondes and the long-term Radiosonde monitoring statistics has not been updated for a number of years. The seventh session of the CIMO Management Group (CIMO-MG-7), Geneva, February 2010, reported that there have been numerous requests for this information and the CIMO-MG agreed that this information should be regarded as extremely important in the framework of WIGOS in order to assess radiosonde and upper-air wind system data quality. In order to address this problem the CIMO-MG-7 requested the president of CIMO to identify an appropriately skilled expert(s) from the UK Met Office who could be tasked with undertaking the role of maintaining the catalogue and long-term radiosonde monitoring statistics.

3. The GCOS Reference Upper-Air Network (GRUAN) is intended to provide long-term high quality climate record of upper-air temperature, water vapour, and other key essential climate variables, particularly in the troposphere and in the lower stratosphere, by a combination of balloon borne and remote sensing state of the art instrumentation, and will constrain and calibrate data from more spatially-comprehensive global observing systems, including satellites and current radiosonde networks (e.g., GUAN). More information, in particular on the status of GRUAN Implementation, including previous GRUAN meetings in Lindenberg (2008), Norman/Oklahoma (2009) and Payerne (2010) are available from www.gruan.org. The overall progress for the establishment of GRUAN, against stated GRUAN-WIGOS Pilot Project aims, has been satisfactory. There has been good progress made on the planning aspects for the CIMO intercomparison, with the inclusion of the GRUAN Lead Centre Head into the organizing committee for the campaign.

4. CIMO-MG reiterated the requirement for a poster on hydrogen danger addressing the safety of hydrogen generators and a review of the guidance material provided in the *WMO Guide to Meteorological Instruments and Methods of Observation*, WMO-No. 8 (CIMO Guide). It requested that ET-UGUN continue working on addressing the operational safety issues related to the operational use of hydrogen generators including the development of a poster on hydrogen safety.

5. In the area of AMDAR measurements, the WIGOS Pilot Project (WIGOS-PP) for AMDAR was established to improve on the practices impacting AMDAR data collection, processing, archiving and dissemination. Both ET-UGUN and AMDAR experts are involved in this project. The AMDAR WIGOS-PP is developing better standard practices as well documenting these practices to ensure sufficient detail accompanies AMDAR observations so that users can better interpret measurements. In addition, new methods and procedures will be developed in preparation for the

deployment of new operational instruments, such as WVSS-II water vapour sensor. The key objectives of WIGOS–PP for AMDAR are:

(a) Development of a new standardized BUFR Template for AMDAR;

(b) Application of WMO Metadata relevant to AMDAR;

(c) Development of a standardized Quality Management Framework for AMDAR data;

(d) Validation and preparation for intercomparison of available water vapour sensor performance;

(e) Update of the AMDAR Reference Manual (WMO-No. 958); and

(f) Development of the framework for generic software specification for AMDAR.

6. As part of the WIGOS-PP for AMDAR the AMDAR community has had initial discussions with the WMO Secretariat and the president of CIMO regarding the validation and preparation for an intercomparison of available AMDAR water vapour sensor performance. It was agreed that before a preparatory meeting between the AMDAR Panel and CIMO takes place in order to define the rules and procedures for an intercomparison of AMDAR and other upper-air data, the WVSS-II water vapour sensor would have to satisfactorily complete USA and European based trials. As part of the overall strategy of validation of the WVSS-II water vapour sensor, the E-AMDAR Programme is planning on installing a WVSS-II water vapour sensor on a European based research aircraft. This installation is scheduled to be completed towards the end of 2010 or early 2011.

7. Through the work of the WIGOS PP for AMDAR the activities focused on developing closer ties with all aircraft manufacturers and related industries on the development of a standardized AMDAR software and hardware solution for all aircraft makes and models. This work has included the close collaboration between the E-AMDAR programme and Airbus on the European CLEANSKY COMET Project aimed at validating the "Buy-In" of the future AIRBUS on-board meteorological measurement system by the user community, and work between the USA AMDAR programme and Boeing to deliver advanced commercial aircraft which, collectively, maximize fleet efficiency and minimize impact of flight hazards on operations including detection and avoidance of thunderstorms, icing and turbulence.

8. The USA AMDAR programme will, as part of a contract with ARINC/SpectraSensors Inc (SSI), install WVSS-II sensors on 31 Southwest Airlines (SWA) B-737 aircrafts and on 25 United Parcel Service B-757 aircrafts. Following the completed 2008 evaluation trials in the USA and Europe, the WVSS-II sensor was redesigned to improve seals and sample chamber thermal integrity. To date the preliminary data from the USA based trial on the newly redesigned and installed sensor-units looks encouraging. As of June 2010, 28 out of 56 WVSS-II-v3 sensors have been installed on the designated aircrafts per the above mentioned contract; it is anticipated that all 56 WVSS-II-v3 units will be installed by the second quarter of 2011.

9. Chamber testing of the latest version of the WVSS-II-v was completed by the Deutscher Wetterdienst (DWD), Climate Chamber of the Meteorological Observatory, Lindenberg, Germany, in September 2009, with Dr Axel Hoff serving as Principle Investigator. The DWD report on these tests concluded that “the sensitivity of the WVSS-II touches the requirements for observations in the upper troposphere or lower stratosphere.” The full DWD report can be found at the following link: http:/amdar.noaa.gov/docs/WVSS-II_Assessment_DWD.pdf.

10. Additional chamber testing of the WVSS-II was conducted at the NOAA Upper-Air Test Facility in Sterling, Virginia, in 2009. These tests and their feedback have resulted in improved

pressure/temperature fitting algorithm of the WVSS-II and independent validation of DWD chamber results.

11. An intercomparison field test of the WVSS-II-v3 and the Vaisala RS-92 radiosonde was recently performed by the University of Wisconsin, Cooperative Institute for Meteorological Satellite Studies (CIMSS). Preliminary results from the field test have shown that the latest version of the WVSS-II water vapour sensor is very much improved on previous versions and a CIMSS report on the WVSS-II-v3/RS92 sounding intercomparisons is forthcoming for the summer of 2010 which is based on the field work conducted at Rockford, Illinois, in November 2009 and May 2010. Additional papers from this field assessment are to be presented by CIMSS researchers at the American Meteorological Society (AMS) Annual Meeting in January 2011.

12. The Steering Group on Radio Frequency (SG-RFC) reaffirmed the need for the meteorological community to prepare to respond to possible future pressures on limiting the 400 MHz METAIDS frequency band. SG-RFC has made the recommendation that the meteorological community should not be too pro-active in proposing a decrease in the 400 MHz bandwidth, but suggested that the meteorological community be prepared in case such requests arise from any Radio Administration. It also noted that there is a need to study the issues on possible bandwidth reduction among meteorological services, taking into account constraints, current trends, and relations with data collection platform use in the 401-403 MHz.

Activity report of the Expert Team on Upper-Air System Intercomparisons (ET-UASI)

13. The membership and terms of reference of the ET-UASI are available at: http://www.wmo.int/pages/prog/www/CIMO/WorkingStructure/membership.html. Two meetings of ET-UASI were held jointly with the International Organizing Committee (IOC) on Upper-air Systems Intercomparisons during the intersessional period in Payerne, Switzerland, from 2 to 6 June 2008 and in Yangjiang, China, from 31 August to 4 September 2009. The working documents are available at: http://www.wmo.int/pages/prog/www/IMOP/meetings.html and the final reports are available at: http://www.wmo.int/pages/prog/www/IMOP/reports.html.

14. ET-UASI and the International Organizing Committee (ET/IOC) reviewed changes in the design of radiosondes following the Seventh WMO Intercomparison of Radiosondes (Mauritius, 2005), their impact on global radiosonde data compatibility and the need for a new global radiosonde intercomparison. It was noted that all manufacturers that participated in Mauritius had made significant changes as a result of the intercomparison and their new versions of radiosondes are already in use or will soon be used in the Global Observing System (GOS). This is also true for manufacturers that did not participate in the Mauritius intercomparison and have candidate systems for the next global intercomparison. The changes in radiosonde designs/sensors are listed in the final report of the ET/IOC. Though positive changes were observed in radiosonde performance resulting from improvements in radiosondes design/sensors, it is important that manufactures should inform CIMO about the changes in the radiosondes, as well as on the results of the conducted tests. It was proposed that manufacturers would provide relevant information to the WMO Secretariat which would be posted on its CIMO Website.

15. It was agreed that:

(a) The design and characteristics of radiosondes in use has been changing radically since the Mauritius intercomparison and there is a need for a new global WMO intercomparison of radiosonde systems;

(b) Significant progress was noted in some countries, such as China, as shown by the long-term quality assessment using the ECMWF OB-FG statistics. These new radiosondes need to be linked to the high quality radiosondes;

(c) In some countries, relatively poor systems still remain, so that not all of the upper-air measurements have the same error characteristics;

(d) The improved radiosondes meet user requirements for operational use and scientific studies, apart from the very high accuracy requested for relative humidity in the upper troposphere and lower stratosphere for climate trend studies;

(e) Knowledge of radiosonde errors is essential when using radiosondes to compare with remote sensing measurements. This includes an understanding of the representativeness of errors from the rapid ascent of the balloon through the vertical structure of the atmosphere, usually 1 km in the vertical in about 3 minutes.

16. The recent international as well as national radiosonde intercomparisons and tests were reviewed. Considered were the test results and the consequent of changes to the observing systems. These included: (a) UKMO tests on the effects of changes in the radiosondes (mainly changes in sensor design) with regards upper-air measurement and their negative impacts on the homogeneity of data; (b) the activities of NOAA NWS radiosonde replacement programme and related activities such as radiosonde acquisitions, radiosonde test and qualification activities and operational issues; (c) the development of the Accurate Temperature Measuring (ATM) radiosonde and early results using rod thermistors conducted by NASA. Early results gathered from nine upper-air sites indicated that thermistor errors were sensitive to the background radiative environment suggesting that fixed corrections may not work. Comparison of ATM with operational radiosondes showed that even after manufacturer's corrections were applied to the measurements, the radiosonde errors may have been larger than suggested by the manufacturers values applied operationally; (d) comparison between the SnowWhite and the Frost-point Hygrometer. Comparable results were found up to the tropopause and occasionally to the lower stratosphere. The utility of the SnowWhite sensor was shown in relation to cirrus clouds. A caution was raised concerning rain and heavy wet-clouds on SnowWhite operations; and (e) the radiosonde test undertaken in Windhoek, Namibia in October 2007, under the auspices of CIMO. This test involved ten comparison flights between the InterMet Systems GPS Radiosonde BAT16G and Vaisala RS92.

17. The recent tests of integrated profiling systems and requirements for further tests and intercomparisons were reviewed, namely:

(a) *UKMO FUND* (Future Upper-Air Network Development) project for 2010-2020 with the aim to optimize and integrate the current network with surface measurement, weather radar, AMDAR, in-situ remote sensing focusing mainly on the Planetary Boundary Layer including its variability. This Testbed was proposed by the ET/IOC to become a WIGOS Demonstration Project pending approval by the UK Met Office;

(b) *COST Action ES0702 EG-CLIMET* (European Ground-based observations of essential variables for CLImate and operational METeorology) as a coordinated development of upper-air measurements and in-situ remote sensing with the aim to design a new integrated observing network in RA VI;

(c) *CN-MET* (Centrales Nucléaires et METéorologie) project of MeteoSwiss that will combine operational surface and upper-air networks data with a high resolution NWP model (COSMO-CH 2.2km). The upper-air network includes one radiosounding station (Payerne), three low-tropospheric wind profilers, and three microwave radiometers for temperature profiling. Observational data will be assimilated into the NWP model. High quality weather forecast will be available for the meteorological surveillance of the power plants. It is planned that the entire system will be operational in 2010;

(d) *LUAMI* (Lindenberg Upper Air Methods Intercomparison campaign): The Richard-Aßmann Observatory at Lindenberg, Germany conducted the LUAMI intercomparison under the auspices of CIMO from the period from 3 to 30 November 2008 with the emphasis on remote sensing techniques. The assessment of remote sensing measurement was supported by in-situ reference sounding techniques. This also provided the opportunity to manufacturers of standard radiosonde systems to participate in the LUAMI campaign in order to prepare their systems for the next Eighth WMO intercomparison of radiosonde systems, Yangjiang, China, 12-31 July 2010. Results will be available in the IOM Report that is being published.

18. The LUAMI campaign demonstrated the ability of ground-based instruments like microwave radiometers, GPS networks and Raman LIDARs for observing humidity profiles and for evaluation of NWP products. The air-borne Differential Absorption LIDAR WALES of DLR proved its reference quality for measuring humidity in the upper troposphere, even within thin cirrus cloud. This instrument has great value for the quality and inter-operability assurance of ground-based remote sensing instruments like Raman LIDARs which was demonstrated by over-flight of the LIDARs employed in Cabauw (NL), Payerne (CH), Lindenberg (D) and Zugspitze (D).

19. The operational radiosondes that participated in LUAMI (Vaisala RS-92, GRAW DFM-06, INTERMET Africa BAT-G4, and METEOLABOR SRS-C34) performed well for measuring temperature and tropospheric humidity, and generally agreed within their stated accuracies. Some issues were identified, in particular concerning the radiation effect on the measurement of humidity in the upper troposphere and the temperature above 25 km altitude. In these cases, the correction schemes and/or the accuracy statements of some sensors might need to be revisited.

20. At LUAMI, the Russian Lyman-α (FLASH) and the Cryogenic Frostpoint Hygrometer (CFH) instruments agreed very well in their observations of stratospheric water vapour and are well suited to measure that variable. The newly developed Vaisala DRYCAP sensor that was tested during LUAMI also showed its ability to detect water above the tropopause.

21. The requirements for the GCOS Reference Upper-Air Network, suggested at the GRUAN meeting in Germany in February 2008, were reviewed. It was noted that:

(a) It had been proposed that a major radiosonde intercomparison be held under the auspices of GCOS and CIMO, managed by the GCOS Working Group on Atmospheric Research Observations (WG-ARO) and the GRUAN Lead Centre (Meteorological Observatory Lindenberg – Richard-Aßmann Observatory, Germany), at one or more GRUAN or other appropriate sites to try to ascertain a best set of instrumentation and practices specifically for GRUAN operations in 2010, and that this should involve both operational and research radiosondes;

(b) The definition of best operational practices for GRUAN, priority list of additional ground-based instrumentation, and recommendations for a set of ground-based instrumentation types has to be defined;

(c) The GRUAN Guide on the observing practices has to be developed to ensure standardization, comparability and high-quality of measurements at all sites and that the ET/IOC should assist the GRUAN in developing the best operational practices;

(d) Some GRUAN activities were related to CIMO activities, such as a common intercomparison strategy, and assistance in selecting appropriate reference sounding systems. A close link between the GRUAN Lead Centre and CIMO should be ensured.

22. ET/IOC reviewed a proposal of Mr C.A. Bower (USA) for the update of the CIMO Guide related to the publication of the WMO upper-air intercomparison results. Draft procedures are available in the final report of the ET/IOC meeting (June 2008) and will be considered for the evaluation of the Eighth WMO Intercomparison of High Quality Radiosonde Systems. Once finalized, guidelines will be published in the CIMO Guide.

23. ET/IOC decided to organize the Eighth WMO Intercomparison of High Quality Radiosonde Systems (WMO-RSO-8) in Yangjiang, China, from 12 to 3 August 2010. The main objective of this intercomparison is to test in the tropical/subtropical moist conditions the relative performances of High Quality Operational Radiosondes (HQOR) in conjunction with the Best Quality Research Sounding Systems (BQRSS). The results will be used to advise Members on a selection of HQOR suitable for RBSN/RBCN and its GUAN sub-network as well as advise GCOS on a selection of systems suitable for GRUAN. Further objectives being:

(a) To improve the accuracy of daytime HQOR measurements and the associated correction procedures to provide temperature and relative humidity accuracies currently possible with night time measurements;

(b) To assess the accuracy and availability of the GPS wind measuring systems;

(c) To evaluate the performance of geometric and geopotential height values obtained from GPS radiosondes (with a possibility to check the associated algorithms);

(d) To evaluate the quality and reliability of BQRSS, and to use this information to evaluate the quality of the working references for the radiosonde test;

(e) To recommend suitable HQOR systems to be used in the RBSN/RBCN and GUAN;

(f) To assess the magnitude of changes introduced by new radiosonde designs;

(g) To identify the best practices used in the preparation of HQOR radiosondes for launch;

(h) To evaluate the added value of using remote sensing equipment in radiosonde systems intercomparisons as recommended by ET-RSUT&T experts (following testbed evaluations);

(i) To evaluate the day-night differences of temperature, relative humidity of HQOR and BQRSS against available remote sensing observations; and to identify, as far as possible, the origins of differences;

(j) To publish the Executive Summary within three months, the draft Final Report within six months and the approved Final Report within nine months after the Intercomparison in the *WMO Instruments and Observing Methods Report* (IOM) series.

24. In addition to the general rules and procedures for WMO Intercomparisons as defined in the CIMO Guide, Part III, Chapter 5, Annex 5.A and 5.B, and Part I, Chapter 12, Annex 12.C, the ET/IOC agreed on all the rules and procedures for WMO-RSO-8 (see ET/IOC final report for details).

25. The ET/IOC agreed on the composition and duties of the Project Team (PT). The WMO-RSO-8 PT consists of: (a) Tim Oakley (UK), the project leader; (b) John Nash (UK, the radiosonde test expert; (c) Sergey Kurnosenko (USA), the data manager; (d) Gonzague Romanens (Switzerland), the data-processing expert for HQOR; (e) Holger Vömel (Germany), the data-processing expert for scientific sounding instruments; (f) Mark Smees (UK), data-processing expert

for the remote sensing instruments; and (f) LI Wei (China), local site manager and the focal point for the intercomparison, including support to the import of intercomparison systems and consumables. PT was responsible for preparing the intercomparison in liaison with the WMO Secretariat. It organized the conduct of the intercomparison and will perform the quality control of data and analysis of the results, and will prepare the Executive Summary, draft Final and Final Reports for consideration by the ET/IOC.

26. The following manufacturers have been accepted as participants in the WMO-RSO-8 with their operational quality radiosonde systems:

(a) GRAW with DFM-06 GPS radiosonde, (400-406 MHz);

(b) INTERMET with the iMet-1GPS radiosonde, (400-406 MHz);

(c) LOCKHEED MARTIN SIPPICAN INC with LMS6 GPS radiosonde, (400-406 MHz);

(d) MODEM with M2K2-DC GPS radiosonde, (400-406 MHz);

(e) MEISEI ELECTRONIC CO., LTD with RS-06G GPS Radiosonde, (400-406 MHz);

(f) METEOLABOR AG with SRS-C34, (400-406 MHz);

(g) VAISALA OYJ with RS92 SGP GPS radiosonde, (400-406 MHz);

(h) The Beijing Chanfeng Surface acoustic company with CF-06-A (400-406 MHz);

(i) The China national Huayun Technology Development Corporation with HY-1 (400-406 MHz);

(j) Nan Jing Da Qiao Machine Co., Ltd, GTS-2 (1680 MHz), on site operational radiosonde system;

(k) Jinyang industrial Co., Ltd with RSG-20A (400-406 MHz).

27. The following scientific sounding instruments were accepted to participate in the WMO-RSO-8 as potential candidates to be used in GRUAN stations:

(a) Cryogenic Frost-point Hygrometer, 2L(CFH(iMet)), (400-406 MHz);

(b) LOCKHEED MARTIN SIPPICAN INC with multi-thermistor radiosonde, P/N 1848-611 LMS6 (400-406 MHz);

(c) MEISEI ELECTRONIC CO., LTD with RS-06G(T), (400-406 MHz);

(d) VAISALA OYJ with RR01, (400-406 MHz).

28. In addition METEOLABOR SnowWhite, (400-406 MHz) will be used for reference purposes.

29. For the remote sensing instruments that may participate in the WMO-RSO-8 see paragraphs 56 and 57.

30. The ongoing collaboration with the Hydro-Meteorological Equipment Industry Association (HMEI) was continued and they provided invaluable support in liaising with the potential

radiosonde manufacturers with regards such topics as participation/qualification and extrabudgetary resources.

Activity report of the Expert Team on Remote Sensing Upper-air Technology and Techniques (ET-RSUAT&T)

31. The membership and terms of reference of the ET-RSUT&T is available at: http://www.wmo.int/pages/prog/www/CIMO/WorkingStructure/membership.html. One meeting of ET-RSUAT&T was held during the intersessional period in Geneva from 23 to 27 November 2009. All working documents are available at WMO Website: http://www.wmo.int/pages/prog/www/IMOP/meetings.html and the final report is available at: http://www.wmo.int/pages/prog/www/IMOP/reports.html. This meeting was organized jointly with the CBS Expert team on Surface-Based Remotely Observations (ET-SBRSO) to streamline the work of the two teams on similar issues while interfacing instrument and network issues. This joint effort was very productive and it should continue in the future.

32. ET-RSUT&T addressed issues related to wind turbines and their impact on weather radars. Wind turbines are tall structures with large propellers that reflect microwaves. They are deployed in localized networks and can be deployed as single or hundreds of turbines. There is generally no regulatory requirement for mutual sharing of unobstructed space with weather radars since they are similar to other structures. Therefore, over time, the mutual effective operation of wind turbines and weather radars could have significant impacts. They can impact weather radar data depending on their location and local terrain. Close to the radar, the individual turbines can create blockage (complete or partial) to completely obscure the weather or affect the Doppler measurements significantly by generating air motion within radar coverage. At very far distances, the wind turbines will not be seen as it will be beyond the line of sight of the radar. In between, the microwave signal will be scattered, reflected and create confounding false echoes. Significant progress was made on assessing the impact of wind turbines on weather radars and on developing relevant guidance material by the expert team. Once finalized, this guidance material will be included in the CIMO Guide so that WMO Members have necessary guidance when selecting sites for their weather radars. It was recognized that there is a need to raise the awareness of the environment agencies and wind industry companies on the impact that wind turbines can have on weather radar and inform them on CIMO and CBS guidance to ease negotiations between their authorities and NMHSs. It was also suggested to publish the location of weather radars to help the wind energy industry in the planning of future turbines to mitigate their impact on weather radars. The guidance on weather radar/wind turbine siting was prepared jointly with CBS ET-SBRSO (see: http://www.wmo.int/pages/prog/www/IMOP/reports/2009/Final%20Report%20ET-SBRSO%20and%20ET-RSUTT.pdf).

33. As regards the exchange of weather radar data and products, some application areas are becoming more demanding and will require access to more basic weather radar outputs, such as radial velocity and reflectivity. While an understanding of the different requirements of each application area has to be better understood, it was generally agreed that in the future raw data should be exchanged by Members, preferably in the form of radar reflectivity and radial winds. To manage these data volumes there would need to be some form of data reduction, probably at the regional level, with global exchange being delivered by Regional Data Centres. However, developing a common radar data format would be difficult and it would be more appropriate to look towards building a better understanding of the radar decoding software, metadata and uncertainty in measurement. Therefore, CIMO has to work towards a clear definition of required raw data to ensure a consistent level of national processing before data exchange. Preliminary discussion started within the expert team and it needs to be continued in the next intersessional period. There is an urgent need to develop a consistent and comprehensive set of quality descriptors associated with the data exchanged and a task team should be established to develop options for a set of

'standard' data quality descriptors for consideration by ET-RSUT&T. Weather radar manufacturers should be involved in addressing the above issues.

34. Widely used Radio Local Area Networks (RLANs) and Dynamic Frequency Selection (DFS) devices are likely to interfere with weather radars; therefore, the problem of protecting weather radars requires a global solution. Little consideration is placed to mobile applications - aircraft, trains, cars, buses, etc. Radar specifications should be provided to the telecommunication industry as future considerations must be carefully addressed, particularly following deployment when remedial solutions are not available. Cooperation and collaboration is encouraged between weather radar manufacturers and the telecommunication industry as it could provide considerable resources to investigate possible solutions with CIMO overseeing this process. A significant pressure is expected to be placed on the use of C-Band radars by the operators of unlicensed RLAN once the density of these system increases. Mitigation of the impact of DFS by RLANs on the primary user of this band, Meteorological C-band Radars, has not been effective in sufficient protection of C-band radars from the potential interface caused by RLANs. The clutter suppression tools currently available to NMHSs are not adequate in removing interference caused by RLANs. ET-RSUT&T, together with CBS, developed a draft Guidance Statement on Weather Radar/Radio Frequency Shared Spectrum that will be considered by CBS-Ext.(2010). (See: http://www.wmo.int/pages/prog/www/IMOP/reports/2009/Final%20Report%20ET-SBRSO%20and%20ET-RSUTT.pdf)

35. Remote-sensing observing systems cannot be compared directly to in-situ observations to assess their capabilities. These instruments have to go through a number of steps to provide the geophysical parameters of interest to users. Therefore, the calibration of remote-sensing systems is a challenge. For example, chains of processing steps are required to convert weather radar data to precipitation rate estimates. These include various steps, such as, ground clutter rejection, vertical profile corrections, target classification, and multi-radar merging algorithms. A need was recognized to intercompare weather radar algorithms in view of identifying the best quality control algorithms and to specify the quality of the radar products, such as Quantitative Precipitation Estimation (QPE). A series of steps to understand/quantify the performance of the algorithms used would be needed. Therefore, several intercomparison workshops were proposed to understand, evaluate and document the various quality control algorithms and adjustment algorithms for QPE. The first workshop would address the first two steps of the process - ground clutter removal and calibrating the reflectivity values.

36. A series of test cases with different types of ground clutter (urban, rural, mountain, anomalous propagation, sea clutter, etc.) were proposed to be collated as the test set: (i) without weather and only ground clutter; (ii) 24 hour datasets with widespread precipitation and ground clutter; (iii) simulation data sets where the ground clutter only data sets will be manipulated with known or simulated weather; and (iv) special cases. An ad hoc group of participants has been formed who will provide data sets or run their algorithms. The first workshop is planned for Exeter, UK in the spring of 2011; it will be by invitation only and limited to about 30 participants. Data sets have already been identified and will be collated and placed on a server at the Bureau of Meteorology (Australia). Decode software will be provided and/or the data will be converted to a single format (netCDF) if requested. Results would be required two months before the workshop so that they can be analyzed prior the workshop. Results of the intercomparisons (in an anonymous manner) will be presented at the workshop and participants will describe used algorithms. An International Organizing Committee will be set-up and will develop required rules and procedures for this intercomparison. This intercomparison should enable the provision of recommendations on how the weather data treatment should be done to obtain best results. The end goal of the overall project is to have comparable data from different radar manufacturers. The timeframe for the intercomparison would encompass the following milestones:

(a) Collection of the data (3-4 months, already started);

(b) Preparation of the data (3-4 months);

(c) Mid-term meeting (kick off meeting) for data analysis;

(d) Analysis of the data by the participants (4-5 months);

(e) Preparation of a summary of the participants results (2 months);

(f) Workshop to present results and agree on main conclusions/recommendations;

(g) Final report of the intercomparison (9 months).

37. A survey on weather radars had been prepared and distributed to WMO Members in August 2009 with a view to the development of a comprehensive web-based weather radar database. The replies to the questionnaire are very encouraging as approximately one third of the Members responded. The process of gathering replies from countries which have not responded to the questionnaire and those who improperly completed it is on-going, including information from other operators of weather radars, such as universities, airports, and TV stations. Mr Ecran Buyukbas and Mr Oguzhan Sireci (both Turkey) indicated that the Turkish Meteorological Service would be willing to develop and host the web-based weather radar database on behalf of WMO. Following unofficial consultations, a formal letter was sent by the WMO Secretariat to the Turkish Meteorological Service requesting confirmation to develop and host the web-based weather radar database on behalf of WMO. The WMO Secretariat formally requested the OPERA Programme Manager, Dr Asko Huuskonen, to make available all relevant information pertaining to the OPERA European meteorological radar network for inclusion into the WMO Weather Radars database. Response from the OPERA was positive and collaboration has started. The initial development of a database will be based on making available all information collected through the survey on Weather Radars and will make provision for WMO Members to make regular updates relevant to their national or regional weather radar systems through a web-based portal. The database should be easily expanded to include additional information that has not been captured by the survey or available on the OPERA database. The database would be accessible through the WMO Website. A project plan will be worked out for the development and implementation of the database.

38. Current and potential capabilities of wind profilers were assessed, especially for their use within WIGOS and with a view to developing guidance and standards on wind profiler siting, data exchange and operation. There are three main groups of wind profiler data available on the Global Telecommunication Network (GTS): (a) NOAA profiler network; (b) European wind profiler network; and (c) Japanese wind profiler network. The operational procedures of the Wind Profiler Network and Data Acquisition System (WINDAS) operated by the Japan Meteorological Agency (JMA) were recommended as a basis for the development of guidance and standards on wind profiler siting, data exchange and operation.

39. Wind profilers are affected by wind turbines and other moving objects in a manner similar to weather radars. In view of minimizing this impact, it was recommended that a guidance statement similar to the statement on the effect of weather radars be developed for wind profilers in the next intersessional period.

40. A requirement was recognized to reinvestigate the calibration techniques used, in particular, for the traceability of surface based remote sensing systems, such as wind profilers, to international standards, and linking wind profiler data uncertainty to that of radiosondes.

41. There is also an urgent need to develop, together with CBS, guidance material for the optimal distribution of wind profilers with respect to other systems. This issue will be brought to the attention of the CBS Expert Team on the Evolution of the GOS (ET-EGOS).

42. Following the publication of results of the LUAMI campaign (see paragraphs 18-20), lessons learned and the outcomes will be used to update or develop relevant guidelines for WMO Members.

43. Current and potential capabilities of other surface-based remote sensing systems, such as GPS, microwave and infrared radiometer and lidars, were assessed, especially for their use within WIGOS and with a view to developing guidance and standards on their siting, data exchange and operation.

44. In general, recent observing system developments are best characterized as incremental improvements in data acquisition techniques and data processing, assimilation, analysis and interpretation. A driving force for this comes from attempts to reconcile the results of field campaigns or intensive observing periods over the years at international facilities such as Lindenberg and the US Department of Energy Atmospheric Radiation Monitoring (ARM) Sites over the years.

45. These campaigns have resulted in a better understanding of the strengths and limitations of existing *in situ* and remote sensing observing systems. This in turn has helped to identify gaps in the current ability to describe and monitor the dominant atmospheric state variables (winds, temperature and moisture) in the upper atmosphere and propose ways to address them.

46. In the process, the atmospheric remote sensing community has gained a better appreciation for the need to integrate various observations that improve the ability to characterize and monitor changes in the characteristics of the upper atmosphere at high temporal and spatial resolutions. Another factor that compels to move in this direction is the understanding that improvements in weather prediction, building or extending long-term climate records, or verifying climate predictions, requires upper-air observations to meet the same standards of accuracy and homogeneity that have always been required of terrestrial observations. To accomplish this, there is focus on identifying and then implementing tools and techniques that allow to verify that remote sensing observations meet certain (yet to be determined) criteria that insure conformance and traceability to international measurement (SI) standards. To maximize the global impact of these tools and techniques on weather forecasting and climate monitoring/prediction, they must be readily implementable in the developing nations on an operational basis.

47. The ET-RSUT&T recommended to consider holding a workshop (in collaboration with the Satellite and GRUAN communities) to evaluate which remote sensing tools and techniques are likely to have success in tying upper-air observations to SI standards. The outputs of such a workshop could include: (a) a report with recommendations and supporting documents; (b) a plan on how to verify and implement proposed recommendations; and (c) a proposal to carry out international demonstration projects.

48. Significant work has to be done to provide appropriate guidance to Members on those new systems that are at the transition between research and operation. CIMO should aim at providing information on when new observing technologies are sufficiently developed and reliable so that they can be deployed on an operational basis and be of interest to NMHSs. Priority should be given to describing those systems that are most relevant to user requirements.

49. As far as guidance concerning the optimal distribution of the deployment of new observing systems and the best mix of instruments is concerned, it has been recognized that it is a very complex topic that depends strongly on the local situation and needs. This should be addressed by

making best use of the outcomes of the national testbed activities assessing the capabilities of remote-sensing upper-air technologies. In this regard, the draft Terms of Reference of a concept of CIMO testbeds was finalized for consideration by CIMO-XV (see agenda item 11).

50. A survey on lightning detection systems was conducted by Mr Dahoui (Morocco) with a view to evaluate operational aspects of current lightning detection systems. It aimed at reporting the strengths and weaknesses of existing systems, including coverage, accuracy, reliability and cost effectiveness. The results of this survey and subsequent analysis will be published as an IOM Report. The survey was undertaken as a preliminary step to the assessment of the need to carry out an intercomparison of lightning detection systems. This intercomparison would be a very complex project that would first require defining how to compare systems that have such different capabilities. ET-RSUT&T recognized that it would be timely to embark on such an intercomparison and recommended that WMO Members that have carried out intercomparisons publish their results. It was noted that some NMHSs may not, for legal reasons, be allowed to publish such results as the lightning data is frequently obtained from commercial providers. Members should be encouraged to exchange lightning data over the GTS to allow interested parties to intercompare them as appropriate. However, there is a need to provide guidance to Members on methods to evaluate the performances and intercompare lightning detection systems.

51. It was recognized that one of the reasons for the non-use of the lightning data is the misconception of its usefulness. It must be shown to WMO Members that each system contributes, but does not substitute, to other observing systems by filling identified gaps and compensating for weaknesses. The lightning detection systems help to add value to other observations by generating composite products from integrated networks that meet the end user requirements more effectively. For example, it should be demonstrated how the integration of weather radar data, lightning data and satellite data can improve the observing and forecasting capabilities of meteorological services.

52. ET-RSUT&T reviewed an updated version of the CIMO Guide Part II, Chapter 7 “Locating the source of atmospherics”, drafted by Prof. H.-D. Betz (see agenda item 7).

53. Mr Dirk Engelbart led the development of ISO standard on LIDARs. The team that produced this document encompasses experts from NMHSs as well as from the industry. It should be noted that the development of this standard was a task of the ET-RSUAT&T work plan and that large contributions of the work were provided by CIMO experts. This document is presently under voting in the committee stage of the ISO standard development process. ET-RSUAT&T reviewed the document and recognized that it was an excellent and thorough document though some small adjustments were still needed and comments were provided directly to the authors. It was noted that the contribution of Mr Dirk Engelbart and other WMO experts needed to be recognized and it was recommended that this document be further finalized as a common ISO/WMO standard. The WMO Secretariat was requested to approach ISO and follow-up on this proposal.

54. ET-RSUT&T reviewed the current status of, and perspective for microwave remote-sensing. It noted that though some meteorological services are in the process of setting up microwave radiometer networks, they are not readily used in an operational mode. Only the measurement of temperature with microwave radiometers can be considered as operational at present. CIMO should develop guidance material on the operational use of passive microwave profiling.

55. ET-RSUT&T reviewed a draft document describing the theory of estimating integrated (total atmospheric column) water vapour from Global Navigation Satellite System (GNSS) signal delays and retrieving geophysical parameters such as integrated (total atmospheric column) precipitable water vapour from them. This included suggestions for: (a) data exchange protocols for the ground-based GNSS observations themselves; (b) quantities estimated or derived from

them, such as tropospheric signal delay and integrated (total atmospheric column) water vapour; and (c) guidelines for the operational use of these data and products in numerical weather prediction and nowcasting derived from the experience of the E_GVAP programme within EUMETNET. The guidelines presented in this document reflect the current understanding of the processes and/or protocols used to make GNSS water vapour measurements, and should be further reviewed and revised by the expert team in the next intersessional period.

56. Regarding the Eighth WMO Intercomparison of High Quality Radiosonde Systems in Yangjiang, China, 12-31 July 2010, the ET-RSUT&T addressed the remote-sensing part of the intercomparison. China Meteorological Administration (CMA) conducted research on the remote-sensing equipments that CMA can offer to participate in the intercomparison. At a time, CMA was planning to provide six parts of observation equipments and they are as follow:

(a) Part I: Cloud-detection Radar;

(b) Part II: Ceilometers;

(c) Part III: Lidars;

(d) Part IV: Doppler Weather Radar;

(e) Part V: Mobile Boundary Layer Wind Profiler Radar;

(f) Part VI: All-sky imager.

57. By observing simultaneously with the six different equipments, it was hoped to obtain a variety of parameters, such as: cloud base height, multiple stratus structures, wind direction and speed (wind shear), vertical integrate liquid (VIL) in rain and water vapour phase etc. ET-RSUT&T agreed on the following recommendations regarding the use of remote-sensing instruments in the radiosonde intercomparison campaign:

(a) To provide vertical scanning of the cloud radar is key to understand the performance of the radiosondes;

(b) The use of a GPS antenna would be mandatory;

(c) The project team should aim at scheduling radiosonde flights at the time of overpasses of CLOUDSAT/CALYPSO (A-train);

(d) The use of a Chinese research aircraft with the capability to measure temperature, pressure, humidity and drop size imaging capabilities should be considered;

(e) To use of microwave radiometer for integral water vapour and integral liquid could be appropriate as liquid water cannot be seen by the radars that were presented;

(f) The work needed to evaluate the remote-sensing data should not be underestimated;

(g) The ground-based remote sensing systems should be set up mainly to help in the analysis of radiosonde systems;

(h) The CMA should take the responsibility for the management of the remote-sensing instruments provided by CMA and develop a database with their measurements that could be used for the analysis of the intercomparison and shared with people interested in analyzing this dataset together with the radiosonde measurements. Mr LI Bai volunteered to assume this responsibility.

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BACKGROUND INFORMATION ON CAPACITY BUILDING

REGIONAL INSTRUMENT CENTRES, QUALITY MANAGEMENT SYSTEMS AND COMMERCIAL INSTRUMENTS INITIATIVES

1. The Expert Team on Regional Instrument Centres, Quality Management Systems and Commercial Instruments Initiatives (ET-RICs) paid particular attention to issues related to strengthening the Quality Assurance of Regional Instrument Centres (RICs) and the determination of the traceability of surface-based measurements to the International System of Units (SI) standards.

2. ET-RIC developed and thoroughly tested the Evaluation Scheme for auditing of Regional Instrument Centres, which provides them with a means to check whether they meet the set requirements and help them to improve their capabilities. This Evaluation Scheme, in the form of an Excel sheet, was published as IOM-Report No. 103 (WMO/TD-No. 1545) and is available on the WMO Website. It is mainly based on the Terms of Reference of RICs and on ISO 17025 “General requirements for the competence of testing and calibration laboratories”. The Evaluation Scheme is based on a checklist and a set of targeted questions. Questions are associated with an explanation comment to help navigate the user and to explain how to further improve RIC capabilities. ET-RIC agreed that this checklist was extremely valuable to improve the capabilities of RICs, but could also be used by any NMHSs Calibration Laboratory for the evaluation of their capabilities according to CIMO requirements. ET-RIC recognized that this is a valuable tool to help RICs or NMHSs that decided to implement a quality assurance process and/or wanted to prepare themselves for certification/accreditation. ET-RIC recommended that all RICs provide the results of their evaluations to the WMO Secretariat. Regional associations should be aware of the existence of this evaluation scheme and should request to use it for the regular evaluation of the RICs under their responsibility. EC-LXII welcomed this development and recommended to Members with RICs to ensure they use the evaluation scheme to check and possibly improve RICs’ capabilities to provide required services to Members of the Region.

3. ET-RIC noted that capabilities of metrology laboratories, such as RICs, can be demonstrated and tested through a range of intercomparisons between laboratories and the results of such intercomparisons presented at CIMO Technical Conferences. ET-RIC recommended that these results also be published on the WMO and RICs Websites to provide evidence of their capabilities to users. In this regard, ET-RIC considered the need to develop a detailed set of procedures for metrology laboratory intercomparisons and agreed that detailed procedures were not needed. As a minimum requirement these intercomparison should consists of the publication of the intercomparison results between the different metrology laboratories and included the calibration values and associated uncertainties for each parameter tested.

4. In view of strengthening the instrument calibration and measurement traceability, in particular for the services provided by RICs, it is important to ensure that appropriate procedures are being used to calculate the uncertainties of the calibrations performed. In spite of the guidance available in the CIMO Guide, and reference therein, on this subject, the proper computation of calibration uncertainties remains a challenge for many calibration laboratories, including RICs. Therefore, ET-RIC proposed to develop a new approach to provide support in the development of quality procedures addressing instrument calibration, in particular uncertainty calculations as a future activity. This gives not only very important information to the user of the instrument, but is also of paramount importance to ensure that the outcomes of laboratory intercomparisons are meaningful. ET-RIC therefore proposed to consider organizing a workshop on the subject in collaboration with regional associations, depending on their needs. The aim of the workshop would

be to support RICs in estimating the uncertainty components and in computing the overall uncertainty budget for the calibrations they perform.

5. The analysis of the Survey on Calibration and Maintenance carried out in 2006 showed that most NMHSs carry out the maintenance of their instruments themselves but also that the traceability of their reference instruments to international standards was not established in many cases. ET-RIC was concerned by this lack of traceability and suggested that more information regarding traceability and applied quality procedures be made available from RICs. It was recommended that RICs develop websites to improve communication with the Members of their Region and to sensitize them to the importance of instrument traceability.

6. The use of traveling standards was recommended for those NMHSs that do not have a calibration laboratory so that they can perform at least verifications/adjustments on the site and to regularly ensure the traceability of their instruments to a RIC.

7. The participants of the Training Workshop on Metrology held in Casablanca, Morocco, 2009, highlighted the difficulties for developing countries to maintain old conception instruments such as thermographs or hygrographs. Some spare parts, such as graph paper for these kinds of instruments, are becoming more and more difficult to obtain. Those mechanical instruments are also difficult to maintain in harsh climate conditions. Mercury, a poisonous substance, is included in instruments such as barometers and thermometers. ET-RIC recalled the need for new, simple and cheap instruments and associated calibration facilities to replace health hazardous instruments, and obsolete instrumentation still used in numerous NMHSs of developing countries. There is a need that RICs are regularly informed on new instrumentation, sensors, systems, software and services that are available for calibration activities and encouraged manufacturers and instruments providers' to assist developing and least developed countries in organizing training events and in ensuring traceability to SI.

8. To ensure traceability of measurements to international standards, NMHSs need guidance on how to set-up or update their Calibration Laboratories as well as guidance and recommendations on the type of instruments required for ensuring traceability to SI. ET-RIC developed a document on "Guidance on instrumentation for calibration laboratories, including RICs". This document provides generic recommendations to WMO Members (not only RICs) that address the matter of the instrumentation needed by calibration laboratories to perform their duties and describes technologies and instruments suitable for these purposes. It also provides information on the whole traceability chain and presents instruments that can be used from the best uncertainty level to the uncertainty level in field conditions. ET-RIC agreed that this document provided the needed guidance and a clear and valuable description of the instrumentation. This document was published as an IOM-report No. 101 (WMO/TD-No. 1543) and is available on the WMO Website.

9. On behalf of the president of CIMO, the ET-RIC chairman attended the 2010 Informal Meeting of Presidents of Technical Commissions' (PTC) representatives on the subject of Uncertainty Analysis in Geneva from 28 to 30 January 2010. PTC representatives recognized that uncertainty is estimated and expressed in different ways by the various WMO communities and agreed that it was worth exploring the possibility of adopting a common framework for estimating and expressing Uncertainty Analysis within WMO Programmes. The meeting also recommended to adopt the principles as expressed in the Guide to the expression of Uncertainty in Measurement (GUM, 1995) and suggested to develop a demonstration project which comprises the estimation of uncertainties and their propagation from measurements to data assimilation to numerical simulation models.

CAPACITY BUILDING AND TRAINING ACTIVITIES

10. The Turkish State Meteorological Service (TSMS) and its RMTC Alanya, in coordination with Mr Ercan Büyükbas, the Co-Rapporteur on Training Activities and Training Materials (R-TA&TM), conducted trainings seminars on weather radars on an almost yearly basis (June 2007; October 2008 and May 2010). Forty-four people coming from different countries of RA I, RA II and RA VI were trained. The associated training material published as the IOM Report No. 88 (WMO/TD-No. 1308) will be updated at the end of this year to incorporate new developments in this area. RMTC Alanya applied new training methods as a lecture was given through a video-web conference by Dr Paul JOE, research scientist with the Meteorological Service of Canada and member of OPAG-UA, during the 2008 session. This contribution increased the training level and was welcomed and appreciated by all participants.

11. In coordination with R-TA&T, the Turkish RMTC of Alanya, conducted two sessions of the training on upper-air observing systems (October 2008 and April 2010) welcoming 28 trainees in total. To improve lectures and practical experiments, the second session was conducted in collaboration with specialists from HMEI.

12. A training course on “basic operation of weather radar and use of radar products” was conducted at Hong Kong, China between 30 November and 4 December 2009 for 10 participants from 10 countries. Details can be found at: http://www.hko.gov.hk/. Two WMO Training Courses on “Radar and Satellite Meteorology” were held at the RMTC at Nanjing, China respectively in April 2007 and in September 2008.

13. A WMO Training Workshop on the GCOS Upper-Air Network (GUAN) upper-air observations for RA I (Africa) was held in Windhoek, Namibia in October 2007 in collaboration with CIMO. Eighteen participants from 17 NMHSs took part in the training that included theoretical and practical parts. The topics addressed covered radiosonde sensors, sounding systems and operational procedures. The UK provided three well-known and experienced lecturers. HMEI collaboration was also very beneficial for practical exercises.

14. A training workshop on GUAN upper-air observations for RA II (Asia) was scheduled to be held in New Delhi, India in 2009. This training event finally had to be canceled, due to the lack of participants registered for the workshop.

15. A Training Workshop on Metrology was held in Casablanca, Morocco, from 31 November to 3 December 2009 and gathered 19 participants coming for the Western and Central RA I French-speaking countries. Among the four lecturers, two came from National Metrological Institutes (France and Morocco) and two from Regional Instrument Centers (France and Morocco). The basic principles for calibration dealing with the basic parameters of ground-based observations (pressure, temperature and humidity) were presented. Both theoretical and practical parts were provided.

16. A training course on automatic weather stations was held in Hong Kong, China from 26 to 30 November 2007, for 9 participants from 9 countries. Additional information can be found under: http://www.weather.gov.hk/wxinfo/news/2007/pre1129e.htm

17. Training courses on automated weather observing systems (AWOS) were organized in November 2008 and in June 2009 by RTC Alanya in Turkey. Twenty-nine participants from 19 different countries took part in these courses.

18. The training material used during former workshops on instruments and calibration methods held in Japan is presently being updated. ET-RIC agreed that this material should be promoted and published as an IOM report after a full revision and validation of the update by ET-RIC.

19. Hong Kong, China will organize a training course on automated weather station (AWOS) network from 29 November to 3 December 2010. It is expected that about 10 participants from around the world will attend the course.

20. The Turkish State Meteorological Service intends to continue its training programme in close cooperation with WMO and to keep on supporting the training activities on observing systems as well as the other WMO activities. TSMS has been collaborating closely with WMO and other experts to organize those courses. Its training courses have become regular and are receiving increased interest (http://rtc.dmi.gov.tr/).

21. R-TA&TM noted the difficulties of collecting information on training organized in the regional associations and not reported by Members, and suggested that training activities should be reported through a dedicated WMO/CIMO web page.

TECO and METEOREX

22. The WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation (TECO-2008) and the Exhibition on Meteorological Instruments, Related Equipment and Services (METEOREX-2008) were hosted by the Russian Federation's Federal Service for Hydrometeorology and Environmental Monitoring (ROSHYDROMET) in St Petersburg (Russian Federation), from 27 to 29 November 2008. The subject theme, to promote and facilitate international standardization and compatibility of meteorological observing systems used by Members within the WMO Global Observing System to improve quality of products and services of Members', was discussed by 240 experts coming from 56 countries. One hundred and sixty-two papers and posters were presented and published as IOM Report No. 96, WMO/TD-No. 1462. METEOREX-2008 was held in conjunction to TECO and attracted over than 100 manufacturers that displayed their latest products and presented their future developments. The participants recognized that these forums offer excellent opportunities to exchange experience and knowledge between the experts of Meteorological Services and the representatives of the private instrument sector.

23. At the kind invitation of the Finnish Meteorological Institute, TECO-2010 was held in Helsinki, Finland, from 30 August to 1 September 2010 in conjunction with the Exhibition of Meteorological Instruments, Related Equipment and Services (METEOREX-2010). One hundred and sixty-one papers were announced for oral and poster presentations on the subject theme of "Observing Technologies and Systems in support of Evolving Demands on Weather, Climate and Water Services" to about 250 participants, and will be published as an IOM Report.

Instruments and Observing Methods (IOM) Reports

24. Efforts were made in producing IOM Reports covering various subjects dealing with instruments and methods of observation. Nine IOM Reports were published since the CIMO-XIV. All are available and downloadable from the WMO/CIMO Website at:
http://www.wmo.int/pages/prog/www/IMOP/publications-IOM-series.html

EDUCATION AND TRAINING REQUIREMENTS

BACKGROUND INFORMATION

1. The Commission noted the decision of EC-LXII to replace WMO Publication No. 258 "Guidelines to the Education and Training of Personnel in Meteorology and Operational Hydrology. Volume I: Meteorology" with a series of new publications. Two of this new series would be overseen by the EC Panel of Experts on Education and Training (EC Panel) whilst the remaining volumes in the series would be overseen by the technical commissions as they developed competencies and education and training requirements for personnel undertaking tasks in their areas of interest.

2. EC-LXII stated that these education and training requirements should appear in publications produced and maintained by the Commissions. The Commission noted that the EC Panel are in the process of producing the first of the new publications which will cover classifications and qualifications of meteorological personnel. This publication is due to be presented to Congress in 2011. The classification scheme will not change from the current one with meteorological personnel classified as either Meteorologists or Meteorological Technicians. The qualifications for both groups will be amended from those outlined in the current (4th) edition of WMO Publication No. 258 and will focus only on the qualifications required to be recognized as a WMO Meteorologist or as a WMO Meteorological Technician.

3. In most cases holding a WMO Meteorologist or WMO Meteorological Technician qualification will be a necessary condition for someone to work as a meteorological specialist within an NMHS. However it will probably not be a sufficient condition as in both cases further specialized education and training would be required for someone to be competent to undertake the tasks required for performing observations, maintaining or calibrating equipment, providing briefing material to many user groups, collecting and quality controlling data, producing forecasts and warnings, undertaking research etc. It is the specification of this additional education and training requirements that EC has delegated to the technical commissions. The Commissions for Aeronautical Meteorology, Hydrology, Climate and Agricultural Meteorology already have members working on these topics as part of Expert Teams or OPAGs. The Annex is an example of the top level competencies recently approved by EC-LXII for personnel in Aeronautical Meteorology.

4. In the context of WIGOS and Quality Management the Commission is expected to support these developments that would ensure that personnel performing tasks such as making meteorological observations, calibrating or maintaining equipment would have the appropriate skills, knowledge and behaviours to do the tasks to the level outlined in the Commission's Guides. There is a distinction between the use of qualifications for determining personnel classification and competencies for determining what tasks a person undertook. This was emphasized by members who had personnel classified as Meteorologists performing meteorological observations who were not Meteorological Technicians. If the task of performing meteorological observations was only to be undertaken by Meteorological Technicians this would not be possible. As the personnel were trained for the meteorological observing tasks they were performing it was consistent with the approach being developed by the EC Panel. Noting the importance of subject matter experts defining the competencies and education and training material the Commission is invited to include this as a task to be undertaken during the intersessional period.

ANNEX

Top level competencies approved by EC-LXII

Aeronautical Meteorological Observer

An **Aeronautical Meteorological Observer** shall,

A. For the area and airspace of responsibility,

B. In consideration of the impact of meteorological phenomena and parameters on aviation operations, and

C. In compliance with aviation user requirements, international regulations, local procedures and priorities,

be able to:

1. Monitor continuously the weather situation;

2. Observe and record aeronautical meteorological phenomena and parameters;

3. Ensure the quality of performance of systems and meteorological information; and

4. Communicate meteorological information to internal and external users.

The CAeM Expert Team on Education and Training are developing the second level competencies which will be used during the competency assessment process. It is expected that at least the first two of these competencies would be in common with those to be developed by CIMO and that there is need for a consistency of approach and collaboration in defining these and linking them with the CIMO Guide to Meteorological Instruments and Methods of Observation.

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THE GUIDE TO METEOROLOGICAL INSTRUMENTS AND METHODS OF OBSERVATION

BACKGROUND INFORMATION

1. The main task of the Rapporteur on the CIMO Guide was to compile and coordinate proposals for modification of the WMO *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) (CIMO Guide).

2. The former Rapporteur on the CIMO Guide, Dr Igor Zahumensky had to resign from his position due to a change in his professional position. He was replaced in his function of Rapporteur by Mr Krunoslav Premec (Croatia) following his nomination by the CIMO Management Group.

3. The Seventh Edition of the CIMO Guide was published in English in 2008 and is available on the WMO Website: http://www.wmo.int/pages/prog/www/IMOP/IMOP-home.html. The translation of the Seventh Edition could not be performed to date for budgetary reasons. EC-LXII expressed concern that translation of the CIMO Guide into the required WMO languages was not secured and questioned whether this may affect the quality of some observations including those for climate and DRR. EC-LXII also recognized that degraded quality of observations could reduce some expected benefits of WIGOS.

4. In the process of revising some chapters of the CIMO Guide, the CIMO Expert Team on Surface Technology and Measurement Techniques (ET-ST&MT) agreed that in view of giving guidance to Members on the most suitable technology to use, the CIMO Guide should give the most appropriate technology in the first place and that all technologies that are still being used by Members should be kept in the Guide, even if they are not manufactured anymore.

5. Presently some chapters of the CIMO Guide are under major revision. These include Part II, Chapter 7 “Locating the Source of Atmospherics” and Part II, Chapter 8 “Satellite observations” that had not been revised for the Seventh Edition of the Guide. Part II, Chapter 9 “Radar Measurements” is also being fully revised to account for the important change in technology that took place in this field. It is expected that these chapters will be available for review by CIMO in late 2010 or 2011.

6. ET-ST&MT proposed changes to the table on Operational Uncertainty Requirements and Instrument Performance that is published in the Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8, Part I, Chapter 1, Annex 1B) which combines the requirements of all WMO Programmes. It is the basic table summarizing the WMO instrumental requirements and serves as a base for many meteorological services for stating their requirements when preparing tenders and to evaluate bids. It is therefore of utmost importance that the table be up-to-date, clear and easily understandable. ET-ST&MT felt that adding too much information in the table may render it more difficult to understand and reduce its use. A full revision of this table should be considered to ensure it appropriately covers the requirements of WIGOS.

7. The CIMO Guide is a critical source of information for NMHSs. It has to be constantly maintained up-to-date, covering also new operational observing systems. Keeping the guide up-to-date, reviewing the proposals for changes from a scientific perspective, as well as taking into account the uniformity in the presentation of the CIMO Guide requires a major amount of work. To ensure that the quality of the information provided in the CIMO Guide be maintained and that the updates could be made available in a timely manner, the Management Group proposed to establish a “CIMO Guide Editorial Board” and recognized that the work load expected from this Editorial Board would likely be much larger than the workload of experts in other expert teams, unless additional consultants were employed to collaborate closely with the CIMO Guide Editorial

Board for the timely publication of this material. As the relevant outcomes of the work of CIMO ETs have to be published in the CIMO Guide, it is crucial that ET chairs ensure that the material prepared by their ET is provided in an appropriate form to be published in the CIMO Guide and closely collaborate with the Editorial board to organize their publication.

8. In the context of its JCOMM pilot project for WIGOS, the JCOMM Ship Observation Team reviewed the CIMO Guide chapter on Marine Observations. An attempt was made to have these proposals reviewed by WMO Members mid-2009 in view of publishing a first supplement of the Guide in the intersessional period. As a number of comments were received in response to this proposal, further work was done on the corresponding chapter.

9. Most proposals for updates or amendments received for the CIMO Guide – from Expert Teams, Working Groups and/or Panels of both the Commission for Instruments and Methods of Observation (CIMO); and the Joint Commission for Oceanography and Marine Meteorology (JCOMM) – were compiled into the Draft First Supplement to the Seventh Edition of the CIMO Guide. This supplement was posted on the WMO Website on 21 June 2010 and Members were invited to review the proposed changes. It is expected that in the absence of major objections this Final Draft of the First Supplement to the Seventh Edition of the CIMO Guide will be approved by the Commission. Furthermore, in the expectation that CIMO-XV would concur with the establishment of a CIMO Guide Editorial Board, controversial issues and major updates were not included in this supplement, but were kept for a detailed examination by the CIMO Guide Editorial Board, prior to their later submission for approval by the Commission.

10. The CIMO Guide is presently providing recommendations to Members, but has no binding authority. In view of achieving homogeneity and comparability of measurements, the non-controversial parts of the CIMO Guide should be upgraded to the level of standards. Therefore, the Management Group was of the opinion that CIMO should consider developing a CIMO Manual. EC-LXI agreed with this proposal and requested CIMO to proceed with the development of a Manual on Meteorological Instruments and Methods of Observation that would be an Annex to the WMO Technical Regulations, in collaboration with the relevant technical commissions as needed. The Council recommended that the development of the Manual takes into account aspects, such as the interoperability of different observing systems, and the aims of reporting observational variables in physical units that are independent of the technology used in making the observations.

11. EC-LXVII agreed that the revised structure of WMO Technical Regulations must document the structure and requirements of WIGOS operations, adequately reflecting contributions of all component systems. It agreed that upon the approval by Cg-XVI, the WIGOS Implementation Plan should include the development of a Manual on WIGOS as a priority activity. CIMO should be prepared to integrate WIGOS activities within work programmes of relevant expert teams and participate in the development of the WIGOS Manual. Also, CIMO will have to take into account the development of the WIGOS Manual in developing the concept for the CIMO Manual.

12. WMO technical documents, guides and manuals provide a very large amount of standards, best practices and guidelines to members that were elaborated by numerous WMO Technical Commissions and relevant partners. However, these documents are sometimes overlapping, insufficiently harmonized and difficult to find and access, which affects data quality and system interoperability. To overcome these problems, the concept of a web-based, user-friendly direct access tool to the CIMO Guide and other related WMO documents was proposed.

13. This new approach provides a comprehensive, coordinated, standardized information framework related to the operation of observing systems and would lead to an enhanced availability and integration of the data and products satisfying the requirements of the users' community. It is based on the recognition that most needed standards are already available, but that they are disseminated and their access is difficult. A demonstration of such a web based

search engine applied on the CIMO Guide was presented to the Management Group. The Management Group agreed that such a tool was strongly needed from the user-community and recommended that ways to finance this project be sought as it would provide an essential contribution to WIGOS. Indeed, the benefits that can be expected from WIGOS will never be achieved if the access to the relevant information is not easy.

BACKGROUND INFORMATION

WMO PRIORITY ACTIVITIES

1. In considering the development and implementation plan for the WIGOS as a high priority endeavour, Cg-XV had recommended to carry out a number of pilot projects to test the concepts. One of these proposals was the CIMO Pilot Project for WIGOS, "Elaborating the underpinning/cross-cutting role and responsibilities of the Instruments and Methods of Observation Programme".

2. A task team was established by the president of CIMO to carry out this project. The first phase of this project consisted in elaborating the role and responsibilities of CIMO within WIGOS through the revision of the Terms of Reference of CIMO. In this process, the other technical commissions, as well as other WIGOS Pilot Projects were consulted on the proposal developed by the task team. As WIGOS is not an individual system, but a framework of observing systems, it was recognized that there was a need to enhance communication and collaboration with other technical commissions and relevant WMO partner organizations that co-sponsor, own and/or operate some of the observing systems. These consultations were carried out by the president of CIMO Dr John Nash, and by the former vice-president of CIMO, Mr Rainer Dombrovsky. Each of the projects responded with interest and indicated some areas of desired collaboration. The Management Group, at its seventh session (15-19 February 2010) agreed with the version of revised Terms of Reference for CIMO developed by the task team.

3. WIGOS's expectations from CIMO are very high, as the first area of WIGOS standardization addresses instruments and methods of observation, while the third area addresses quality assurance, which are both relevant to CIMO. As CIMO's resources would not allow addressing everything at once, the CIMO Management Group was of the opinion that CIMO should concentrate on activities on which it could be most effective and strengthen collaboration with other TCs. CIMO's work plan would have to be established and tasks prioritized to provide the best possible support to WIGOS's implementation. Furthermore, the Management Group felt CIMO should concentrate on technical work (such as standards) rather than on the development of the managerial aspects of WIGOS, which are more relevant to TCs involved in network management.

4. Many of the major new challenges faced by WMO require that the technical commissions work more actively with one another to address issues in a cross-cutting fashion and support the new emerging issues of the Organization. Therefore, at the Meeting of the Presidents of Technical Commissions (PTC), the presidents were tasked to review the Terms of Reference (ToRs) of their Commissions in view of best supporting the major goals of the Organization. The individual ToRs of the technical commissions would not refer directly to the specific Expected Results of the Organization, however the general ToRs applying to all Commissions would refer in a general manner to the strategic planning of the Organization.

5. With a view to providing the most relevant support to the Organization in addressing WMO's high priority areas, i.e., WIGOS, GFCS, DRR and Capacity Building, and to improve its efficiency and effectiveness, the CIMO Management Group recognized the need to review the working structure of CIMO to improve its responsiveness to the WMO high priorities. Therefore, a new structure of CIMO is presented for consideration by the session under agenda item 11 to complement the proposed ToRs.

6. EC-LXII agreed that WMO priority areas should be the Global Framework for Climate Services (GFCS), Capacity Building, WMO Integrated Observations and Information Systems, Disaster Risk Reduction, and Aviation Meteorology.

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BACKGROUND INFORMATION

CIMO VISION

1. CIMO needs to adapt to the changing realities in which it is carrying out its work so as to provide the guidance that is expected from it in the most appropriate and effective manner. These changing realities include the evolving requirements of WMO priority initiatives (GFCS, WIGOS&WIS, capacity building, DRR and aviation meteorology), the development of new technologies and observing techniques that impact observing systems, and also the evolving context in which experts are working.

2. The need for standardization and guidance on instruments and methods of observation remain of key importance for WMO and NMHSs activities and services to ensure that they are based on quality observations and that they meet users requirements. The new instrumentation and techniques that are becoming available require significant testing before they can be used operationally in observing networks and represent significant investments. To provide the guidance on such techniques making best use of resources, CIMO has to rely on the tests that are being carried out at national level and draw guidance from their results. As CIMO is relying on the work of experts from NMHSs and related institutions to achieve its goals, it is crucial that Members and experts are aware of CIMO's aims to engage in and provide support to its activities.

3. In this context, the CIMO Management Group decided to develop a vision statement for CIMO. This statement would help to inform Members of CIMO's role in supporting priority activities of WMO, such as WIGOS, GFCS and DRR, to clarify how CIMO expects to meet its goals and also to motivate and stimulate experts in participating in the activities of CIMO. It could also be used to raise support for CIMO activities.

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OVERVIEW OF DECISIONS OF Cg, EC and TCs ON STRATEGIC PLANNING

BACKGROUND INFORMATION

1. The Fifteenth World Meteorological Congress (Cg-XV) approved a new framework for the Results-based Management (RBM) of the Organization. The approval of the RBM approach included the implementation from 2008 of the Strategic Plan that defined three Top Level Objectives, five Strategic Thrusts and eleven Organization-wide Expected Results. The Operating Plan and the Results-based Budget for the period 2008-2011 direct the programmatic implementation activities of the Organization.

2. Cg-XV, through Resolution 27 (Cg-XV) on the WMO Strategic Plan, requested the technical commissions to adhere to the direction and priorities set forth in the Strategic Plan and to organize their programme structures and activities so as to pursue the top-level objectives and to achieve the Expected Results.

3. The sixtieth session of the Executive Council (EC-LX, June 2008) requested that within the WMO strategic planning process, each technical commission should prepare a note on lessons learned, experiences gained and prospective challenges in the course of the implementation of the current WMO Strategic Plan, which would be used in the preparation of the next Plan. It agreed that technical commissions should develop Operating Plans for 2012–2015 based on the experience gained through the development of the Operating Plan for the fifteenth financial period.

4. The sixty-first session of the Executive Council (EC-LXI, June 2009) noted that the presidents of technical commissions (PTCs) had held extensive discussions on RBM and actions towards the improvement of the efficiency and effectiveness of the Commissions and aligning activities to the WMO Strategic Plan during their meeting held in Geneva, Switzerland from 2 to 4 February 2009. It noted that the PTC recognizes the cross-cutting nature and the principal and important role of the WMO Programmes. It noted with satisfaction the suggestions given by PTC for consideration by the Executive Council Working Group on Strategic and Operational Planning (EC WG/SOP) indicating the need for further exploring the outlined concept, which suggested alternatives for conducting technical commission meetings.

5. The Commission for Instruments and Methods of Observations (CIMO) at its fourteenth session (December, 2006) requested its Management Group to develop its strategic plan, based on the WMO Strategic Plan 2008-2011, in which it would identify CIMO's own Key Performance Targets (KPTs) in support of the overall WMO KPTs identified for each Expected Result. The Commission had requested that the KPTs should be specific, measurable, achievable, relevant, and timebound.

6. The presidents of technical commissions, at their meeting in January 2010 in Geneva, made the following recommendations involving the PTCs and the Secretariat:

- **PTC Actions**

(a) The SP document should be short and concise;

(b) The SP should provide the direction and focus for the activities of the Members and the technical commissions (TCs);

(c) WMO should advocate for one stable WMO SP and relevant groups should establish operating plans for implementation;

(d) The presidents of technical commissions and regional associations will develop their operating plans based on the draft WMO SP for 2012-2015; and

(e) The operating plans of TCs and RAs may include activities that do not need financial support from the Secretariat but contribute to the achievement of Expected Results.

- **Secretariat Actions**

(a) The relationships and specific roles of TCs and RAs should be made clearer in the SP;

(b) The contributions from partners to the achievement of ERs should be highlighted in the OPs; and

(c) The Secretariat should provide presidents of TCs and RAs with a template to guide the development of their specific operating plans.

The CIMO Management Group, at the meeting held February 2010 in Geneva, was informed of the progress in the development of the WMO Strategic Plan and Operating Plan for 2012-2015. The Management Group was provided with a template to guide the preparation of Operating Plans.

WMO STRATEGIC AND OPERATING PLANS (2012-2015)

WMO Strategic Plan 2012-2015

7. EC-LXI considered and agreed to endorse the following recommendations put forth by its working group concerning the WMO Strategic Plan for the period 2012-2015:

(a) To develop a Strategic Plan and Operating Plan that is concise and that can be easily understood by different audiences including decision-makers;

(b) To base the strategic direction of the Organization on Global Societal Needs (GSN) namely improved protection of life and property (from impacts of hazardous weather, climate, water and other environmental events) and increased safety of transport on land, at sea and in the air; poverty alleviation, sustained livelihoods and economic growth (in connection with the Millennium Development Goals) including improved health and social well-being of citizens (related to weather, climate, water and environmental events and influence); and sustainable use of natural resources and improved environmental quality. In connection with these GSNs, the strengths of WMO and its unique contribution should be portrayed with a view to distinguish WMO clearly from other international organizations that also deal with such, or similar, GSNs in their strategic planning and programme delivery. A brief description of WMO's major achievements illustrated by informative statistics, tables and graphics, should be used to underpin the unique competencies and contribution of the Organization;

(c) To describe what stakeholders outside WMO expect from the Organization in the medium and longer term, as well as the strategic priority areas the Organization defines for its Programmes with a view to optimize the effectiveness of its performance in responding to the GSN with limited resources;

(d) To use the "results chain", i.e. Strategic Thrusts (ST) -> Expected Results (ER) -> Key Outcomes (KO) -> Deliverables -> Activities, as the structure of the strategic planning process. STs and ERs (and corresponding performance metrics) would be the backbone structure of the SP, and the ERs further detailed by the corresponding programme-based KOs (with performance metrics) and Deliverables should form the substance of the OP;

(e) The framework of the next SP should consist of the five Strategic Thrusts (ST) and eight organization-wide Expected Results (ER) as indicated in the report of the EC-LXI (see framework on page 6);

(f) To develop a focused set of limited Key Performance Indicators highlighting the added value of the services rendered by the Organization to its Members. The Key Performance Indicators should remain stable and be measurable over the longer term enabling the monitoring and performance evaluation process;

(g) To involve the regional associations and the technical commissions in the development of Expected Results and Key Performance Indicators, Key Outcomes and a manageable number of related performance measurement parameters and to ensure that those are based on Members' needs and adequately reflect the programme areas of the Organization. Such involvement would also facilitate the establishment of baselines and realistic target setting.

WMO Operating Plan 2012–2015

8. As concerns the WMO Operating Plan 2012–2015, EC-LXI considered and agreed to endorse the following recommendations put forth by its working group:

(a) In view of the Cg and EC requests to develop the Operating Plan on an Organization-wide basis, to invite the involvement of technical commissions and regional associations from the outset of the strategic planning process;

(b) To develop the KOs in an active coordination process involving EC, RAs, TCs and the Secretariat in a form that relates to the WMO Programmes and provides the basis for the necessary programme activities, the budget planning and the resulting budget proposal;

(c) In the course of that process to identify and benefit from cross-programme synergies between the technical commissions and regional associations so as to obtain effective and optimized programme implementation plans;

(d) To identify and describe in the WMO Operating Plan the roles and responsibilities of constituent bodies.

MONITORING AND EVALUATION

9. EC-LXI endorsed the report of its Working Group on WMO Strategic and Operational Planning (Geneva, 16–18 March 2009) on matters related to the WMO Monitoring and Evaluation (M&E) Plan. The Plan outlines the main features of the system, the involvement of the WMO constituent bodies in the M&E process, and a phased implementation approach. The Council also noted that it was based on the findings of a cost-benefit analysis and M&E experiences reported by several NMHSs. The Council stressed the importance of the WMO M&E System for a successful implementation of RBM at WMO and endorsed the following recommendations of its WG/SOP:

(a) The WMO M&E Plan should be used as the action plan for the development and implementation of the WMO M&E System, including a Preparatory Phase (2009), a M&E Pilot Phase (2010–2011) and the full M&E System (as of 2012), with reporting by the Secretary-General to EC on progress made;

(b) Selection of Expected Result 5 and Expected Result 8 for the Pilot Phase (2010–2011).

10. Specifically, the Council requested the technical commissions and regional associations to contribute to the M&E process through collecting and assessing monitoring and performance information related to programmes under their technical responsibility.

11. The Council requested that an evaluation of the Pilot Phase be conducted and submitted to Cg-XVI. In this context, the Council noted that the Secretariat had already developed the M&E framework for Expected Result 5, which would be used in the Pilot Phase. It reiterated the need for a cost prudent approach for the implementation of the M&E System and requested that the evaluation of the Pilots include a realistic assessment of the costs and workload for the Full Implementation Phase of the System.

PROGRESS IN THE DEVELOPMENT OF WMO STRATEGIC AND OPERATING PLANS (2012-2015)

WMO Strategic Plan 2012-2015

12. The structure of WMO Strategic Plan (SP) 2012-2015 has been based on the recommendations of PTC and EC WG/SOP endorsed by the EC-LXI as listed above.

13. The Expected Results (ERs), Key Outcomes (KOs) and the associated Key Performance Indicators (KPI) for each result were developed through consultations with all Departments at the Secretariat with input from regional associations (RAs) and technical commissions (TCs).

14. The draft SP was shared with RAs, TCs and management groups to establish the adequacy of representation of their respective areas of interest and for them to make proposals for improvement.

15. Every effort is made to improve the description of KOs and KPIs to facilitate assessment of performance in the achievement of results.

16. The inputs received were integrated into the draft document.

17. The sixty-second session of the Executive Council (Geneva, 8-18 June 2010) decided to recommend the draft Strategic Plan 2012-2015 with minor editorial amendments to the Congress for approval.

WMO Operating Plan 2012-2015

18. The structure of the WMO Operating Plan (OP) 2012-2015 has been based on the recommendations of PTC and EC WG/SOP endorsed by the EC-LXI as listed above.

19. The KOs, KPI, KPT, activities and deliverables form the key elements of the OP. Every effort is made to ensure that the KPT and deliverables are adequately defined to facilitate monitoring and evaluation.

20. The draft OP was shared with RAs, TCs and management groups to establish the adequacy of representation of their respective areas of interest and for them to make proposals for improvement.

21. The inputs received were integrated into the draft document.

22. The third session of the EC WG/SOP (Geneva, 29-31 March 2010) recommended that:

(a) Effectiveness and efficiency of TCs are separate issues that need to be analyzed separately. In streamlining operations close attention in the WMO OP (which contains the Secretariat Operating Plan) needs to be given to the effectiveness of the working mechanism affected;

(b) The Operating Plan that includes contributions by the TC's, RA's and the EC Working Groups, Panels and Committees be prepared in a format that clearly identifies the links among ER's, KO's and the Budget;

(c) A time-table for providing inputs into the operating plans be prepared to facilitate timely submissions of inputs;

(d) The Secretariat to facilitate the sharing of inputs between RAs and TCs to enhance synergies;

(e) The EC Panels, including the EC Panel on Polar Meteorology, be requested to provide inputs to WMO-wide Operating Plan; and

(f) The meetings of TCs should focus on outcomes and decisions that define follow-up actions.

23. The Council, at its sixty-second session (Geneva, 8-18 June 2010), considered the draft WMO Operating Plan 2012-2015 and noted that it was a highly detailed document that could be used for management decision-making and for monitoring and evaluation of the Strategic Plan. The Council requested that the document be further refined with inputs from TCs, RAs and EC panels and working groups, and encouraged those that had not yet provided their input to do so.

MONITORING AND EVALUATION

24. The Council recalled its decisions taken at the sixty-first session *(Abridged Final Report with Resolutions of the Sixty-first Session of the Executive Council* (WMO-No. 1042), general summary, paragraphs 7.2.12–7.2.14) and noted the progress in the implementation of the pilot phase of the WMO Monitoring and Evaluation (M&E) system.

25. The Council noted the observations of its Working Group on WMO Strategic and Operational Planning (WG/SOP) on the difficulty of assessing the contribution of NMHSs to the improved protection of lives, livelihoods and property as it involves many players.

26. The Council considered and endorsed the following recommendations of its working group with respect to the development and implementation of the WMO M&E system:

(a) The focus of the M&E systems should be on activities of WMO and issues on which there is a direct impact;

(b) The Secretariat considers the possibility of working with other organizations specializing in analyzing societal impacts, e.g. World Bank;

(c) The results of the pilot phase be used to improve the presentation of KPIs for the next financial period and also help the Congress have a view on how the WMO has moved towards ERs;

(d) The focus should be on how activities of NMHSs help society to adapt to climate variability and change; and

(e) The working group be involved in developing a standardized questionnaire to assess the impacts of the achieved results. Such a survey could help create baselines and targets.

WIGOS - BACKGROUND INFORMATION

Status of development of the WIGOS concept

1. The sixty-second session of the WMO Executive Council (EC-LXII) noted with appreciation that the Executive Council Working Group on the WMO Integrated Global Observing System and the WMO Information System (EC-WG/WIGOS-WIS) and its Subgroup on WIGOS had reviewed the status of implementation of the WIGOS concept in response to the request by EC-LXI. The Council considered the views and recommendations of EC-WG/WIGOS-WIS and articulated its guidance for the future development and implementation of WIGOS.

2. The Council noted with appreciation the updated version of the WIGOS Concept of Operations (CONOPS) *(see CIMO-XV/INF. 9(1)1)* and endorsed the WIGOS Development and Implementation Strategy (WDIS) *(see CIMO-XV/INF. 9(1)2)* with the understanding that these documents may be further refined following the lessons learned from the WIGOS Test of Concept Phase. The Council urged the Secretary-General to make a concise version of these documents available in all WMO working languages for the next Congress.

3. EC-LXII noted the progress made in the WIGOS Projects. The Council appreciated the role and input of the relevant technical commissions and the AMDAR Panel in initiating and implementing the WIGOS Pilot Projects (WPP). The Council also expressed its appreciation for the efforts made by Kenya, Morocco, Namibia (RA I), Republic of Korea (RA II), Brazil (RA III), the United States of America (RA IV), Australia (RA V) and the Russian Federation (RA VI) in implementing of their WIGOS Demonstration Projects (WDP).

4. Some Pilot and Demonstration Projects have to date not yet been completed. As these projects were designed to be ongoing while other projects were unable to be completed due to the requirement for additional guidance material and standards that are still to be developed. However, a significant number of lessons were learned from all the projects. The Council underlined that these projects should continue to be an important activity in the future WIGOS implementation stages, in particular to assist LDCs and SIDS to fully benefit from the WIGOS.

5. WDPs and WPPs provided lessons learned, feedbacks and perspectives on the potential benefits, value and impacts of the WIGOS implementation process at the national and regional level which were necessary for the finalization of CONOPS and WDIS. The Council requested that key outcomes and lessons learned from the successful WIGOS Projects, as well as WIGOS related projects taken by Members or Regions, be evaluated and results be shared among Members. The Council reaffirmed that the success of the WIGOS process would strongly depend on the collaboration and cooperation among all WMO Members as well as among WMO, WMO Programmes, and its partner organizations.

CIMO's involvement in WIGOS Pilot Projects

6. As mentioned above, following the guidance of Cg-XV, several WIGOS pilot projects were initiated to test the WIGOS concept, identify problem areas and to help in elaborating the WIGOS Development and Implementation Plan. CIMO was responsible to carry out one of these projects entitled "Elaboration of the underpinning/cross-cutting role and responsibilities of the Instruments and Methods of Observation Programme and CIMO in the context of WIGOS".

7. This Pilot Project was directed at defining CIMO's role and responsibilities within the WIGOS framework as well as to test and demonstrate them through collaboration with the other WIGOS Pilot and Demonstration Projects to validate the effectiveness of the proposed TOR in addressing the WIGOS needs. In this context, the CIMO Project Team developed a proposal for a revision of the CIMO Terms of Reference with due consultation with the other technical

commissions and WIGOS pilot projects that was submitted for approval by the Commission under agenda item 8. CIMO also decided to collaborate more closely with those projects that expressed highest interest for collaboration and that had already clear plans with a clear linkage to CIMO's role. These were as follows: AMDAR Pilot Project, JCOMM Pilot Project, and GRUAN Pilot Project.

8. The WIGOS Pilot Project for AMDAR was established to improve on the practices impacting AMDAR data collection, processing, archiving and dissemination. The AMDAR WIGOS-PP has been developing better standard practices as well as documenting these practices to ensure sufficient detail accompanies AMDAR observations so that users can better interpret measurements. In addition, new methods and procedures will be developed in preparation for the deployment of new operational instruments, such WVSSII water vapour sensor. CIMO's role in the AMDAR-PP would be to participate in testing the AMDAR humidity sensors with other upper-air data following preliminary testing by the AMDAR community.

9. CIMO participated in the JCOMM Pilot Project "Integration of marine meteorological and other appropriate oceanographic observations into the WMO Integrated Global Observing System". In particular, guidance was provided on the establishment of Marine Instrument Centres that follow closely the concept of the CIMO Regional Instrument Centres. Also, collaboration happened in view of updating the *WMO Guide to Meteorological Instruments and Methods of Observation*, WMO-No. 8 (CIMO Guide), Chapter on Marine Observations.

10. The GRUAN Pilot Project includes participation of the GRUAN community in the 8th WMO Intercomparison of High Quality Radiosonde Systems (Yangjiang, China, 12 July-3 August 2010) that is organized by CIMO. The aim of this collaboration is to provide advice to GCOS on a selection of systems suitable for the GCOS Reference Upper-Air Network (GRUAN).

11. Furthermore, in the context of its Pilot Project, CIMO collaborated with CBS on two proposed classifications for land surface observing stations for use within WIGOS. The first classification addresses the siting of stations and the second their maintained performance. These classifications are needed as quality observations cannot be ensured only by the use of high-quality instrumentation, but rely at least as much on the proper siting of the instruments and on their maintenance. They are the first step towards providing a measure of the data quality to users of meteorological observations to allow them to assess whether specific observations meet the quality needed for their applications, which is of crucial importance for example for all climate applications and in particular for climate change monitoring. These classifications are presented in more details in other CIMO-XV documents.

WIGOS Concept of Operations (CONOPS)

12. Based on the lessons learned from the WIGOS Test of Concept phase, the basic characteristics of WIGOS are specified in CONOPS that describes user needs for, and expectations from, the proposed system and how the system should operate to fulfil those needs. CONOPS provides a logical transition for WIGOS from initial to full operational capabilities, recognizing that CONOPS will continue to be refined and will remain a basic reference document to the WIGOS Development and Implementation Strategy (see below) and the WIGOS Implementation Plan (WIP), which will be developed following Cg-XVI, and consideration of the WIGOS Development and Implementation Strategy (WDIS). The current version of CONOPS better describes the operational aspects of WIGOS which allows WIGOS to fully meet user expectations.

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

organizations for the benefit of society. As a system of observing systems, WIGOS will be an organizational framework enabling the integration and optimized evolution of WMO observing systems. This will allow continuous and reliable access to an expanded set of environmental data and products resulting in increased knowledge and enhanced services across all WMO activities.

14. WIGOS is expected to provide timely, quality-assured, quality-controlled and well-documented long-term observations. Addressing these requirements, WIGOS should ensure:

(a) Homogeneity, interoperability, compatibility and traceability of observations from all WIGOS constituent observing systems. This should be based on guidance and studies to be conducted by CIMO through the Instruments and Methods of Observation Programme (IMOP) and related WMO Programmes and those of partner organizations within WIGOS constituent networks, including tests, calibration and intercomparisons;

(b) Improved access in real-time, near-real-time and delayed mode to a wider range of observations required to meet the needs of Members through WMO and WMO co-sponsored programmes, as well as relevant international conventions;

(c) Improved metadata, data management, archival and data retrieval capabilities;

(d) Strengthened capability of all Member countries to access and utilize observations from all WMO and co-sponsored observing systems.

15. Implementation of Quality Management (QM) procedures according to WMO Programmes' requirements by data producers/owners of observing systems/networks, and development of strategies to guarantee systems interoperability, including meeting documented standards for data quality of observing systems and instruments, will be required to meet such expectations in collaboration among all technical commissions.

16. A database of standards should be developed. It would provide a single access point to all the WMO standards, guidelines, best practices, procedures, etc., addressing all aspects of observations (instruments, methods of observation, metadata format, coding, etc.). Such a database would enable, on the one hand, the network managers and operators to easily access the information they need to set-up and run their systems and, on the other hand, the data users to understand the standards that were used in performing specific observations they are considering using, providing appropriate metadata are available.

WIGOS Development and Implementation Strategy (WDIS)

17. WDIS is based on the WMO Strategic Plan, taking into account lessons learned from WIGOS projects and other activities carried out during the WIGOS Test of Concept phase. The document describes the steps to be followed by WMO to improve governance, management, and integration of observing systems. WDIS also includes capacity-building requirements and clearly specifies responsibilities across the WMO system for the further development and implementation of WIGOS, addressing coordination and technical challenges of the implementation process.

18. The WIGOS Implementation phase, to be undertaken between 2012 and 2015, will focus on developing and implementing a framework for an improved, effective and sustained organizational, programmatic, governance and procedural structure. Such a structure will enable a common standardization approach, uniform implementation of WMO regulations, and data integration and interoperability across all WMO observing systems. It will also provide a single focus for integrated and coordinated operational management of all WMO observing systems and a mechanism for coordination with WMO co-sponsored and contributing observing systems.

19. Once the framework is established, WIGOS will enter its Operational phase. During this phase, WIGOS constituent observing systems and networks will continue to evolve to improve service delivery and support decision making in response to the evolving needs of users and technological opportunities. Although this phase is not limited in time, it is anticipated to include an initial period of rapid enhancement of observing capabilities between 2016 and 2019 in order to meet the highest priority needs.

20. As specified in CONOPS, a principal requirement for integration is the standardization in three key areas: Instruments and Methods of Observation; WIS information exchange and discovery; Quality Management Framework. As part of the implementation strategy, a successful WIGOS standardization process will have to adequately address the differences and inconsistencies in current technical specifications, data acquisition and management systems used by individual NMHSs and partner organizations before national and international observing systems can be regarded as truly integrated.

21. All WIGOS relevant information, including the WIGOS Projects available documentation as well the final reports of the EC WG and its Subgroup, is available on: http://www.wmo.int/pages/prog/www/wigos/index_en.html.

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WMO INFORMATION SYSTEM (WIS) - REPRESENTATION OF DATA AND METADATA

BACKGROUND INFORMATION

1. CIMO-XIV noted that WIS could play a useful role in its programme activities, specifically in facilitating the non-real-time information exchange of IMOP programmes. WIS was also expected to provide efficient information discovery, access and retrieval services. The Commission requested that IMOP requirements on WIS services be identified. It also emphasized the importance of pursuing CIMO participation in the development of WIS-related data management functions, specifically as regards instrument-related and surface and upper-air observational data representation formats and metadata.

2. CBS-XIV (see reference 1) agreed that the application of the ISO 191xx series of geographic information standards (see references 2 and 3) to the development of a WMO conceptual model of data representation should be considered as a fundamental element of a CBS policy on data representation systems. Applying a standard approach for data representation, this should lead to the development of a WMO core profile of the ISO 19100 series for metadata and data, encompassing the WMO core profile of the ISO metadata standard (see reference 4). CBS-XIV tasked the OPAG-ISS Inter-Programme Expert Team on Metadata and Data Interoperability (IPET-MDI) to develop and maintain a WMO conceptual data model and a WMO core profile of the ISO 19100 series of standards for metadata and data.

3. CBS-XIV was of the opinion that WMO would benefit from closer cooperation with the Open Geospatial Consortium (OGC) (see reference 5), which sets standards for web access to geospatial information. A Memorandum of Understanding (MoU) between WMO and OGC (see reference 6) was signed in November 2009. The WMO/OGC Memorandum of Understanding is instrumental in providing the mechanism for the coordination between the activities carried out by the OGC Met Oceans Domain Working Group (DWG) and hydrology DWG (see reference 7), and the activities carried out by the expert teams of the CBS OPAG-ISS with a view to developing the use of ISO/OGC standards for the WIS. In accordance to the MoU, OGC privileges are granted to eight WMO experts. The Meeting of the Presidents of Technical Commissions (28-30 January 2010) expressed its support for the tasks and designation of the experts, including a WIGOS expert from CIMO tasked to develop awareness of ISO/OGC standards such as Observations and Measurements (ISO 19156), Sensor Web Enablement (SWE) (see reference 8) and related standards within WMO WIGOS community and CIMO.

4. The first meeting of the IPET-MDI (Geneva, 27 to 29 April 2010) noted the special relationship between WIGOS and WIS. WIGOS depends on the successful implementation of WIS. Fundamental to the success of WIGOS will be the ability of the WIS infrastructure to cope with the diverse information requirements from the integrated sensor networks. This will require further evolution of the metadata and data standards managed by IPET-MDI. The meeting noted the information on the development of standards for WMO data and associated metadata relevant to WIGOS given in the document “WIGOS standardization framework for data and associated metadata” (see reference 9). It invited the Secretariat to continue updating the document “WIGOS standardization framework for data and associated metadata” with a view to fostering the awareness of the development of the standards for data and metadata for the development of the WIGOS.

References

1. *Abridged Final Report with Resolutions and Recommendations of the Fourteenth Session of CBS* (WMO-No. 1040, Dubrovnik, Croatia, 25 March–2 April 2009) (http://www.wmo.int/pages/prog/www/CBS/Reports/CBS-XIV_Dubrovnik2009/WMO-1040_en.pdf)

2. ISO Technical Committee 211 (http://www.isotc211.org/)

3. ISO TC 211 standard guide (http://www.isotc211.org/Outreach/ISO_TC%20_211_Standards_Guide.pdf)

4. Version 1.1 of the WMO core profile of the ISO Metadata standard (http://wis.wmo.int)

5. Open Geospatial Consortium (OGC) (http://www.opengeospatial.org/)

6. WMO/OGC Memorandum of Understanding (MoU) (ftp://ftp.wmo.int/In-box/To-www/DM/20091123_OGC_WMO_MOU.pdf)

7. Meteorology/hydrology OGC Domain Working Groups (DWGs) (http://www.opengeospatial.org/projects/groups/wg)

8. OGC's Sensor Web Enablement (SWE) standards (http://www.opengeospatial.org/ogc/markets-technologies/swe)

9. WIGOS standardization framework for data and associated metadata (http://www.wmo.int/pages/prog/www/WDM/modelling/WIGOS_framework_data_metadata_v1.doc)

BACKGROUND INFORMATION ON THE GFCS

1. At the invitation of the Government of Switzerland, the World Climate Conference-3 (WCC-3) was held in Geneva, Switzerland, from 31 August to 4 September 2009. It was organized by the World Meteorological Organization (WMO), in collaboration with the United Nations Educational Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP), the Food and Agriculture Organization of the United Nations (FAO), the International Council for Science (ICSU) and other intergovernmental and non-governmental partners. Some 2,500 participants from more than 150 countries, 13 Heads of State and Government, 81 Ministers, 34 United Nations organizations and 36 other international organizations attended the Conference.

2. The Expert Segment of the Conference, including some 200 speakers and 1,800 participants, reviewed a wide range of individual and community-based papers and presentations from climate science, service, application and user communities as well as the results of deliberations by a number of other major climate service stake-holder groups, in a series of sessions, forums, workshops and round-tables. Development, provision and uptake of climate services, and requirements for climate services were discussed under the following themes:

(a) The shared challenge for climate science, services and applications;

(b) User needs and applications;

(c) The scientific basis for climate services;

(d) Adaptation to climate variability and change;

(e) Societal perspectives on climate services;

(f) Implementing climate services;

(g) Exploiting new developments in climate science and services.

3. WCC-3 concluded with a High Level declaration and decided the establishment of a global Framework for Climate Services (GFCS) as a long-term cooperative arrangement through which the international community and relevant stakeholders will work together to achieve its stated goal. The Framework encompasses five major components: Observation and Monitoring; Research, and Modelling and Prediction; a Climate Services Information System; a User Interface Programme; and Capacity Building.

4. WMO prepared a Position Paper which describes the components of GFCS (see http://www.wmo.int/pages/gfcs/documents/GFCS_Position_Paper_DRAFT_REV_1_en_1.pdf) EC-LXII considered the Executive Summary of the Position Paper on GFCS reproduced in the Annex to this document and highlighted the important role of NMHSs in the provision of meteorological (weather and climate) and hydrological services in accordance with the WMO Convention. The Council noted with satisfaction that the contribution of relevant programmes and activities of WMO have been adequately reflected in the Position Paper, ensuring a strong role for the WMO Programmes in supporting the various components of GFCS. The Council endorsed the finalization of the Position Paper and requested the Secretary-General to appropriately reflect these views in the Position Paper before submitting it to the High-level Taskforce on GFCS.

5. The Meeting of the President of Technical Commissions recognized the need for inter-Commission oversight and coordination for dealing with cross-cutting technical issues and

that the "coordination of activities for the implementation of GFCS" should constitute a permanent item on the PTC agenda to deal with issues associated with coordination among various Commissions for the implementation and operation of GFCS.

6. Taking into account the outcomes of WCC-3, the establishment of GFCS and the need for climate data to support a wide range of activities in climate monitoring, CCl-XV agreed on the priority work in climate observations and data management for the 2010-2014 intersessional period as follows:

(a) To facilitate an analysis of how the various observation-system types and technologies, including conventional observations, automated observations, and remotely sensed data, can most effectively and synergistically be deployed to support various types of climate activities, including climate monitoring, service provision and workplan, in ways that are appropriate to the level of precision required and cost-effective, and to communicate this information to relevant technical commissions, space agencies and GOS planners;

(b) To place an increased emphasis on the quality of in-situ, remote sensing and model data as an integral part of Climate Data Management. In this regard, climate metadata should be given high attention as it is an essential part of the data quality management process which requires an end-to-end quality assurance approach in all steps including collection, archiving, dissemination, discovery and exchange; and provide advice to Members, in collaboration with other technical commissions and programmes on minimum requirements and standards for climate observations;

(c) To contribute to the activities of the Inter-Programme Expert Team on Metadata and Data Interoperability (IPET-MDI), and improve interoperability and effectiveness of climate data exchange, by prospecting an optimal WMO Core Profile for climate metadata and database on the ISO 191xx series of standards to refine the WMO stations catalogue to create a more in-depth description of climate database on the former INFOCLIMA;

(d) To consider other types of data in climatology including space-based data, radar data and data from other remote sensing platforms, and how these can most effectively be integrated with data from conventional observing systems. The Commission should work closely with CBS, CIMO and GCOS on developing a minimum set of requirements for NMHSs to benefit from these data and be able to properly and practically use them for climate studies and for the development of improved climate services. The Sustained Coordinated Processing of Environmental Satellite Data for Climate Monitoring (SCOPE-CM) led by the WMO Space Programme and Eumetsat's SAF-CM was highlighted as offering significant opportunity for advancement;

(e) To consolidate the ongoing work in Climate Data Management Systems by ensuring improved interoperability through the WIS using the WMO Metadata Core Profile and ISO standards, in addition to incorporating new features, functionalities and interfaces with other databases, such as hydrological, agriculture, health, environmental and socio-economic databases. This effort should include establishing and maintaining a register of existing and any future CDMS and their respective functionalities, and implementing best practices in training and implementation. The use of GIS should be promoted to best use of these new features with the aim of developing modern and useful data services;

(f) To continue providing the international coordination and monitoring of Data Rescue and Digitization of Climate Records and promoting the development of regional DARE initiatives similar to the one being implemented in the greater Mediterranean region (MEDARE) and the use of web portals to inform on and monitor DARE activities and projects and related data inventories;

(g) To place an increased emphasis on polar observations and observations of the cryosphere in general and to assist in the development of standards for solid precipitation, and for standards for observations in mountainous terrain.

Annex: 1

ANNEX

Executive Summary of the Position Paper on Global Framework for Climate Services

The Heads of State and Government, Ministers and Heads of Delegations present at the World Climate Conference-3 (WCC-3), held from 31 August to 4 September 2009 in Geneva, through the Conference declaration, decided to establish a Global Framework for Climate Services (hereafter referred to as "the Framework") to strengthen the production, availability, delivery and application of science-based climate monitoring and prediction services. The declaration decided that a task force, consisting of high-level independent advisors, would prepare a report, including recommended action on the proposed elements of the Framework, taking into account the concepts outlined in the Brief Note annexed to the Declaration. This position paper outlines the overall vision of the Framework for consideration by the task force.

INTRODUCTION

1. Adaptation to climate variability and change represents an important challenge for the sustainable development of society. To be effective, adaptation requires a policy framework, technology and practices to adjust to expected changes, supported by relevant climate information and tools. The Framework is designed to mainstream climate science into decision-making at all levels and help ensure that every country and every climate-sensitive sector of society is well equipped to access and apply the relevant climate information. The overarching goal of the Framework is: To enable better management of the risks of climate variability and change at all levels, through development and incorporation of science-based climate information and prediction services into planning, policy and practice.

2. Climate services deal with the generation and provision of a wide range of information on past, present and future climate and its impacts on natural and human systems. Also included is the application of that information for decision-making at various levels in society. As understanding of the climate system grows and society becomes more aware of the potential benefits from use of this knowledge, communities will increasingly expect that these services are: accessible, dependable, usable, credible, authoritative, responsive, flexible and sustainable.

THE CONCEPT AND COMPONENTS OF THE FRAMEWORK

3. Climate information and products are dependent on sustained, long-term, high-quality observations of climate elements over the land and oceans and in the atmosphere; synthesizing these observations; monitoring various processes and understanding them through diagnostics, research and modelling; and making predictions/projections of what to expect in weeks, months, years or decades to come. Further, the application of climate services must involve close interaction between the providers and the users. As such, the production and application of climate services requires concerted multidisciplinary efforts.

4. Given the complexity of and requirements for climate services, addressing the immense variety of user needs for climate services is beyond the capacity of any single organization, a small group of organizations or a country. It calls for an unprecedented collaboration among institutions across political, functional and disciplinary boundaries. The Framework is, therefore, conceived as an integrating set of international arrangements which will be built upon the established global climate observation and research programmes as well as operational structures into an end-to-end product generation, service provision and application system. Many of these elements (systems,

programmes, projects, institutions, etc.) are either already in place or are in the process of being established. The Framework must be designed to be an effective, efficient and economically viable mechanism for the generation, delivery and application of climate services.

5. Noting that the "Global Framework for Climate Services" should be user-need driven, as a process, and the recommendations incorporated in the Conference Statement, it is proposed to have five major components: (i) observations; (ii) climate research, modelling and prediction; (iii) a climate services information system (CSIS); (iv) a climate user interface programme (CUIP); and (v) capacity building.

OBSERVATIONS

6. National Meteorological and Hydrological Services (NMHSs), for more than 150 years, have built infrastructure for observation on land, at sea and in the air that measure meteorological and some environmental variables. Various agencies are charged with the national implementation of the individual observing networks and systems. These observing networks across a number of observing domains follow procedures and adhere to standards established through intensive work of the WMO Technical Commissions, which now fall under the WMO Quality Management Framework. Over the past 50 years the growth in remote sensing technology and computer capabilities has led to very accurate high-resolution, multispectral digital renderings that comprise satellite data today. With sophisticated users and their concomitant requirements, the earth system observation by satellites are used for a variety of applications that span time scales from nowcasting to climate, and include land, ocean, atmosphere and ecological applications

7. In response to the decisions at the Second World Climate Conference (1990), the Global Climate Observing System (GCOS) was conceived. GCOS is built on the WMO Integrated Global Observing System (WIGOS), the IOC-WMO-UNEP-ICSU Global Ocean Observing System (GOOS), the FAO-UNEP-UNESCO-ICSU Global Terrestrial Observing System (GTOS), and a number of other domain-based and cross-domain research and operational observing systems. Its overall objective is to support all components of the World Climate Programme (WCP), the climate change assessment role of the Intergovernmental Panel on Climate Change (IPCC), and the international climate policy role of the United Nations Framework Convention on Climate Change (UNFCCC). To ensure the quality and consistency of observations, GCOS has developed a set of Climate Monitoring Principles to guide the collection, archiving and analysis of in-situ and satellite-based climate observations. The Global Earth Observation System of Systems (GEOSS) encompasses Earth observations in nine societal benefit areas. GCOS has been recognized as the key climate-observing component of GEOSS.

8. WMO periodically evaluates the requirements for observations for a variety of applications (e.g. weather forecasting, seasonal climate predictions for application in agriculture, aviation, and water management, among others), and to meet IPCC and UNFCCC requirements, through 'Rolling Review of Requirements' process. The GCOS also reports on the progress and the adequacy of the global observing systems for climate in support of the UNFCCC. Climate and climate related observations are needed for: climate system monitoring; climate change detection and attribution; operational climate prediction on seasonal-to-interannual time scales; research to improve understanding, modeling and prediction of the climate system; assessment of the impacts of, and vulnerability and adaptation to, natural climate variability and human-induced climate change; and applications and services for sustainable economic development. In addition, related systematic environmental and socio-economic data and information are needed to assess human and environmental vulnerabilities and plan actions that must be taken in various development sectors to adapt to climate variability and change.

9. These reviews have identified a number of critical issues related to the observations such as: spatial and temporal data gaps; absence of organized and standardized socio-economic data

gathering mechanism; limited access to some data; non-availability of historical records in digitized form; appropriate processing and archiving systems to handle vast amounts of data; and interoperability of data. It is important to reduce these gaps as they adversely impact the reliability of climate services including monitoring, predictions and projections.

10. Underpinning an effective climate service is the systematic gathering of high quality basic climate and environmental data. The vision for the observation component of the Framework is to greatly enhance the capabilities of WMO Members to access, develop, implement and use integrated Earth- and space-based systems for weather, climate and hydrological observations, as well as related environmental observations, to fill-in the critical gaps, and to make available the variety of climate data required to monitor the Earth's climate system, understand it better and make better predictions and projections; along with the related environmental and socio-economic data from various application areas to assist society for the decision making process as it determines impacts and vulnerabilities, adapts to climate change, and develops mitigation and adaptation strategies. Considering that weather and climate know no political boundaries, it is vital that the meteorological and hydrological data that are fundamental to operations and research are quickly and reliably shared around the world.

11. Establishing and maintaining an operational observing system requires significant human and financial resources. In competition with major societal and economic issues, observing systems often get relatively low priority and funding in national financial planning. As a result, observation networks around the world are deteriorating, in both the developed and developing countries. With respect to data access, some restrictive data policies and the non-availability of some of these data sets in electronic form prevent the optimal use of the data and information generated by these systems for the benefit of society.

12. Strengthening, upgrading and modernizing the observation networks that NMSs currently use for weather observations to better serve the needs of weather, climate and water services is a high priority. Observational networks established for research, but which have potential ongoing applications in weather and climate services, need to be converted into robust operational observation programmes with sustained funding. It is essential that data are collected to the required standards to meet the purposes for which their use is intended.

13. Collection of environmental, biodiversity, and socio-economic data, which is largely ad hoc and not well organized in most countries, needs to be coordinated. There are a limited number of standards developed so far for observation and archiving of such data. For sector-specific information, products and services, all sectors would also have to systematically collect and manage relevant data for their activities. Barriers to sharing of data among various institutions within the country and with the global research community need to be removed.

14. A WMO Integrated Global Observing System (WIGOS), supported by an integrated WMO Information System (WIS) is essential to realizing the socio-economic benefits to be derived from a wide range of weather, climate, water and related environmental products and services. WIGOS will ensure a coordinated WMO contribution to the cosponsored GOOS and GTOS and will be key to the successful implementation of GCOS in support of the UNFCCC, and in the development and implementation of the future Global Framework for Climate Services (GFCS). Through WIGOS and WIS, and their support for GOOS, GTOS and GCOS, WMO will make a fundamental contribution to the success of the Global Earth Observation System of Systems (GEOSS).

CLIMATE RESEARCH, MODELLING AND PREDICTION

15. Climate research, including modelling and prediction aspects, is essential for the Framework to characterize climate variability and change and to generate quantitative climate predictions and climate projections on a range of time and space scales. The World Climate

Research Programme (WCRP), established in 1979 jointly by WMO, the ICSU, and joined later by the Intergovernmental Oceanographic Commission (IOC) of UNESCO as a major component of the World Climate Programme (WCP), has helped determine the extent to which climate can be predicted, and the extent of human influence on the climate system. It has successfully laid the scientific foundation for the climate services of the future. Its current research projects, particularly those pursuing the coupled climate and Earth-system models, are poised to push the frontiers of climate prediction further. Climate research has successfully developed policy-relevant future climate scenario projections for the twenty-first century that form a key component of the IPCC process.

16. While climate science has advanced significantly during the last four decades, many scientific challenges still remain. There is an increasing need in society for information about the future state of the climate system in the near term, extending from years to decades, to support development of practical applications and crucial decision-making. New focus is required on the development of decadal prediction systems, an area of research still in its infancy. Further, there are many inherent uncertainties in our estimates of the past, present and future behaviour of the climate. Large uncertainties in climate information, predictions and projections make it difficult for planners in various development sectors to use them confidently in their decision-making processes and, therefore, have to be reduced to the greatest extent possible.

17. The full understanding of the climate system requires an understanding of all natural processes of the Earth system, along with the climate-relevant socio-economic processes. To meet the expectations of the Framework, there is, therefore, a need for a more holistic Earth system approach to observations, monitoring, modelling, analysis and prediction.

18. The potential for climate prediction on longer timescales and with better spatial resolutions is tied to the availability of high-performance computational infrastructure and adequately trained scientific staff. Significant increases in the computing capacity available to the global and regional weather and climate centres are called for in order to accelerate progress in improving predictions. It is widely agreed that more researchers need to be working on the forecast systems to fully exploit the predictability potential available in the climate system, and to address the enormous challenge of understanding the Earth system and its future evolution.

19. Weather and climate research are closely intertwined; progress in our understanding of climate processes and their numerical representation is common to both. The models used for weather and climate prediction are essentially based on the same physical principles and formulations, though the way they are deployed is substantially different. Experts advocate adopting a more seamless prediction approach. Seamless prediction (on timescales from a few hours to centuries) needs to be further developed and extended to aspects across multiple disciplines relevant to climate processes.

20. Availability of highly skilled human scientific talent, particularly in the developing regions of the world, is critically lacking. There is also a need to improve skills among scientists to properly interpret research findings and to improve the skills of those who apply this information to national planning initiatives. To address the above-noted needs for climate research, modelling and prediction, to ensure development of the knowledge base, of reliable high resolution products and to reduce uncertainties in present climate information and products, will take an unprecedented multinational effort, with significant supercomputing, infrastructural and human resource deployment.

CLIMATE SERVICES INFORMATION SYSTEM

21. The Climate Services Information System (CSIS) should be designed to deliver the climate information that users need for the decisions they have to make. Given that climate

processes are global in character and operate on a wide range of time and space scales, the flow of information from global to local scales is essential and must be facilitated. For an effective delivery of climate information, an appropriate institutional mechanism is required to generate, exchange and disseminate quality information at global, regional and national levels on an operational basis.

22. The CSIS, based on the inputs from the observations and research components, and in line with the implementation of WMO Information System (WIS) as the backbone system, will require physical infrastructure such as computers, institutions and centres; skilled human resources for product development and consultation; and mechanisms for interactions with users. Many of the elements of what should be the fully operational CSIS already exist in some form, but need to be further developed and standardized.

23. The establishment of the WCP in 1979 laid the foundation for modern climate services. Advances in the provision of climate services have been gradual, useful and timely, but in the last decade the demands for climate information at the local level and expectations of better tools for decision-making have grown rapidly and continue to outpace capabilities. There are a number of gaps between present capacities and the expectations of the policy makers, planners, operators, nations, communities, and individuals that must be addressed.

24. The CSIS should be based on the three-tiered structure of entities at global, regional and national levels. They include global data centres and global producing centres of long-range forecasts (GPCs), Regional Climate Centres (RCCs) and National Climate Services (NCSs). NCSs either within or closely associated with NMSs, mandated by the national governments, would be at the forefront of the CSIS information development, dissemination and application cycle. The CSIS should encourage and facilitate the collaboration of NCSs with relevant boundary and specialized sectoral institutions to enable them to work with national agencies, including governmental and non-governmental organizations, universities and national research institutes that are mandated to serve different sectors and at different levels of administration. NCSs should get global and regional inputs from the RCCs and GPCs, and should benefit from the consensus development mechanisms of the Climate Outlook Forums (COFs).

25. COFs, at regional and national levels, have shown promising results in user engagement. They have been developed, for the most part, on a pilot basis and therefore do not adequately cover all the regions of the world, nor do they adequately cater to the needs of information at local levels and as often as users might need. It is imperative therefore to ensure that the network of these elements is expanded spatially and covers the range of quality products users require, facilitates a common understanding of climate risks and opportunities, provides information on inherent uncertainties, and advises on how the information can be applied for the optimal results.

26. RCCs would need the infrastructure, capacity and mandate to develop high-quality regional scale climate products using products generated at the global scale and incorporating regional information. They will develop and monitor regional climate variability and extremes, conduct climate watches, and downscale prediction and projection products from global centres. RCCs would be expected to develop a broader suite of region-specific products to address regional needs and help NCSs to develop the capacity of downscaling regional products, tailoring them and delivering to the national users. The establishment of RCCs has begun only recently, and will require significant human and financial inputs to accelerate the global implementation.

27. Climate services, therefore, should be strongly rooted in the existing capabilities for the provision of weather services and the years of research, investment and collaboration among all National Meteorological and Hydrological Services (NMHSs). The CSIS should rely on and expand the weather and climate infrastructure developed over time and should strengthen the human expertise needed for its operation. While all WMO NMSs provide some climate services, especially

those related to data, aspects related to prediction, services and user liaison require considerable development. It is essential to devise production systems to meet user needs more explicitly, especially at national and local levels, to provide “actionable” information. A comprehensive and systematic plan of well-defined actions and appropriate resources would be required to turn the existing disparate elements into a coherent, cohesive and dynamic functioning system.

28. Flow of information and generation of products and services within the system would require regular feedback from users at various levels for continual improvement of services. The CSIS should therefore have very close links with the CUIP component of the Framework.

CLIMATE USER INTERFACE PROGRAMME

29. The Climate User Interface Programme (CUIP) should aim to bridge the gap between climate services providers and users, the decision-makers in various sectors and the public at large, by providing mechanisms through which the users of climate information can liaise actively with climate service providers and vice versa, with the value of the climate service to the community being judged on its ability to improve decision-making.

30. CUIP should coordinate, facilitate and oversee the development of mechanisms at various levels (global to regional, national and local (in close relation with the national government)) in various sectors. It should: help users express their needs; prioritize these user needs; promote, facilitate and coordinate focused interdisciplinary (applied climate) research; facilitate communication and use of climate information; capture and disseminate knowledge in diverse socio-economic settings; and obtain user feedback in implementation of other three Framework components described above.

31. Central to the development of user-specific climate information is the recognition that the needs of the user community are diverse and complex. At the same time it has to be recognized that “users” work at various spatial and temporal scales and have common as well as differing needs.

32. CUIP is seen as a set of activities, projects and initiatives running across all the components of the Framework but particularly concentrating on the application of climate information and products in decision-making in various sectors and at various levels of the user spectrum. CUIP would need to have its roots down to the national levels. The CUIP initiatives/activities may differ from sector to sector. As such, it has to be developed jointly with national, regional and global partners who have direct links and interaction with various sectoral user groups.

33. NCSs would need to establish arrangements with boundary organizations/extension agencies in different sectors, and popularize the concept of National Climate Outlook Forums (NCOFs) in close collaboration with sectoral ministries or interest groups. At the regional level, CUIP would depend on mechanisms and partnerships developed on the basis of socio-economic, physical and climatic conditions, supported by global entities where required. Regional entities such as River Basin Organizations and economic groupings, possibly in association with Regional Climate Outlook Forums (RCOFs), can play a crucial role in facilitating such mechanisms. At the global level, CUIP would enhance cooperation within research networks belonging to different disciplines, coordinate applied climate research, and encourage interdisciplinary research to develop applications and tools. It should largely be led by various United Nations Agencies and other intergovernmental organizations (IGOs) and non-governmental organizations (NGOs).

34. Effective communication of climate information is vital to ensure its appropriate application. The communication strategy under the Framework has to be based on a broad range of modern media and user-friendly content. These communication means would have to be built

into various elements of the Framework to build advocacy, generate awareness, interact and encourage involvement.

CAPACITY BUILDING

35. Implementation of the Framework will require capacity building through: strengthening and aligning of institutional arrangements; strengthening of existing and, where required, establishment of new infrastructure and systems; and development of human skills and training. Particular emphasis should be placed on the needs of developing and least-developed countries including Small Island Developing States (SIDS), and particularly vulnerable regions such as Africa.

36. In many countries, absence of clear mandates among various institutions on climate-related issues may adversely impact the provision of climate services. There is need for institutional strengthening in governance, management and funding as well as human resources development. At the same time it will require an improvement in the infrastructure within countries to systematically and sustainably undertake high-quality climate observations, undertake research and establish and operate various elements of the CSIS. Developing countries would require international support to attain a desirable level of capability to participate in the implementation of the Framework and optimally make use of its products.

37. To develop the human capacity needed for the implementation of the Framework, a review of the educational qualifications and on-job training requirements for climate specialists would have to be taken up. New skills would be required to be developed, at a much larger scale, as climate service provision is made operational in countries. Countries would have to develop clear human resources development plans to address this issue. As these skills would be technology intensive, universities within the countries would be in the best position to participate or take the lead in these activities.

GOVERNANCE AND RESOURCING OF THE FRAMEWORK

38. Implementation of the Framework needs be coordinated and overseen through a governance mechanism to: ensure adequate technical and professional guidance; provide oversight; ensure that resources are used efficiently; assign and ensure accountability for realizing the vision of the Framework; set directions and monitor progress; ensure respective roles and mandates; facilitate resource mobilization; and suggest policy directions, where required. Much has been learnt about climate coordination efforts through experiences from the Coordinating Committee for the WCP (CCWCP). In deliberating on governance structures, the task force may wish to take into account the experiences from a number of current models guiding the WMO co-sponsored programmes GCOS and WCRP, and the IPCC.

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DEVELOPMENT AND IMPLEMENTATION OF THE WMO QMF BACKGROUND INFORMATION

1. The third session of the Inter-Commission Task Team (ICTT) on Quality Management Framework (QMF), Geneva, Switzerland, 28-30 October 2008, reviewed the status of the WMO QMF, in particular in the different technical commissions, and the necessary next steps for a credible implementation of the WMO QMF throughout the Organization including the Secretariat.

2. After the adoption of the ISO/WMO working arrangements in accordance with Resolution 31 (Cg-XV), it is a natural next step to strive towards the implementation of QM throughout the Organization, from the Secretariat to the constituent bodies and in NMHSs of Members. The upgrading of a recommendation to a standard has made it mandatory in the aviation service provision and both ICAO and WMO are now urging Members who have not done so to take the necessary steps to implement a recognized Quality Management System (QMS) in their services before November 2012. The meeting also recommended having a Quality Manager at the WMO Secretariat who would coordinate the cross-cutting issues involving all the players, WIGOS being one of them.

3. It was also seen as very important to recommend necessary steps to adopting ISO/WMO common standards by any technical commission or constituent body. The meeting therefore recommended that the responsible body should attempt to establish and present:

(a) The benefit/cost implication to Members of elevating an existing Technical Regulation/Manual/Guide to a common Standard, considering the consequences of converting recommendations to compulsory standards (from “should” to “shall”);

(b) Cross-cutting elements of the proposed common Standard with other WMO documents under the control of different technical commissions or Executive Council panels and working groups, requiring an action from these bodies following a change of status. To this end, presidents of technical commissions and EC Members are to be informed about potential impacts and invited to register an interest in the document being processed;

(c) An assessment of which elements in the common Standard could create a risk if adopted, and which ones would constitute a risk if omitted or not approved as a common ISO/WMO standard. This risk assessment should be provided with reference to ISO 31900:2009 Risk Management – Principles and guidelines.

4. Enhancing the QMF implementation process will need to be considered by WMO senior management in the overall WMO strategic and operational planning process, and was reflected in EC-LXII/APP_WP 4.2. In order to make best use of existing guidance, EC-LXII approved a recommendation of a workshop of the ICTT in late 2009 to rewrite and “convert” WMO-No. 1001 *Guide on the Quality Management System for the Provision of Meteorological Services for International Aviation* into a “generic guide” fit for purpose for all WMO Programmes. Additional sections to be provided could include the following topics:

(a) Selecting a quality management consultant;

(b) Developing and producing a quality manual;

(c) Developing procedures;

(d) Conducting internal audits; and,

(e) Selecting an organization to perform the ISO compliance certification.

5. Additional attachments in the guidance could include, for example, National Meteorological or Hydrometeorological Service (NMHSs) Quality Manuals as best practice examples.

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GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS (GEOSS)

BACKGROUND INFORMATION

1. WMO Congress Guidance

1.1 In 2007, the Fifteenth WMO Congress (Cg-XV) issued guidance regarding WMO involvement in the Group on Earth Observations (GEO). With that guidance, the Council encouraged all WMO Members to become Members of the Group on Earth Observations (GEO), and in doing so, their support of the Global Earth Observation System of Systems (GEOSS) 10-year Implementation Plan. Cg-XV noted that in addition to improving observing systems, especially in areas beyond national jurisdictions, GEO had capacity-building as one of their key objectives and therefore, membership could offer National Meteorological and Hydrological Services (NMHSs) enhanced access to a broader range of environmental data, metadata and products.

1.2 Cg-XV stressed that the participation of WMO in GEO had to be on the basis of mutual benefit that maximized synergies while minimizing duplication. Cg-XV noted that some national delegations to GEO did not include representatives from NMHSs, and that representatives of NMHSs in national delegations would provide enhanced scientific and technical expertise to GEO, as well as increased national visibility for their organizations. Cg-XV also noted that a number of GEO Members had established national GEO Committees comprised of representatives of several Ministries, in order to develop a multidisciplinary approach to their participation in GEO, and that these National GEO Committees could serve as a catalyst for domestic action to better coordinate and/or sustain national observing systems.

1.3 Cg-XV reaffirmed the following Executive Council decisions: to endorse GEOSS and its 10-Year Implementation Plan; to provide full support for the GEO process and resulting GEOSS; to support its implementation to the maximum extent possible within the WMO mandate; and to make available all essential data as defined in WMO Resolution 40 (Cg-XII) which covers WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities. Interactions through the GEO interoperable arrangements are intended to serve the needs of the global community. In doing so, WMO Members would have access to other GEO data and products also available through the GEO interoperable arrangements.

2. WMO Executive Council Guidance

2.1 In June 2010, at the sixty-second session of the WMO Executive Council (EC-LXII), guidance previously issued by Cg-XV regarding WMO involvement was reaffirmed. The Council encouraged WMO Members to participate in relevant GEOSS activities, and to engage fully within national GEO coordination mechanisms to reinforce the role of NMHSs in understanding national-level needs for information and services, and their responsibilities for delivering such services in the areas of weather, climate, water and disaster risk reduction. Further, through participation in GEO, WMO Members will be better positioned to draw attention to critical gaps in contributed GEOSS systems and to utilize the leverage of GEO to address them.

2.2 The Council urged the Commission for Basic Systems (CBS) and other relevant technical commissions and joint Steering Committees to strengthen interoperability arrangements with GEO so that WMO Members can continue to benefit from data beyond that governed by WMO Resolutions 40 (Cg-XII) and 25 (Cg-XIII), and that others can similarly benefit from WMO data for weather, water, climate and other environmental data holdings.

2.3 Lastly, the Council encouraged active participation by all WMO/GEO Members in the GEO Plenary and Ministerial Summit (Beijing, China, 3-5 November 2010). The Council noted that this Ministerial Summit will mark the halfway point in the 10-year GEOSS Implementation Plan and that the session is likely to focus on how GEO, through GEOSS, can contribute to addressing critical societal needs particularly in developing and Least Developed Countries (LDCs), including a cross-cutting emphasis on data sharing and the coordination and sustainability of *in-situ* observations.

3. WMO's Contributions to GEOSS

3.1 In 2007, Cg-XV emphasized that relevant WMO components should also be GEOSS components. Cg-XV specifically cited both the unique WMO systems, such as the World Weather Watch Global Observing System (GOS) and Global Data-processing and Forecasting System (GDPFS), Global Atmosphere Watch (GAW), Global Telecommunication System (GTS), World Hydrological Cycle Observing System (WHYCOS), Global Terrestrial Network for Hydrology (GTN-H), WMO Information System (WIS), and the WMO co-sponsored systems such as the Global Climate Observing System (GCOS), Global Ocean Observing System (GOOS) and Global Terrestrial Observing System (GTOS). Since this guidance was issued, linkages between these programmes, or relevant components of these programmes, and GEOSS have occurred.

3.2 In this regard, the 30 progress highlights presented at the GEO-VI Plenary in Washington, D.C. in 2009, WMO and/or its co-sponsored programmes were credited with contributing to 12 of the highlights as shown below:

(a) Access to Long-Records of Global Precipitation (Germany, Japan, USA, CGMS, WCRP);

(b) New Reanalysis Data for Climate Change Detection (Japan, USA, ECMWF, WCRP);

(c) Global Weather Forecasts for Early Warning Research (WMO);

(d) Prototype Multi-Model Applications for Extreme Event Prediction (WMO);

(e) New High-Resolution Experiments for Weather/Climate Prediction (WCRP, WMO);

(f) Direct Contribution to Earth-System Prediction Initiative – Cape Town Plenary/Summit 2007 & WCC-3 2009 (WMO, WCRP, IGBP, ICSU);

(g) New Health Decision-support Tools to Mitigate Meningitis Outbreaks in Niger & Ethiopia (USA, France, WMO, WHO);

(h) GEONETCast Now Fully Operational – New Product Navigator and Training & Alert Channels (EUMETSAT, CMA, NOAA, ROSHYDROMET, WMO);

(i) Carbon Community of Practice (Australia, Canada, France, Germany, Japan, Netherlands, Norway, South Africa, UK, USA, CEOS, ESA, GCOS, WCRP, WMO);

(j) Integrated Global Water Cycle Community of Practice (Argentina, Australia, Canada, China, Finland, France, Germany, Japan, Netherlands, Panama, Portugal, Switzerland, UK, USA, UNESCO, WMO);

(k) Health and Environment Community of Practice (Brazil, EC, France, Senegal, USA, IEEE, UNOOSA; WHO, WMO);

(l) Global Agricultural Monitoring Community of Practice (Argentina, Australia, Austria, Belgium, Brazil, China, EC, France, India. Italy, Netherlands, South Africa, USA, ESA, FAO, WMO).

4. Benefits accruing to WMO Members

4.1 As a result of a study requested by EC-LXI, benefits reported of WMO's involvement in GEO fell into several categories – data access and delivery, leveraging national investments, greater visibility and capacity building.

4.2 Members reported that they have benefited from access to new data sets beyond those available through WMO Resolutions 40 (Cg-XII) and 25 (Cg-XIII). These new data sets were generally from the terrestrial domain, and included such topics as land cover, ecosystems, agriculture and biodiversity. These additional data sets were viewed as complementary to the ongoing work of NMHSs, particularly in the areas of climate and water.

4.3 As a corollary to access to greater data holdings, all WMO data resources have been registered with GEOSS, and are now available not only through WIS, but also through the GEO Portal thereby increasing WMO data delivery. WMO data are now being viewed by organizations and entities outside the WMO community, making these data more widely available and useful for many diverse applications.

4.4 The GEONETCast partnership among EUMETSAT, CMA, NOAA and ROSHYDROMET, reported earlier as a key accomplishment of GEO has facilitated a global broadcast of environmental information beyond that which is transmitted by the GTS, and has enabled the data-access and delivery benefits described in 3.2 and 3.3. Similarly, national investments in data collection and information infrastructure are better leveraged when more users and diverse communities have access to, or benefit from, these investments.

4.5 In terms of capacity building, the GEO Secretariat has provided financial support for WMO training courses by providing speakers, paying the travel costs for speakers, and/or paying for additional participants from Least Developed Countries. Similarly, WMO has benefited from higher attendance at workshops sponsored jointly with GEO, and again, GEO has funded additional participation for attendees from Least Developed Countries. The GEO Secretariat has also assisted the WMO Secretariat in writing proposals and seeking resources from national and international funding agencies for these proposals.

5. Potential Opportunities for Enhanced Involvement

5.1 The greatest potential opportunity for enhanced involvement centres on exploiting the benefits associated with delivery of, and access to, information. Again, this includes both the delivery of weather, water, climate and related disaster information to those outside the WMO community, and access by WMO Members to other types of information beyond what is delivered through Resolutions 40 (Cg-XII) and 25 (Cg-XIII).

5.3 There is also a potential opportunity for enhanced involvement as the Global Framework for Climate Services (GFCS) evolves and for GEO contribution and support to the GFCS. Since GFCS will be an end-to-end system, it could be characterized as one of the contributing systems in GEOSS. This action could provide more visibility to GFCS, increase the appreciation for the multidisciplinary components and could facilitate and enable the collaborative efforts and dialogue which must be undertaken with a broad and diverse user community for GFCS to succeed.

6. CIMO's involvement in GEOSS

6.1 The CIMO activities related to GEOSS were coordinated by the CIMO Management Group member, Alexander Gusev, in his function of CIMO Coordinator for the Global Earth Observing System of Systems.

WMO DISASTER RISK REDUCTION (DRR)
BACKGROUND INFORMATION

1. According to statistics from the Centre for Research on the Epidemiology of Disasters (CRED), over the last three decades, on the global scale, more than 90% of the total number of disasters, 72% of the casualties and 75% of the total economic losses were related to hydrometeorological hazards. These impacts are expected to rise as a consequence of potential increases in frequency and severity of hydrometeorological hazards linked to climate variability and change, according to the Fourth Assessment Report of the IPCC (2007).

2. In May 2006, the DRR Programme conducted a country-level fact-finding survey to assess Members' capacities, requirements and priorities in DRR. The survey was disseminated to 187 Members of WMO, of which 139 countries provided responses. The survey results have been analyzed and a report is available on line at: http://www.wmo.int/pages/prog/drr/natRegCap_en.html and all individual surveys are available through a database at the WMO Secretariat. In summary, the survey indicated that droughts, flash and river floods, strong winds, severe storms, tropical cyclones, storm surges, forest fires, heat waves, landslides and meteorological hazards linked to aviation, were the top ten hazards of concern to all Members.

3. The Fifteenth WMO Congress (Cg-XV) approved the strategic goals of WMO in disaster risk reduction, derived from the Hyogo Framework for Action 2005-2015 (HFA), which was adopted by 168 countries during the World Conference on Disaster Reduction (January 2005, Kobe, Japan). These include:

(a) Development, improvement and sustainability of early warning systems in particular related to scientific and technical infrastructures, systems and capabilities for research, observing, detecting, forecasting and warnings of weather-, water- and climate-related hazards;

(b) Development, improvement and sustainability of systems, methods, tools and applications of modern technologies such as geographical information systems for recording, analyzing and providing hazard information for risk assessment, sectoral planning and other informed decision-making;

(c) Development and delivery of warnings, specialized forecasts and other products and services that are timely, understandable to those at risk and driven by requirements of disaster risk reduction decision processes and operations;

(d) Stimulate a culture of disaster preparedness through strengthening of capacities for better integration of NMHSs' products and services in disaster risk reduction, and continued public education and outreach campaigns;

(e) Strengthening cooperation and partnerships of WMO and NMHSs in national, regional and international mechanisms and structures for implementation of disaster risk reduction.

4. The WMO strategic goals in DRR are implemented through national and regional projects using a six phased project management framework that includes project identification, planning, implementation, reporting and evaluation, sustainability and expansion. The following criteria should be considered for project initiation:

(a) Alignment with WMO strategic priorities related to DRR;

(b) Built on priorities, capacities, DRR requirements and needs of Members within a region, sub-region or country-grouping;

(c) Have both a national capacity development component, complemented with a regional cooperation component;

(d) Involve integrated planning, budgeting, and implementation, leveraging expertise, resources and activities of WMO technical programmes, constituent bodies and external partners, with roles and responsibilities clearly defined;

(e) Result-based approach, with clear outcomes, deliverables and timelines;

(f) Must be scalable;

(g) Sustainability of capacities overtime to be considered within the project design;

(h) Ensure end-to-end solutions to the Members leading to better DRM decision-making capacities;

(i) Have a well-defined resource mobilization strategy.

5. The DRR Programme, with assistance from the Resource Mobilization Office, is identifying bi-lateral donors who are interested in supporting DRR activities in different regions. A list with contact information of the key officers responsible for DRR portfolios in these agencies is being compiled together with their regional and thematic priorities for funding, to ensure that donors are engaged from an early stage of the project development process to build a track record. After a disaster the WMO DRR Programme works with partners to initiate links to funding mechanisms such as: (i) UN Flash Appeal addressing more urgent needs of the country; and (ii) post disaster needs assessment and reconstruction planning (PDNA). This approach was used after the tragic 12 January 2010 earthquake in Haiti to: (i) develop more urgent capacities of the National Meteorological Service to address warning and information needs for the 2010 rainy and hurricane season; and (ii) medium- to long-term development of the Meteorological Service to support not only early warning systems (EWS) but also information needs of main economic sectors in Haiti over the long-term. The approach was also used after the tragic 2004 tsunami to raise nearly USD 800,000.00 for upgrading the Global Telecommunication System (GTS) of the Indian Ocean Rim countries. The funds were used for 17 technical missions to evaluate the GTS upgrade needs and upgrade of the GTS in Pakistan, Myanmar and Bangladesh

6. Under the cross cutting framework of the DRR Programme two types of national/regional cooperation projects are underway in a number of WMO Regions to demonstrate the benefits of the DRR project management framework. These include:

(a) First type: National and regional disaster risk management and adaptation projects with the World Bank, UN–International Strategy for Disaster Reduction (UN-ISDR), and UNDP which focus on development of national capacities and regional cooperation along three components, including: (i) disaster risk management institutional capacities across various economic sectors (e.g., health, infrastructure and urban planning, agriculture, energy, civil protection and emergency planning, etc.) (Lead: UN-ISDR, UNDP); (ii) NMHS and their partnership with disaster risk management stakeholders (Lead: WMO); and (iii) financial risk transfer and insurance markets (Lead: the World Bank). These programmes are initiated by UN-ISDR and the World Bank to which WMO is invited as a key partner for addressing capacity developments of the NMHS and their partnerships. This type of project has been initiated in eight countries in Southeast Europe, eight countries in Central Asia and Caucuses, and five countries in Southeast Asia. The first step for initiating these

projects was a detailed institutional capacity assessment and identification of national needs and priorities as well as development of a regional cooperation framework;

(b) Second type: Comprehensive end-to-end multi-hazard early warning system (MH-EWS) projects building upon capacity development activities of WMO technical programmes in countries that have some institutional capacities for emergency preparedness and planning. The first step in initiating these projects involves a “MH-EWS Training Workshop with Focus on Institutional Partnerships and Coordination,” held under the umbrella of the RAs, bringing together directors and senior executives from NMHS and DRM agencies, regional and international organizations as well as the development and funding agencies to identify the needs and priorities for the development of regional/sub-regional cooperation programmes complemented with national MH-EWS development projects.

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WMO POLAR OBSERVATIONS - BACKGROUND INFORMATION

Executive Council Panel of Experts on Polar Observations, Research and Services

1. The Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS) was established at EC-LX in 2008. The EC-PORS promote and coordinate relevant activities of WMO Programmes that are carried out in the Antarctic and Arctic regions by WMO Members. The Panel interfaces with all WMO Programmes as well as other related programmes throughout the world, meeting global needs and requirements for meteorological, climatological and hydrological observations, research and services in the Polar Regions. Among its terms of reference, the Panel is to facilitate acquisition, exchange and archiving of observational data from Polar Regions in compliance with the WMO Integrated Global Observing System (WIGOS) requirements related to instruments, data exchange (WMO Information System (WIS)) and Quality Management Framework (QMF), and to underpin the provision of services required for safe operations in the Polar Regions.

2. EC-PORS activities, working documents and a final report of the first session (October, 2009) of EC-PORS are available at the WMO Website http://www.wmo.int/pages/prog/www/Antarctica/antarctic.html. The Panel has established task plans for: (a) Antarctic responsibilities; (b) building a framework for its work in observations, research and services; (c) advancing the concept for an International Polar Decade; (d) providing leadership for development of a Polar Prediction System; and (e) building partnerships. Many of these topics relate to CIMO interests and responsibilities. All these tasks will require Members' support in order to deliver WMO activities in Polar Regions. CIMO is invited to nominate its focal point to interface with EC-PORS on issues related to instruments and methods of observation standardization, maintenance and operation. The second session of EC-PORS will be held in Hobart, Australia, 18-20 October 2010.

3. EC-PORS agreed that there is an operational dimension to Antarctic activities and as there is no regional association covering the Antarctic, it will therefore continue the function previously handled by the EC Working Group on Antarctic Meteorology. The Panel acknowledged that WMO has a need to coordinate the work of Members with respect to observations for the Antarctic. The Panel will lead review and updating of relevant resolutions of the Congress (Cg) and the Executive Council (EC), and of standard regulatory material relevant to the Antarctic. The Panel, through WMO Members, plans to get updates on monitoring networks and their infrastructure. The Panel would welcome CIMO's identification of issues or concerns and current activities related to instruments and methods of observation in the Antarctic.

4. Services are seen as the driver that anchors the Panel's work. Polar observation is of a high priority in support of research and services. The Polar observing programme includes observations from research and observational networks, satellite, in-situ and new technologies and includes issues of acquisition, exchange, access and ensuing products. The Panel emphasized that polar observation is not only a high priority in support of research and services but also that high quality observations are required for mid-latitude forecasts. The challenge of sustaining networks in Polar Regions cannot be overstated. The Panel agreed to acquire information on deficiencies in the implementation and operation of the networks and to define possible measures to close gaps by identifying priorities. Members noted that Pan-Arctic observational networks on hydrology, including all components of the cryosphere, are a major priority. The relevance of supersites for integrated, multidisciplinary monitoring to provide standardized data, not only to WIS and WIGOS, but also for satellite product development and calibration and validation of space based observations, was noted. Satellite remote sensing is a most effective way to increase our ability to observe polar areas. Action has been initiated to have a Space Task Group with an updated mandate formally established within EC-PORS, building on the very successful IPY Space

Task Group. CIMO involvement is expected as regards the identification of supersites and their instrumentation and observations.

5. The Panel noted the need for more work in the development and validation of satellite and in-situ observation in the Polar Regions, including:

(a) Automated measurements;

(b) Methods to retrieve the cloud liquid and ice water path over snow and ice surfaces;

(c) Data-assimilation schemes for satellite-based water vapour over snow and ice surfaces;

(d) Algorithms for sea ice concentration and other cryosphere components;

(e) Novel techniques such as unmanned aircraft;

(f) Surface-based atmospheric remote sensing stations for Cal/Val of satellite-derived products;

(g) Sensitivity studies on the value of polar data undertaken by major operational NWP centres (e.g. e.g. ECMWF, UKMO, NCEP, CMC, etc.) to determine, for example, whether an upper-air observation in the Antarctic is worth continuing.

It has been recognized that some of the above work was already initiated or is planned by CIMO. It is proposed that the membership of relevant CIMO expert teams include EC-PORS representatives to make a link between CIMO and EC-PORS.

6. The Panel noted the need to coordinate WMO weather, climate and its activities with respect to water with other Organizations engaged in hydrology, permafrost (encompassing 25% of the Earth's surface), glaciology and oceanography. EC-PORS discussed many polar observing networks, not just the GOS. It discussed polar observing issues relevant to GCOS, GAW, Arctic-HYCOS, permafrost networks, Buoy Networks, and University of Wisconsin's Antarctic Surface Weather Network (AWS). A common theme was the challenge of sustaining and funding networks in remote, harsh, cold environments and new networks established during IPY. Some challenges identified for the AWS network included:

(a) AWS measurements meet some, but not all, of the WMO measurement standards;

(b) Issues include the semi-permanency of many stations, irregular maintenance schedules, and changes in measurement heights due to snow accumulation/melt;

(c) It is difficult to meet the standards with limited funding, logistical issues, and the harsh environment of Antarctica. Some agencies will support AWS installation and maintenance for research purposes but not for operational (e.g., WMO) use;

(d) Satellite communication (Argos) costs are high, and becoming an issue for some AWS operators;

(e) WMO measurement standards should be reviewed for the Polar Regions in general.

CIMO's guidance on instruments and methods of observation and the associated standards of measurement suitable for polar observing, especially using automatic weather stations, would be very valuable in developing sustained and integrated observing of the Polar Regions. The WMO Guides on Instruments and Methods of Observation, Hydrological Practices and Climatological

Practices are very valuable for the research as well as for the operational community. It is proposed that CIMO expand the CIMO Guide to include a chapter related to measurements and observations in Polar Regions.

7. EC-PORS is to provide the oversight on IPY Legacy Observing initiatives, including Integrated Arctic Observing System (iAOOS), Southern Ocean Observing System (SOOS), Global Cryosphere Watch (GCW) and Sustaining Arctic Observing Networks (SAON). The EC-PORS co-chairperson, David Grimes (Canada) represents WMO on the SAON Steering Group. SAON is a process to support and strengthen the development of multinational engagement for sustained and coordinated pan-Arctic observing and data sharing systems that serve societal needs. SAON's goal is to enhance Arctic-wide observing activities by facilitating partnerships and synergies among existing 'building blocks', and promoting sharing and synthesis of data and information. WMO has been active in providing information on its networks, data exchange, data management including its data policies. It was emphasized to SAON that WMO sets standards for making observations, calibration and maintenance of instruments and that fundamental to our success is that the data are standardized, quality controlled and serve as authoritative information for numerous applications. CIMO's efforts in this regard can contribute directly to the improved environmental monitoring by other agencies.

8. EC-PORS recommended pursuing further development of and establishment of a Polar Prediction System (PPS) to be hosted within one or more operational facilities. The value of such an approach offers the community a conduit for the evaluation of and experimentation on operational products. This requires articulation of a "Polar Agenda" connecting the user community/decision-makers through to research; and refining the operational outputs and nesting this within the global system. WWRP, with WCRP, is hosting a polar prediction workshop in October 2010 to improve the understanding of polar processes affecting polar weather, the assimilation of data in Polar Regions, and the prediction of high impact weather over Polar Regions. Objective verification of coupled forecast systems poses many challenges in the Polar Regions due to sparse in-situ data and verification using remote sensing is a critical research area for the Polar Regions. An understanding of the quality of polar data, including their potential errors and biases is essential in developing a PPS.

9. EC-PORS supported launching the International Polar Decade (IPD) and recognized the need to inform and engage a broad partnership. There is need to further scope IPD with other relevant scientific bodies and international organizations, with a workshop considered viable in early 2011 where a CIMO representative would be invited to participate. One possibility for a "rallying" agenda for IPY follow-on is the elaboration of an Arctic and Antarctic polar prediction capacity. An IPD could provide CIMO with a framework for potential future polar initiatives/intercomparisons.

Global Cryosphere Watch

10. EC-PORS provides oversight and support to the development of the WMO Global Cryosphere Watch (GCW) initiative. The Panel recognized the importance of, and strongly endorsed GCW, which would extend from observation through research to prediction and services. GCW is recognized as an integrator between water, weather, climate and the cryosphere (e.g. snow, ice, glaciers, permafrost) within the framework of WIGOS (see ftp://ftp.wmo.int/Documents/SESSIONS/EC-PORS-1/INF04_GCW.pdf).

11. An EC-PORS GCW Task Team was established to work within the Panel's observation framework to support development of the GCW implementation strategy required for the Sixteenth WMO Congress. Tasks have been identified that would demonstrate and test the GCW concept as part of the GCW implementation strategy. A key task is to determine which IGOS Cryosphere Theme ("CryOS") recommendations can be implemented in GCW and how. For example, there are

recommendations related to snow and solid precipitation measurement using in-situ and satellite sensors. Several relate directly to CIMO's current survey on the impact of automation on the measurement of precipitation in cold climates, for example:

(a) Undertake bias analysis and corrections of historical precipitation gauge data at regional to global scale, including the Antarctic;

(b) Examine the impact of automation on precipitation measurement and related QA/QC challenges, including compatibility between national data, and manual vs. auto gauge observations;

(c) Encourage national research agencies to establish programmes to provide support for the development of new instruments to measure solid precipitation at high latitudes;

(d) Expand the use of wind shields and direct measurement of winds at emerging auto gauge sites/networks, and augment existing AWS networks to include near real-time snow depth measurements in cold regions.

12. For WMO to make available "authoritative" precipitation products, on a global and regional scale which incorporate knowledge on errors of measurement, GCW needs these issues and others to be addressed. There is an urgent need for Members, through CIMO and in cooperation with other Commissions and Programmes, to initiate appropriate intercomparisons to determine the errors in measurement for snowfall, snow depth and precipitation in cold climates, especially for AWS.

13. EC-PORS noted the importance of supersites/reference sites for integrated, multidisciplinary monitoring. GCW aims to implement a standardized network of cryospheric observatories in cold climate regions, not just polar regions, where as many cryospheric elements as possible would be monitored in a standard manner for the long-term. These sites would augment relevant Coordinated Energy and Water Cycle Observations Project (CEOP) reference sites, GAW or Global Terrestrial Network sites and would also be suitable for validation of satellite and model outputs of cryospheric elements. The GCW team, through the cooperation of Members, will identify candidate GCW reference sites, building on existing programmes at stations or observatories. These efforts require collaborative compilation of existing guidelines and standards for cryospheric measurements and products from a variety of sources. New guidelines may be required for some cryospheric elements. CIMO is viewed as an important partner in this effort.

14. GCW will require a robust portal to meet a variety of user needs for cryospheric information. There are several IPY data centres/portals which could be suitable contributors in the development of a virtual portal, and Norway has offered to develop a prototype portal to test the concept.

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WMO GLOBAL ATMOPSHERE WATCH (GAW) PROGRAMME

BACKGROUND INFORMATION

1. WMO/GAW coordinates global long-term observations and analysis of the chemical composition of the atmosphere. GAW focal areas are ozone and UV radiation, greenhouse gases, selected reactive gases, aerosols, precipitation chemistry and urban air pollution. Quality assurance (QA) and quality control (QC) are a high priority of the GAW programme. QA/QC includes comparison campaigns and support for personnel training and a set of Central Facilities that are aimed for the support and propagation of standards and scales.

2. The GAW Training and Education Centre, GAWTEC, hosted by Germany, continues to give two two-week courses annually for station personnel teaching measurement techniques and data analysis to about 10-13 trainees per session. Since the first GAWTEC training course held in the summer of 2001 about 200 trainees from 55 different countries have been educated in Schneefernerhaus/Hohenpeissenberg. Intensive training on instruments operation is also part of comparison and calibration campaigns.

UV radiation

3. The first comparison of multiband filter radiometers (MBFR) was performed in Oslo in May 2005. Results of the comparison were published in the GAW Report No. 179 - "Intercomparison of Global UV Index from Multiband Filter Radiometers: Harmonization of global UVI and spectral irradiance". The next UV broadband intercomparison campaign is planned for November 2010 in Buenos Aires, Argentina.

Surface ozone

4. The first International GAW Calibration Workshop of TECO surface ozone gas analyzers for the South Cone countries was organized by the calibration center in Buenos Aires at the end of 2006. Seven instruments participated in the comparison. All participating instruments left the Workshop with a calibration consistent with GAW Report 97 recommendations (precision and accuracy: $\pm$5 % for values > 20 ppb; $\pm$2 ppb for values between 0-20 ppb). The next campaign is planned to be held in the last quarter of 2010 in Buenos Aires.

Total ozone

5. Since its establishment in November 2003, the Regional Brewer Calibration Center-Europe (RBCC-E), hosted by Spain, has held five Brewer intercomparisons. The 5th RBCC-E Calibration Campaign was held in Arosa (Switzerland) from 19 to 30 July 2010.

6. The South African Weather Service (SAWS) hosted the 3rd African Regional Dobson Spectrophotometer Intercomparison (IC) meeting in October 2009. Instruments from USA, Germany, Australia, South Africa, Botswana, Seychelles, Nigeria, and Kenya took part in the comparison. The Cairo Dobson was calibrated later (June/July 2010) at Hohenpeissenberg, Germany.

7. The next Dobson intercomparison will take place in WMO Region III, in Buenos Aires during November/December 2010.

8. Brewer instruments have been calibrated by International Ozone Services in Nepal, Indonesia, Russia, Iran, Egypt, Morocco, Chile, Brazil, and Bolivia through funds provided by Canada.

9. The following reports on ozone have been published:

(a) Operations Handbook - Ozone Observations with a Dobson Spectrophotometer Revised 2008 (GAW Report No. 183);

(b) Towards a Better Knowledge of Umkehr Measurements: A Detailed Study of Data from Thirteen Dobson Intercomparisons (GAW Report No. 180);

(c) The Ninth/Tenth Biennial WMO Consultation on Brewer Ozone and UV Spectrophotometer Operation, Calibration and Data Reporting (GAW Reports Nos. 175/176, respectively).

Physical properties of aerosols

10. Regular calibration and comparison workshops are organized by the Institute for Tropospheric Research in Leipzig, Germany which serves as the WMO/GAW World Calibration Center for Aerosol Physics (WCCAP):

(a) A workshop comparing six European H-TDMA (Hygroscopicity-Tandem Differential Mobility Analyzer) instruments that measure hygroscopic properties of aerosol particles was held in February 2006;

(b) Condensation particle counters (CPCs) measure the integral particle number concentration of aerosol particles larger than a certain threshold diameter in the submicrometer size range. In November 2006 and March 2008, CPC calibration workshops were conducted;

(c) Differential/Scanning Mobility Particle Sizer (DMPS/SMPS) spectrometers workshops were organized in November 2006 and February/March 2008 and an SMPS workshop was held in June 2009;

(d) Spectral aerosol light absorption is an important parameter for the assessment of the radiation budget of the atmosphere. Many on-line measurement techniques for aerosol light absorption, such as the Aethalometer, the Particle Soot Absorption Photometer (PSAP), and the Multi Angle Absorption Photometer (MAAP) have been available for several years. Absorption Photometer Workshops were organized in March 2007 and 2009 to investigate scattering artifacts depending on particle size and loading;

(e) A nephelometer workshop was conducted parallel with the absorption photometer at the WCCAP facilities in March 2007. It focused on the scattering coefficient measurements.

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COLLABORATION WITH RELEVANT INTERNATIONAL ORGANIZATIONS

BACKGROUND INFORMATION

International Organization for Standardization (ISO)

1. WMO was recognized by ISO as an international standardizing body. Following this recognition, WMO signed working arrangements with the International Organization for Standardization (ISO) on 16 September 2008. These arrangements enable increased collaboration between WMO and ISO allowing the development of common ISO/WMO technical standards. Such standards would be published independently by ISO and WMO with exactly the same content and mentioning they are the equivalent of each other. In this context the WMO Technical Commissions are free to choose the material that they want to submit for consideration as common ISO/WMO standards. WMO can retain WMO specific standards and retains control over the development and updating of the joint standards.

2. The ISO Standard development process comprises six stages:

(a) Stage 1: Proposal stage;

(b) Stage 2: Preparatory stage;

(c) Stage 3: Committee stage;

(d) Stage 4: Enquiry stage;

(e) Stage 5: Approval stage;

(f) Stage 6: Publication stage.

The ISO-WMO working arrangements enable WMO to propose existing WMO publications to be published as ISO standards. Such documents would enter the ISO approval process at an advanced stage (namely at stage 4 as five-month final draft standard or five-month enquiry draft standard depending on whether they fall within the scope of an existing ISO Technical Committee or not).

3. EC-LXI adopted Resolution 8 on the procedures to be followed in proposing common WMO/ISO technical standards. It requires the WMO body initiating the proposal to prepare comprehensive supporting documentation that includes:

(a) The benefit/cost implication to Members of submitting an existing Technical Regulation/Manual/Guide for adoption as a common WMO/ISO Standard, considering the consequences of converting recommendations to compulsory standards (from “should” to “shall”) when applicable;

(b) A full description of the cross-cutting elements of the proposed common Standard with other WMO documents under the control of different technical commissions or Executive Council panels and working groups that would lead to a requirement for action from these bodies in the event of the Standard being created. To this end, presidents of technical commissions and Executive Council members are to be informed about potential impacts and invited to register an interest in the document being processed;

(c) An assessment of which elements in the common Standard could create a risk if adopted, and which ones would constitute a risk if omitted or not approved as a common WMO/ISO standard. This risk assessment should be provided with due reference to the AS/NZ 4360:2004 Standard for Risk Management.

4. At present, only one document was identified as a possible candidate for such a common ISO/WMO standard. It is the Siting Classification for Surface Observing Stations on Land that is discussed in more details under agenda item 4.

5. Strong links already exist between CIMO experts and ISO Technical Committees. Mr Bruce Forgan, Chairperson of the CIMO ET-MR&ACM is also chairing the ISO Technical Committee (TC) 180 Sub-Committee (SC) 1 (i.e. ISO TC180/SC1) responsible for the solar radiation standards. Mr Engelbart, former chair of the CIMO ET-RSUATT, led the development of ISO standard on LIDARs. Furthermore, a number of CIMO experts are also members of ISO Technical Committees and one of them, Mrs Rodica Nitu is the Chairperson of ISO TC146/SC5 “Meteorolgy”.

6. CIMO ETs recognized the benefit of having strong liaison with ISO to collaborate in the development and revision of standards to ensure that relevant ISO standards continue to meet the requirements of the meteorological community. Experience will need to be gained on the practical implementation of the working arrangements, as to date no WMO standard was formally proposed to be submitted as a common ISO/WMO standard yet.

International Committee for Weights and Measures (CIPM)

7. On 1 April 2010, WMO signed a Mutual Recognition Arrangement (MRA) with the International Committee for Weights and Measures. WMO designated three laboratories to represent it in activities organized within the CIPM MRA:

(a) World Radiation Centre (PMOD/WRC, Davos, Switzerland), for solar irradiance;

(b) World Calibration Centre (WCC-Empa, Dübendorf, Switzerland), for surface ozone; and

(c) National Oceanic and Atmospheric Administration Earth System Research Laboratory (NOAA/ESRL, Boulder, Colorado, USA), for carbon dioxide, methane, nitrous oxide and carbon monoxide concentrations.

8. WMO organized together with the International Bureau for Weights and Measures (BIPM) the “WMO-BIPM Workshop on Measurement Challenges for Global Observation Systems for Climate Change Monitoring: Traceability, Stability and Uncertainty” was held from 30 March to 1 April 2010, at the WMO Headquarters in Geneva, Switzerland. The vice-president of CIMO, Prof. B. Calpini, was the co-chair of the steering committee responsible for the organization of the workshop. The workshop objectives were to:

(a) Identify key measurement issues in climate science, Numerical Weather Prediction model (NWP) and Earth observation where there is a requirement for improved underpinning metrology;

(b) Foster closer links and develop dialogue between the metrology and the Earth observation systems communities;

(c) Drive agenda setting and road mapping within National Metrology Institutes (NMIs) and ensure that measurement science is developed to meet the needs of climate science, NWP and Earth observation community needs;

(d) Inform the Earth observation systems community about the capabilities and plans of the NMIs.

The workshop enabled to establish links between experts from the metrology and meteorology communities. It is expected that the recommendations and the conclusions drawn from the Workshop will be published as a joint BIPM/WMO document.

Collaboration with Manufacturers of Hydro-meteorological Equipment and the Association for Hydro-meteorological Equipment Industry (HMEI)

9. Members of the Association of Hydro-Meteorological Equipment Industry (HMEI) took part in most CIMO ET meetings. Their participation and contributions were very welcomed by the ETs. It was recognized that the collaboration with HMEI was beneficial to both parties.

10. A large number of instrument manufacturers and HMEI members participated in the recent WMO instrument intercomparisons, like the Field Intercomparison of Rainfall Intensity Gauges (Vigna di Valle, Italy, 2007-2009), the Combined Intercomparison of Thermometer Screens/Shields in conjunction with Humidity Measuring Instruments (Ghardaia, Algeria, 2008-2009), and the 8th Intercomparison of High-Quality Radiosonde Systems (Yangjiang, China, 12 July-3 August 2010). A number of manufacturers also participated in CIMO training events. The collaboration with manufacturers in all these events was very positive and it was recognized that they provide significant support and contributions to CIMO by taking part in those activities.

11. A manufacturers meeting was organized for the participants of the Field Intercomparison of Rainfall Intensity Gauges. It was a success and helped to optimize data acquisition especially with respect to synchronization of RI output with the reference. Participants were satisfied with the conduction of the meeting, for having the chance to inspect their instruments and get a personal feedback concerning some operational aspects.

The Network of European Meteorological Services (EUMETNET)

12. Collaboration with Operational Programme for the Exchange of weather RAdar information (OPERA) of the Network of European Meteorological Services (EUMETNET) took place in the context of the development by WMO of a weather radar database. OPERA agreed, at its meeting held in Uppsala, Sweden (2 to 4 June 2010) to provide the content of the OPERA database to WMO to include it in the WMO database that is being hosted by the Turkish State meteorological Sevice.

European Union Cooperation on Science and Technology (COST)

13. CIMO experts were involved in actions of the European Union Cooperation on Science and Technology (COST). These included in particular the COST Action ES0702 EG-CLIMET "European Ground-Based Observations of Essential Variables for Climate and Operational Meteorology" that was initiated in May 2008 and will last for at least a period of four years. Test-beds established for this COST Action will allow the initiation of the CIMO test-bed instrument facilities as requested by EC-LIX. The COST 727 action on "Measuring and Forecasting Atmospheric Icing on Structures" ended in September 2009. It is expected that the final report of this action will be published as an IOM Report.

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FUTURE WORK AND WORKING STRUCTURE OF THE COMMISSION

Future working structure of the Commission

1. With a view to providing the most relevant support to the organization in addressing priority areas, such as WIGOS and GFCS, and to improve its efficiency and effectiveness, the Management Group reviewed the working structure of CIMO to improve its responsiveness to changing requirements and led to the proposal that is submitted to CIMO-XV for consideration. The Management Group was of the opinion that more emphasis should be put on standardization, remote-sensing and new technologies as well as on the updating of the CIMO Guide.

2. The following principles were agreed upon in reviewing the structure:

(a) The MG should be small enough to be more responsive, but keep regional balance in its composition, as far as possible;

(b) MG members would be expected to carry out cross-cutting roles, beside their OPAG chairing functions, such as liaison with other important programmes or TCs;

(c) MG members would be assigned oversight responsibility for a specific ET and would be expected to attend the meetings of those ETs to be well-aware of their progress and problems and to be able to effectively contribute to the management of the Commission;

(d) As some experts were not fully aware of the roles and responsibilities they would have when they applied for a position within CIMO, the Terms of Reference of each type of position should be clarified. In particular, it should be stressed that the role of the ET Chair is not to do all the work himself, but to mobilize people to do the work and coordinate the ET activities;

(e) ETs would be established as well as Task Teams (TT) which would be composed of a subset of the ET members, and concentrate on a specific topic;

(f) Specific collaborations and associated activities (such as intercomparisons) could be performed by task teams;

(g) Meetings of TT would generally not be called before sufficient material was prepared by the TT members;

(h) TTs could contribute to different ETs;

(i) Each ET should hold a teleconference, with the responsible MG member, in the six months following CIMO-XV. Such teleconferences would be used as a kick-off meeting to establish contact between the ET members, agree on work plan responsibilities and start the work;

(j) In view of ensuring a good effectiveness of the ETs, the tasks given as priorities to an ET should preferably be closely linked to the work that the ET members are doing for their home institutions;

(k) Important, but less attractive tasks, may need to be subcontracted to be finalized;

(l) Keep the number of rapporteurs and coordinators to a minimum. (It was felt that the following rapporteurs might be needed: Rapporteur on AWS Portal and Rapporteur on Radiosonde Catalogue.);

(m) More emphasis should be set on remote-sensing observing systems, such as weather radars, wind profilers and lightning detection systems. Appropriate guidance could be obtained by improving the collaboration with testbed sites (see section 4.4).

3. The Terms of Reference of CIMO ETs that were adopted by CIMO-XIV were very detailed and far too extensive to be carried out in one intersessional period. The Management Group agreed to reformulate the ET Terms of Reference in a more generic manner. However, the work of the ET will need to be prioritized to ensure that the ETs deliver optimally.

4. The CIMO Guide is a critical source of information for NMHSs to ensure the quality of observations. It is also essential for developing countries in acquiring information on new technologies and methods of observations needed to improve their observing networks. The CIMO Guide has to be constantly maintained up-to-date, covering also new operational observing systems. Keeping the Guide up-to-date, reviewing the proposals for changes from a scientific perspective, as well as taking into account the uniformity in the presentation of the CIMO Guide requires a major amount of work. To ensure that the quality of the information provided in the CIMO Guide be maintained and that the updates could be made available in a timely manner, the Management Group proposed to establish a “CIMO Guide Editorial Board” composed of a maximum of four members, one of them being a member of the Management Group. It was recognized that the work load expected from these members would likely be much larger than the workload of experts in other expert teams, unless additional consultants were employed.

5. The outcomes of the work of the ETs needs to be included, as appropriate, into the CIMO Guide. Therefore, the ET Chairs will be responsible to ensure that the material is prepared in an appropriate manner and should collaborate with the CIMO Guide Editorial Board for the publication of the material.

6. The experience gained through the CIMO Pilot Project on WIGOS showed that much better collaboration could be established with other technical commissions or groups by sending CIMO representatives to the relevant meetings of these communities (e.g. other TCs and RAs), rather than asking them to join a CIMO ET meeting, before strong collaboration and interest to work together on specific topics had been established. It is therefore expected that in the next intersessional period some of the collaboration with other TCs and RAs would take place by sending Management Group members, or other appropriate CIMO experts, to these meetings.

7. Zero nominal growth of the WMO Secretariat Regular Budget (RB) over a number of years had implications on funding of CIMO activities, like instrument intercomparisons, technical conferences, update of the CIMO Guide and capacity building and training activities. A CIMO Trust Fund was established to strengthen CIMO resource mobilization and allow external resources to support critical CIMO activities, like instrument intercomparisons and the development of updates to the CIMO Guide.

Gender Mainstreaming

8. The first meeting of the EC Advisory Panel on Gender Mainstreaming was held in Geneva, on 25 and 26 February 2010. The panel recommended that all WMO constituent bodies should appoint focal points on gender issues that should liaise with the EC Panel.

9. The Panel recommended implementing the following activities:

(a) Develop a work plan for 2010-2011;

(b) Develop a work plan for 2012-2015;

(c) Populate the gender mainstreaming framework;

(d) Analyse data and compile report on the questionnaire sent out in September-October 2009 on the implementation of gender mainstreaming activities;

(e) Update and maintain the contacts database of focal points on gender issues;

(f) Facilitate website content update;

(g) Facilitate external collaboration initiative for the WMO Secretariat;

(h) Facilitate implementation of gender mainstreaming activities with RAs, TCs and NMHSs focal points on gender issues;

(i) Organize and facilitate meetings and workshops on gender mainstreaming;

(j) Facilitate development of the WMO gender mainstreaming tool kit.

10. EC-LXII agreed to assign high priority to the issue of gender mainstreaming and its inclusion in relevant parts of the WMO Strategic Plan, in particular those dealing with service delivery, capacity building and natural disaster reduction, given the vital role of women in areas such as agriculture and food security, water resources management, family health and overall household wellbeing and management.

CIMO Testbeds and Lead Centres

11. The two concepts of CIMO Testbeds and Lead Centres were formulated some years ago and the Executive Council (EC) requested CIMO to work on these topics. The purpose of establishing CIMO Testbeds and Lead Centres is to promote a collaboration between CIMO and relevant NMHSs in testing, development and standardization of meteorological instruments and their performance for the benefit of all WMO Members. This collaboration would utilize and build on both existing state-of-the-art facilities and specific expertise currently available at NMHSs for the provision of guidance to all WMO Members. At the same time, it would represent recognition by CIMO of existing state-of-the-art facilities and expertise available in the designated Testbed and Lead Centres, as well as of their significant contribution towards developing guidance for WMO Members; and their impact on the WMO observing systems.

(a) **Testbeds** are centres with experimental facilities to assess the capabilities of various remote-sensing upper-air technologies and to provide guidance on remote-sensing instrumentation from a variety of observing systems, like guidance concerning the optimal distribution of the deployment of new observing systems and the best mix of instruments;

(b) **Lead Centres** are centres of excellence for Instrument Development and Testing that could be focused on a specific parameter.

12. The CIMO Management Group developed draft generic Terms of Reference for Testbeds and Lead Centres to be submitted to CIMO-XV for approval. It is expected that nominated testbeds and lead centres would regularly produce Instruments and Methods of Observation (IOM) Reports that would in turn be used in developing guidance to be incorporated in the CIMO Guide.

13. A call for submitting proposals of Testbeds and Lead Centre by Members was sent out requesting proposals to include at least a description of the infrastructure and instrumentation available as well as the proposed main activities of the testbed/lead centre. At the date of writing two proposals had been received.

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DRAFT PROPOSAL FOR THE ESTABLISHMENT OF A WMO-CIMO LEAD CENTRE ON PRECIPITATION INTENSITY (LC-PRIN) *"BENEDETTO CASTELLI"* (ITALY)

1. WMO Lead Centre on precipitation intensity

In consideration of the requirement for general standardization of precipitation intensity measurements, the need for building the hierarchy of the traceability of precipitation intensity measurements to International System of Units standards, and the need for instruments development to promote worldwide instrument compatibility and interoperability within WIGOS, it is proposed to establish, in Italy, a CIMO Lead Centre on Precipitation Intensity (**LC-PRIN**).

The LC-PRIN is intended as a Centre of Excellence for instrument development and testing which would be established with the purpose of providing Members with specific guidance and standard procedures about instrument calibration and their achievable accuracy, performing laboratory and field tests and the intercomparison of instruments, and providing research advances and technical developments about the measurement of precipitation intensity and the related data analysis and interpretation.

It will be focused both on liquid precipitation intensity (rainfall intensity - RI) and on solid precipitation intensity (snowfall intensity - SI).

The establishment of the Lead Centre would allow practical capitalization of the experience and know-how developed and reinforced in the course of the recent WMO Laboratory Intercomparison of Rain Intensity Gauges (Trappes, Genova, De-Bilt, 2004-2005) and WMO Field Intercomparison of Rain Intensity Gauges (Vigna di Valle, 2007-2009), whose scientific aspects and results has been respectively published by WMO in the reports IOM No. 84 (WMO/TD-No. 1304, 2005) and IOM No. 99 (WMO/TD-No. 1504, 2009).

The LC-PRIN will have a distributed organization, being located at three main sites so as to make best use of the available know-how and infrastructures. It will consist of:

(a) A laboratory for instruments testing and calibration in controlled conditions, located at the University of Genova (**LC-LAB**) one of the site hosting the WMO Laboratory Intercomparison of Rain Intensity Gauges (2004-2005);

(b) A field site characterized by a Mediterranean climate with intense, prolonged rainy periods, located at the Italian Meteorological Service (IMS) Centre of Meteorological Experimentations (ReSMA) in Vigna di Valle (Rome), where an infrastructure has been realized for testing and intercomparing liquid precipitation measurement instruments (**LC-RI**) during the WMO Field Intercomparison of Rain Intensity Gauges (2007-2009);

(c) A mountain site, characterized by snowy periods and harsh climate conditions, located on the top of Mt Cimone (2163 mt a.s.l.), in the hearth of the northern Apennines, operated by the IMS Mountain Centre (CAMM) and envisaged for solid precipitation intensity measurements (**LC-SI**).

2. Main activities and competences

The following main activities are proposed for the establishment of the LC-PRIN:

(a) The CIMO LC-PRIN maintains capability to perform dynamic calibration, metrological confirmation and intercomparison of rain intensity gauges in the laboratory according to the recommended CIMO procedures (CIMO-XIV – Recommendation 2). It would develop suitable devices and technical procedures to improve the testing capabilities following the results of the WMO Field Intercomparison of RI gauges (e.g. the evaluation of stability of 1 minute measurements, the determination of the 1 minute step response function, the recommendation for accurate time synchronization of 1 minute intensity measurements, the evaluation of possible standard calibration procedures for non-catching type precipitation gauges). The LC-LAB located at the University of Genova has competence for this activity;

(b) The CIMO LC-PRIN maintains suitable equipment for laboratory calibration and the traceability of its measurement standards and measuring instruments, therefore providing support for certification of the instruments' performance as a suitable Independent Third Party Organization. The LC-LAB has the necessary infrastructure and the competence for this activity;

(c) The CIMO LC-PRIN makes research on suitable equipment and procedures for routine field testing of network precipitation gauges to be proposed as recommended for the standardization of field calibrations of precipitation gauges during operational use, as well as on the interpretation of the influence of measurement errors on meteo-hydrological applications, correction procedure for historic data series, and post-processing techniques for automatic correction of the measured rain intensity. The LC-LAB, located at the University of Genova, and the LC-RI, located in Vigna di Valle (IMS), both have competences for this activity;

(d) The CIMO LC-PRIN has the necessary test bed and equipped facility to perform regular field measurement campaigns or international/regional comparisons with the purpose of testing the performance of different measuring principles for rainfall intensity (RI) and the effects of laboratory calibrations mentioned above on the measured intensities. The LC-RI has the necessary infrastructures and the competence for this activity;

(e) The CIMO LC-PRIN maintains a set of gauges acting as a working reference for field measurements of rainfall intensity; working reference rain gauges are inserted in a pit according to the ISO/EN 13798:2002 - revised 2010 (Specification for a Reference Rain Gauge Pit) to minimize the effect of weather related errors on measured rain intensities. The LC-RI has the necessary infrastructure for reference rain gauges and the competence for maintaining and operating a set of gauges acting as working reference;

(f) Considering the results of the WMO Solid Precipitation Measurements Intercomparison 1986-1987 (IOM No. 67 and WMO/TD-No. 872, 1998) and the developed know-how and results obtained for the WMO Field Intercomparison of Rainfall Intensity Gauges (2007-2009), the capabilities of the LC-RI of Vigna di Valle could be transferred to a suitable site for field measurements of snowfall intensity (SI); the related infrastructure (LC-SI) could maintain a working reference for field measurements of snowfall to be installed according to the WMO reference standard (DFIR) to minimize the effect of weather related errors on measured snow intensities. Considering the meteorological-representative location, the climatology and the occurrence of harsh climate conditions, the IMS Mountain Centre, located at the top of Mt Cimone, could be envisaged to operate as LC-SI;

(g) The CIMO LC-PRIN will collaborate with relevant CIMO Expert Teams in developing guidance material;

(h) The LC-PRIN will propose standards on precipitation intensity measurements for consideration in WMO and ISO technical committees (under ISO/WMO working arrangement on 16 September 2008);

(i) The CIMO LC-PRIN will provide reports on all significant tests to the CIMO community, through publication of IOM reports and publications in scientific journals;

(j) The LC-PRIN will cooperate with regional RICs and other international test bed facilities for the organization and participation in field tests for specific purposes or in international/regional intercomparisons;

(k) The CIMO LC-PRIN will provide technical support and vocational training and will organize periodic training courses on general and specific topical issues related to liquid/solid rainfall intensity measurements.

3. Infrastructures description

3.1 Hydraulic Laboratory "E. Marchi" – University of Genoa.

Annex 1.

3.2 IMS Centre of Meteorological Experimentation (ReSMA) – Vigna di Valle.

Annex 2.

3.3 IMS Mountain Centre (CAMM) – Mt Cimone.

Annex 3.

4. WMO-CIMO LEAD CENTRE "Benedetto Castelli"

It is the intention of Italy to dedicate the future Lead Centre on precipitation to the scientist of the 17th Century Benedetto Castelli, a founder of modern hydraulics and a designer of the first European rain gauge (bibliography is attached).

4.1 A brief bibliography of Benedetto Castelli

Annex 4.

Annexes: 4

ANNEX 1

The Laboratory infrastructure of the CIMO LC-PRIN for rainfall intensity measurements *(CIMO LC-Lab)*:

Hydraulic Laboratory "E. Marchi"
Rain Intensity Measurement Laboratory
- University of Genova -

The wide range of laboratory equipment and available facilities at the University of Genoa allow the development of both basic and applied research and experimental activities in the field of hydrology and environmental monitoring as well as the characterization and qualification of instruments and processes relevant for environmental protection. The Laboratory is classified as highly qualified according to the Italian Decree by Law 297/99.

In particular, the below specialized devices for rain gauge testing are available, together with the basic electronic equipment for data acquisition, in both analogical and digital form, as well as specific devices to comply with the data output requirements of typical rain gauges.

AUTOMATIC DEVICE FOR STATIONARY CALIBRATION TESTS

The University of Genoa developed an automatic device designed to satisfy the WMO requirements for calibration and testing of rain intensity gauges. The device, named "Qualification Module for RI Measurement Instruments" (QM-RIM), is based on the principle of generating controlled water flows at a constant rate from the bottom orifice of a container where the water levels are varied using a cylindrical bellow. The water level and the orifice diameter are controlled by software in order to generate the desired flow rate. This is compared with the measure that is obtained by the RI measurement instrument under consideration so that dynamic calibration is possible over the full range of rain rates usually addressed by operational rain gauges.

The Qualification Module for Rain Intensity Measurement Instruments developed at the University of Genova, and extensively used during the recent WMO laboratory calibration initiatives.

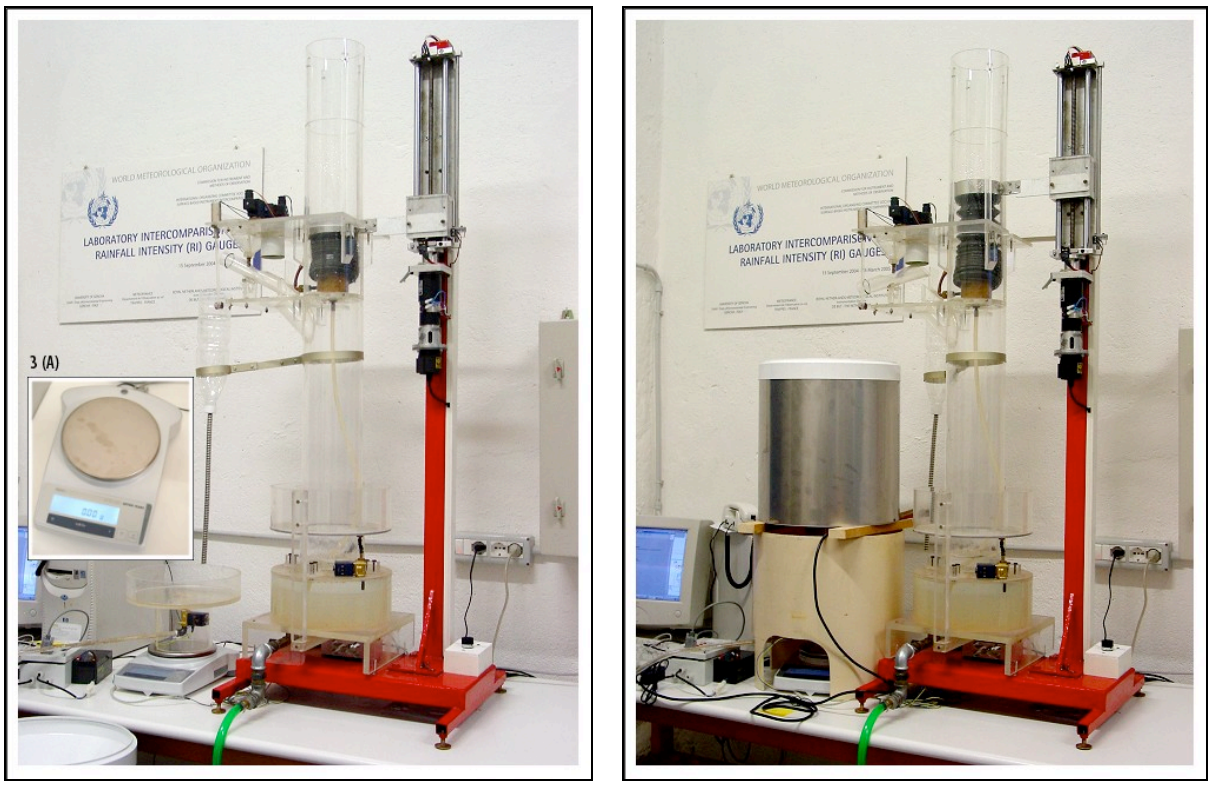
The QM-RIM calibration procedure is based on the capability of the system to produce a constant water flow. This flow is provided to the RI gauge under test and the duration and the total weight of water that flows through the instrument are automatically recorded by the acquisition system. The weight is determined using a precision balance. During the test the ensemble precision balance/weighing tank is protected by a plastic structure which also supports the RI gauges under calibration. The duration of the tests and the mass measurement are controlling factors for determining the uncertainty of the test. Therefore, mass and duration used for each test were chosen so that the uncertainty of the reference intensity was less than 1%, taking also into account the resolution of the instrument.

The total water weight and the duration of the test determine the value of the generated rainfall intensity (reference intensity I_r). Accordingly, the efficiency of the QM-RIM in calibrating RI measurement instruments strictly depends on its capabilities in generating different constant flow rates. A constant flow rate is a basic requirement for an accurate estimation of the reference intensity I_r. The flow rate Q is simply provided by the classic equation:

$$Q = \xi \cdot \Omega \sqrt{2gH} \quad ,$$

where g is gravitation constant and ξ is a suitable coefficient.

Based on such equation and assuming ξ as constant, different steady flow rates can be generated by simply varying the water head H and the section area of the orifice Ω.



Present configuration of the QM-RIM with (right) and without (left) a RI gauge under test. The inner rectangle also shows a close view of the precision balance.

In the QM-RIM the water head H is varied using a cylindrical bellows. The expansion of he bellows is controlled by a motor with encoder while the water flow is maintained by a submerged pump. The diameter of the bottom orifice is otherwise regulated by a set of three electro valves

equipped with different nozzles. The water level and the orifice diameter are software controlled in order to generate the desired flow rates.

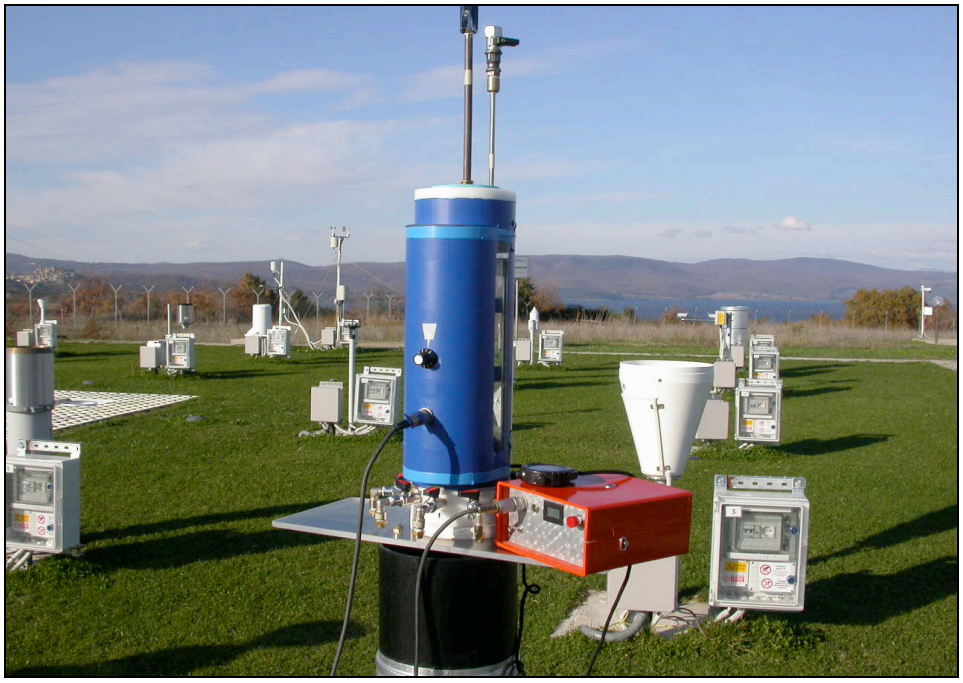
Moreover, since only variations of the water head *H* can produce variations of Q, the system has been developed to rapidly compensate ΔH by means of an overflow control mechanism. The spilling mechanism at the top of the bellows allows compensation of both the possible decrease and increase of the water level. This particular feature of the QM-RIM is particularly relevant when the uncertainty for the constant flow generation apparatus is calculated.

Accurate metrological validation is a crucial issue in testing the performance of any calibration apparatus. Reliability of calibration is in fact strictly connected with the capability in controlling and managing inherent calibration uncertainties. The effectiveness of laboratory calibration is based on the inherent uncertainties of the calibration apparatus that, as stated above, must assure a relative uncertainty better than 1%.

The automatic device was designed for the calibration of rain intensity measurement instruments by means of a simple reproducible laboratory procedure and is able to provide calibration curves for different types of rain gauges. All the proposed standard procedures refer to the typologies of systematic and random errors as defined in the ISO Guide to the Expression of Uncertainty in Measurement (International Organization for Standardization, Geneva, Switzerland, 1993).

PORTABLE DEVICE FOR MANUAL TESTING OF RAIN GAUGES IN THE LAB/FIELD

The portable device was developed at the University of Genoa with the aim of providing the on-site capability of performing the same kind of tests that are used for the calibration of catching type rain gauges under controlled conditions in the laboratory.



The portable device for field calibration of catching type gauges in use during the WMO Field Intercomparison of RI gauges.

The same methodology is indeed adopted, based on the generation of a constant water flow from a suitable hydraulic device within the range of operational use declared by the instrument's manufacturer. The water is conveyed to the funnel of the instrument under test in

order to simulate a constant rainfall intensity. The relative difference between the actual flow of water conveyed through the instrument and the “rain intensity” measured by the instrument itself is assumed as the relative error of the instrument for the given reference flow rate.

The principle exploited by this portable device is that of preserving a constant hydraulic head over a given orifice area by ensuring the automatic and continuous pressure adaptation of the air/water contained inside a closed container. The transit time of the water level between two fixed limits is the only variable to be measured to complete the test at any reference rainfall intensity. In order to reduce the sampling error, with reference to e.g. a tipping-bucket rain gauge having a resolution of 0,2 mm (bucket volume of 20 g) and a collector’s area of 0,1 m2, the container should be filled in with at least 2 litres of water, so that at least 100 tips of the buckets will occur.

The developed portable device allows to perform:

- High precision tests for rain intensity measurement uncertainties rather than for the sole rain accumulation over a given time period;
- Dynamic calibration tests rather than just volumetric or single intensity tests;
- The generation of rigorously constant water flows for the entire duration of each test;
- The entire calibration procedure recommended by WMO for rain intensity measurement instruments, with one single apparatus and on-site;
- Non invasive tests that do not require modifications of the instrument and changes from its current operational conditions;
- Tests that are immediately available, since no special post-processing of the data measured during the tests is required.

From the operational viewpoint the portable device has the advantages to avoid taking down the rain gauge for delivery to the laboratory, to perform the tests rapidly – with durations that are comparable to the usual time spent for ordinary maintenance interventions, and to require non-specially trained personnel to perform the tests – due to the very simple operations required. Also, the portable device is well suited for use in less industrialized countries, where simple and readily understandable technologies are required, with no need for any sophisticated component and just a limited volume of water required to perform the tests.

The portable device is an ideal and cost-effective solution for metrological qualification of rain intensity instruments within the framework of the quality assurance procedures that are now widely adopted by the organizations in charge of managing meteorological measurement networks at the regional, national and international levels.

RESEARCH

Various research activities are connected to this laboratory and the testing activities therein.

The research performed concerns the themes of physical and stochastic hydrology, monitoring and remote sensing of precipitation, modelling of space-time rainfall fields, monitoring and prediction of extreme events, risk management and warning systems, floods and flash floods, basin hydrology, distributed hydrological modelling, urban hydrology, storm water quality and water treatment.

The results of these research activities are synthesized in a series of papers published in international journals or as conference proceedings in the fields of hydrology, water resources management, multi-sensor environmental monitoring and prediction and mitigation of hydro-geological hazard. A list of the scientific production over the last 10 years, limited to what is connected to the rain intensity laboratory, is reported below.

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ANNEX 2

The field infrastructure of the CIMO LC-PRIN for rainfall intensity measurements *(CIMO LC-RI)*:

The IMS Centre of Meteorological Experimentations (ReSMA) – Vigna di Valle

SITE DESCRIPTION

The Centre of Meteorological Experimentations (ReSMA) of the Italian Meteorological Service at Vigna di Valle, Italy (42.083 N, 12.217 W) is located on the top of a hill at 262 meters above sea level. It is close to Bracciano Lake and 12 km from an isolated mountain chain in the northern direction (600-900 m above msl). The location is generally characterized by a wind regime of dominant flows during the year from SW (warm-humid air masses) and from NE (cold-dry air masses). The most intense rainy period is from October to December; however spring and summer intense events are also possible. During the rainy period or in strong spring events, the maximum recorded rainfall intensity (RI [mm/h]) lasts at least 20-30 minutes and generally depends on rain thunderstorms and showers due to a combination of cold and warm fronts mainly coming from SE-SW. The worst weather conditions normally occur when perturbations meet a strong lake humidity condition (beginning of autumn, early spring, hottest summer days). The situation is similar during summer: intense precipitation events (but less frequent) occur mainly with dominant winds from E and from Rome “hot island” zone (50 km from Vigna di Valle).

During precipitation events, an average wind speed of 5m/s is generally recorded, except in cases of enhanced Tower Cumulus (TCU) clouds or Cumulonimbus (CB) outflows (stronger winds) that usually precede intense showers for several minutes.

The infrastructure for RI measurements was built in the experimental area of ReSMA (Fig. 1). It is a flat 400m^2 grass field which is equipped with 34 concrete platforms (4 corner-platforms and 30 evenly distributed platforms) and a central 4-fold ISO standard pit for the installation of the set of reference RI gauges (ISO/EN 13798:2002, revision 2010). Each platform is supplied with power supply (AC and VDC), serial communication converters, 8 free and 8 coupled high quality double shielded cables for data acquisition and low voltage threshold discharge protections (Fig. 2).

Fig. 1: Experimental area of ReSMA and the Intercomparison test bed– Vigna di Valle, Italy

Fig. 2: WMO Field Intercomparison test bed – Vigna di Valle (Italy).

The Vigna di Valle site was selected by the WMO as the suitable location for the organization of the Field Intercomparison of Rainfall Intensity Gauges and an appropriate intercomparison test bed has been realised for this campaign which has been conducted from 2007 to 2009. The results of the intercomparisons have been published in WMO/TD-No. 1504 (2009) and in the WMO IOM series as report No. 99, at present available on CIMO-IMOP Website.

DATA ACQUISITION

The data acquisition system is composed by a Campbell Scientific CR1000 data-logger equipped with serial output filtering peripherals (SDM-SIO4), switch closure/open collector peripherals (SDM-SW8A), multiplexers peripherals (AM16/32A), memory cards (field data storage), converters for serial protocols (ADAM4520 - RS232-422-485), 2 battery packs, an UPS system and an Ethernet module for communication and data transfer to the main PC (second data storage). The main PC was also equipped with an UPS and a RAID1 hard disk system for providing fail safe operations and an uninterrupted data acquisition. Moreover the system was equipped with a couple of external USB hard disks for full backup of raw data (third data storage).

The DAQ system could be programmed for performing direct measurements (for switch closure gauges, vibrating wire rain gauges, pulse emitting rain gauges, wind monitoring sensors, temperature/RH sensors, etc.) and serial output acquisition for string emitting rain gauges.

The clock of the CR1000 provides the measurements timestamp used for optimal synchronization, especially relevant for the evaluation of reduced-scale sampling time (e.g. 1 minute data for Rainfall Intensity measurements).

The man-operated H24 GCOS-GAW meteorological station of Vigna di Valle (WMO ID 16224) is located in the same area and its observations may be used as metadata for RI measurements campaigns.

QUALITY ASSURANCE ASPECTS

Dedicated automatic quality checks has been developed for the WMO Field Intercomparison (*see WMO/IOM No. 99*): their upgraded version will be employed for the future activities of the LC-PRIN, in order to provide quality checked RI data, quality checked ancillary data and QC information (e.g. flags, suspect data, erroneous data, etc.), to be used for data analysis and evaluation of results.

Quality checks and related procedures are part of a Quality Assurance (QA) plan to ensure proper data and metadata acquisition, storage, processing and analysis. All information on visual inspection, observations, maintenance and repair are usually stored in electronic logbooks, to be used as data quality information and in QA reports.

The local staff concerned with LC-PRIN activities can perform daily visual checks, cleaning of instruments when necessary, and calibration status checks when required by instruments technical manuals.

A suitable portable device for field calibration of catching type instruments can be used for performing field tests and calibrations verification.

Italian Air Force
ReSMA – Italian Met Service Centre of Meteorological Experimentations
Via Braccianese Claudia km 20,100
00062 Vigna di Valle
ITALY
Tel.: (+39) 06 99 80 10 13
Fax: (+39) 06 99 87 297
e-mail: vigna@meteoam.it

ANNEX 3

The field infrastructure of the CIMO LC-PRIN for snowfall intensity measurements *(CIMO LC-SI)*:

The IMS Mountain Centre (CAMM) - Mt Cimone

SITE AND CENTRE DESCRIPTION

The CAMM centre is located in the hearth of the Apennines, with its operative base on the top of Mt Cimone (2165 m a.s.l.), and logistic base in Sestola (1020 m a.s.l.), at about 65 km from Modena and 87 km from Bologna.

Mt Cimone is the highest peak of the northern Apennines, with a field of view free for all 360°. The geographic location and the high altitude make Mt Cimone a strategic and particular representative site for telecommunications and for meteorological observations and research (Fig. 1)

The Centre is depending on C.N.M.C.A. (Centro Nazionale di Meteorologia e Climatologia Aeronautica – National Meteorological and Climatological Air Force Centre) of Pratica di Mare (Rome); C.A.M.M. has three main duties:

- Telecommunications, with radio link and a TLC laboratory;
- Synoptic and Aeronautical weather observations;
- Environmental GAW observations.

In particular, CAMM deals with traditional meteorology (aeronautic and synoptic) for air navigation assistance and for weather forecast service and with GAW observations for climate and atmospheric changing monitoring.

The Centre is composed by a Gathering and Processing Data Service, a Meteorological Station and a Special Observations Unit.

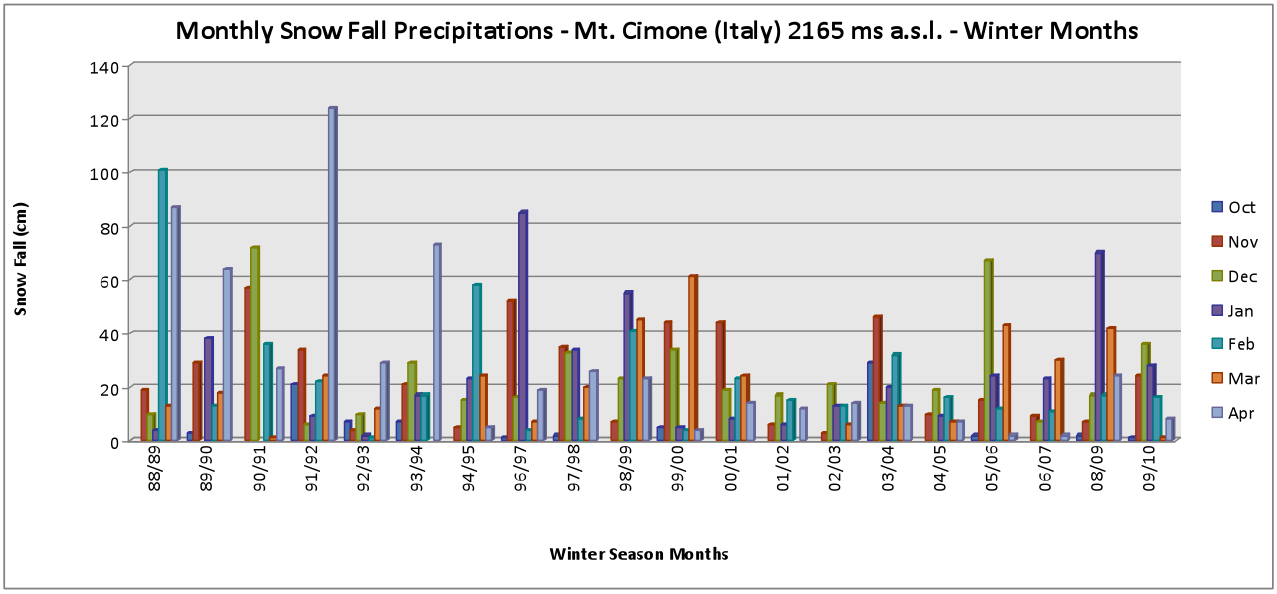
CAMM has got various data series (both meteorological and GAW) among the most ancient in Europe, in particular the time series of the measurement about carbon dioxide concentration, starting from 1979, is the longest in Europe.

Fig. 1: CAMM infrastructures located on top of Mt Cimone (Italy)

CLIMATE DESCRIPTION

Mt Cimone is characterized by a very particular climate with many extreme weather conditions due to strong winds for much of the year (up to 216 km/h); rapid ice formation with flags which may grow up to 40 cm in 3 hours from October to March; very low temperatures (- 22°C absolute minimum temperature measured in January 1981). The observatory is covered by clouds for 15-20 days per month, and it is only during the summer time that this value decreases to 10-12 days, but it also increases the frequency of high intensity thunderstorms with much lightning.

From the snow precipitation point of view, during the winters of the last 20 years the average has fallen to about 1,70 m of snow with a maximum value of 3,12 m in 2008 and a minimum 0,62 m in 2002. The average number of days with snow per year is 37 with a maximum value of 60 in 2008 and a minimum of 23 in 2006. In a single day the maximum amount of snow measured was 59 cm on 11 December 1990.



Italian Air Force
CAAM – Italian Met Service Mountain Centre
Via della Ville, 40 – 41029 SESTOLA
ITALY
Tel.: (+39) 0536 62512
Fax: (+39) 0536 62446
e-mail: cimone@meteoam.it

C.A.M.M.
MONTE CIMONE

ANNEX 4

A brief bibliography of Benedetto Castelli

Antonio Castelli was born in Brescia, Italy, in 1578 and took the name Benedetto upon entering the Benedictine order in 1595. From perhaps 1604 to 1607 he lived in a monastery in Padua and studied under Galileo. Upon receiving a copy of Sidereus Nuncius, in Brescia in 1610, he applied for a transfer to Florence, where he arrived in 1611. Castelli helped see Galileo's Discourse on Floating Bodies through the press and published the reply (largely written by Galileo) to the polemics against it. Castelli was also active in the initial stages of Galileo's sunspot research in 1612, coming up with the method of projecting the Sun's image through the telescope.

Upon Galileo's recommendation, Castelli was appointed professor of mathematics at the University of Pisa in 1613. When the court was visiting Pisa late that year, Castelli was invited to dinner and became involved in a lengthy after-dinner discussion about the merits of the Copernican System. Castelli presented Galileo's arguments about reconciling the Copernican theory with certain biblical passages, e.g. in the book of Joshua. It was this occasion that prompted Galileo to write a long letter to Castelli on the subject of science and religion, which was later expanded into the Letter to the Grand Duchess Christina. Both versions of the letter circulated in manuscript, and the Letter to the Grand Duchess was printed in Strasbourg in 1636.

Castelli moved to Rome in 1626 to become a consultant to the Pope on the management of rivers in the Papal States (a perennial problem) and professor of mathematics at the University of Rome. In 1628 he published the important work on hydraulics, “Della Misura dell'Acque Correnti”, or "On the Measurement of Running Waters," a book that may be considered the foundation of modern hydrodynamics. Benedetto Castelli gave the first description of a rain gauge in Europe while he was involved in the lowering of the Lake Trasimeno. He was the first to state clearly the continuity equation. In a document dated 1639 and addressed to Galileo Galilei, Castelli, referring to the low levels of the lake, calculates how much the lake level would increase after a given rainfall, based on the amount of rain found in a vessel: this vessel can thus be considered the first rain gauge in Europe. B. Castelli installed a raingauge in the countryard of the Benedectine monastery of St. Peter in Perugia, in order to provide a basis for the variations in level of the lake.

DRAFT PROPOSAL FOR THE ESTABLISHMENT OF A WMO-CIMO TESTBED FOR GROUND-BASED REMOTE-SENSING AND IN-SITU OBSERVATIONS

METEOSWISS AEROLOGICAL STATION PAYERNE (SWITZERLAND)

1. The MeteoSwiss aerological station Payerne is one of the WMO - GRUAN (GCOS Reference Upper Air Network) reference sites. As such, MeteoSwiss intends to make the aerological station Payerne available as a Testbed for ground based remote-sensing and in-situ observations, for comparing operational radiosondes and in particular for testing and comparing possible future reference radiosondes.

2. At the Payerne observing station, upper air measurements have been made routinely since 1941. Balloon borne radiosondes measuring pressure, temperature, humidity are operationally performed twice a day (00 and 12 UTC). Ozone profiles are measured three times per week. With long tradition of using its own Swiss SRS400 radiosonde, the Payerne aerological station has been collaborating with radiosonde manufacturers since decades and has been playing an important role at several international radiosonde intercomparisons.

3. Aerological radiosonde profiling at Payerne has been expanded in recent years with ground-based remote sensing profiling techniques. Wind profilers were first introduced in the 1990s and are now routinely operated at the station. Temperature and humidity profiles are measured with different types of microwave radiometers, and a new LIDAR system has recently been installed at Payerne for operational water vapour profile measurements. While remote sensing systems have limited altitude performances, they largely improve temporal resolution, providing temperature, humidity and wind profiles every thirty minutes for present weather analysis and for high temporal resolution weather prediction model assimilation.

4. Within the European COST Action ES0702 - European Ground-Based Observations of Essential Variables for Climate and Operational Meteorology - (EG-CLIMET), we presently establish a research program investigating the uncertainty of radiosonde profiles and integrating the different upper-air profiling systems, with the final goal of establishing a reference for upper air temperature and humidity profile measurements. These activities are well within the aims and goals of the GRUAN initiative.

5. Given the above mentioned circumstances and current efforts at Payerne to further develop and foster high-quality radiosondes and remote sensing techniques to improve upper air profile quality and temporal resolution, we submit the Payerne GRUAN station as a candidate for becoming a WMO CIMO Testbed centre. As such the MeteoSwiss Payerne internal reports that will address issues about upper air remote sensing technologies will also be submitted in the form of WMO CIMO IOM reports, thus giving a chance for further sharing expertise and resources with international partners and other Meteorological Services.

6. We therefore are very pleased to propose the establishment of a CIMO Testbed for upper air observations at our Payerne atmospheric observing station.

ANNEX

Description of MeteoSwiss Payerne atmospheric observing station

Payerne is the principal atmospheric observing station of Switzerland, with operational and research surface and upper air measurement systems belonging to several international long-term monitoring networks and research projects. Other measurement systems are located at higher altitudes within the Alps at some distance from Payerne up to 3500 m asl (Jungfraujoch). Both in-situ and surface based remote sensing techniques are used. The main objectives are the monitoring of a vertical atmospheric column on a long-term basis, the quality assurance of atmospheric measurement systems, as well as the validation of the numerical weather prediction models.

The measurements meet the requirements of several international networks (GSN, GUAN, GAW, BSRN, NDAC, EMEP). The Payerne observatory is also presently involved in several COST projects and has a close collaboration with several national and international research groups.

Location: 46.8 N, 7.0 E, 491m (asl), hilly terrain on the Swiss Mittleland between the Jura Mountains and the Alps. Main measurement systems:

Profiling

- Operational radiosonde station (4 soundings per day, 3 ozone soundings per week, 1 tropospheric “reference” humidity sounding per month)
- Operational Low Level Windprofiler (1290 MHz)
- Operational Ceilometer
- Operational Ozone microwave radiometer
- Operational Microwave temperature and water vapour radiometers
- Operational Water vapour Raman lidar
- Operational GPS antenna (water vapour column)

Surface

- Operational surface meteorological station, as well as test facilities
- Operational surface radiation measurements (full Baseline Surface Radiation Network programme + UV components + surface layer measurements on a 30 m mast),
- Operational surface air pollution station Coordinated Alpine sites near Payerne:
- Arosa (Dobson and Brewer ozone spectrophotometers),
- Jungfraujoch (full in-situ aerosol GAW-programme operated by research institutes)
- Zimmerwald (GPS and microwave systems, Uni Bern)
- At other sites: 3D operational precipitation radars as well as radiation monitoring stations.

Additional information can be found in the following web-sites:
http://www.meto.gov.uk/research/interproj/cwinde/profiler/payerne/index.html
http://www.meteosuisse.admin.ch/web/en/climate/climate_international.html
http://www.meteosuisse.admin.ch/web/en/research/projects/cn-met.html
http://www.meteosuisse.admin.ch/web/en/research/projects/lidar.html
http://www.meteosuisse.admin.ch/web/en/weather/ozone_layer.html

Contact

MeteoSwiss, Station aérologique - Case postale 316, CH-1530 Payerne, Switzerland
E-mail: dominique.ruffieux@meteoswiss.ch - Tel.: +(41 26) 662 6274

DRAFT PROPOSAL FOR THE ESTABLISHMENT OF A WMO-CIMO TESTBED FOR IN-SITU REMOTE-SENSING INTRUMENTS (TB-REM) "SODANKYLÄ" (FINLAND)

1. INTRODUCTION

1.1. PURPOSE OF THE DOCUMENT

This document is the quick response by FMI to the recent invitation by CIMO to submit proposal to CIMO remote sensing test beds. FMI is offering the exceptionally versatile and well equipped sub-arctic observatory at FMI-Arctic Research Center (FMI-ARC) at Sodankylä, Northern Finland (67N) for this purpose. As the invitation was fairly broadly formulated and came with fairly short notice it is understood that this document may not be complete and FMI is prepared to update and complement this proposal in accordance with the possible requests by CIMO.

1.2. PROPOSAL LAYOUT

The proposal includes the site description and description of the relevant instrumentation. The appendices include data base description. It is understood that purpose of the Testbed-REM is to assess the capability of various ground based remote sensing instruments, however, these instruments require precise measurements of ground level parameters.

2. SITE DESCRIPTION

FMI-ARC (http://fmiarc.fmi.fi)**:** The Arctic Research Center at Sodankylä has an exceptionally versatile monitoring program and consequently participates in many observational networks including World meteorological Organization WMO coordinated GAW and GRUAN (Global Reference Upper Air Network) , SYNOP and radio/ozone sonde networks. Other networking includes NDACC (Network for Detection of Atmospheric Composition Change), TCCON (Total Carbon Column Observing Network) and several projects funded by ESA and EU. FMI-ARC has long history for accepting visiting instruments and has decades of experience of hosting the arctic campaigns especially in the frame of EU, ESA and EUMETSAT projects. In the present organization of FMI the Arctic Research Centre is part of the Arctic Research Unit that executes one of the 7 core research programs of the Research Division of FMI. Arctic Research Centre itself is organized in three units: Research, Satellite operations and Technical development and support. A total number of personnel is 25. The site coordinates are : ***67.368 °N, 26.633 °E, 179 m*** above mean sea level. Sodankylä area is usually classified as a boreal region. However, with regard to the stratospheric meteorology, Sodankylä can be considered to be an Arctic site, often lying beneath the middle or the edge of the stratospheric polar vortex and in the zone of polar stratospheric ozone depletion.

The Sodankylä meteorological site has a long history extending back to 19th century as a boreal- sub arctic meteorological and magnetic observatory. Continuous, homogenized time series of the key Sodankylä weather parameters start from the year 1908 and the radiosonde record, also homogenized to the extent possible, goes back to 1949. In the present time FMI-ARC executes ground based observation program serving both operational weather forecasting and atmospheric research, internationally competitive arctic global change research program, competent technical development and support functions and satellite data receiving, processing and archiving functions. FMI-ARC is connected to headquarters with a 100 Mbps connection that is upgraded to a 10 Gbs connection on August 2010. The summary of the observational program of Sodankylä site is listed in Table 1.

Figure 1. Location of Sodankylä site

Table 1. Regular Observations at FMI-ARC, Sodankylä

Observation type	*Starting year*	*Description*
Ground weather observations		
Temperature, air pressure, air relative humidity, wind speed and direction, precipitation, visibility, soil temperature,snow cover	1908	Ground
Air chemistry: radon-222 (aerosol beta activity, alpha counting)	1996	Ground
Solar radiation observations		
Global-, reflected-, diffuse- and direct component of solar radiation, sunshine hours radiation	1957	16 m tower
Aerosol optical depth	2004	16 m tower
Ground-based UV- and (remote sensing) ozone observations		
Global UV-radiation, spectral UV-radiation	1990	Ground
Total column ozone, total column nitrogen dioxide	1990	Atmospheric pilar
Balloon borne observations		
Temperature, air pressure, air relative humidity, wind speed and direction from radiosondes	1949	Ground to 30 km
Ozone concentration from ECC sonde	1988	Ground to 30 km
Water vapor concentration from a frost point hygrometer	2002	Ground to 30 km
Aerosol backscatter coefficient ratio from backscatter sondes	1994	Ground to 30 km
Meteorological mast Experiment		
Soil temperature and moisture profiles, RH% at 10 cm, leaf (needle) wetness, heat flux	1999	Ground
Snow depth, snow temperature profile, air temperature and relative humidity 10 cm above soil or snow	1999	Ground
Sonic wind speed, direction, temperature, friction velocity, heat vertical flux at 3,8,32 and 47 m	1999	48 m high mast
Temperature, relative humidity, wind 3,8,18,25,38,47 m, water vapour vertical flux	1999	48 m high mast
Global-, reflected-, diffuse- component of solar radiation, net radiation, photosynthetically active radiation	1999	48 m high mast
Long-wave radiation, outgoing long-wave radiation, radiation temperature of canopy	1999	48 m high mast
CO2 vertical flux	1999	48 m high mast
Greenhouse gases by ground-based remote sensing observations		
Column average dry-air mole fractions of CO2 and CH4	2009	Atmospheric column
Other ground-based remote sensing reference observations		
Spectral VIS-NIR surface reflectance	2006	Forested and open terrain
Brightness temperature from L-, X-, Ku-, K-, W-band microwave radiometer	2009	Terrain and atmosphere
Other observations		
Snow observations along a 4 km snow course		Ground

3. MEASUREMENT METHODOLOGY

The Meteorological station of FMI-ARC belongs to WMO regular network –station number 836. The total ozone and ozone soundings program is part of WMO Ozone and UV network – station number 262. The practices in the surface observations, radiosoundings and ozone soundings follow WMO instructions /RD04/ and appropriate instrument manufacturers manuals /RD05/, /RD06/, /RD07/, /RD08/ and /RD 09/. For the stratospheric humidity soundings with cryogen cooled frost point mirror techniques the practices of University of Colorado, the manufacturer of the hygrometer, has been adopted at Sodankylä since 1996. Continuous ground-based measurement of ozone is performed by Brewer spectrophotometer at the site. In future, the tropospheric water vapor and temperature profiles and total amount of water vapor will be obtained by a microwave radiometer.

4. INSTRUMENTATION DESCRIPTION

4.1. ATMOSPHERIC PROFILES

4.1.1. Vertical profile of Air temperature

RS92: Vertical profile of Air temperature will be measured by balloon borne radiosonde RS92 developed and manufactured by Vaisala. RS92 is the newest Vaisala product, a digital radiosonde evolution based of the RS80-RS90 sonde family, the most widely used Pressure, Temperature, Humidity (PTU) in the WMO meteorological network since early 1980s. The temperature accuracy of those sondes given by Vaisala is ±0.2 C at the 2-sigma level throughout the troposphere for night time measurements (Paukkunen et al., 2001). This is consistent with the detailed uncertainty analysis given by Luers for the sonde RS90 (1997). Altitude positioning is based on hydrostatic altitude calculation. Vertical resolution of the data recording is 2 seconds, which leads to 8-10 m vertical resolution given the typical balloon ascent of 4-5 m/s.

4.1.2. Vertical profile of Atmospheric humidity

Vertical profile of Atmospheric humidity will be measured by RS92 radiosonde in the troposphere and by CFH sonde in the troposphere and stratosphere. Considering the humidity measurements the typical useful range for RS92 humidity sensors is from surface to upper troposphere, while the CFH instrument can be used in both troposphere and the lower stratosphere. Due to price considerations only RS92 will be used in all the soundings to map rapidly changing troposphere and CFH is used much less frequently to measure fairly stationary stratosphere up to 10 hPa and secondly to provide validation of RS92 measurements in the upper troposphere. For RS92 sonde validation purposes this sonde will be attached to each CFH payload. In addition an ozonesonde will be flown in each CFH payload.

RS92: Compared to RS90 (the earlier model of the sonde) the ground preparation of RS92 differs at one point: the regeneration is used, where the sensor is heated to drive off any contaminants and recover the original calibration accuracy (Hirvensalo et al., 2002). As in the case of RS90 the design is based on double humicap structure, which makes it possible to continue heating also during the flight up to the upper troposphere: alternating sequentially, one humicap is in the measuring mode while another one goes through the heating cycle. The design has two major advantages over the conventional RH sensors: double humicap effectively resists icing of the sensor (icing ruins the humidity measurements because instead of atmosphere the micro climate under the ice cover is measured) and improves time constant, which becomes critical in the colder temperatures of the upper troposphere. RS92 and RS90 were the most accurate operational radiosondes among a number of sondes tested by Milosevich et al. (2006). They found that the RS92 mean humidity accuracy relative to the reference instrument is <1% in the lower troposphere, <2% in the middle troposphere, and <3% in the upper troposphere.

CFH (Cryogenic Frostpoint Hygrometer): This is a new and improved version of the NOAA/CMDL cryogenic hygrometer, which has been the long-standing standard for balloon-borne stratospheric water vapor measurement. The cryogenic cooling of the frostpoint mirror ensures that the frost point temperatures are achieved even in the coldest and driest layers of stratosphere. Compared to its predecessor CFH has a more modern electronic system with a microprocessor control which has led to a simpler operation and improved reliability. Measurement uncertainty of the CFH instrument in the polar region (Sodankylä) range between 9 percent in the lower stratosphere and about 4 percent in the lower troposphere. The instrument has been tested at several sites included FMI Sodankylä during December 2005- April 2006. In Sodankylä also several comparison flights with Lyman alpha techniques hygrometer were performed during the same period confirming a good agreement with Lyman alpha observations. This instrument is now used routinely at several sites for validation of satellite measurements and process studies in the upper troposphere and lower stratosphere region.

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4.1.3. Vertical profile of Ozone concentration

Ozone profile will be measured by electrochemical concentration cell (ECC) ozone sondes which have an accuracy of 5 % in the stratosphere according to Komhyr et al.,1995). Total Ozone Intercomparison and Validation Campaign at Sodankylä during spring 2006 and 2007 (http://FMI-ARC.fmi.fi/SAUNA/) showed that the difference between total ozone from sondes and Brewer spectrophotometer is less than 1% for the carefully prepared modern ECC sondes (Kivi et al., 2007). During the campaign the ozone sondes will be interfaced to RS92 radiosondes, thus providing accurate measurement of air pressure. FMI has also performed a number of dual sonde

flights in order to assess the effect of the concentration of the sensor sensing solution on ozone retrievals. These experiments suggest the use of 0.5 % KI sensing solution regarding the EN-SCI Corporation z type of ozone sondes which will be used in the campaign (Kivi et al., 2007). The operational procedures used for preparation of ozone sondes are given by EN-SCI Corporation (1996) and more specifically for the use with RS92 sondes by Vaisala (2004).

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4.1.4. Vertical profile of water vapour measured from the surface;

The vertical profile of water vapour will be observed by a microwave water vapour and temperature profiler manufactured by DA-Design, Finland. The radiometer uses direct detection filterbank technology. The specifications of the radiometer are presented in the table below.

Table 2. Specifications of the radiometer

Parameter	Value
Frequency channels	22.20 GHz 23.04 GHz 23.80 GHz 25.44 GHz 26.25 GHz 27.66 GHz 31.40 GHz 36.50 GHz
Radiometric resolution	0.1 K
Absolute accuracy	0.5 K
Integration time	User selectable, 100 ms intervals

4.2. ATMOSPHERIC COLUMNS

4.2.1. Total columnar amount of water vapour measured from the surface

The GPS receiver in the nearby (20 km) Finnish Geodetic Institute (FGI) station will be utilized in the campaign. The GPS data and parallel AWS weather data are relayed directly through FGI to EUREF Permanent Network (EPN) and Zenith Total Delay and Total columnar amount of water vapour from this data are retrieved by Geoforschungszentrum Podsdam (GFZ) through bilateral cooperation with FMI. The accuracy of the integrated water vapor measurement is 1-2 mm.

4.2.2. Total columnar amount of ozone

TOZ will be obtained by a Brewer MK II spectrophotometer at Sodankylä. Since the early eighties Brewer grating spectrometers have been installed at several stations (Kerr et al., 1985) and at many stations Dobson instruments have been replaced by Brewer spectrophotometers or are planned to be replaced. The Brewer is a modified Ebert type grating spectrometer which can be operated in single or double monochromator configuration. This

instrument uses five wavelengths in the spectral range 306.3 and 320.1 nm for the standard ozone retrieval. Particular advantage of the Brewer is its fully automated operation.

Brewer measurements have a long history in Sodankylä (Kyrö, 1993, Kivi et al., 1999). Regular annual calibration of the both FMI Brewers (another one is located at Jokioinen, southern Finland) is based on the travelling standard Brewer no. 17, which in turn is calibrated against the Brewer basic triad at Environment Canada, Toronto. In addition the Brewer at Sodankylä has participated in international intercomparison campaigns organized by the Nordic Ozone Group (NOG) at Izaña, Tenerife, in 1993 and 1996, and at Tylösand, Sweden, in 2000. Accuracy of the Brewer instrument is ±1 % for the direct-sun total ozone retrieval. Currently FMI is participating to the ESA project "CEOS Inter-calibration of ground based spectrometers and Lidars" (2009-2014) which includes an accurate characterization and regular inter-comparisons with THE European Brewer reference instruments operated by RBCC-E (WMO Regional Brewer Calibration Center for Europe).

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4.2.3. Column amounts of greenhouse gases.

Columnar amounts of GHGs are measured at FMI-ARC FTS station. The station is a part of the Total Carbon Column Observing Network (TCCON), a world wide network of ground-based Fourier Transform Spectrometers recording direct solar spectra at near infrared region. From these spectra, accurate and precise column-averaged abundances of atmospheric constituents, including CO_2, CH_4, N_2O, HF, CO, H_2O, and HDO, are retrieved.

The Sodankylä FTS facility has been operative since February 2009. The core instrument is a Bruker IFS 125 HR, a very high resolution Fourier Transform Spectrometer. The device is equipped with an A547N Solar Tracker and three quantum detectors: Si, InGaAs, and InSb photo diodes. With the current setup, the spectral coverage extends from visible to mid infrared the limiting factors being the sampling laser wavelength at around 15800 cm^{-1} and the responsivity of the InSb detector at 1850 cm^{-1}. The maximum optical path difference is 258 cm resulting in a minimum resolution of 0,0035 cm^{-1}.

4.3. SURFACE PARAMETERS

The following measurements belong to routine meterological program at Sodankylä:

1. Surface temperature with an accuracy better than 0.2K;
2. Air temperature with an accuracy better than 0.2K;
3. Relative humidity with an accuracy better than 5%;
4. Surface Pressure with an accuracy better than 0.1 hPa;

4.4. ADDITIONAL SURFACE PARAMETERS

1. Wind speed and direction at 10m
   Will be provided through the Vaisala Automated Weather Station Milos 500.
2. Precipitation rate in mm/h
   Will be provided through the Vaisala Automated Weather Station Milos 500.
3. Atmosphere optical thickness
   In Sodankylä a specialized instrument Precision-Filter-Radiometer (PFR) sun photometer is used to measure Atmosphere Optical Thickness, AOT. Each instrument consists of a Precision Filter Radiometer (PFR, manufactured by Physikalisch-Meteorologisches Observatorium Davos / Weltstrahlungszentrum PMOD/WRC) and a Kipp&Zonen 2AP Gear Drive suntracker. PFR is a research grade instrument to measure direct solar irradiance in 4 narrow spectral bands centred at wavelengths recommended by WMO (wavelengths of 862, 500, 412 and 368 nm with 5 nm FWHM bandwidth). The Precision-Filter-Radiometer is calibrated every winter at manufacturer's laboratory at Geneva. The accuracy of the retrieved AOT values of the PFR depends mostly on the uncertainties of the instrument calibration and is estimated to be within 5%

4.5. METADATA

The Metadata includes measurement location, measurement time and quality control flags for the sonde data.

4.6. CALIBRATION AND ACCURACY OF CORE ATMOSPHERIC PARAMETERS

4.6.1. Core atmospheric parameters

1-2. Vertical profiles of Air temperature and Atmospheric humidity

RS92: The T and RH sensors of RS92 are calibrated in Vaisala calibration chamber CAL-4. This calibration involves high-precision reference equipment with internationally traceable calibration for low uncertainty. In addition to factory calibration the operators at the launch site make ground check which gives the bias corrections with respect to site calibrator just before the launch. WMO also has standard practice to intercompare the commercial radiosondes regularly, lastly in Mauritius 2005, Nash et al. (2006).

Nash, J., R. Smout, T. Oakley, B. Pathack, S. Kurnosenko, WMO Intercomparison of High Quality Radiosonde Systems, Vacoas, Mauritius, 2-25 February 2005. Available at:
http://www.wmo.int/pages/prog/www/IMOP/reports/2003-2007/RSO-IC-2005_Final_Report.pdf

CFH: The measuring principle of the CFH sensor is based on keeping a constant frost layer on the gold coated mirror. This is accomplished through optical measurements of mirror reflectivity and an electronic feedback system which keeps the reflectivity constant. The temperature of the mirror surface then represent dew/frost point and it is measured with a thermistor, which is imbedded into the mirror disk. Each thermistor is individually calibrated to a NIST traceable standard. The CFH is calibrated continuously over the temperature range between +25°C to -100°C. A four point equation (adapted from Steinhart and Hart, 1968) is used to simplify the conversion from resistance to temperature. The calibration points are chosen such that the error is minimized over the range of expected frost point temperatures, which span from about +25°C at the tropical surface to -94°C in the stratosphere or the extreme tropi-cal tropopause. The use of this equation introduces a systematic error not greater than 0.04°C for all mirror temperatures between -94°C and +25°C. At both the warm and the cold end of the temperature spectrum, this is a significant improvement over the previously used fixed three point calibration fit for the old NOAA/CMDL hygrometer (see Vömel et al., 2007). This is particularly relevant for measurements near the surface and the determination of the total water vapor column, as well as for middle stratosphere and cold tropical tropopause observations, where the calibration fit can be used without correction.

Six thermistors are re-calibrated in each calibration run. This helps to identify potential problems in any calibration run and can be used to establish the stability of the calibration procedure. So far, these thermistors have been calibrated in 8 different calibration runs. Among all thermistors and all calibration runs, the resistances at four standard temperatures were reproduced to within 0.06±0.5%. This uncertainty in the resistance measurement translates to an uncertainty in the temperature measurement of 0.007 ± 0.03°C over the entire temperature range. Therefore, based on the re-calibration of these 6 standard thermistors, one can assume that the uncertainty in the mirror tempera-ture measurement introduced by the calibration procedure is less than 0.03°C at the 1 sigma level.

=========

Paukkunen, A., V. Antikainen, and H. Jauhiainen (2001), Accuracy and performance of the new Vaisala RS90 radiosonde in operational use, paper presented at 11th Symposium on Meteorological Observations and Instrumentation, Am. Meteorol. Soc., Albuquerque, N. M., 14–18 Jan.

Vömel, H., M. Fujiwara, M. Shiotani, F. Hasebe, S. J. Oltmans, and J. E. Barnes (2003), The behavior of the Snow White chilled-mirror hygrometer in extremely dry conditions, J. Atmos. Oceanic Technol., 20, 1560– 1567.

Vömel, H., Rummukainen, M., Kivi, R., Karhu, J., Turunen, T., Kyrö, E., Rosen, J., Kjome N. and Oltmans, S., 1997. Dehydration and sedimentation of ice particles in the Arctic stratospheric vortex. Geophys. Res. Lett., 24, 795-798.

Miloshevich L. M., H. Vömel, D. N. Whiteman, B. M. Lesht, F. J. Schmidlin, F. Russo (2006), Absolute accuracy of water vapor measurements from six operational radiosonde types launched during AWEX-G and implications for AIRS validation, J. Geophys. Res., 111, D09S10, doi:10.1029/2005JD006083.

Miloshevich, L. M., A. Paukkunen, H. Vömel, and S. J. Oltmans (2004), Development and validation of a time lag correction for Vaisala radiosonde humidity measurements, J. Atmos. Oceanic Technol., 21, 1305–1327.

Miloshevich, L. M., H. Vömel, A. Paukkunen, A. J. Heymsfield, and S. J. Oltmans (2001), Characterization and correction of relative humidity measurements from Vaisala RS80-A radiosondes at cold temperatures, J. Atmos. Oceanic Technol., 18, 135– 156.

Luers, J. K. (1997), Temperature error of the Vaisala RS90 radiosonde, J. Atmos. Oceanic Technol., 14, 1520– 1532.

Hirvensalo, J., J. Wahn, and H. Jauhiainen (2002), New Vaisala RS92 GPS radiosonde offers high level of performance and GPS wind data availability, paper presented at 12th Symposium on Meteorological Observations and Instrumentation, Am. Meteorol. Soc., Long Beach, Calif.

Vömel, H.; Yushkov, V.; Khaykin, S.; Korshunov, L.; Kyrö, E.; Kivi, R. (2007). Intercomparisons of Stratospheric Water Vapor Sensors: FLASH-B and NOAA/CMDL Frost-Point Hygrometer. Journal of Atmospheric and Oceanic Technology, 941 - 952 .

Vömel, H.; Selkirk, H.; Miloshevich, L.; Valverde-Canossa, J.; Valdés, J.; Kyrö, E.; Kivi, R.; Stolz, W.; Peng, G.; Diaz, J. A. (2007). Radiation Dry Bias of the Vaisala RS92 Humidity Sensor. Journal of Atmospheric and Oceanic Technology, 953 - 963.

4.6.2. Additional atmospeheric parameters

1. Vertical profile of Ozone concentration

The measurement using the electrochemical concentration cell (ECC) ozone sondes is in principle an absolute electrochemical measurement : one ozone molecule sampled by the system produces 2e charge. Hence sonde equations becomes (after some elaborations):

P(O3) = 4.308*10^-4 * (I-Ib) *t*T*PC*C

where:
P(O3) = ozone partial pressure in millipascals
I = the cell output current in microamperes
Ib = cell background current,
t = flow rate in seconds per 100 cm3 of air flow
T = air temperature in sonde pump in K,
PC = altirude dependent pump flow rate correction due the decreasing pump performance in the lower pressures
C = correction coefficient based on the simultaneous TOZ measurements (not needed for the modern ECC sondes).

Am-meters and thermistors are calibrated at Vaisala. PC is a LUT based on the field and laboratory measurements by sonde manufactures, t is measured with the flow meter at the site and response to ozone is also tested at the site with the ozoniser/test unit.

=========

Vaisala, Digital Ozonesonde RS92 USER'S GUIDE, M210547EN-B, October 2004
Komhyr, W. D., R. A. Barnes, G. B. Brothers, J. A. Lathrop, and D. P. Opperman, Electrochemical concentration cell ozonesonde performance evaluation during STOIC 1989, J. Geophys. Res., 100, 9231 – 9244, 1995.

EN-SCI Corporation, Instruction Manual, Model 1Z ECC-O3-Sondes, Boulder, Colorado, 1996.

2. Vertical profile of water vapour measured from the surface and the total column of water

The raw brightness temperature data are internally calibrated by the microwave profiler. The absolute calibration of the radiometer receiver is performed by measuring an ambient temperature target and a LN2 cooled target. Additionally the microwave profiler is calibrated with

tipping-curve calibration (Han and Westwater, 2000) every month. The tipping-curve calibration algorithm provides accuracy of 0.5 K.

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Han, Y., and Westwater, E. R.: Analysis and improvement of tipping calibration for ground-based microwave radiometers, IEEE Trans. Geosc. Remote Sens., 38(3), 1 260–1 276, 2000.

3. Total columnar amount of ozone

Brewer spectrophotometer is annually calibrated against the world travelling reference Brewer. In addition our Brewer is regularly participated in the international intercomparisons, 1993, 1996, 2001, 2006. ESA CEOS intercal project include yearly intercomparisons with RBCC-E reference for the next 5 years. Daily monitoring of spectrometer response is done with the internal calibration lamps.

4.6.3. Core surface parameters

1. Surface temperature with an accuracy better than 0.2K;
2. Air temperature with an accuracy better than 0.2K;
3. Relative humidity with an accuracy better than 5%;
4. Surface Pressure with an accuracy better than 0.1 hPa;
5. Cloud amount as cloudy fraction of the whole sky at the station;
6. Visual estimation of cloud bottom and top height.

4.6.4. Additional surface parameters

1. Wind speed and direction at 10m;
2. Precipitation rate in mm/h.

Will be provided through the Vaisala Automated Weather Station Milos 500. Initial calibrations made at the factory. Periodical check ups of the calibrations are made at FMI calibration laboratory.

3. Atmosphere optical thickness

Precision filter radiometer PFR is calibrated annually in Davos at the manufacturer laboratory.

Appendix 1: Applicable and Reference Documents

Applicable Documents

/AD 01/ EUMETSAT POLAR SYSTEM Atmospheric Sounding Campaign, Statement of Work, EUM.OPS-EPS.SYS.SOW.06.0038, Issue 1, 06-Apr-2006

Reference Documents

/RD 01/ General Conditions of Tender, EUM/COL/DOC/00/0350

/RD 02/ Special Tender Conditions, EUM/COS/STC/06/1378, v1, 26 April 2006

/RD 03/ General Conditions of Contract, EUM/COL/DOC/00/0411

/RD 04/ Guide to Meteorological Instruments and Methods of Observation, 1997. Published by WMO, WMO-No. 8

/RD 05/ Vaisala, DigiCORA® III MW31, TECHNICAL REFERENCE, 2004

/RD 06/ Vaisala, DigiCORA® III MW31, USER'S GUIDE, 2004

/RD 07/ Vaisala, Digital Ozonesonde RS92 USER'S GUIDE, M210547EN-B, October 2004

/RD 08/ EN-SCI Corporation, Instruction Manual, Model 1Z ECC-O3-Sondes, Boulder, Colorado, 1996.

/RD 09/ SCI-TEC Instruments Inc., Brewer ozone spectrophotometer, Operator’s manual, April, 30, 1987, Revision A.

Appendix 2: Litdb Renewal Description

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1. INTRODUCTION

1.1. BACKGROUND

Finnish Meteorological Institute's (FMI) Arctic Research Centre (ARC) in Sodankylä has a great number of different measurements in several fields of environmental sciences. The data from these measurements are deliverer and stored in many places but mainly distributed via the litdb-database (http://litdb.fmi.fi). To ensure convenient use of the data in the future, major developments are in progress and the new litdb should be operational in 2011.

The new database will provide user defined parameters from wanted periods of time delivered in a single text-file through a user-friendly web interface. The metadata related to the measurements will be provided as well.

2. DEFINITIONS

2.1. MEASUREMENT DATA

Measurement data refers to actual measurement data i.e. to the results of measurements.

2.2. METADATA

Metadata is used to describe the relevant information about measurement procedures, equipment, local variables, time, and quality of the data.

2.3. PAYLOAD

Payload consists of measurement data and metadata. It is the effective data, stored in the database or archive, and provided to end users.

2.4. CATALOGUE-DATA

Catalogue-data is a technical term describing the location information of the payload in the archiving system. With the help of the catalogue, the database will be able to retrieve the requested measurement data and to return it to the user.

3. SCRIPTING LANGUAGE

The database used in this project will be MySQL. This choice was made because MySQL is a free program and doesn't need any license or maintenance contracts. It is widely used and has lot of material available on internet and as books. Also it is the most known database program for persons involved in this project.

The internet interface will be built up using php scripting language. The data handling and modification for MySQL compatible form is done using perl scripting language in LINUX environment.

4. TECHNICAL DESCRIPTION

4.1. NUMERICAL ASCII DATA EXCLUDING PTU DATA

4.1.1. Tables

For each measurement type, a table is created. Name of the table denotes type of the data (ASCII) and measurement type name. Naming convention:

Ascii_Label

where *Label* is the measurement type name.

Example:

Measurement type is AWS, thus the table to be created is

Ascii_AWS

4.1.2. Columns

Columns are described below. The name of the column is mentioned first followed by the MySQL data type in parenthesis.

Timestamp unique id (timestamp)	Instrument specific parameter 1 (double or in some cases varchar)	Instrument specific parameter 2 (double or in some cases varchar)	Instrument specific parameter N (double or in some cases varchar)

4.2. NUMERICAL ASCII DATA, PTU DATA

4.3. BINARY DATA

4.3.1. Tables

For each instrument, a separate data table will be created. Name of the table denotes type of the data (binary) and instrument name. Naming convention:

Binary_Label

where *Label* is the instrument name.

Example:

Webcam instrument is *Ccam1*, thus the table to be created is

Binary_Ccam1

4.3.2. Columns

Columns are described below. The name of the column is mentioned first followed by the MySQL data type in parenthesis.

Timestamp unique id (timestamp)	Path (varchar)	Filename (varchar)	Instrument label (varchar)

…

File type (varchar)

Filename convention:

yyyymmdd_hhmmss_label.xxx

where yyyy is year, mm month, dd day, hh hour, mm minutes, ss seconds, label instrument description label and xxx file type extension.

Example:

Webcam file is *100614_143003_Ccam1.jpg*

Entry in MySQL will be

2010-06-14 14:30:03	/data/webcam/Ccam1/2010	100614_143003_Ccam1.jpg	Ccam1

…

jpg

4.4. Flow chart

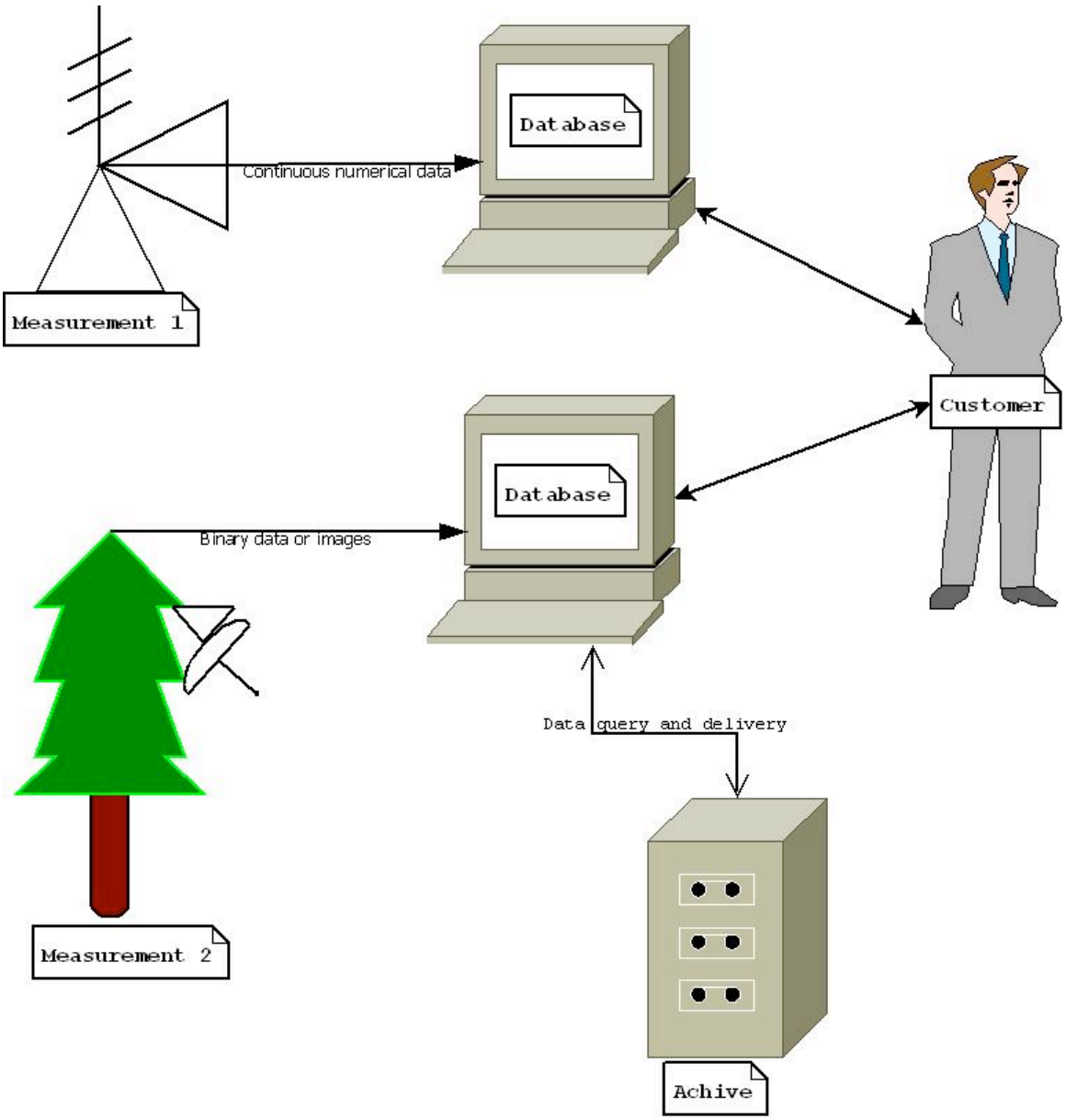

Figure 1: Schematic view of data chains in new LitDB. Data from measurement 1 is similar as described in chapters 1 and 2 and data from measurement 2 is as described in chapter 3. The databases are the same but in this image they are separated to illustrate the idea of different data.

DRAFT PROPOSAL FOR THE ESTABLISHMENT OF A WMO-CIMO TESTBED FOR IN-SITU REMOTE-SENSING INTRUMENTS (TB-REM) "Ankara" (TURKEY)

1. Turkish State Meteorological Service (TSMS) has been operating a very huge and comprehensive observing network consisting of weather radars, automatic weather stations and upper air observing systems. TSMS, as an active member of WMO activities, intends to be a nominee for the **CIMO Testbeds for ground based remote-sensing and in-situ observations (TB-REM)** in line with its one of the major goals of evaluating the performance of equipments, testing of them and developing guidance material.

2. TSMS has been organizing regular training courses related to weather radars, AWOSs and radiosonde stations since 2005 in the scope of **WMO/CIMO/OPAG-CB** activities.

3. TSMS recently has developed a project proposal to develop and manufacture polarimetric X band radars in Turkey with the contribution and cooperation of The Scientific and Technological Research Council of Turkey (TUBITAK), Middle East Technical University (METU) and Bilkent University.

4. General information about the observing systems operated by TSMS is as follows:

Type of system	**Number**	**Explanations**
Weather Radars	6	-all Klystron based, -3 single polarized, -3 dual polarised, -4 more radars by the end of 2011 -Satellite and radio-link for data transmission
Radiosonde Systems	8	-GPS based, -2 launches per day
Automatic Weather Stations (AWS)	418	-418 AWS, -GSM, satellite, terrestrial line for data transmission -200 more AWS by the end of 2011.

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DRAFT PROPOSAL FOR THE ESTABLISHMENT OF A WMO-CIMO TEST BED AND A CIMO-LEAD CENTRE (REPUBLIC OF KOREA)

TESTBED – BOSEONG

INTRODUCTION

As part of its endeavor of the Republic of Korea to participate in WIGOS activities, the Korea Meteorological Administration (KMA) has been creating an observing site at Boseong since 2008 in cooperation with the local government. The purpose of the site is to enhance standardization of meteorological observation. It aims at becoming one of best practices of standardization of meteorological observation for the WMO Member countries, and evolving into a global standardized weather station.

1. SITE INFORMATION

The site is a flatland surrounded by agricultural land, facing the South Sea:

1.1 Place: Boseong, Jeollanam-do, Republic of Korea.

1.2 Location: 34.7633N, 127.2123E, 2.8m above mean sea level (AMSL).

1.3 Area: 135,000 □ .

2. INFRASTRUCTURE AND INSTRUMENTATION

The site is equipped with ground-based remote-sensing instruments and in-situ instruments for testing their performance through parallel observation:

2.1 Ground-based remote-sensing instruments: An autosonde, a wind profiler, an optical rainfall rate sensor, a rainfall micro-radar, a radiometer.

2.2 A multi-purpose meteorological observation tower (300m, 11-levels, secured by cables).

2.3 Automatic Weather System (AWS)
- Purpose: Synoptic and agrometeorological meteorological observation;
- Elements: Wind speed and direction, temperature, humidity, pressure, precipitation, solar radiation, sunshine duration, soil temperatures/moisture.

2.4 Future Additions (2012): Pyrheliometer, 3D ultrasonic wind speed/direction sensor, scanning lidar, LI7500, PM10/2.5, Skyradiometer, net radiation sensor, soil temperature/moisture sensor, agrometeorological observations (Micrometeorology/spectral feature measurements, GHG/energy flux observations).

3. PROPOSED MAIN ACTIVITIES

KMA plans to perform parallel observations using various atmospheric profilers and rainfall micro-radar for the upper air and in-situ observational equipment for the synoptic weather. During winter KMA will test performance of automated snow depth sensor, including conducting field experiments neighboring areas, by comparing automated ultrasonic snow depth sensor and laser snow depth sensor with manual observations. In addition KMA will be developing an East

Asian carbon tracking system and archive data for verification of the national greenhouse gas inventory.

KMA plans to develop various activities for the WMO Members' capacity building. This would include sharing its experiences and expertise with and providing training programmes to the WMO Members, and publishing intercomparison and performance testing reports to contribute to the standardization of observing conditions and quality management of observational data.

LEAD CENTRE - CHUPUNGNYEONG

1. GENERAL INFORMATION

Chupungnyeong, one of KMA's synoptic observational stations, is located at the middle area of Korean Peninsula. It has been performing the synoptic observation since 1935, and was designated Korean Standard Weather Observatory for sensor performance testing and intercomparison observation by KMA in 2008.

1.1 Station: Chupungnyeong.

1.2 Location: 36.21999 N, 127.994476 E, 240.9 m AMSL.

1.3 Area: 5,345 □.

1.4 Surroundings: The area surrounding the site consists of mountainous terrain.

1.5 Notable characteristic: Standard Weather Observatory including an experimental facility.

2. INFRASTRUCTURE AND INSTRUMENTATION

The station is equipped with facilities for testing of instruments' performance:

2.1 Pits gauge: Weighing precipitation gauge and 10 precipitation gauges available for comparison.

2.2 Double fence for weighing precipitation gauge.

2.3 12 towers for anemometer intercomparison.

2.4 Synoptic observing facility: Automatic Weather Systems (AWSs) [3 (10-m) observing towers, 2 (5-m) mobile towers].

2.5 Laboratory: Reference equipment for temperature, humidity, precipitation, and radiation.

2.6 Radiation measuring equipment: 3 types of trackers and reference radiometer (PMO6).

3. CORE ACTION PLAN

It includes among others:

3.1 To perform the laboratory testing of individual weather sensor performance ability:

- Temperature, humidity, precipitation, pressure, radiation, sunshine, snow depth sensors and data-logger;
- Co-use of laboratory for improvement and development of weather sensors with commercial weather service providers.

3.2 To perform the field experiments of weather sensor and instruments:
- Temperature, humidity, precipitation, pressure, radiation, sunshine, snow depth sensors and data-logger;
- Trial transition of state-of-the-art observing equipment in daily operations (sunlight shield, ultrasonic wind speed/direction sensor, weighing precipitation gauge) to operations;
- Field testing of automated weather systems using ubiquitous sensor network (USN) technology.

3.3 To develop standardized guidance through weather sensor performance testing and field experiments to contribute to WIGOS activities.

3.4 To improve Members' observational infrastructure capacity through intercomparisons and training opportunities jointly coordinated by the CIMO expert team and sensor providers.

For further information, please contact: Mr. Lee Hyuk-Je, Observation Policy Division, KMA,
E mail: hjpose@kma.go.kr Tel.: +82 2 2181 0708 Fax: +82 2 836 2386

DRAFT PROPOSAL FOR THE ESTABLISHMENT OF A WMO-CIMO TEST BED AND FOUR CIMO-LEAD CENTRES (GERMANY)

Expression of interest in establishing the Lindenberg Testbed and four Lead Centres at Lindenberg Meteorological Observatory – Richard Assmann Observatory

The Deutscher Wetterdienst (DWD) expresses its interest in establishing **the Lindenberg Testbed**, south-east of Berlin with the core measuring site at the Lindenberg Meteorological Observatory – Richard Aßmann Observatory (MOL-RAO).

Furthermore, the Deutscher Wetterdienst (DWD) is also interested in establishing several **Lead Centres** at the observatory:

- Lead Centre for in-situ sounding based on routine and research radiosoundings;
- Lead Centre for radiation measurements of both spectral and broadband radiation;
- Lead Centre for wind profiling using remote sensing instrumentation;
- Lead Centre for ABL measurements, with special emphasis on energy flux measurements.

The observatory has a very long tradition of atmospheric profiling having used in-situ technique for more than 100 years and remote sensing observation of atmospheric parameters and processes for more than 10 years. Currently, MOL-RAO is the reference site within DWD for measuring atmospheric processes on a long-term, 24/7 basis and hosts the Lead Centre of the GCOS Reference Upper-Air Network (GRUAN).

At the observatory, four radiosondes are launched daily (every six hours), and the analysis of both ascent and descent profiles is carried out on a routine basis. Data from these soundings are used for data assimilation in numerical weather prediction models, the GCOS Upper-Air Network (GUAN) and the GCOS Reference Upper-Air Network (GRUAN).

For more than 10 years, the capabilities of precise vertical profiling have been enlarged through the operation of a suite of active and passive surface-based remote sensing instruments at MOL-RAO. Merged with in-situ observations, these measurements are used to provide vertical profiles of temperature, humidity and wind with high and specified accuracy. Over the last years, these measurements and the composite vertical profiles were used:

- To quantify the long-term variability of climate variables at different atmospheric levels;
- To evaluate atmospheric (mainly physical) processes in regional climate models and numerical weather prediction models; and
- To validate several satellite products, like vertical profiles inferred from the MetOp/IASI or products computed by the Eumetsat Satellite Application Facility on Climate Monitoring (CM-SAF).

To prepare a complete data set of the 3D atmospheric column, additional measurements within the Baseline Surface Radiation Network (BSRN), GCOS Surface Network (GSN), WCRP / Coordinated Energy and Water Cycle Observations Project (CEOP) and the WCRP / Baltic Sea Experiment (BALTEX) are carried out at MOL-RAO.

Based on the current DWD strategy and the objectives far beyond 2015, long-term viability of the Meteorological Observatory Lindenberg – Richard Aßmann Observatory and thus the Lindenberg Testbed as well as the four Lead Centres to be established is assured.

A more detailed description of the proposed Lindenberg Testbed and the four Lead Centres is given in the annex.

Annex: 1

ANNEX

Lindenberg Testbed and Lead Centres at MOL-RAO of Deutscher Wetterdienst (DWD)

For more than 100 years, the Lindenberg Meteorological Observatory – Richard Aßmann Observatory (MOL-RAO) has been a permanent observing site in a rural landscape with the main focus on vertical profiling of the atmosphere. At the beginning, the basic sensor platforms for this purpose were kites and balloons. Today, research activities in this field are focused on the use of modern remote sensing techniques. However, the current 24/7 measurement programme as well as research activities also cover atmospheric boundary-layer and radiation studies. The observatory is also a climate reference site of the Deutscher Wetterdienst (DWD), operates a 24/7 routine weather station (incl. routine radiosoundings every six hours) and hosts the GCOS Reference Upper-Air Network Lead Centre.

The observational 24/7 programme of the observatory is based on the **3D/4D Lindenberg Column (20 x 20 x 35 km3)** of all relevant physical properties of the atmosphere including a detailed quality control. More specifically, the following tasks are covered:

- Long-term climate monitoring, especially of atmospheric processes and their variabilities;
- Process validation of numerical model outputs including the preparation of data sets for data assimilation;
- Reference site for different WMO Programmes (BSRN, GRUAN, GUAN, GSN, CEOP, GABLS);
- Validation of satellite products (CM-SAF, Metop/IASI, ADM-Aeolus, EarthCARE);
- Market analysis, tests and implementation of new instruments for future use in the DWD operational network;
- Research for development and qualification of techniques and algorithms for quality improvements on standard techniques;
- Process studies on the base of special campaigns and / or in cooperation with numerical modelling; and
- Calibration of various radiation instruments at the RA-VI radiation calibration centre.

Within the observational programme, routine observations as well as process studies (synergy of surface based and satellite-remote sensing data for special investigations) are focused on:

- Measuring profiles of basic atmospheric parameters, like wind, temperature and humidity plus profiles of cloud properties;
- Measuring atmospheric water in its three phases to quantify the local water cycle;
- Measuring the energy exchange between surface and atmosphere to quantify the local energy cycle;
- Measuring radiant fluxes, irradiance and spectral radiance, e.g. to characterize the radiant field as well as the optical aerosol parameters;
- Measuring insolation, energy fluxes and precipitation in a limited-area network to quantify regional aspects of the energy and water cycle;
- Research activities towards improved observations in future and a better understanding of atmospheric processes.

In 2010, the core instruments of the Lindenberg Meteorological Observatory – Richard Aßmann Observatory are the following (most of which have been in operation for more than 10 years):

- Active remote sensing instruments, like Raman-lidar, cloud radar, wind profiler/RASS, micro cloud radar, sodar/RASS, and laser ceilometer – operated at the observatory site;
- Passive remote sensing instruments, like microwave profiler / radiometer, Fourier-Transform IR spectrometer, and GPS – operated at the observatory site;

- ABL measuring instruments, like conventional meteorological instruments, eddy-covariance measurements, various instruments to measure soil moisture and temperature, all components of the broadband solar and terrestrial fluxes and laser and microwave scintillometers – operated at the ABL grass site Falkenberg (approx. 5 km apart of the observatory) with a 99m tower and at the forest site Kehrigker Forst (approx. 10 km away from the observatory) with a 30m tower;
- Instruments to measure air and soil parameters, precipitation and insolation within a regional network in the Lindenberg area;
- Radiation instruments, like broadband short-wave and long-wave radiometers, precision filter radiometer, UV spectral radiometers, and whole sky imagers – operated at the observatory site;
- Aerological (in-situ) instruments, like routine (VAISALA 92, GRAW, Intermet) and research (cryospheric frostpoint hygrometer, backscatter sondes, optical sondes) sondes, and ozone sondes – operated at the observatory site.

Due to the use of state-of-the-art reference instruments at the MOL-RAO, links to relevant manufacturers are well established.

The Lindenberg Testbed

The main task of the Lindenberg Testbed should be the testing and operation of remote-sensing instruments (single remote-sensing instruments as well as a mix of remote-sensing instruments) in the Lindenberg Column (20x20x35 km3) to characterize small-scaled physical processes in the atmosphere over a heterogeneous landscape including their description of measurement uncertainties. These additional measurements would complete the 3D/4D observation within the atmospheric column.

The core instrumentation will be provided by the observatory (see above) and the 24/7 operation of most of the instruments (remote sensing, ABL instrumentation, radiation) will be ensured. Reference observations from in-situ observations using routine radiosondes (every six yours) and research sondes (on a monthly basis) will also be available. A guidance based on existing instruments and techniques is mandatory for interested collaborators.

Furthermore, research and meteorological institutions from research centres, universities and meteorological services are kindly invited to contribute instruments and their expertise. Based on the available expertise at the observatory, significant steps would be expected for the description of measurement principles, the improvement of measurement instruments and methodologies and use in numerical atmospheric models.

The participants of the Lindenberg Testbed could use the infrastructure (power and data connection) at the observatory, the ABL site of Falkenberg and the forest site. With regard to additional sites in the Lindenberg area, the observatory will provide the support for administrative and technical aspects.

Lead Centres hosted at MOL-RAO / DWD

1. Lead centre for in-situ sounding

Due to the close collaboration with the GUAN and GRUAN network activities, MOL-RAO provides a climate chamber (with variable pressure from 10 to 1000 hPa, variable temperature from 190 to 300K, variable relative humidity from 0 to 100%, and variable wind speed from 0 to 10 m/s) to calibrate routine and research radiosounding systems. An important task of GRUAN is to determine measurement uncertainty and the transparency of the entire analysis chain. This information / guidance will be provided to all WMO members.

Concerning the measurement frequency of radiosondes, routine sondes were launched every six hours, whereas research sondes were only launched on a monthly / bi-monthly basis. During experimental campaigns (e.g. LAUNCH 2008, LABPIAT 2010) a more frequent launch of clusters of routine and research sondes could be realised at least on a daily basis. For the campaigns, several radiosonde manufacturers provided significant contributions, like new or updated research / routine radiosondes. These campaigns / comparison studies led to a close collaboration between manufacturers (like GRAW, Intermet, Meteolabor, Modem, VAISALA) and the Lindenberg observatory.

2. Lead centre for radiation

Since many years now, MOL-RAO has operated the RA-VI radiation centre and a Baseline Surface Radiation Network (BSRN) site. To calibrate radiation instruments at the RA-VI radiation centre, three general procedures can be provided:

- Calibration against the World Radiation Centre (WRC) standard;
- Calibration under defined standard clear-sky conditions; and
- Calibration under defined standard laboratory conditions – blackbody rooms with/without climate conditioning.

For more than 100 years, broad band measurements have been carried out in Potsdam and Lindenberg. For more than 25 years, additional routine spectral and broadband measurements have been carried out at the Lindenberg site, and for aerosol optical thickness also in Zingst (marine site), Lindenberg (lowland site), Hohenpeißenberg (mountain site) and Zugspitze (mountain top site). These measurements, in combination with detailed calibration at the RA-VI centre, allow to precisely determine measurement uncertainties and long-term changes in solar and terrestrial radiation. The work at the RA-VI radiation centre will soon be accredited according to ISO standardisation. As a matter of consequence, the guidance for the measurement principles will be prepared under these regulations.

3. Lead Centre for wind profiling

Since the beginning of the implementation of the European Windprofiler Network (previously Eumetnet WinPROF, currently EUCOS WinProf) MOL-RAO has been fully involved in the scientific, technical and operational planning and realisation of the network. A staff member of MOL-RAO, Dr Volker Lehmann, was the first programme manager of Eumetnet WinPROF. Furthermore, MOL-RAO is responsible for the scientific use of all DWD-operated wind profilers.

On the basis of this expertise, MOL-RAO provides a Lead Centre for wind profiling to assist all WMO Member States in planning and/or operating a wind profiler in their national network.

4. Lead Centre for ABL measurements

Based on the energy flux measurements and related meteorological measurements supplied to the Coordinated Energy and Water Cycle Observations Project (WCRP) of the World Climate Research Programme (WCRP), MOL-RAO (Dr Frank Beyrich) could define both standards for measuring these fluxes and standards for the quality assurance procedure. The measurements are mainly carried out at the ABL site of Falkenberg (grass) and at Kehrigker Forst (forest) and have been available in the CEOP database since 2003. This work could be realised in close collaboration with the three European BALTEX/CEOP sites Cabauw (operated by KNMI), Sodankylä (FMI) and Lindenberg (DWD). A huge number of publications proves the successful operation of the MOL-RAO ABL site. To ensure the high accuracy standard, the observatory provides technical support for calibration purposes and assists with the characterisation of measurement uncertainties.

Finally, MOL-RAO is ready to assume the task of developing standard procedures for all aspects of the mentioned measurements related to the Lead Centres and as to operate the necessary instruments with a view to promote worldwide instrument compatibility and interoperability. The observatory is also prepared to provide advice on the use of the individual instrument and to collaborate with the relevant CIMO Expert Teams in developing guidance material. All steps, especially those explained in the individual guidance, will be realised according to the ISO 9001:2000 (Reg.-Nr. 816/2324 ZER-QMS) standard.

DRAFT PROPOSAL FOR THE ESTABLISHMENT OF A WMO-CIMO LEAD CENTRE (UNITED STATES OF AMERICA)

NOAA/NCAR LEAD CENTER FOR EVALUATION OF PRECIPITATION SENSORS, SPECIFICALLY IN SUPPORT OF WIGOS - CLIMATE MONITORING AND AVIATION

Precipitation is one of the most important atmospheric variables for ecosystems, hydrologic systems, climate, and weather forecasting. Despite its importance, accurate measurement remains challenging, and the lack of recent and complete intercomparisons leads researchers to discount the importance and severity of measurement errors. These errors are exacerbated for the automated measurement of solid precipitation and underestimates of 20-50% are common.

Although we have spent centuries measuring precipitation, significant challenges remain to be overcome. Accuracy can be difficult to obtain, or even define, for precipitation measurements, but is extremely important for understanding climate variability and change. Measurement error must be reduced, particularly in the face of general circulation model projections of a 5% increase in precipitation over land over the next 100 years.

The magnitude of this projected change is small and will require extremely accurate long-term measurements for verification. Fulfilling the need for climate quality precipitation data requires overlap with existing measurements and a continuing need for intercomparisons and tests of various gauge-wind shield configurations.

The problem of undercatch in precipitation gauges resulting from wind-induced turbulence at the gauge orifice and wetting losses on the internal walls of the gauge, can seriously affect the utility of precipitation data for climate change studies. While solid precipitation measurements have been the subject of many studies, there have been only a limited number of coordinated assessments on the accuracy, reliability, and repeatability of automatic precipitation measurements.

The most recent comprehensive study, the “WMO Solid Precipitation Measurement Intercomparison” concluded in 1998 and focused on manual techniques of solid precipitation measurement. Precipitation gauge technology has changed considerably in the last 12 years and the focus has shifted to automated techniques.

BACKGROUND

1. The National Center for Atmospheric Research (NCAR) has developed an instrumentation test site near Marshall, Colorado. The purpose of this site has been to test various instrumentation, precipitation gauge, gauge shielding, and upper air observations in support of the Research Applications Laboratory's (RAL) Winter Weather Group as well as Earth Observing Laboratory (EOL). The Marshall site's proximity to the Rocky Mountains makes it an ideal geographic location for measuring snowfall during the winter months. The additional suite of high-quality surface instrumentation deployed at Marshall helps establish it as an outstanding site available to develop and evaluate the performance of different precipitation and snow depth sensors.

2. The winter precipitation testbed was established in 1991, and was designed to evaluate solid precipitation measurements using a variety of automated approaches. The establishment of this site was motivated by the need for real-time measurement of snowfall rate in support of aircraft ground deicing operations.

3. Early studies at the site helped establish that the currently used technique to measure snow intensity via visibility is a poor estimate of the liquid equivalent snowfall rate (Rasmussen et al. 1999). An analysis of previous ground deicing accidents suggested that snowfall intensity was under-estimated during a number of these accidents in terms of liquid equivalent rate (Rasmussen et al. 2000). This realization has sparked FAA sponsored work regarding the development of a liquid equivalent system that can be used by airlines in support of ground deicing. A variety of gauges were tested at the site in support of this effort, including the development of a new precipitation sensor called the "hotplate".

4. The testbed is also being utilized for assessment of accurate surface measurement of precipitation, including solid precipitation, which is an important need for documenting changes in the future and past climate. The NOAA Climate Reference Network program built upon the testbed infrastructure established in the 90's to deploy and test a variety of current and new gauges to serve in a reference network established with the goal of measuring national trends in precipitation.

5. This study concentrated on testing six different wind shield types, and was designed to determine which wind shield design would produce the most accurate measure of the water content of winter (solid) precipitation using an automated snow gauge for long term climate measurements for use by the NOAA Climate Reference Network. In addition, some shield-gauge combinations were duplicated to help determine the variability of measured precipitation at the site.

Figure 1 - Aerial image of the Marshall, CO testbed.

6. This testbed has been in continuous operation for 15 years, supporting projects ranging from aircraft anti-icing fluid testing, to testing snow gauge shielding designs and is a joint collaboration between NOAA, NCAR, NWS and FAA. While the site configuration and instrumentation have changed over the years, a number of core elements have been retained over the years, including the presence of WMO standard Double Fenced Intercomparison Reference (DFIR) shields for snow measurement, and standard meteorological measurements such as temperature, humidity, winds, pressure, etc.

7. The current site also includes a second DFIR shielded GEONOR snowgauge, three single Alter shielded GEONORs and a double Alter shielded GEONOR. A GEONOR gauge is used in the center of each of these shields. Three different models of the TR525 tipping bucket rain gauges are also operational at the site, as well as two hotplate precipitation sensors. In addition to a 10 meter standard met measurement tower, winds are also measured at 3 and 2 meters. A Biral HSS VPF-730, Vaisala PWD-22, ScTI E-LEDWI and WIVIS sensors are used for present weather and visibility measurements. When not being used for other projects, 3D and 2D video disdrometers are also regularly run at the site.

8. The testbed is presently being utilized for research to support the development of transfer functions for the various configurations as a function of wind speed and temperature and turbulence and precipitation rate. It is also being used to develop a common snow depth algorithm with Canadians that examines new approaches for the measurement of snow depth that includes acoustic, optical and GPS sensors.

9. The testbed is well suited for assessment of snow depth sensors, different raingauge/windshield configurations, new technologies for measuring snow depth, precipitation, temperature, windspeed and solar radiation. The present emphasis is on the measurement of solid precipitation.

Qty	Shield Type	Gauge Model	Years in Operation
CRN			
1	Double Alter	T-200B-M	2008 – present
2	Double Alter	T-200B	2008 – present
1	Belfort Double Alter	T-200B	2009 – present
1	Belfort Double Alter	AEPG 600	2009 – present
1	Single Alter	T-200B	2008 – present
2	SDFIR	T-200B	2008 – present
1	Double Alter	AEPG 600	2008 – present
1	SDFIR	AEPG 600	2009 – present
3	Double Alter	Heated TB3	2008 – present
2	SDFIR	Heated TB3	2008 – present
NWS			
1	DFIR	Pluvio	2009 – present
1	Double Alter	Pluvio	2009 – present
1	Single Alter	Pluvio	2009 – present
NCAR			
2	DFIR	T-200B	2003 – present
1	16 in Single Alter	T-200B	2008 – present
1	18 in Single Alter	T-200B	2004 – present
1	6 ft Double Alter	T-200B	2004 – present
1	8 ft Double Alter	T-200B	2008 – present

Table 1 - Description of the number, type of wind shield, precipitation gauge model, and dates of operation of the precipitation gauges in operation at the testbed.

SELECTED PAPERS

Baker, C.B.: Measurement of solid precipitation using different rain gauge/shield configurations from the USCRN precipitation testbeds. Second Snowfall Workshop Toronto, ON, 2008.

Evaluation of a double-Alter wind shield using sonic anemometers. Tilden Meyers, NOAA/ARL, Oak Ridge, TN; and E.J. Dumas, M.E. Heuer, C.B. Baker, M. Hall, and T. Wilson. 13th Symposium on Meteorological Measurements and Observations June 2005
The new precipitation algorithm for the three-wire Geonor gauge of the U.S. Climate Reference Network- objectives, description and performance.

William G. Collins, Short and Associates, Queenstown, MD; and C.B. Baker, T.B. Wilson, R. Buckner, and M. Phillips 13th Symposium on Meteorological Observations and Instrumentation June 2005.

Wade, C., and J. Cole, 2001, Final Report to CRN Management on the Snow Gauge and Windshield Evaluation Studies Conducted at NCAR from January to April 2001, NCAR Research Applications Program (RAP), 17 July 2001.

Larsen, L.W., C.B. Baker, E.L. May, and H. Bogin, Operational Testing of Various Precipitation Sensors in Support of the United States Climate 13th Reference Network, Symposium on Meteorological Observations and Instrumentation, 19-23 June 2005, Savannah, GA, P4.4.

Rasmussen, R.M., J. Vivekanandan, J. Cole, B. Myers, and C. Masters, 1999: The estimation of snowfall rate using visibility. J. Appl. Meteor., 38, 1542–1563.

Rasmussen, R.M, J. Cole, K.R.K. Moore, and M. Kuperman, 2000: Common snowfall conditions associated with aircraft takeoff accidents. J. Aircraft, 37, 110–116.

Kochendorfer, J., C.B. Baker, M.E. Hall, T.P. Meyers, and T. Wilson (2010): Precipitation-measurement intercomparison for NOAA's historical climatology network: the effects of wind shield and sensor type. 90th American Meteorological Society Annual Meeting, January 2010, Atlanta, GA.

CONTACT

Dr. C. Bruce Baker, Director NOAA/ATDD
Dr. Roy Rasmussen, Senior Scientist, NCAR/RAL

DRAFT PROPOSAL FOR THE ESTABLISHMENT OF A WMO-CIMO TESTBED FOR IN-SITU REMOTE-SENSING INTRUMENTS (TB-REM) "Obninsk" (Russia)

1. INTRODUCTION

PURPOSE OF THE DOCUMENT

This document is a response to the CIMO proposal to preare testbeds for remote observations (measurements).

The State Institution "Research and Production Association "Typhoon" (RPA "Typhoon" under Roshydromet proposes a site well-equipped with measuring instrumentation based on the 300-m High Meteorological Mast (HMM-300) located in the center of the European territory of Russia in Obninsk.

As the invitation was fairly broadly formulated and came with fairly short notice it is understood that this document may not be complete and SPA "Typhoon" is prepared to update and complement this proposal in accordance with the possible requests by CIMO.

PROPOSAL LAYOUT

The proposal includes the site description and the description of the relevant instrumentation.

2. SITE DESCRIPTION

The testbed includes three meteorological sites located in Obninsk and outside its territory.

The main site is the territory of the meteorological experimental site with the HMM-300 (http://typhoon-tower.obninsk.org) of the area of 14 ha located practically in the center of Obninsk at the height of 187 m above the sea level (55°06'70" N; 36°35'88" W). Predominant surface ground around the test site is covered with forests with apartment houses. At present the construction of buildings surrounding the territory of the experimental site has been practically completed. Several one-story buildings not higher than 5 meters are located in the territory of the site. There are also open ground sections covered with groups of trees and bushes. The local perimeter of the roughness calculated with the measurement data of wind speed profile in the air near the ground (at the heights of 3 and 16 m) makes 10–15 cm. The main technical parameters of the complex are: the 315-m mast with the diameter of

2.4 m with 13 test sections having four sliding hands on each of them for placing special meteorological sensors.
There is a meteorological section (of about 300 x 400 m^2) in the territory of the site. Accumulation and processing of the signals from the sensors placed on the mast and in the territory of the experimental site are made with the help of modern computer-aided devices.
At the distance of 4700 m from the meteorological site the meteorological section (the area of which is 1.4 ha) equipped with remote sensing instruments for measuring dynamic characteristics of the mesosphere – lower thermosphere.
At the distance of 1200 m from the meteorological HMM-310 site in the main territory of the SPA "Typhoon" there is an Obninsk lidar station designed for measuring the parameters of the middle atmosphere.
The meteorological experimental site with the HMM has a long story since the middle of the 20th century as an experimental site of the Institute of Experimental Meteorology.

The summary of the observational programme of the experimental site (testbed) "Obninsk" is listed in Table 1.

Table 1. Regular Observations at the testbed "Obninsk"

Observation type	*Starting year*	*Description*
Ground weather observations		
TEMPERATURE, AIR PRESSURE, AIR RELATIVE HUMIDITY, WIND SPEED AND DIRECTION, PRECIPITATION, VISIBILITY, SOIL TEMPERATURE, SNOW COVER	1964	Ground
AIR CHEMISTRY: RADON-222 (AEROSOL BETA ACTIVITY, ALPHA COUNTING)	1968	Ground
Solar radiation observations		
GLOBAL-, REFLECTED-, DIFFUSE- AND DIRECT COMPONENT OF SOLAR RADIATION, SUNSHINE HOURS RADIATION	2010	Ground
AEROSOL OPTICAL DEPTHIN THE ATMOSPHERIC DEPTH	2010	
Ground-based UV- and (remote sensing) ozone observations		
GLOBAL UV-RADIATION, SPECTRAL UV-RADIATION	1991	Ground
TOTAL COLUMN OZONE, TOTAL COLUMN NITROGEN DIOXIDE	1991	Atmospheric column
MEASUREMENTS OF OZONE CONCENTRATIONS IN THE ATMOSPHERIC SURFACE LAYER	2003	
MEASUREMENTS OF CONCENTRATIONS OF VOLATILE ORGANIC COMPOUNDS AT THE LEVEL OF 0, 100, 200, 300 M	2003	
Meteorological mast Experiment		
VERTICAL PROFILES OF OZONE CONCENTRATIONS AT THE LEVELS OF 0, 100, 200, 300 M	2003	
MEASUREMENTS OF THE AIR ELECTRIC SPACE CHARGE AND AEROSOL CONCENTRATIONS AT THE LEVELS OF 0, 100, 200, 300 M	2003	

MEASUREMENTS OF VERTICAL PROFILES OF GREENHOUSE AND RADIATIVELY-ACTIVE GASES (CO_2, CH_4,CO, N_2O) CONCENTRATIONS AT THE LEVELS OF 0, 100, 200, 300 M	2003	
MEASUREMENTS OF OZONE SURFACE CONCENTRATIONS AND VERTICAL PROFILES AT THE LEVELS OF 0, 100, 200, 300 M	2003	
SOIL TEMPERATURE AND MOISTURE PROFILES, RH% TO THE HEIGHT OF 1 M	2010	Ground
SNOW DEPTH	2010	Ground
SONIC WIND SPEED, DIRECTION, TEMPERATURE, FRICTION VELOCITY, HEAT VERTICAL FLUX AT 8, 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275 AND 300 M	2010	310-m high mast
TEMPERATURE, RELATIVE HUMIDITY, WIND SPEED AT 8, 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275 AND 300 M	2010	310-m high mast
Greenhouse gases and aerosols in ground-based remote sensing observations		
MEASUREMENTS OF TOTAL CONTENTS OF GREENHOUSE AND RADIATIVELY-ACTIVE GASES (CO_2, CH_4, H_2O, N_2O, CO) IN THE ATMOSPHERIC COLUMN	1998	Atmospheric column
MEASUREMENTS OF ATMOSPHERIC TRANSPARENCY AND AEROSOL OPTICAL DEPTH	1993	Atmospheric column
Other ground-based remote sensing reference observations		
MEASUREMENTS OF WIND SPEED AND DIRECTION IN THE MESOSPHERE AND LOWER THERMOSPHERE BY SOUNDINGS OF METEOR TRAILS	1964	
SPECTRAL RADIATION OF THE UNDERLYING SURFACE	2006	In the territory of HMM-300
RADIANCE OF THE UNDERLYING SURFACE AT THE WAVELENGTHS FROM 0.3 TO 16 μM	2000	
SPECTRAL RADIATION OF CLOUDS WITHIN THE WAVELENGTH RANGE FROM 0.3 TO 16 μM	2000	
LIDAR SOUNDINGS OF VERTICAL DISTRIBUTIONS OF OZONE AND AEROSOL TEMPERATURE IN THE ATMOSPHERE UP TO THE ALTITUDE OF 70 KM.	2011	
MEASUREMENTS OF TEMPERATURE VERTICAL PROFILES, WIND SPEED AND DIRECTION UP TO THE ALTITUDES OF 4000 M.	2010	Sodars, wind profiler
Additional measurements		
MEASUREMENTS OF PRECIPITATION CHEMICAL COMPOSITION	2010	Ground
ATMOSPHERIC AEROSOL PARTICLE SIZE DISTRIBUTION FUNCTION (0.05-10 μM)	2010	Ground
OPTICAL AND MICROPHYSICAL CHARACTERISTICS OF THE UPPER LEVEL CLOUDS	2010	

3. MEASUREMENT METHODOLOGY

The measurements of meteorological parameters of the atmospheric surface layer are made at the meteorological stations manufactured at the SPA “Typhoon”, by foreign firms Viasala, Gill, etc. Total ozone (TO) and sulfur dioxide contents have been measured since 1991. The measuring station “Obninsk” is registered in the World Ozone and UV Data Center (WOUDC), being one of the main world data centers as a part of the WMO Global Atmospheric Watch Programme (GAW WMO).

The number of the measuring station “Obninsk” in the (WOUDC) base is 307, identification in the GAWSIS is Obn.

Dynamic characteristics of the mesosphere-lower thermosphere are measured by short-wave radars with the method of following meteor trails.

The measurements of atmospheric aerosol microphysical characteristics are made with the help of electrostatic and photoelectrical aerosol particle meters.

The measurements of total contents of greenhouse gases are made by the spectroscopic method.

Concentrations of surface ozone are measured by the Thermo Ozone Analyzer Model 49i.

Measurements of precipitation chemical composition are made at the Chemical and Analytic Center of RPA “Typhoon” that is taking part in intercalibrations at a regular basis.

Optical characteristics of clouds and underlying surface are measured with spectroradiometric instrumentation developed at RPA “Typhoon”.

4. DESCRIPTION OF THE MAIN INSTRUMENTS AND DEVICES

4.1. The Measuring and Computation Center of the High Meteorological Mast (HMM-310 m)

The major directions of scientific researches for which AMM-310 is intended are experimental researches in the boundary layer of the atmosphere of temperature and wind parameters, turbulence, conditions of transposition and scattering of impurities, heat and mass exchange between a surface and the atmosphere.
A detailed description of the High Meteorological Mast capabilities, technical characteristics and examples of on-line data presentation are given on the site:
http://typhoon-tower.obninsk.org

4.2. Meteorological Complex MC-15

Technical Characteristics

A. MEASURED PARAMETERS AND MEASUREMENT RANGE:
- WIND VELOCITY (HORIZONTAL) ..... 0.2…60 M/S
- WIND VELOCITY (VERTICAL) ..... MINUS 5…5 M/S
- WIND DIRECTION ..... 0…360°
- AIR TEMPERATURE..... MINUS 40 °C... 50 °C
- RELATIVE AIR HUMIDITY .....0%.....100%
- ATMOSPHERIC PRESSURE ..... 800…1067 HPA

B. MEASUREMENT ERROR:
- WIND VELOCITY (HORIZONTAL)..... ± (0.2+0.03·V) M/S
- WIND VELOCITY (VERTICAL)..... ± (0.1+0.02·V) M/S
- WIND DIRECTION..... ± 6°
- TEMPERATURE ..... ± 0.4 °C
- RELATIVE HUMIDITY ..... ± 3 %

- ATMOSPHERIC PRESSURE …….… ± 0.3 HPA

C. FREQUENCY OF MEASUREMENT CYCLES..... 6.25 OR 12.5 HZ

4.3. Measurement Device for Ozone surface Concentration.

Measurements of ozone surface concentrations are made with the optical method with the help of the Thermo Ozone Analyzer Model 49i.

4.3. Measurement Device for Dynamic Parameters of the Mesosphere-Lower Thermosphere

Measurements of wind speed and direction as well as of turbulent characteristics of the mesosphere-lower thermosphere are made with a short-wave radar with the following characteristics:

- THE HEIGHT OF THE ATMOSPHERIC LAYER ANALYZED ……80…105 KM
- THE RANGE OF DISTANCES …….. 90…300 KM
- MEASUREMENT ACCURACY OF DISTANCES …… ± 2 KM;
- MEASUREMENT RANGE FOR AZIMUTHS …….. 0 ÷ 360 DEG.
- MEASUREMENT RANGE FOR ANGULAR ALTITUDES …… 0 ÷ 360 DEG.
- ACCURACY OF AZIMUTHS AND ANGULAR ALTITUDES MEASUREMENTS….± 0.5 DEG.
- DOPPLER FREQUENCY MEASUREMENT RANGE ……. MINUS 100 HZ ÷ PLUS 100 HZ
- DOPPLER FREQUENCY MEASUREMENT ACCURACY …… ± 1 HZ;
- WIND VELOCITIES RANGE …… FROM MINUS 300 TO PLUS 300 M/S
- INSTRUMENTATION ERROR OF A WIND VELOCITY SINGLE MEASUREMENT ……// NO LOWER (LESS) THAN ± 0.5 M/S.

Monitoring of other parameters of the atmosphere, underlying surface (surface ground), precipitation chemistry is made by the measuring instrumentation certified according to Russian standards.

SUGGESTED ACTION ON THE RESOLUTIONS AND RECOMMENDATIONS ADOPTED BY THE COMMISSION PRIOR TO ITS FIFTEENTH SESSION AND STILL IN FORCE

I. RESOLUTIONS ADOPTED BY CIMO-XIV

Res. Number	Title	Suggested action	Comments
1.	CIMO Open Programme Area Groups (OPAGs)	Not to be kept in force	Will be replaced by a new resolution (agenda item 11)
2.	CIMO Management Group	Not to be kept in force	Will be replaced by a new resolution (agenda item 11)
3.	Participation of women in the work of the Commission	To be kept in force	Still need to encourage participation of women in commission activities
4.	Revision of previous resolutions and recommendations of the Commission	Not to be kept in force	Will be replaced by a new resolution (agenda item 11)

II. RESOLUTIONS ADOPTED PRIOR TO CIMO-XIV AND STILL IN FORCE

Res. Number	Title	Suggested action	Comments
1 (CIMO-XIII)	Working Structure of the Commission for Instruments and Methods of Observation	Not to be kept in force	Will be replaced by a new resolution (agenda item 11)

III. RECOMMENDATIONS ADOPTED BY CIMO-XIV

Rec. Number	Title	Suggested action	Comments
1	Measurements in severe icing conditions	To be kept in force	Work not completed
2	Standardized procedure for laboratory calibration of catchment type rainfall intensity gauges	Not to be kept in force	Work completed: Included in draft supplement to the CIMO Guide (agenda item 7)

Rec. Number	Title	Suggested action	Comments
3	Procedure and reference instruments for field rainfall intensity intercomparisons	Not to be kept in force	Intercomparison to which this recommendation was addressed is completed
4	Terms of Reference of the World, Regional and National Radiation Centres for Solar Radiation	Not to be kept in force	Work completed: terms of reference were included in the CIMO Guide
5	Development of UV Calibration Centres	To be kept in force	On-going need for the establishment of UV calibration centres
6	Establishment of the primary WMO Reference Centre for Aerosol Optical Depth Measurements	Not to be kept in force	EC-LIX approved this recommendation
7	WRC infrared radiometry section	To be kept in force	On-going need to improve traceability of infrared irradiance measurements to SI units
8	Use of GPS geometric height to derive pressure and geopotential height from operational radiosondes	Not to be kept in force	Recommendations already largely implemented by manufacturers
9	Suitable temperature measurements for high quality reference upper-air stations	To be kept in force	Work not completed
10	Usefulness of interoperable upper-air systems	To be kept in force	Guidance provided in the recommendation is still valid
11	Regional Instrument Centre with full capabilities and functions	Not to be kept in force	Work completed: terms of reference were included in the CIMO Guide
12	Regional Instrument Centre with basic capabilities and functions	Not to be kept in force	Work completed: terms of reference were included in the CIMO Guide
13	Review of the previous resolutions of the Executive Council related to the Commission	Not to be kept in force	Will be replaced by a new resolution (agenda item 12)

IV. RECOMMENDATIONS ADOPTED PRIOR TO CIMO-XIV AND STILL IN FORCE

Rec. Number	Title	Suggested action	Comments
1 (CIMO-XII)	Possible conflicts with external standardization organizations	To be kept in force	On-going need to coordinate activities to avoid conflicts between standards of WMO and other standardizing bodies
3 (CIMO-XII)	Introduction of new meteorological instruments	To be kept in force	Guidance provided in recommendation is still valid
4 (CIMO-XI)	Calibration of meteorological and related geophysical instruments	To be kept in force	On-going need for development of standards for the calibration of advanced sensor instrumentation
6 (CIMO-XI)	Improvement of instrumentation used in observing systems of developing countries	To be kept in force	On-going need to ensure maintenance of network instruments
8 (CIMO-XI)	Correction of upper-air measurements	To be kept in force	On-going need for information on corrections applied to upper-air data, specially in view of climate requirements
12 (CIMO-XI)	Education and training for capacity building	To be kept in force	On-going need for training of instrument specialists
13 (CIMO-XI)	Intercomparisons of instruments	To be kept in force	On-going need to conduct instrument intercomparisons

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SUGGESTED ACTION FOR REVIEW OF RESOLUTIONS OF THE EXECUTIVE COUNCIL RELATED TO THE COMMISSION AND STILL IN FORCE

Resolution	Title	Suggested action	Comments
13 (EC-XXXIV)	Development and comparison of radiometers	To be kept in force	On-going need for regular international pyrheliometer intercomparisons
7 (EC-LIX)	Report of the fourteenth session of the Commission for Instruments and Methods of Observation	Not to be kept in force	Will be replaced by a new resolution to be adopted by EC-LXIII.

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BACKGROUND INFORMATION ON THE REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION AND OF RELEVANT RESOLUTIONS OF THE EXECUTIVE COUNCIL

The main aim in reviewing the resolutions and recommendations is to have, at the end of the session, a coordinated set of the Commission's decisions, brought up-to-date, in accordance with the latest developments regarding each subject.

Earlier resolutions relating to a subject on the agenda shall be examined during the study of this agenda item and specific proposals shall be made regarding the action to be taken on them (e.g. whether they have become redundant or whether they should be incorporated in a new resolution). The resolution that deals with the revision of previous resolutions and recommendations of the Commission should be reviewed under the present agenda item.

Previous recommendations of the Commission, other than those referred back to it by the Executive Council, are recommendations that the Executive Council has transformed into its resolutions, transmitted to another body or simply noted. In any of these three cases, they cease to be a direct responsibility of the Commission, so that CIMO can merely note the action on its previous recommendations and present comments, if necessary, concerning them. However, if the Commission considers that the action taken has not produced the results which it had in mind when passing the recommendations, or that it is necessary to propose a modification of the action, it can adopt a new recommendation on the same subject.

As regards relevant resolutions of the Executive Council, the Council has laid down the following principles to be followed when reviewing its previous resolutions:

(a) Past resolutions should be incorporated as far as possible in any subsequent resolution taken on the same subject - resolutions thus incorporated will not be kept in force;

(b) In so far as possible, past resolutions relating to subjects constituting a single field should be combined in a single resolution. When the subject is dealt with in a publication of the Organization (WMO Technical Regulations), this single resolution will be adopted in such a form that it can be included directly in the publication;

(c) Resolutions that are partly obsolete should be replaced, as far as possible, by revised text containing only those parts which are maintained.

To assist the Commission in examining the resolutions and recommendations adopted prior to its current session, a list of suggested actions on these resolutions and recommendations is given in Appendix B. Another list of suggested actions for review of resolutions of the Executive Council related to the Commission is given in Appendix C. Draft decisions of the Commission are presented in CIMO-XV/Doc. 12, Appendices A and B.

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