ACRIM TOTAL SOLAR IRRADIANCE MONITORING DURING SOLAR CYCLES 21 – 23

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Critical Characteristics of TSI Monitoring Experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>PI Mode</th>
<th>Observatory Frequency</th>
<th>Shutter Calibration Frequency</th>
<th>Electrical Calibration Frequency</th>
<th>Degradation Calibration</th>
<th>Solar Pointed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nimbus7/ERB</td>
<td>Quiet</td>
<td>3-4 days</td>
<td>None</td>
<td>2 weeks</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SMM/ACRIM1</td>
<td>Yes</td>
<td>30 min/LEO orbit</td>
<td>1 day, cycle</td>
<td>Continuous</td>
<td>2-fold redundant</td>
<td>Monthly</td>
</tr>
<tr>
<td>ERBS</td>
<td>No</td>
<td>30 min/LEO orbit</td>
<td>1 day, cycle</td>
<td>Continuous</td>
<td>2-fold redundant</td>
<td>Monthly</td>
</tr>
<tr>
<td>UARS/ACRIM2</td>
<td>Yes</td>
<td>30 min/LEO orbit</td>
<td>1 day, cycle</td>
<td>Continuous</td>
<td>2-fold redundant</td>
<td>Yes</td>
</tr>
<tr>
<td>SOHO/VIRGO</td>
<td>Yes</td>
<td>Continuous</td>
<td>2 week, monthly</td>
<td>Continuous</td>
<td>2-fold redundant</td>
<td>Yes</td>
</tr>
<tr>
<td>ACRIMSAT/ACRIM3</td>
<td>Yes</td>
<td>Continuous</td>
<td>2 week, monthly</td>
<td>Continuous</td>
<td>3-fold redundant</td>
<td>None</td>
</tr>
</tbody>
</table>

Constraining Composite TSI Time Series

- Composite TSI time series have been constructed using results from the Nimbus7/ERB, SMM/ACRIM1, UARS/ACRIM2, SOHO/VIRGO and ACRIMSAT/ACRIM3 experiments
- In-flight comparisons provide contiguous results at the mutual precision level of experiments
- Key to constructing a 23+ year-long time series is relating the non-overlapping ACRIM1 and ACRIM2 results
- Nimbus7/ERB and ERBS overlap the ACRIM1-ACRIM2 gap and can be used to relate their results

‘ACRIM’ Composite TSI Time Series

- Two ‘ACRIM’ Composite Time Series
  - NNA3 uses original results from Nimbus7/ERB and ACRIM1,2,3 experiments
  - NNAVA3 uses original results from Nimbus7/ERB, ACRIM1,2,3 and VIRGO experiments
- Overlapping comparisons with Nimbus7/ERB used to relate ACRIM1 and ACRIM2 results
- Reported on ACRIM3 ‘native scale’ through chain of overlapping comparisons

ACRIM OBSERVATIONS, COMPOSITE TOTAL SOLAR IRRADIANCE TIME SERIES AND MEASUREMENT STRATEGY

Active Cavity Radiometer Irradiance Monitoring (ACRIM) experiments have provided high precision, high traceability Total Solar Irradiance (TSI) results during 20 of the nearly 24 years of satellite monitoring.

A composite TSI time series nearly 24 years in length has been constructed from the results of the Nimbus7/ERB, SMM/ACRIM1, UARS/ACRIM2, SOHO/VIRGO and ACRIMSAT/ACRIM3 experiments.

A TSI trend + 0.04 % per decade has been found between the solar cycle minima of 1986 and 1996.

Overlap and redundancy of TSI flight experiments have been essential in the compilation of a precise, traceable TSI database to date.

Periodic calibration of satellite TSI experiments by a shuttle-based cryogenic radiometer capable of 0.01 % SI uncertainty is an essential additional component of the strategy that is needed to provide confirmation of traceability and protect the TSI database from catastrophic failure.
Comparison of ‘ACRIM’ and ‘PMOD’ Composite TSI Time Series

- **ACRIM Approach**
  Nimbus7/ERB, ACRIM1,2,3 and VIRGO results
  Nimbus7/ERB comparisons relate ACRIM1 and ACRIM2 results
  ACRIM3 ‘native scale’

- **PMOD Approach**
  Nimbus7/ERB, ACRIM1,2,3 and VIRGO results
  Modifies Nimbus7/ERB to conform to ERBS over ACRIM gap
  Modifies Nimbus7/ERB & ACRIM to conform to solar proxy model predictions during solar cycle 21 maximum
  VIRGO pre/post 1998 SOHO hiatus results related using ACRIM2 comparisons

Conclusions

- Difference in minima-to-minima trends for Nimbus7/ERB and ERBS referenced TSI composites is an artifact of ERBS degradation during ACRIM Gap
  - ‘ACRIM’ + 0.04%/decade minima-to-minima trend resolved with +/- 0.005 – 0.01%/decade uncertainty
  - Lower TSI during solar maxima of ‘PMOD’ composite likely an artifact of conformance to TSI solar proxy model that underestimates TSI during maxima