

WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR INSTRUMENTS AND METHODS OF OBSERVATION

**CIMO EXPERT TEAM ON
METEOROLOGICAL RADIATION AND ATMOSPHERIC
COMPOSITION MEASUREMENTS**

First Session

Davos, Switzerland

6-10 February 2006

FINAL REPORT



WMO General Regulations 42 and 43

Regulation 42

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

Regulation 43

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

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EXECUTIVE SUMMARY

This report provides a summary of the first session of the Expert Team on Meteorological Radiation and Atmospheric Composition Measurements (ET) held in Davos, Switzerland from 6 to 10 February 2006.

The main objective of the ET meeting was to discuss and approve the results of the Tenth International Pyrheliometer Comparison (IPC-X) and the conjointly organized Regional Pyrheliometer Comparisons (RPCs), Davos, Switzerland, 26 September to 14 October 2005. Due to the favorable weather measurements were taken on a total of 11 days, resulting in over 1000 data points for PMO2, Angström, and HF-type pyrheliometers. All member instruments of the World Standard Group (WSG) of absolute pyrheliometer were used to transfer the World Radiometric Reference (WRR) from IPC-IX (2000) to IPC-X (2005). WSG member instruments were performing well within the long-term stability of 0.2% of the measured value as required by the CIMO guide. However, the WRR reduction factors of the participating instruments seem to have changed by -500 ppm on average since IPC-IX. Several possible causes for the observed drift were investigated but experts were unable to explain it. The ET requested the World Radiation Centre (WRC) to investigate further the issue and present its final decisions in the IPC-X Final Report due in April 2006. The team will approve the Final Report by correspondence. The Report will be published by WMO as an IOM Report.

The ET evaluated status of the World Infrared Radiometer Calibration Centre (IRC), established at the PMOD/WRC in January 2004 following the Recommendation 1 (CIMO-XIII). There is still some work to be done to ensure that the Absolute Spectral Radiometer (ASR) is an appropriate reference point for far infrared measurements. The meeting believes that the World Infrared Standard Group (WISG) will provide a very useful interim reference for pyrgeometer far infrared measurements until a long-term absolute reference can be established. To assist in assuring the stability of the WISG the meeting suggested that carefully selected pyrgeometers outside the WISG are periodically compared to the WISG. The ET provided recommendation for future operational practice and also suggested that the World Infrared Radiometer Calibration Centre be renamed to the Infrared Radiometer Centre (IRC) as a component of the World Radiation Centre

The ET recognized the CAS SAG Ozone/Aerosol/UV responsibility for the total ozone, optical depth and UV radiation measurements and agreed to reformulate relevant task in the CIMO ET Work Plan to avoid any possible duplication of the work done by two teams. The ET role would be to monitor the effort of CAS on operational practice associated with those measurements, to collaborate with CAS on matters related to the most suitable method maintaining long-term, cost-effective measurements of total ozone, optical depth and UV and to keep the CIMO Guide up-to-date.

The ET felt that mechanisms and protocols should be introduced into the CIMO Guide to ensure that to be a Regional or National Radiation Centre it must rather should have effective traceability to the WRR. As a result, new proposal of the Terms of Reference of radiation centers were proposed for adoption by CIMO-XIV.

The ET also discussed the new updated versions of the CIMO Guide to Meteorological Instruments and Methods of Observation WMO-No. 8 (CIMO Guide) related to the work of the team and suggested that more changes should be introduced to the seventh edition of the CIMO Guide.

The ET proposed recommendations for consideration by CIMO-XIV Session, Geneva, December 2006.

GENERAL SUMMARY

1. ORGANIZATION OF THE SESSION

1.1 Opening of the session

The first session of the Expert Team on Meteorological Radiation and Atmospheric Composition Measurements (ET) was held in the World Radiation Centre (WRC) in Davos, Switzerland from 6 to 10 February 2006.

1.1.1 Mr Klaus Behrens, the Chairman of the ET, opened the session. He welcomed participants and wished everyone a fruitful and productive meeting. The list of participants is given in Annex I.

1.1.2 Following the opening of the session, Professor Werner Schmutz, the director of Physikalisch-Meteorologisches Observatorium Davos (PMOD) also welcomed participants to Davos.

1.2 Adoption of the agenda

1.2.1 The ET adopted the Agenda for the meeting, which is reproduced at the beginning of this report.

1.3 Working arrangements for the session

1.3.1 The working hours and tentative timetable for the meeting were agreed upon.

2. REPORT OF THE CHAIRMAN

2.1 Mr Behrens presented a report of ET's activities since its establishment in 2002. He pointed out that the team is small but responsible for wide range of important tasks, such as the Tenth International Pyrheliometer Comparison and the establishment of the World Infrared Radiometer Calibration Centre (IRC). He concluded that some tasks had been successfully achieved and some still required substantial work to be done in order to provide deliverables to CIMO-XIV session.

2.2 The chairman indicated that one of the major objectives of this meeting is to evaluate the IRC and the World Standard Group of absolute long-wave radiometers and to provide guidance for the future IRC operations.

3. WORK PLAN

3.1 The ET checked the deliverables achieved so far according to the Work Plan of the team for this intersessional period and, based on the discussion on the agenda items, the Work Plan was updated. The updated Work Plan is in ANNEX II.

3.2 The ET agreed that some of the tasks are of a continuous nature and should be put forward to the ET's Work Plan for the next intersessional period. The team also identified the need to address other issues and defined the possible tasks for the next intersessional period. See ANNEX III.

4. COLLABORATION WITH PMOD/WRC DAVOS

4.1 Tenth International Pyrheliometer Comparison And Regional Pyrheliometer Comparisons

4.1.1 Mr Finsterle, the Project Leader, provided comprehensive information to the meeting on the Tenth International Pyrheliometer Comparison (IPC-X) and conjointly organized Regional Pyrheliometer Comparisons, Davos, Switzerland, 26 September to 14 October 2005. An Ad-Hoc Group of experts in radiometry was established to oversee the procedures of IPC-X. The final report of the Ad-Hoc Group's report was published in November 2005 on CIMO/IMOP website: http://www.wmo.int/web/www/IMOP/intercomparisons/IPC-X/IPCX_Ad_Hoc_Committee_Report.pdf.

4.1.2 The preliminary report and preliminary results of IPC-X have been distributed among the members of the Ad-Hoc Group in December 2005 and are available at ftp://ftp.pmodwrc.ch/stealth/ipc-x/IPC_REPORT/preliminary.pdf. An updated version of the preliminary report was provided to the ET meeting in a form of the working document: http://www.wmo.int/web/www/IMOP/meetings/Surface/ET-MRandACM_Davos/Doc.4.1_IPC-X_Rep_1.gz

State of the World Standard Group

4.1.3 The World Standard Group of pyrheliometers (WSG) is stable. During IPC-X the WSG included the six absolute pyrheliometers PMO2, PMO5, CROM2L, PAC3, HF18748, and TMI67814. Since IPC-IX (2000) all of the WSG member instruments were performing within the required long-term stability of 0.2% of the measured value.

IPC-X Statistics

4.1.4 The weather conditions were very favorable throughout the intercomparison. Measurements were taken on a total of 11 days, resulting in over 1000 data points for PMO2 compared to the minimum requirement of 150 points. The 77 participants from 42 countries operated a total of 101 instruments.

Transfer of the World Radiometric Reference

4.1.5 In the draft analysis all six instruments of the WSG were used to transfer the World Radiometric Reference (WRR) from IPC-IX (2000) to IPC-X (2005), and their preliminary WRR reduction factors are in the draft report.

Dissemination of the WRR

4.1.6 The WRR is defined and calculated as the mean value of the simultaneous measurements of at least three WSG instruments. Each participating instrument was assigned a new WRR factor determined by averaging the ratios of the WRR to the instrument for all data points satisfying the data selection criteria specified in the Ad-Hoc Group report.

Stability of the realization of the WRR

4.1.7 An analysis of the WSG suggests that its representation of the WRR was stable over the past five years. Based on the preliminary analysis the WRR reduction factors of participating instruments showed that they may have changed since IPC-IX. Similar differences were evident when comparing the preliminary results to IPC-VIII. However, it has to be determined whether these changes are significant. Several possible causes for the observed changes were investigated but experts have yet been unable to explain it. Among the possible causes are the data selection criteria and evaluation procedures that were applied to past IPCs' data, small drifts

in WSG member instruments, and an under-estimation of the uncertainty of the WRR factors determined at IPC-IX. The investigation of possible causes was the subject of extended discussions during the ET meeting. The ET could not provide an answer and directed the PMOD/WRC to investigate the issue and present its final decisions in the IPC-X Final Report due in April 2006. The ET recommended to PMOD/WRC the following:

- Determine whether the observed change in the relationship of the participating instruments to the WSG from IPC-IX to IPC-X, as compared to the historical changes, is statistically significant.
- Determine whether any of the WSG instruments has drifted and should be excluded from the WSG.
- Find the reason why excluding PAC3 only seems to affect the WRR factors of HF-type cavities but not PMO-type instruments.
- Investigate the data analysis methodologies of the previous IPCs and their potential impact on maintaining the realization of the WRR.
- The results of the investigation be made available to the members of the ET, invited experts and members of the Ad-Hoc Group for review.

4.1.8 The final report of IPC-X will be submitted to the chairman of the ET for final approval and publication before the end of April 2006.

4.2 Evaluation of the World Infrared Radiometer Calibration Centre

4.2.1 Mr Gröbner provided detailed information on the World Infrared Radiometer Calibration Centre (IRC), established at the PMOD/WRC in January 2004 based on the Recommendation 1 (CIMO-XIII), covering all operational aspects of the IRC, such as, Instrumentation used (Blackbodies, Absolute Spectral Radiometer (ASR), World Infrared Standard Group (WISG)), traceability, stability of the WISG of pyrgeometers, maintenance and quality control, calibration procedure, uncertainties and future plans. See ANNEX IV for details.

4.2.2 It was clear from the results that there is considerable work to be done to ensure that the ASR is an appropriate reference point for far infrared¹ (3 – 50 μm) measurements. However, the meeting believes that the WISG will provide a very useful interim reference for pyrgeometer measurements until an absolute reference can be established. To assist in assuring the stability of the WISG the meeting suggested that carefully selected pyrgeometers outside the WISG are periodically compared to the WISG. The ET recognized that the leadership of this important task changed during the intersessional period and therefore less work was accomplished than anticipated at the time of CIMO XIII Session. The ET was impressed by the effort that Mr Gröbner has expended since arriving at the IRC and expressed support of his future work plan.

4.2.3 There was also discussion on the apparent lack of uniformity in the four coefficients of the BSRN pyrgeometer equation, (Philipona et al (1995)), when derived by different groups for the same instrument. The uncertainty introduced by using different coefficients for the same instrument was deemed to be an issue and that a mechanism be established in collaboration with the WCRP/BSRN community to determine how these coefficients can be derived.

4.2.4 The ET also proposed that CIMO invites the BSRN community in collaboration with the Infrared Radiometer Centre (IRC) to examine the consistency of characterizing pyrgeometers (Recommendation 4.2.4).

4.2.5 The Expert Team members and the invited experts performed an evaluation of the IRC including the WISG of pyrgeometers and recommended that (Recommendation 4.2.5):

¹ The terms “far infra-red”, “infra-red”, “long-wave” and “terrestrial” radiation are equivalent for the purpose of this document.

- The World Infrared Radiometer Calibration Centre be renamed to the Infrared Radiometer Centre (IRC) as a component of the World Radiation Centre;
- The IRC establishes the Interim WMO Pyrgeometer Infrared Reference using the procedures and instrumentation that make up the World Infrared Standard Group;
- The IRC, whenever possible, incorporate new types of instruments into WISG;
- The members of CIMO be encouraged to develop instruments and methods to improve traceability of far infrared irradiance measurements to SI units;
- At least every three years, Regional Radiation Centres (RRCs) supporting networks for measuring far infrared irradiance shall submit a pyrgeometer to the IRC for calibration or verification;

4.2.6 The ET decided that as a part of its future Work Plan it examines the transfer of WISG to network measurements of infrared irradiance.

4.2.7 The chairman, on behalf of the ET, expressed his appreciation to PMOD for the establishment of the IRC and a satisfaction with the current operational status of the IRC. He suggested that the ET in collaboration with the IRC would develop the Terms of Reference (TOR) for infrared calibrations at Regional Radiation Centres.

5. OTHER ACTIVITIES RELATED TO METEOROLOGICAL RADIATION MEASUREMENTS

5.1 Matters related to Baseline Surface Radiation Network

5.1.1 Mr Behrens reported on the liaison with the World Climate Research Programme (WCRP) on matters related to Baseline Surface Radiation Network (BSRN), providing the history of BSRN establishment and its main tasks.

5.1.2 There are about 40 BSRN sites worldwide. At present, BSRN is a part of Global Energy and Water Cycle Experiment of the WCRP (WCRP/GEWEX). Recently, BSRN has also been identified as the radiation network of the Global Climate Observing System (GCOS).

5.1.3 Radiation measurements have a long tradition within CIMO, which is also responsible for the international and regional pyrhelimeter comparisons, e.g., the establishment of the World Radiometric Reference (WRR).

5.1.4 CIMO's responsibility for the WRC, as well as for RRCs and NRCs, clearly identifies its role in radiation measurements. The team agreed that in order to guarantee the worldwide data homogeneity, regular calibrations of solar and terrestrial radiation instruments should be performed according to CIMO Guide. The general procedures/practices for calibrations and intercomparisons should be kept under permanent review in the CIMO Guide.

5.2 Operational Practices Related to Total Ozone, UV and Aerosol Optical Depth Measurements

Total Ozone Measurements

5.2.1 Mr Barturen reported on the operational practice associated with the total (column) ozone measurements with reference to the work done or planned by the CAS Scientific Advisory Group for Ozone (SAG Ozone).

5.2.2 The team recognized the CAS SAG Ozone responsibility for the total ozone measurements and agreed to reformulate the relevant task in the CIMO ET Work Plan to avoid any possible duplication of work done by the two teams. The ET role would be to monitor the effort of CAS on operational practice associated with the total ozone measurements, to collaborate with CAS on matters related to the most suitable method of maintaining long-term, cost-effective, total ozone measurements and to keep the CIMO Guide up-to-date.

5.2.3 The ET recognized the valuable contribution that the Regional Centers have made in their respective regions to implement QA and QC techniques and methodologies associated with the operation and calibration of the instruments used to measure total ozone, especially Brewer and Dobson spectrometers. More effort should be done regarding the calibration/characterization of filter type of instruments used in the measurements of total ozone.

5.2.4 The ET stressed the need for timely archiving of ozone data at the World Ozone and UV Data Centre (WOUDC).

UV Measurements

5.2.1 Mr McArthur reported on the operational practice associated with the UV radiation measurements with reference to the work done or planned by the CAS Scientific Advisory Group on UV radiation (SAG UV).

5.2.2 The team recognized the CAS SAG UV responsibility for the UV radiation measurements and agreed to reformulate the relevant task in the CIMO ET Work Plan to avoid any possible duplication of work done by two teams. The ET role would be to monitor the effort of CAS on operational practices associated with the UV radiation measurements, to collaborate with CAS on matters related to the most suitable method maintaining long-term, cost-effective, UV measurements and to keep the CIMO Guide up-to-date.

5.2.3 Over the last intersessional period there have been a number of documents published by the CAS SAG UV that will aid in improving the CIMO Guide on the observation of UV radiation. In the crucial area of UV filter radiometers, the SAG UV has not been able to produce a technical document. Nevertheless, several countries have successfully operated narrow-band filter radiometer networks and it is believed that based on their QC/QA and operations documentation (if it can be made available to WMO) the appropriate sections of the CIMO Guide can be successfully updated.

5.2.4 The ET recognized the valuable contribution that the SAG UV had made in attempting to define QA and QC techniques for UV instruments, the technical specifications and the techniques for measuring spectrally resolved UV radiation, and the technical specifications and methodologies associated with the operation and calibration of broadband UV instruments.

5.2.5 The ET endorsed the use of the GAW and network publications as a basis for writing the appropriate sections of the Guide on UV radiation observations.

5.2.6 The ET recommended that one of its members be invited as an observer to the CAS GAW SAG UV for the purpose of maintaining the appropriate ties between scientific research observations and network observations of UV radiation. (Recommendation 5.2.6)

5.2.7 The ET agreed that two other matters need to be addressed in the future: (1) the ongoing problems associated with the archiving of UV data at the World Ozone and Ultra-violet Data Centre (WOUDC); and (2) the need to ascertain the quality and traceability of the calibration of UV instruments using various regional centers. Recommendations to encourage further action on these matters are given below.

5.2.8 The ET, recognizing the continuing development of UV calibration centers, the development of new reference methods and the need to insure global comparability of UV observations, recommended that a comparison of calibration methodologies at existing calibration centers be undertaken in the future. Such a comparison will need to be coordinated through other WMO Technical Commissions and Programs and other multi-national coordinating bodies (e.g., EU). (Recommendation 5.2.8)

5.2.9 The ET recognized that the observation of UV radiation is not often a part of the mandate of NMHSs. Therefore, efforts should be made to encourage the linkage between NMHSs' and those organizations that are mandated to observe UV radiation in WMO member countries.

5.2.10 The ET stressed the need for timely archiving of UV radiation data at the World Ozone and UV Data Centre (WOUDC).

Optical Depth Measurements

5.2.11 Mr Behrens reported on the operational practice associated with the Optical Depth (OD) Measurements with reference to the work done or planned by the CAS Scientific Advisory Group on Aerosols (SAG Aerosol).

5.2.12 The team recognized the CAS SAG Aerosol responsibility for the OD measurements and agreed to reformulate the relevant task in the CIMO ET Work Plan to avoid any possible duplication of work done by the two teams. The ET role would be to monitor the effort of CAS on operational practices associated with the OD measurements, to collaborate with CAS on matters related to the practices associated with OD measurements and to keep the CIMO Guide up-to-date.

5.2.13 With the reference of the WMO/GAW Experts Workshop on A Global Surface-Based Network for Long-Term Observations of Column Aerosol Optical Properties, Davos, 8-10 March, 2004, there are currently ten independent networks with about 90 stations with a continuous record for the past 4 years. More stations operate during certain campaigns (e.g., AERONET has had campaigns in Africa and South America). Global coverage corresponds roughly to the landmass distribution, (1/3 SH, 2/3 NH), with Australia, Europe and North America accounting for more than 50% of stations; Major gaps exist in Africa, India, Latin America and the Polar Regions.

5.2.14 Recognizing the significant contribution of the SAG Aerosol in defining the QA/QC procedures, the ET endorsed the SAG Aerosol plan to produce a QA/QC manual on OD.

5.2.15 The ET recognizes the need to establish a primary reference centre to provide traceability for OD measurements, allowing international intercomparisons and the guarantee of quality to meet the needs of climate studies. The ET recommends that the World Optical Depth Research and Calibration Centre (WORCC) at PMOD/WRC becomes the primary WMO reference center for OD networks as part of the activities of the World Radiation Centre ([Recommendation 5.2.15](#))

6. OTHER BUSINESS

6.1 Issues related to standardization

6.1.1 The meeting was informed on ISO Technical Committee (TC) 180 "Solar Energy" Sub-Committee (SC) 1 "Climate Measurements and Data" related standards on solar energy.

6.1.2 It is now 13 years since the ISO TC180/SC1 related standards on solar energy measurement were released. The use of these standards is recommended in the CIMO Guide. The CIMO ET discussed the effectiveness of these standards given that in recent years there have been significant developments and improvements in solar energy measurement. It was also determined that TC180/SC1 was no longer functional and it was unclear if any other ISO TC had taken over the role in relation to the standards. While these standards may still be relevant, there was concern that it has been some considerable time since they were reviewed by appropriate experts in the ISO structure of committees.

6.1.3 In this regard, the CIMO ET recommends that WMO approach ISO to request that the standards linked to TC180/SC1 be reviewed and if necessary updated to reflect current best practice in solar energy measurement.

6.2 World, Regional and National Radiation Centres

6.2.1 The non-attendance of some Regional Radiation Centres at IPC-X is of concern to the CIMO ET. This non-attendance compromises the traceability of irradiance measurements performed by these radiation centers, their associated national centers, and their role as radiation centers under CIMO. As a result the ET felt that mechanisms and protocols be introduced into the CIMO Guide to ensure that to be a Regional or National Radiation Centre it must have effective traceability to the WRR. The ET reviewed Annex 7.C of Chapter 7 of the CIMO Guide to incorporate these mechanisms and protocols. (See ANNEX V). Even if the concept was adopted unanimously, there is a need to define the figures related to uncertainty of reference pyrhemometers. The ET will adopt those figures by correspondence before March 2006 so that the revised Terms of Reference of radiation centers can be submitted to the CIMO-XIV for consideration. (Recommendation 6.2.2)

6.3 CIMO Guide

6.3.1.1 The ET was informed on the status of the Seventh edition of the WMO Guide to Meteorological Instruments and Methods of Observation, WMO-No. 8 (CIMO Guide), especially the revision of the Chapter 7 "Measurement of radiation", Chapter 8 "Measurement of sunshine duration", Chapter 16 "Measurement of ozone" and Chapter 17 "Measurement of atmospheric composition".

6.3.1.2 The chairman appreciated the work done by ET members in updating chapters 7 and 8, however, it was felt that there is still a need to revise those chapters, especially in view of the discussion on IPC, WRR and RRCs. In this regard, the members are requested to provide their suggestions to Mr Forgan (by 1 March 2006) who will coordinate the preparation of a final revision and provide the strikeout version of chapters 7 and 8 to the chair of the ET.

6.3.1.3 As regards the Chapter 17 "Measurement of atmospheric composition", it is extremely important that the chapter include comments on cleanness and sterilization of relevant equipment. The ET agreed that in future update of the Chapter 17, this should be taken into consideration.

6.3.1.4 The ET recommended that the seventh edition of the CIMO Guide be accessible through the CIMO/IMOP website (Recommendation 6.3.1.3).

7. RECOMMENDATIONS TO CIMO-XIV

7.1 With reference to a discussion on the above agenda items, the Expert Team developed the recommendations for the consideration by the CIMO-XIV (see ANNEX VI).

8. DRAFT REPORT OF THE SESSION

8.1

9. CLOSURE OF THE SESSION

9.1 The session was closed on 10 February 2006 at 15:30 h.

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WORK PLAN (updated: 10 February 2006)
Expert Team on Meteorological Radiation and Atmospheric Composition Measurements
(2003-2006)

No.	Task description	Person responsible	Action	Deadline	Deliverables	Deadline
1	Facilitate further activities related to meteorological radiation measurements:					
1 a)	IPC-X, 2005, WRC, Switzerland	W. FINSTERLE in co-operation with the ad hoc group of the IPC	1. Assist in the preparations and participate in the IPC-X 2. Analyze results of IPC-X	Jan. 04 Dec. 05	<ul style="list-style-type: none"> • Concept for IPC-X comparison • Preliminary Report • Published results of the IPC-X 	Sep. 04 Dec. 05 Apr. 06
1 b)	RPCs, 2004-2006, either in conjunction with IPC-X or at RPCs concerned	W. FINSTERLE in co-operation with the ad hoc group of the IPC	1. Assist in the preparations and participate in the RPCs 2. Analyze results of RPCs	Jan. 04 Jan. 06	<ul style="list-style-type: none"> • Concept for RPC comparisons • Published results of the RPC comparisons 	Mar. 06 Apr. 06
1 c)	Liaise with the World Climate Research Programme on matters related to Baseline Surface Radiation Network and inform Members of developments	K. BEHRENS	1. Identify the role of CIMO in further development of BSRN 2. Liaise with WCRP on identified matters	Jan. 06 Jan. 06	<ul style="list-style-type: none"> • Report to Members on BSRN 	May 06
1 d)	Monitor the efforts of the CAS SAG Ozone on the operational practice associated with total ozone measurements	O. M. BARTUREN	1. Collaborate with CAS on matters related to the most suitable method maintaining long-term, cost-effective, total ozone measurements	Jan. 06	<ul style="list-style-type: none"> • Proposal for update of the CIMO-Guide 	Jun. 06
1 e)	Monitor the efforts of the CAS SAG UV on operational practice associated with UV and, aerosol optical depth measurements	UV: L.J.B. McARTHUR J. GRÖBNER Aerosol: K. BEHRENS	1. Collaborate with CAS on matters related to practices associated with UV and, aerosol optical depth measurements	Jan. 06	<ul style="list-style-type: none"> • Proposal for update of the CIMO-Guide 	May 06

No.	Task description	Person responsible	Action	Deadline	Deliverables	Deadline
1 f)	Monitor the efforts of the CAS SAG UV on UV Measurements	L.J. B. McARTHUR	1. Collaborate with CAS on matters related to UV Measurements	Jan. 06	<ul style="list-style-type: none"> Proposal for update of the CIMO-Guide 	May 06
1 g)	Update the CIMO Guide	All members	1. Develop proposals for update of Ch 7 and Ch 8 of the CIMO Guide	Jan. 06	<ul style="list-style-type: none"> Updated Ch 7 and Ch 8 of the CIMO Guide 	May 06
1 h)	Develop further the establishment of a World Standard Group of absolute long-wave radiometers	J. GRÖBNER N. Fox	1. Collaborate with PMOD/WRC on the establishment of a World Standard Group of absolute long-wave radiometers	Jan. 05	<ul style="list-style-type: none"> One absolute long-wave radiometer traceable to SI developed and operational 	2008
1 i)	Coordinate the dissemination of World Radiometric Reference (WRR) factors to regional and national radiation standards	W. Finsterle	1. Disseminate radiometric factors to regional and national radiation standards	Mar. 06	<ul style="list-style-type: none"> IOM Report to Members 	May 06
1 j)	Coordinate the dissemination of pyrgeometer calibration coefficients	J. Gröbner	1. Disseminate pyrgeometer calibration coefficients	On demand	<ul style="list-style-type: none"> Calibration coefficients to users 	On demand
1 k)	Provide technical/scientific guidance in the establishment and continuing quality assurance of IRC Davos	B. FORGAN I. REDA & all ET members	1. Collaborate with PMOD/WRC on the establishment of a IRC	Jan. 06	<ul style="list-style-type: none"> Infrared Radiometer Centre (IRC) established and QA guaranteed 	Feb. 06
1 l)	Initiate activities so that high quality solar radiation measurements may be widely guaranteed in all national radiation networks through training courses and in the establishment of networks in areas with a low density of radiation stations	K. BEHRENS (Act. 1,3) W. FINSTERLE (Act. 2, 3)	<ol style="list-style-type: none"> Review the quality of solar radiation measurements in national networks Assist NRC by developing proposals for improvements in quality of solar radiation measurements Develop proposal for training courses in solar radiation measurements 	Jan. 06 Jan.06 Sep. 05	<ul style="list-style-type: none"> IOM Report on the quality of solar radiation measurements Support provided and documented to National Radiation Centers (NRCs) Syllabus and lecture notes for training in solar radiation measurements Report to OPAG-CB on specific training needs 	May 07 May 07 Sep 05 May 06
1 m)	Status of the traceability of the calibration methods	W. SCHMUTZ N. FOX	1. Review the status of the traceability of calibration methods	May 06	<ul style="list-style-type: none"> Report to Members on the status of the traceability of calibration methods 	May 06

FUTURE WORK PLAN
Expert Team on Meteorological Radiation and Atmospheric Composition Measurements
(2007-2010)

No.	Task description	Action	Deliverables
1	Facilitate further activities related to meteorological radiation measurements:		
1 a)	IPC-XI, 2010, WRC, Switzerland	<ol style="list-style-type: none"> 1. Assist in the preparations and participate in the IPC-XI 2. Analyze results of IPC-XI 	<ul style="list-style-type: none"> • Guidelines for IPC-XI • Published results of the IPC-XI
1 b)	RPCs, 2006-2010, either in conjunction with IPC-XI or at RPCs concerned	<ol style="list-style-type: none"> 1. Initiate RPCs 2. Assist in the preparations and participate in the RPCs 3. Analyze results of RPCs 	<ul style="list-style-type: none"> • Guidelines for RPC comparisons • Published results of the RPC comparisons • At least one RPC
1 c)	Coordinate the dissemination of World Radiometric Reference (WRR) factors to regional and national radiation standards	<ol style="list-style-type: none"> 1. Disseminate radiometric factors to regional and national radiation standards 	<ul style="list-style-type: none"> • Instrument and Observing Methods (IOM) Report to Members
1 d)	Liaise with the World Climate Research Programme on matters related to Baseline Surface Radiation Network and inform Members of developments	<ol style="list-style-type: none"> 1. Identify the role of CIMO in further development of BSRN 2. Liaise with WCRP on identified matters 	<ul style="list-style-type: none"> • Report to BSRN on ET activities • Report to Members on BSRN
1 e)	Liaise with the CAS SAG Ozone on the operational practice associated with total ozone measurements	<ol style="list-style-type: none"> 1. Collaborate with CAS on matters related to practices associated with total ozone measurements 	<ul style="list-style-type: none"> • Report to Members • Proposal for update of the CIMO-Guide
1 f)	Liaise with the CAS SAG UV on operational practice associated with UV measurements	<ol style="list-style-type: none"> 1. Promote the need for the intercomparison of UV calibration centers to the CAS SAG UV 2. Collaborate with CAS on matters related to practices associated with UV measurements 	<ul style="list-style-type: none"> • Report to CAS SAG UV • Proposal for update of the CIMO-Guide
1 g)	Liaise with the CAS SAG Aerosol Measurements	<ol style="list-style-type: none"> 1. Collaborate with CAS on matters related to practices associated with aerosol Measurements 	<ul style="list-style-type: none"> • Report to Members • Proposal for update of the CIMO-Guide

No.	Task description	Action	Deliverables
1 h)	Update the CIMO Guide	1. Develop proposals for update of Chapters 7, 8, 16, 17 of the <i>CIMO Guide</i>	<ul style="list-style-type: none"> • Updated Ch 7, 8, 16, 17 of the <i>CIMO Guide</i>
1 i)	Develop further the establishment of the World Infrared Standard Group (WISG) of radiometers	1. Collaborate with PMOD/WRC/IRC on the development of the WISG of radiometers	<ul style="list-style-type: none"> • At least one absolute radiometer traceable to SI developed and operational
1 j)	Coordinate the dissemination of pyrgeometer calibration coefficients	1. Calibration of the pyrgeometers at the IRC	<ul style="list-style-type: none"> • Calibration certificates to users
1 k)	Provide technical/scientific guidance to the IRC Davos	1. Perform the scientific evaluation of the IRC	<ul style="list-style-type: none"> • Report to IRC and Members
1 l)	Initiate activities so that radiation measurements in all national radiation networks are of a high quality	<ol style="list-style-type: none"> 1. Develop methodology for assessing the quality of radiation data 2. Review the quality of radiation measurements in national networks 3. Assist NRC in improving the quality of radiation measurements 4. Develop proposal for training courses in radiation measurements 	<ul style="list-style-type: none"> • Survey on quality of radiation measurements • IOM Report on the quality of radiation measurements • Methods distributed to NRCs on specific radiation issues • Syllabus and lecture notes for training in radiation measurements
1 m)	To determine the status of the traceability of radiation measurements to SI	1. Assessment of the traceability of radiation measurements to SI	<ul style="list-style-type: none"> • Report to Members
1 n)	To examine the transfer of WISG to network measurements of infrared irradiance	1. Survey on how field pyrgeometers are calibrated	<ul style="list-style-type: none"> • Report to Members

INFRARED RADIOMETER CENTRE

See separate file "**Infrared Radiometer Centre.pdf**" on

<http://www.wmo.int/web/www/IMOP/reports.html>

TERMS OF REFERENCE OF THE WORLD, REGIONAL AND NATIONAL RADIATION CENTRES

(Draft)

ANNEX 7.C

SPECIFICATIONS FOR WORLD, REGIONAL, AND NATIONAL RADIATION CENTRES

World Radiation Centres

World Radiation Centres were designated by the thirtieth session of the Executive Committee in 1978 through its Resolution 11 (EC-XXX) to serve as centres for international calibration of meteorological radiation standards within the global network and to maintain the standard instruments for this purpose.

A World Radiation Centre ~~should~~ shall fulfil the following requirements:

- (a) it ~~should~~ shall either
 - (1) possess and maintain a group of at least three ~~of the most~~ stable ~~absolute~~ pyrheliometers or absolute radiometers, the calibration of which is directly derived from ~~with a traceable 95 per cent uncertainty of less 1 Wm⁻² to the World Radiometric Reference~~, and in stable clear sun conditions with direct irradiances above 700 Wm⁻², 95 per cent of any single measurements of direct solar irradiance will be expected to be within 4 Wm⁻² of the irradiance; or
 - (2) provide and maintain an archive for solar radiation data from all the member states of WMO~~The World Radiation Centre Davos is requested to maintain the World Standard Group for the realization of the World Radiometric Reference;~~
- (b) it should undertake training of specialists in radiation;
- (c) the staff of the centre should provide for continuity and should include qualified scientists with wide experience in radiation ;
- ~~(bd)~~ it shall ~~should~~ take all steps necessary to ensure at all times the highest possible quality of its standards and testing equipment, and where its has a metrological role;
- ~~(ee)~~ it should serve as a centre for the transfer of the World Radiometric Reference to calibration of the regional centres standards;
- ~~(ef)~~ it ~~shall~~ should have the necessary laboratory and outdoor facilities for the simultaneous comparison of large numbers of instruments and for the reduction of the data;
- ~~(eg)~~ it ~~shall~~ should follow closely or initiate developments leading to improved standards and/or methods in meteorological radiometry;
- (h) it shall be assessed by a National or International agency or CIMO experts, at least every 5 years to verify traceability of the direct solar radiation measurements.
- ~~(f) it should undertake training of specialists in radiation;~~
- ~~(g) the staff of the centre should provide for continuity and should include qualified scientists with wide experience in radiation.~~

Regional Radiation Centres

A Regional Radiation Centre is a centre designated by a Regional Association to serve as a centre for intraregional comparisons of radiation instruments within the Region and to maintain the standard instruments necessary for this purpose.

A Regional Radiation Centre should satisfy the following conditions before it is designated as such and should continue to fulfil them after being designated:

- (a) it ~~shall~~ should possess and maintain a standard group of at least three stable pyrheliometers radiometers, with a traceable 95 per cent uncertainty of less 1 Wm⁻² to the

World Standard Group, and in stable clear sun conditions with direct irradiances above 700 Wm⁻², 95 per cent of any single measurements of direct solar irradiance will be expected to be within 6 Wm⁻² of the irradiance~~which consists, of either three standard radiometers of the Ångström, silver-disk or absolute radiometer type or of two absolute radiometers;~~

- (b) one of the ~~standard radiometers~~ shall ~~should~~ be compared at least once every five years against the World Standard Group;
- (c) the standard radiometers ~~shall~~ ~~should~~ be intercompared at least once a year to check the stability of the individual instruments. If the mean ratio, based on at least 100 measurements, and having an 95 per cent uncertainty less than 0.1 per cent, has changed by more than 0.2 per cent and if the erroneous instrument cannot be identified, then a recalibration at one of the World Radiation Centres has to be performed prior to further use as standard;
- (d) it ~~shall~~ ~~should~~ have the necessary facilities and laboratory equipment for checking and maintaining the accuracy of the auxiliary measuring equipment;
- (e) it ~~shall~~ ~~should~~ provide the necessary outdoor facilities for simultaneous comparison of national standard radiometers from the Region;
- (f) the staff of the centre should provide for continuity and should include a qualified scientist with wide experience in radiation.
- (g) it shall be assessed by a National or International agency or CIMO experts, at least every 5 years to verify traceability of the direct solar radiation measurements.

National Radiation Centres

A National Radiation Centre is a centre designated at the national level to serve as a centre for the calibration, standardization, and checking of the instruments used in the national network of radiation stations and for maintaining the national standard instrument necessary for this purpose.

A National Radiation Centre should satisfy the following requirements:

- (a) it ~~shall~~ ~~should~~ possess and maintain at least two one pyrheliometer standard radiometer of the Ångström, silver-disk or absolute radiometer type for use as a national reference for the calibration or radiation instruments in the national network of radiation stations with a traceable 95 per cent uncertainty of less 4 Wm⁻² to the regional representation of the World Radiometric Reference, and in stable clear sun conditions with direct irradiances above 700 Wm⁻², 95 per cent of any single measurements of direct solar irradiance will be expected to be within 20 Wm⁻² of the irradiance;
- (b) one of the national standard radiometers ~~s~~ ~~shall~~ ~~should~~ be compared with a regional standard at least once every five years;
- (c) the national standard radiometers shall be intercompared at least once a year to check the stability of the individual instruments. If the mean ratio, based on at least 100 measurements, and having an 95 per cent uncertainty less than 0.2 per cent, has changed by more than 0.6 per cent and if the erroneous instrument cannot be identified, then a recalibration at one of the Regional Radiation Centres must be performed prior to further use as standard;
- ~~(e)~~ it ~~shall~~ ~~should~~ have the necessary facilities and equipment for checking the performance of the instruments used in the national network;
- ~~(e)~~ the staff of the centre should provide for continuity and should include a qualified scientist with experience in radiation.

National Radiation Centres ~~shall~~ ~~should~~ be responsible for preparing and keeping up to date all necessary technical information for the operation and maintenance of the national network of radiation stations.

Arrangements should be made for the collection of the results of all radiation measurements made in the national network of radiation stations and for the regular scrutiny of these results with a view to ensuring their accuracy and reliability. If this work is done by some other body, the National Radiation Centre should maintain close liaison with that body.

List of World and Regional Radiation Centres

WORLD RADIATION CENTRES

Davos	(Switzerland)
St. Petersburg ²	(Russia)

REGIONAL RADIATION CENTRES

Region I (Africa):

Cairo	(Egypt)
Khartoum	(Sudan)
Kinshasa	(Zaire)
Lagos	(Nigeria)
Tamanrasset	(Algeria)
Tunis	(Tunisia)

Region II (Asia):

Pune	(India)
Tokyo	(Japan)

Region III (South America):

Buenos Aires	(Argentina)
Santiago	(Chile)
Huayao	(Peru)

Region IV (North and Central America):

Toronto	(Canada)
Boulder	(United States)
Mexico City	(Mexico)

Region V (South-West Pacific):

Melbourne	(Australia)
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Region VI (Europe):

Budapest	(Hungary)
Davos	(Switzerland)
St. Petersburg	(Russia)
Norrköping	(Sweden)
Trappes/Carpentras	(France)
Uccle	(Belgium)
Lindenberg	(Germany)

² Mainly operated as a World Radiation Data Centre (WRDC)

RECOMMENDATIONS TO CIMO-XIV

RECOMMENDATION 4.2.4 “COEFFICIENTS OF THE BSRN PYRGEOMETER EQUATION”

Considering that:

1. There is an apparent lack of uniformity in the four coefficients of the BSRN pyrgeometer equation, (Philipona et al (1995)), when derived by different groups for the same instrument;
2. The uncertainty introduced by using different coefficients for the same instrument is an issue;
3. There are divergent views in the scientific community on the determination of infrared irradiance derived from the pyrgeometer measurements.

The expert team recommended that:

1. CIMO invites the BSRN community in collaboration with the Infrared Radiometer Centre (IRC) to examine the consistency of characterizing pyrgeometers.

RECOMMENDATION 4.2.5 “INFRARED RADIOMETER CENTRE (IRC)”

Considering that:

1. The IRC, established at the PMOD/WRC in January 2004 following the Recommendation 1 (CIMO-XIII), is crucial for the worldwide quality and compatibility of infrared data;
2. There is a need to develop further infrastructure and operational procedures of the IRC.

The expert team recommended that:

1. The World Infrared Radiometer Calibration Centre be renamed to the Infrared Radiometer Centre (IRC) as a component of the World Radiation Centre;
2. The IRC establishes the Interim WMO Pyrgeometer Infrared Reference using the procedures and instrumentation that make up the World Infrared Standard Group;
3. The members of CIMO be encouraged to develop instruments and methods to improve traceability of far infrared³ irradiance measurements to SI units;
4. At least every three years, Regional Radiation Centres (RRCs) supporting networks for measuring far infrared irradiance shall submit a pyrgeometer to the IRC for calibration or verification.

RECOMMENDATION 5.2.6 “CIMO Collaboration with CAS on UV matters”

Considering that:

1. CAS is taking the lead in developing quality systems for monitoring UV irradiance.

The expert team recommended that:

1. The CIMO ET be invited as observer to the CAS SAG UV for the purpose of maintaining the appropriate ties between scientific research observations and network observations of UV radiation.

³ The terms “far infra-red”, “infra-red”, “long-wave” and “terrestrial” radiation are equivalent for the purpose of this document.

RECOMMENDATION 5.2.8 “Development of UV Calibration Centers”

Considering that:

1. There is a need for the continuing development of UV calibration centers, the development of new reference methods and the need to insure global comparability of UV observations.

The expert team recommended that:

1. A comparison of calibration methodologies at existing calibration centers be undertaken in the future.
2. A comparison will need to be coordinated through other WMO Technical Commissions and Programs and other multi-national coordinating bodies.

RECOMMENDATION 5.2.15 “Creation of primary WMO reference centre for Optical Depth”

Considering that:

1. There is a need to establish a primary reference centre for Optical Depth (OD) measurements.
2. The World Optical Depth Research and Calibration Centre (WORCC) has made an excellent contribution in improving the understanding of OD measurements.

The expert team recommended that:

1. That the World Optical Depth Research and Calibration Centre (WORCC) at PMOD/WRC becomes the primary WMO reference center for OD networks as part of the activities of the World Radiation Centre.

RECOMMENDATION 6.2.2 “TERMS OF REFERENCE (TOR) OF THE WORLD, REGIONAL AND NATIONAL RADIATION CENTRES”

Considering that:

1. There have been significant improvements in understanding the uncertainties of pyrheliometer measurements.
2. Some Regional Radiation Centers no longer have traceability to the WRR.

The expert team recommended that:

1. The revised TOR of the World, Regional and National Radiation Centres (Annex V) are approved for publication in the CIMO Guide.

RECOMMENDATION 6.3.1.3 “ACCESSIBILITY OF CIMO GUIDE ”

Considering that:

1. The information of the Guide should be distributed in a timely manner and as widely as possible.

The expert team recommended that:

1. The seventh edition of the CIMO Guide would be publicly accessible through the CIMO/IMOP website.