The Total Solar Irradiance (TSI) Database

ACRIM

Active Cavity Radiometer Irradiance Monitor Experiments

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Satellite Total Solar Irradiance (TSI) Observations

TOTAL SOLAR IRRADIANCE MONITORING RESULTS: 1978 to Present

- NIMBUS7/ERB
- SMM/ACRIM1
- ACRIM GAP
- ERBS/ERBE
- SOHO/VIRGO
- UARS/ACRIM2
- ACRIMSAT/ACRIM3
- SORCE/TIM

Daily mean results reported on experiments' native scales

RC Willson, earth_obs_fig1 05/19/2010
Direct correlation of TSI and solar magnetic activity is well established
• Before and after ACRIM Gap: ACRIM1, ACRIM2, ERB & ERBE track solar activity and conform to paradigm
• During ACRIM Gap: ERB tracks solar activity and conforms to paradigm, ERBE does not
ACRIM Composite TSI Time Series

Minima trend between during solar cycles 21 - 23: + 0.037 %/decade

TSI trend between minima during solar cycles 21 - 24, approaching next minima: + 0.010 %/decade

ACRIM Composite:

1. Uses Nimbus7/ERB, ACRIM1, 2 & 3 results
2. Uses Nimbus7/ERB comparisons to bridge the 'ACRIM Gap'
3. Uses TSI results published by satellite experiment teams
4. Results reconciled to ACRIM3 native scale

Fractional components of ACRIM Composite:

ACRIM: 89.3 %
Nimbus7/ERB: 10.7 %

1 Wilson & Mordvinov, GRL, 2003

RC Wilson, earth_obs_fig26 05/16/2010
PMOD Composite TSI Time Series

Minima trend during solar cycles 21 - 23: -0.007 %/decade
Minima trend during solar cycles 21 - 24, (approaching next minima): -0.012 %/decade

PMOD Composite:
- Uses Nimbus7/ERB, ACRIM1, ACRIM2 and VIRGO results
- Conforms results to TSI Proxy Model predictions
- Modifies published results of Nimbus7/ERB & ACRIM1
- Uses ERBS/ERBE scale to bridge the ‘ACRIM Gap’
- Results reconciled to VIRGO native scale

1 Frohlich & Lean, GRL, 1998
2 Lean, Beer & Bradley GRL, 1995
3 Frohlich, AGU Geophysical Monograph 141, 2004
ACRIM Composite TSI Time Series and SORCE/TIM results

Minima trend between during solar cycles 21 - 23: + 0.037 %/decade
TSI trend between minima during solar cycles 21 - 24, approaching next minima: + 0.011 %/decade

ACRIM Composite:
1
Uses Nimbus7/ERB, ACRIM1, 2 & 3 results
Uses Nimbus7/ERB comparisons to bridge the ‘ACRIM Gap’
Uses TSI results published by satellite experiment teams
Results reconciled to ACRIM3 scale

Fractional components of ACRIM Composite:
ACRIM: 89.3 %
Nimbus7/ERB: 10.7 %

Components of ACRIM Composite:
ERB ACRIM1 ERB ACRIM2 ACRIM3

1 Willson & Mordvinov, GRL, 2003
RC Willson, earth_obs_fig26tim 05/16/2010
TOTAL SOLAR IRRADIANCE MONITORING DURING ACRIM3 MISSION

Results reported on experiments’ native scales

Greenwich Sunspot Number

RC Willson, earth_obs_fig13  05/16/2010
Results from the SMM/ACRIM1 experiment

TSI effects of solar magnetic activity regions

Sunspots cause TSI decreases

Surrounding faculae cause TSI increases

TOTAL SOLAR FLUX
SOLAR MAXIMUM MISSION
MARCH 1980 | APRIL 1980

0.05%
SUNSPOT NUMBER & TOTAL SOLAR IRRADIANCE DURING SORCE/TIM MISSION

ACRIM3 Slope: -0.008 (%/yr)

VIRGO slope: -0.014 (%/yr)

TIM Slope: -0.011 (%/yr)

RC Willson, earth_obs_fig52  05/19/2010
Comparison of ACRIM3, VIRGO and TIM Observations

TOTAL SOLAR IRRADIANCE MONITORING DURING ACRIM3 MISSION

TSI @ 1 AU (w/m²)

Year


Reported on experiment’s native scales

ACRIM3

VIRGO (-2.05 W/m²)

ACRIM3 (-2.57 W/m²)

VIRGO

SORCE/TIM

TIM (+2.00 W/m²)

RC Willson - earth_obs_fig2 04/30/2010
ACRIMSAT/ACRIM3 Degradation History

Polynomial Fit Order: 6

Sensor A

Sensor B

Degradation Residuals

Std. Dev. for Sensor A: 19

Std. Dev. for Sensor B: 16

RC Willson - Earth_obs_fig8 05/18/2010
VIRGO Level-1 Total Solar Irradiance

Version 6_002_0910

Data from the VIRGO Team, 27 Oct 2009
Assessment of Satellite TSI database ‘Native’ Scale Differences

Ground-based calibration and comparisons during 2010

• Power and irradiance calibration of ACRIM3 at LASP TSI Radiation Facility (TRF)
  Test refurbished ACRIM3 flight spare instrument
  Use same procedures and facility employed with GLORY/TIM and PICARD/PREMOS

• Diffraction and scattered light investigation
  Analysis by NRL and NIST
  Experimental confirmation at NRL

TSI calibration conference hosted by NRL

• Areas of exploration:
  LASP/TRF and NRL test results for ACRIM3
  Comparisons of LASP/TRF test results for ACRIM3, TIM and PREMOS
  NPL testing of PMO sensors
  Calibration of SOVAP
  Satellite TSI calibrations including ACRIM3/VIRGO – TIM scale difference
  Identify further testing indicated by findings

Convene AGU Fall meeting (2010) special session on NRL conference findings

NASA Senior Science Review (2011)
Satellite Total Solar Irradiance (TSI) Observations

Satellite Total Solar Irradiance Monitoring

1 Daily mean results reported on "native" scales of experiments (W/m² @ 1 AU)

RC Willson, earth_obs_fig6 05/18/2010