Results of the 10th International Pyrheliometer Comparison IPC-X

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IPC-X 2005

- 73 participants representing 42 nations
  - 16 Regional Radiation Centers
  - 23 National Radiation Centers
  - 11 manufacturers and other institutions
- 101 participating pyrheliometers (6 WSG)
- 104 data series' on 11 days
  - 1352 data points for PMO2
  - 1144 data points for Ångströms and HF/AHF's
  - 624 data points for PMO6
- 1 RRC of RA III missing
The World Standard Group (WSG)
Data Acquisition

- Readings from manually operated instruments (mostly Ångströms and older HF's) were typed into micro-terminals connected to the WSG DAQ computer.

- Readings from computer controlled instruments were written to floppy or memory sticks and fed into the WSG DAQ at the end of the day.

- All data were evaluated on the WSG DAQ computer.
Long-Term Stability of the WSG

![Graph showing WRR factor over years from 1980 to 2005 for different markers: PMO2, PMO5, CROM2L, CROM3R, PAC3, TMI67814, HF18748.](image)
Transfer of the WRR – Two Options

Either...
1) Use only CROM2L, MK67814, and PMO5
or...
2) Use all six instruments

➔ Option 2) was selected for the following reasons...

<table>
<thead>
<tr>
<th>WRR factor trends since IPC-IX (2000)</th>
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<tbody>
<tr>
<td>PMO2</td>
<td>-930 ppm ↓</td>
</tr>
<tr>
<td>CROM2L</td>
<td>-12 ppm →</td>
</tr>
<tr>
<td>MK67814</td>
<td>48 ppm →</td>
</tr>
<tr>
<td>HF18748</td>
<td>599 ppm ↑</td>
</tr>
<tr>
<td>PAC3</td>
<td>466 ppm ↑</td>
</tr>
<tr>
<td>PMO5</td>
<td>8 ppm →</td>
</tr>
</tbody>
</table>
1st Reason: “Health Examination” of PMO2

- *Increase* in sensitivity is only possible when electronics parts drift (amplifiers, standard resistor)
- The electronics unit of PMO2 was thoroughly tested and re-characterized in the laboratory after IPC-X, but no deviation from its original characterization was detected.
2\textsuperscript{nd} Reason: Participating Instruments

![Graph showing relative change of WRR for different participating instruments.](image)
New Puzzle: Trends depend on Type of Instrument!
2006 U.S. National Pyrheliometer Comparison

- Three instruments from the WRC participated in the 2006 U.S. National Pyrheliometer Comparison at NREL in Golden, CO
  - Independent confirmation of IPC-X procedures
  - Confirmation of PMO5 (92 ppm) and PMO6 (46 ppm) IPC-X results
  - Incoherent results of AHF-32455 (~1000 ppm) during IPC-X and NPC 2006 are not related to the observed trends but will be investigated
Quality Assurance

WRC staff repaired two broken instruments and assisted with several others.
Capacity Building

- Seminar talks and capacity building workshops were held during bad weather
  - Radiometry
  - Uncertainty in measurements
- Over 30 presentations were given by WRC experts, participants, and guest speakers
  - National radiation networks
  - Sun-Photometry and AOD measurements
  - Earth's radiation budget
- All presentations are available for download on ftp://ftp.pmodwrc.ch/stealth/ipc-x/Symposium
ftp://ftp.pmodwrc.ch/stealth/ipc-x/IPC_REPORT
Conclusion

• Excellent weather conditions allowed collecting a large number of data points
• The WSG performed well within the CIMO stability requirements
• New WRR factors were assigned to all but one (defective) participating instruments
• On average the WRR factors of participating instruments were lower by 471 +/- 206 ppm (95 % confidence) than in 2000
• Systematic differences between different types of instruments remain unexplained at this time
Outlook

• Although still in good condition the WSG will need to be renewed in the future
  – Two candidate pyrheliometers on loan from China are currently being tested
• Limitations in the concept to maintain the stability of the WRR by periodic IPC's became apparent in the unexplained discrepancies between different types of instruments
  ➔ The WRC will evaluate and test a new concept based on cryogenic technology