

Report of the Ad Hoc Committee for International Pyrheliometric Comparison X

The Ad Hoc Committee (ADC) for IPC-X was created on 25 September 2005 under the terms of reference given in Appendix A and the membership as at Appendix B.

The ADC met at various times during the IPC-X to monitor progress and make recommendations to CIMO and PMD/WRC for IPC-X and future comparisons. At the first meeting it was clear that the WRR WSG had been well maintained over the period 2001-2005, and that unlike for IPC-IX, all the remaining WSG instruments were available for IPC-X. After an examination of the relative sensitivities of the instruments between 2001 and September 2005 there was some evidence for an increase in the sensitivity of PMO2 and a decrease in sensitivity of HP18748. The Director of the IPC-X indicated a desire to investigate the trend in PMO2 post-IPC-X.

Recommendation 1: That if the results from IPC-X verify that the upward trend in sensitivity of PMO2 is significant, PMOD investigate the electronics and support structures of PMO2 as soon as possible after IPC-X so that any refurbishment can be completed and its impact determined.

The ADC discussed the possibility of also investigation of the decrease of sensitivity of HF18748. It was decided not to recommend any invasive investigation of HF18748 given that PMO2 was likely to be investigated and potential refurbished before the next IPC. However, the ADC believed that some investigations could be taken to see if the control electronics of the HF were a factor. For example, by swapping the control boxes of HF18748 with those of AHF32455 and noting the impact.

The ADC also examined the results of candidate instruments for addition to WSG. No candidate had the necessary traceability to examine its long term performance and suitability to be part of the WSG, hence no instruments were recommended for addition to the WSG. However, the ADC noted that there were 3 candidates that could be considered at IPC-XI, namely, SIAR-2a, SIAR-2b and AHF32455.

The ADC at its first meeting examined the data selection criteria (see appendix C) proposed at IPC-IX for the evaluation of the final coefficients. The ADC felt that the criteria were useful guidelines for IPC-X and circumstances permitting that they should be used in the evaluation of IPC-X. The only exceptions were the criteria 3 and 6. Criterion 3 was problematic given the distribution of instruments at PMOD/WRC and the representativeness of the wind measurements. Criterion 6 stated that an entire series be removed if more than two out of 13 individual observations do not meet the standard deviation criterion 5. It was felt that with the availability of the wide field of view cloud detector, the individual readings in a series could be used, as per the evaluation of final results in IPC-IX. Unlike IPC-IX, for IPC-X there were a large number of available series and days of data, indicating that the final evaluations would be based on a statistically significant number of comparison points.

Recommendation 2: The data selection criteria documented in the final report of IPC-IX be accepted for IPC-X with the exception of criteria 3 and 6.

Recommendation 3: PMOD consider the development of a representative wind monitoring system for IPC-XI.

The ADC discussed the recommendations from IPC-IX as reported in the final report for IPC-IX. It was clear that none of these recommendations had been acted upon by the members of CIMO and Regional Associations and there were no regional comparisons with participation by the WSG conducted between 2001 and 2005. After some discussion the ADC agreed to endorse the IPC-IX ADC recommendations and use national and regional representatives to foster and promote the recommendations of the ADC of IPC-IX. For completeness the recommendations from the ADC of IPC-IX are listed at Appendix D.

Recommendation 4: That the recommendations of the ADC of IPC-IX on the 'Considerations on the Future of the International Pyrheliometer Comparisons' be promoted for discussion and resolution at future CIMO and Regional Association meetings.

The ADC noted the report on meteorological radiation measurements (agenda item 4.5) and fully endorsed the 4 recommendations (Annex II to paragraph 4.5.10) on the need for Regional Pyrheliometric Comparisons and Training. However, it was also noted with concern that no regional comparisons occurred between IPC-IX and IPC-X, and that some Regional Radiation Centres (RRC) were not represented at IPC-X. It is stated in the CIMO Guide, Chapter 7 that for Regional Radiation Centres "One of the standard radiometers should be compared at least once every five years against the World Standard Group".

The lack of regional inter-comparisons to the WGS and no participation in IPC-X by 3 RRCs may have a significant impact on solar irradiance and exposure traceability at regional and national centres. Given that the majority of regional centres are participation in other global programs, for example, GCOS, GAW, WCRP etc, there may be impacts on the effectiveness of global measurement programs.

Recommendation 5: That CIMO determine if the Region III Buenos Aires, Argentina Regional Radiation Centre wishes to continue as a RRC, and if so determine a suitable means to provide the RRC with appropriate traceability to the WSG and the WRR.

Recommendation 6: That CIMO determine if the Region I Kinshasa, Zaire Regional Radiation Centre wishes to continue as a RRC, and if so determine a suitable means to provide the RRC with appropriate traceability to the WSG and the WRR.

Recommendation 7: That CIMO determine if the Region I Tunis, Tunisia Regional Radiation Centre wishes to continue as a RRC, and if so determine a suitable means to provide the RRC with appropriate traceability to the WSG and the WRR.

The AHC was unanimous in the view that providing traceability of reference pyrheliometers to the WRR using regional and national regional absolute radiometers is a vital role of RRCs, NRCs and representative organisations. It provides a foundation for traceability of pyrheliometers and pyranometers used in solar energy

networks, to ensure coordinated and comparable regional and solar energy measurements.

Recommendation 8: The dissemination of the WRR through RRCs and National Pyrheliometric Comparisons be revitalized by making efforts to increase the participation of relevant meteorological organizations.

It was also noted by the ADC that for those RRCs, that did not participate either in IPC-X or a regional inter-comparison remain, one must question whether they can remain RRCs without conformance to the most fundamental traceability requirements. If CIMO deem they can remain a functioning RRC then the entire traceability hierarchy of world, regional and national centres is questionable. However, as the ADC noted that there are no guidelines or recommendations in the CIMO documentation on the conformance requirements of an RRC and the implications of non-compliance.

Recommendation 9: The CIMO guidelines and requirements for being a RRC also include information to determine the status of a RRC that does not conform to the traceability requirements.

Recommendation 10: The CIMO Guide be edited to include the outcomes of recommendation 9.

The ADC discussed the situation that has developed for a number of countries using electrical substitution and equivalence cavity instruments, in particular, the cases where the instrument participated in the comparison but not the normal control system used in the member country for local comparisons and measurements. The ADC noted that in this case the end-to-end (including the instrument) system used in the country of origin did not have traceability to the WSG through the IPC-X and the uncertainty of measurements with the normal end-to-end system has increased. Only the instrument and the control system used at the IPC-X had traceability to the WSG.

Recommendation 11: PMOD prior to IPC-XI should inform all invited participants that they bring their end-to-end monitoring systems that include the instrument and its control box.

The ADC were also advised that the El Salvador Eppley NIP that participated in the comparison had been refurbished between 30 Sept and 3 Oct, and the instrument had significantly different sensitivities prior and post modification.

Recommendation 12: The El Salvador NIP be provided with two coefficients from IPC-X; one for prior to 4 Oct and one for post-3 Oct.

The ADC noted with satisfaction that IPC-X had the highest recorded comparison points for all types of instruments at an IPC, thanks to over a week of clear sun and sky periods.

The ADC noted with pleasure the excellent facilities and resources made available to the IPC-X participants by PMOD and expressed its thanks to Dr Wolfgang Finsterle, the Organiser of the IPC-X, the Director of PMOD/WRC, Dr Werner Schmutz and

the very cooperative and helpful staff at PMOD for making the comparison run so smoothly.

Appendix A

Terms of reference for the ad-hoc working group at IPC-X

Following the usual procedure at previous IPCs, that are based on Resolution 1 of CIMO-XI, an ad-hoc working group has been set up at IPC-X.

The ad-hoc working group meets during the comparisons as often as necessary to evaluate the performance of the World Radiometric Reference (WRR) and recommend the updating of the calibration factors of the participating instruments. The group approves the procedure to compute the new WRR factors of the WSG as well as the calibration factors of the participating instruments. In addition, the group discusses and recommends the future of IPC and RPCs.

Miroslav Ondras, Senior Scientific Officer of WWW Observing System Division, WMO-responsible for the IPC-X, proposed the following composition for the ad-hoc working group:

Appendix B

Members

Mohamed Hussein Kornay	Region I	Egypt
Kohei Honda	Region II	Japan
Pedro Mostraj Aquilera	Region III	Chile
Augustin Muhlia	Region IV	Mexico
Don Nelson	Region IV	USA
Bruce W Forgan (Chair)	Region V	Australia
Zoltan Nagy	Region VI	Hungary
Werner Schmultz	PMOD/WRC	Switzerland
Wolfgang Finsterle	WRC/PMOD	Switzerland
Klaus Behrens	CIMO Expert Team	Germany

Appendix C

Data Selection Criteria for Final Evaluation

1. Only observations falling within appropriate measurements periods be accepted and that the last series for any group of instruments stop before the end of the period is reached (based on calculations associated with the instrument field of view).
2. That no measurements be used for Angstrom pyrheliometers if a cloud is within 15 degrees of the sun. No measurements will be used for the absolute cavity radiometers (field of view = 5 degrees) if a cloud is within 8 degrees of the sun.
3. That no measurements be used if the wind speed is greater than 2.5 m/s.
4. That no data be used if the 500 nm AOD is greater than 0.120.
5. That an individual point be excluded from the series if the variation of the 8 fast PMO2 measurements is greater than 0.5 Wm⁻².
6. That an entire series be removed from consideration if more than two out of 13 individual observations do not meet criterion 5.
7. That the minimum number of acceptable data points be 150 for the PMO2 taken over a minimum of three days during the comparison period.

Appendix D

Recommendation of Ad hoc committee of IPC-IX

(Appendix A of report of IPC-IX)

The Ad-hoc Group of the Ninth International Pyrheliometer Comparison (IPC) has met several times to discuss means of ensuring the future stability and transfer of the World Radiation Reference (WRR) in coming years. Specific concerns that the committee has addressed below include:

- The transfer from the WRR to Regional Radiation Centre (RRC) absolute instruments. Several comparisons have resulted in limited data sets, even after the three weeks of time allotted for the comparison.
- The increase in the number of National Radiation Centres (NRC) being invited to the IPC because RRCs are unable to hold Regional Association (RA) pyrheliometer comparisons during the intervening time periods. This has led to an increased concern that the transfer from RRCs to NRCs has become less effective, and that the overall level of communication between the two types of centres has been reduced.
- The increase in the cost of the comparison at the same time the budget for comparisons within CIMO has decreased.

The effectiveness of maintaining the World Standard Group (WSG) of instruments at PMOD over the last 30-or-so years is indicated by the nearly insignificant change in the WRR during this time period. The expertise developed must remain in tact along with the on-going maintenance of the individual WSG instruments. However, the increasing age of the WSG is becoming a concern to both the staff of the WRC and the Ad-hoc Group. CIMO indicates that the WSG must consist of a minimum of 4 absolute cavity instruments of different types so that the WRR may be maintained. At present the WSG consists of seven instruments, however, over the last 5 years three of these instruments have shown signs of aging (note that many of these instruments are more than 30 years old), with the possibility that they may have to be removed from the WSG because of increased uncertainties. The PMOD has explored several possibilities to obtain different instruments to operate along with the WSG, but these investigations have led to the deployment of only one further instrument during the last 5 years. There is a further time delay from the deployment of an instrument and its acceptance into the WSG because of the need to ensure that the new instrument is stable over an inter-IPC period. This present state of instrumentation may well make the need for constant monitoring of the WRR more critical at this time than in previous years.

The number of National Radiation Centres at the last two comparisons is also a concern to both the staff of the WRC and the Ad-hoc Group. The combining of the Regional Radiation Comparisons (RPCs) with the IPC increases logistical support significantly. Furthermore, members of the Ad-hoc Group believe that the combining of RPCs with the IPC both reduce the maintaining of the WRR through comparisons throughout the 5-year period between comparisons and reduce the educational opportunities afforded to National Centres when an RPC is held within the Region.

Based upon the above general discussion, the Ad-hoc Group present the following recommendations:

1. **That an International Pyrheliometer Comparison be held once every five years at the World Radiation Centre.** The regular bringing together of experts with Regional Standard instruments provides a necessary check on the stability of the WSG of instruments and increases the probability of detecting any bias in the WRR. Keeping the WSG at the WRC reduces the risk in altering the WRR by eliminating the need to move the entire WSG of instruments and the electronic equipment associated with these instruments.
2. **That the comparison be open-ended to ensure that the amount of data collected is sufficient to assure the quality of the World Radiation Reference and the transfer of this reference to the participating Regional Radiation Centres.** Comparisons during 1980, 1990 and 2000 had limited numbers of observations due to inclement weather conditions during the 3-week period of the IPC. During the 1995 comparison, more data than necessary was collected to statistically ensure the stability of the WRR. If the amount of data collected is insufficient, ending the comparison prematurely on a fixed date tends to increase the uncertainty in the calculation of the WRR. This in turn may have significant effects on the clients utilizing the services of the Regional and National Centres. By fixing the location of the comparison in Recommendation One, the working group encourages the WRC to carefully

determine the best portion of the year to host such a comparison so that the time required to obtain the necessary quantity of measurements is minimized. From climatological mean data there are several times of the year when the minimum required number of clear days for a successful comparison can be expected within a 14 day period. At the same time it is recognized the clear weather conditions cannot be guaranteed.

3. **That the Regional Associations within CIMO ensure that a minimum of one RRC from within the region be represented at the IPC and that the regional centre(s) representing the region be fully compliant with the regulations of an RRC as outlined in Annex C of the CIMO Guide (WMO No. 8, 1996).** The Ad-hoc Group recognizes that for many regions the cost associated with sending a delegation from a RRC is significant, but it is crucial that a well-equipped and trained individual(s) be sent from each region. During past IPCs a number of RRCs have not had the appropriate equipment and therefore have not been able to participate to the fullest extent. The sending of such centres is counter-productive. The Regional Associations are encouraged to examine each RRC within the region to determine whether they meet the standards set down in the CIMO Guide.
4. **That RPCs are held separately and not be in conjunction with the IPC.** The primary task of an IPC is the transfer of the WRR to instruments maintained by RRCs. The combining of RPCs with the IPC increases the complexity and logistics of the task considerably. Furthermore, the educational aspects of both the IPC and the RPCs are diluted. Specific courses that should be provided to individuals of RRCs cannot be given because of the divided interests of the participants. Of greater concern is the limited number of individuals from NRCs that are able to attend due to cost. Specific courses that could be normally tailored for NRCs within Regional Associations are not available at a combined RPC and IPC.
5. **That organizations that are not RRCs be charged a participants fee for attending the IPC and that all funds obtained from such fees be used to offset the cost of shipping equipment from the WRC to the RPC.** During the last two IPCs several participants have represented either private sector or government laboratories not associated with the WMO. In some cases government and private-sector laboratories are now mandated under law to maintain standards directly traceable to the WRR through participation in an IPC every five years. These participants illustrate the demand for such a comparison of absolute radiometers for users other than those associated directly with meteorological organizations. Furthermore, these organizations use the calibrations obtained while attending the IPC for commercial advantage. The Ad-hoc Group suggests that such institutions be charged a fixed participants fee to partake in such a comparison. National laboratories desiring, or mandated to attend the IPC should also be charged the same rate, although these institutions are strongly encouraged to attend only the appropriate regional comparison. As recognition of past practices those laboratories or manufacturers providing instruments to the WSG would be exempted from all charges as a courtesy for donating instruments. It is hoped that this latter exemption may encourage the donation of instruments of

different designs to the WSG. All fees collected will be used to offset the cost of transporting WRR equipment to the RPCs. The distribution of the funds will be a weighted against the distance from the WRC to the six regions.

6. **The maximum number of attendees at an IPC be determined by the WRC.** While the above recommendations are meant to reduce the number of active participants to any IPC, the final number of participants to an IPC must be controlled by the WRC because of the logistics associated with such an important task. The success of an IPC cannot be jeopardized because of too many participants. Under reasonable circumstances the attendance priority should be RRC, NRC and finally commercial interests.
7. **That the dissemination of the WRR through RPCs be revitalized to protect the integrity of the WRR through the five-year period through participation in regional comparisons in each of the 6 WMO regions.** Changes in the WRR through the comparison of instruments directly related to the WRR with those of regional centres would be more quickly noticed. Six RA comparisons during a 3.5-year period provide a crosscheck against the WRR at intervals of roughly 7 months. An RPC would require that a minimum of one instrument from the WSG, and two absolute cavities that have been compared with the WSG within a six-month period before the RPC and that a statistically significant data set be obtained to show the stability of these instruments to the WRR (these instruments should be of different manufacture).
8. **That it is the responsibility of each Regional Association to provide a host for an RPC, which will be held in the period 6 months to 4 years following the completion of an IPC. The date and duration of the RPC will be established in conjunction with the WRC.** The reduction in the number of RPCs during the last ten years is a disturbing trend. Recommendations Three and Four are meant to encourage the re-establishment of the RPC. It is recommended strongly that RAs become more involved in the measurement of radiation and the transfer of the WRR through RPCs. For example, budget freed by sending only one RRC to the IPC could be used to build the necessary infrastructure and provide travel grants to increase the number of participants from NRCs. This decentralization will provide NRCs the opportunity to discuss problems found within the region, but may not be significant to the larger global community, while at the same time reducing travel costs, and probably the time required to fulfill the measurement requirements of an RPC. The combining of RPCs is encouraged if RAs believe that the benefit to the participating NRCs is increased over organizing separate regional comparisons. Furthermore, it would be ideal if one RRC from outside the RA also attend the RPC. This would increase expertise with respect to teaching NRC personnel and provide further crosschecks on the stability of the WRR during the period between IPCs. The Ad-hoc Group further suggests that to increase the capability of individual RRCs that any funding provided by the RA be linked to that RRC hosting the RPC during the following inter-IPC period. The WRC is committed to providing the necessary salary and travel expenses to ensure that qualified staff is available to operate the WSG instrument(s).

9. **That the Regional Radiation Centres be provided with education courses directly related to hosting an RPC during their attendance at the IPC.** As part of the reduction in numbers at the IPC and the focus of the IPC on RRCs, the education program can be better tailored to meet the needs of the attendees. To encourage the successful operation of an RPC, courses will be developed by the WRC to provide a means of aiding RRCs to successfully host such comparisons.

10. **That during an RPC education courses be provided to NRCs that will increase the capability of National Centres in the calibration of radiometers and the development and maintenance of national radiation networks.** It is believed that the decentralization of regional comparisons away from the IPC will provide opportunities for educating individuals from National Centres not available elsewhere. As part of the program associated with hosting an RPC, the RRC would have opportunity to develop special courses suitable for the participants of the region. These courses could either be taught by individuals within the region or in cooperation with WRC staff that would be attending the RPC. By keeping comparisons on a regional base, many members of the Ad-hoc Group believe that issues of culture and language would be reduced, thus encouraging increased participation by NRCs.