The Satellite Total Solar Irradiance Database

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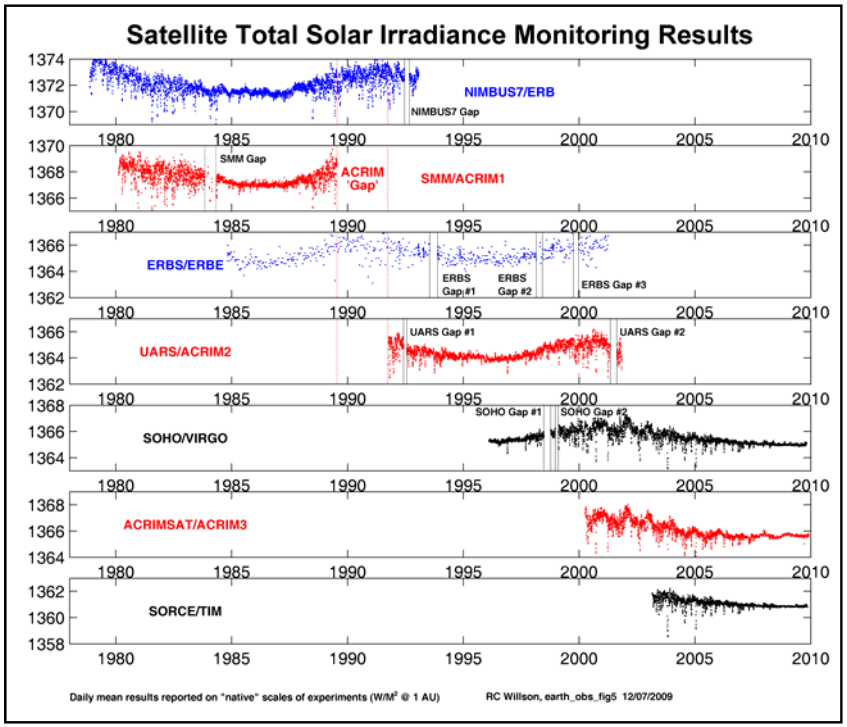
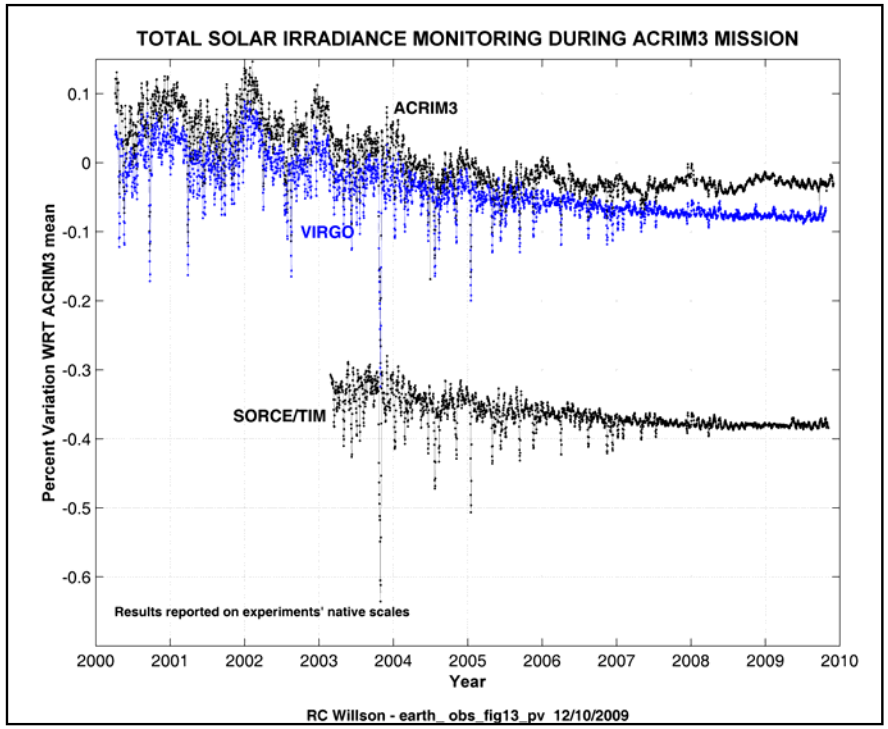
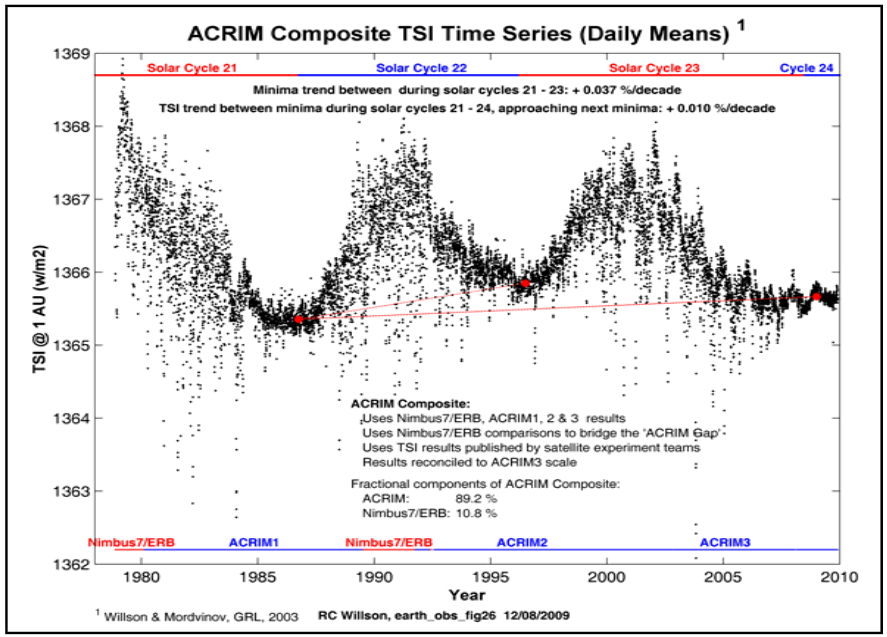


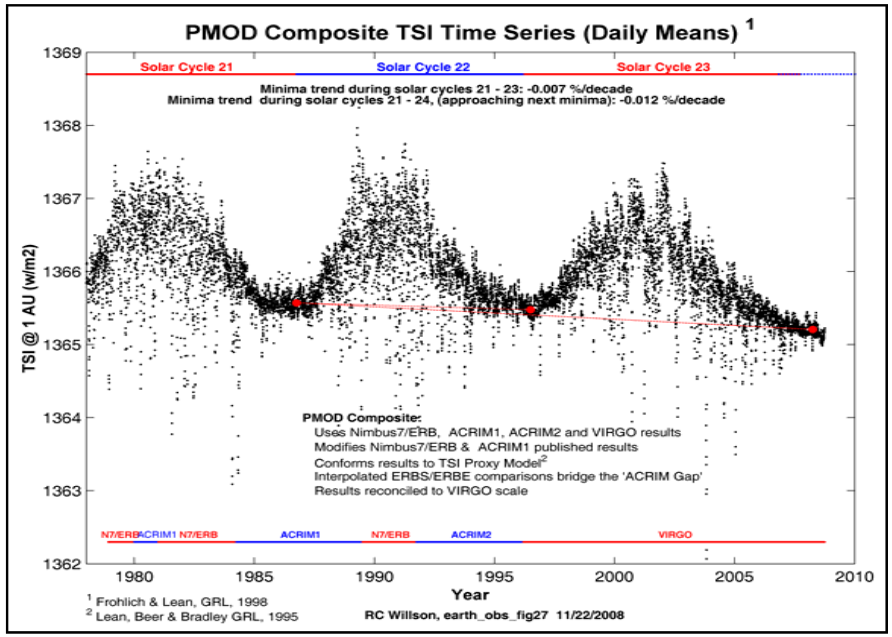


- **Total solar irradiance (TSI) has been monitored for more than three decades (1978 - 2009) by a series of contiguous, overlapping satellite experiments.**
- **A precise composite TSI time series requires relating ACRIM1 and ACRIM2 results across the two year gap 'ACRIM Gap'.**
- **The precision of ACRIM3 results is ~ 5 ppm/year.**
- **The accuracy of TSI observations is not significantly less than 1000 ppm.**
- **Traceability is provided by overlapping comparisons of satellite TSI experiments at instrument precision levels.**
- **Redundant, overlapping experiments is the only approach for sustaining a long term TSI database for climate change investigations.**

- **The native scales of ACRIM3 and VIRGO results agree within +/- 0.05 %, within their theoretical uncertainties of +/- 0.1 %.**
- **The native scale of TIM results is ~ 0.35 % lower, exceeding its theoretical uncertainty of +/- 0.01%.**
- **Variations in ACRIM3, VIRGO and TIM TSI results agree well in amplitude and phase until ~ 2005.**
- **The sensitivity of VIRGO and TIM to variations seen in the ACRIM3 results appears progressively degraded after mid-2005.**
- **VIRGO and TIM TSI results show a degraded response relative to the ACRIM3 after 2006.**

Composite TSI : Comparison of ACRIM and PMOD Time Series



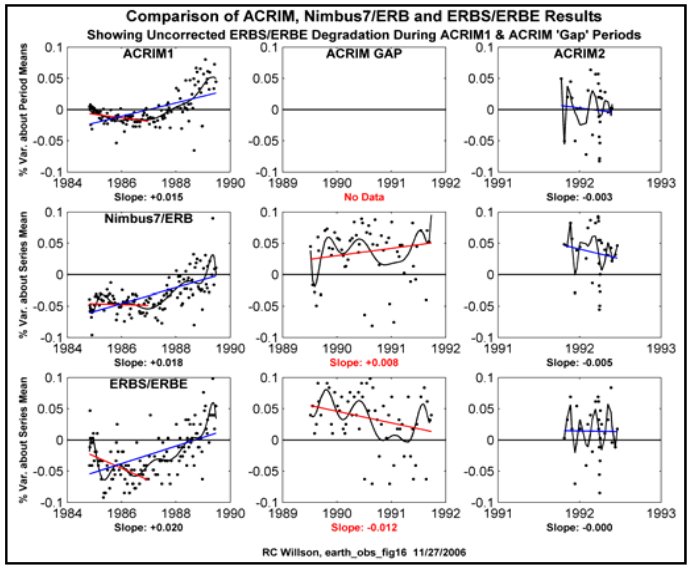


- **The ACRIM TSI composite uses published results from ACRIM and Nimbus7/ERB experiments. It bridges the 'ACRIM gap' using ACRIM1 and ACRIM2 comparisons with Nimbus7/ERB results.**
- **TSI trends between solar activity minima are considered to be the most reliable predictors of decadal and longer solar luminosity variations that might be significant for climate change.**
- **Relative to the solar cycles 21 – 22 minimum, the ACRIM composite trended upward during cycles 21 – 23 (+ 0.037%/decade) and then downward to the following cycle 23 – 24 minimum (+ 0.0010%/decade).**
- **Phenomenological analyses indicate a significantly greater climate change sensitivity to solar variations than indicated by Global Circulation Models.[1]**
- **Climate sensitivity to solar variability must be understood to evaluate the relative effects of natural and anthropogenic contributions to climate change.**

1. **Scafetta, N., and R. C. Willson (2009), ACRIM-gap and TSI trend issue resolved using a surface magnetic flux TSI proxy model, Geophys. Res. Lett., 36, L05701, doi:10.1029/2008GL036307**

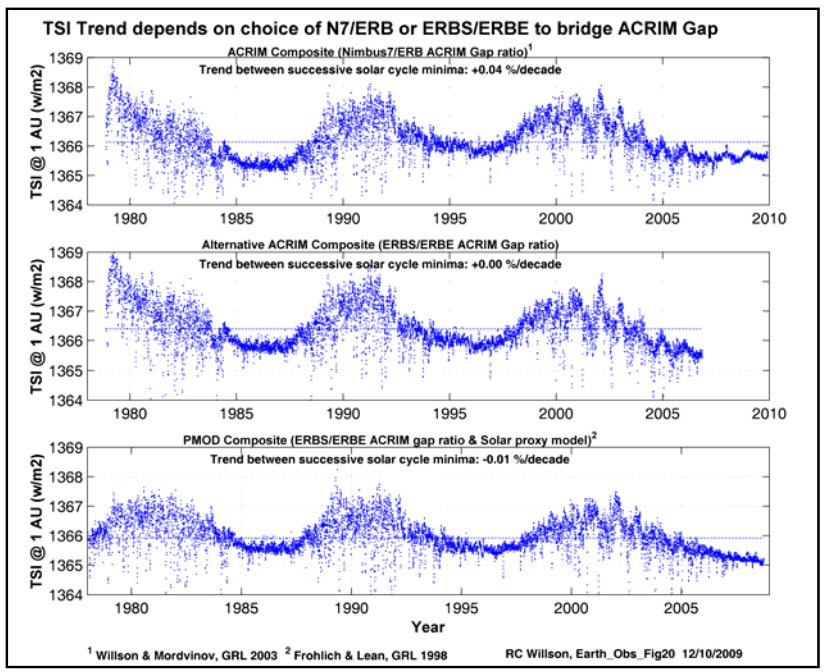
- **The PMOD composite approach uses a different subset of satellite TSI observations than ACRIM. PMOD bridges the 'ACRIM gap' using ACRIM1 and ACRIM2 comparisons with Nimbus7/ERB results re-calibrated to conform to the ERBS/ERBE scale. Published Nimbus7/ERB and ACRIM1 results were altered to conform to the predictions of TSI proxy models.**
- **The absence of a trend in the PMOD composite (and any composite based on the ERBS/ERBE ACRIM gap ratio) has been shown to be an artifact of uncorrected degradation of ERBS/ERBE results during the gap (See next poster panels).**
- **TSI proxy models are not competitive in precision or accuracy with satellite TSI observations. Their use by the PMOD composite convolutes the large model uncertainties with the more precise observational data.**
- **Composite TSI series like the PMOD that conform calibrated satellite observations to the predictions of approximate proxy models cannot provide the most valid interpretation of the extant TSI observational database.**

Resolution of 'ACRIM-gap' dilemma: ERBE degradation



ERBS/ERBE show Uncorrected Degradation

- ERBS/ERBE results exhibit uncorrected degradation during the ACRIM gap (1989 – 1991)
- Slopes of ACRIM, Nimbus7/ERB and ERBS/ERBE are comparable during ACRIM1 and ACRIM2 overlap periods
- ERBS/ERBE degrades significantly during the ACRIM gap when TSI should be increasing due to rising solar activity levels.
- ERBS/ERBE degradation during the ACRIM gap equals the trend difference between the Nimbus7/ERB-based and ERBS/ERBE-based composite TSI time series.



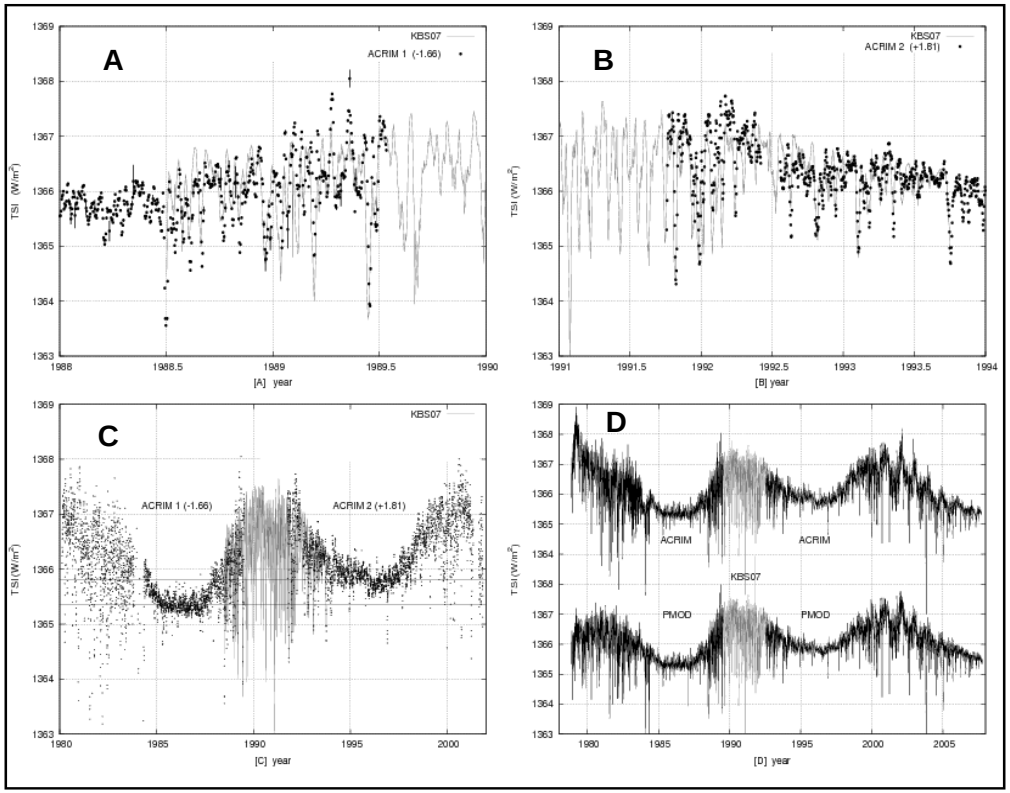
Composite TSI Trend depends on choice of ACRIM gap ratio

1. ACRIM composite, based on Nimbus7/ERB ACRIM gap ratio. Yields a + 0.034 %/decade trend between solar cycles 21 – 23 minima.
2. An alternative ACRIM composite, using the ERBS/ERBE ACRIM gap ratio, yields a negligible trend between solar cycles 21 – 23 minima, similar to PMOD.
3. The PMOD composite, based on the ERBS/ERBE ACRIM gap ratio, and yields a negligible trend between solar cycles 21 – 23 minima.

Conclusions

- The ACRIM TSI composite time series is the most accurate representation of the TSI satellite measurement results as published by the original experiment science teams.
- The ACRIM TSI composite time series doesn't rely on proxy modeling or de-facto modifications of published observational results.
- The trend difference between ACRIM and PMOD composites is an artifact of ERBS/ERBE degradation during the ACRIM Gap
- Lower PMOD composite results at solar maxima are artifacts of:
    1. Cycle 21: Alteration of published ACRIM1 and Nimbus7/ERB results to conform to solar proxy models
    2. Cycles 22 & 23: ERBS/ERBE degradation during ACRIM gap

Resolution of the 'ACRIM-gap' dilemma: The KBS07 Proxy



ACRIM-KBS07 Composite

Panels A and B: ACRIM1 & ACRIM2 (black dots) compared with the KBS07 TSI.

Panel C: ACRIM-KBS07 composite TSI over 1980 – 2005 common data range.

Panel D Comparison of ACRIM-KBS07 and PMOD-KBS07 composites.

Both use KBS07 (gray line) to connect ACRIM1 and ACRIM2 across the ACRIM-gap.

A TSI trend between successive minima of + 0.03 % is found for both mixed composites.

Conclusions

- **The ACRIM-gap dilemma for composite satellite TSI observations can also be resolved by bridging the ACRIM gap with TSI derived from Krivova's [2007][1] model using the surface distribution of solar magnetic flux proxy.[2]**
- **ACRIM-KBS07 and PMOD-KBS07 TSI composites are constructed using original ACRIM and PMOD values, except for the ACRIM gap, where TSI from the Krivova model is used to connect ACRIM1 and ACRIM2 results.**
- **Both ACRIM-KBS07 and PMOD-KBS07 composites demonstrate a TSI trend of 0.033 (+/- 0.004) %/decade between the solar activity minima of 1986 and 1996.**
- **This trend is <u>not</u> significantly different from the 0.037 %/decade trend found in the ACRIM composite [Willson & Mordvinov, 2003] [3].**
- **This finding supports the contention that the ERBS/ERBE results are flawed by uncorrected degradation during the ACRIM gap.**
- **This finding refutes the adjustment of Nimbus7/ERB ACRIM gap results used to construct the PMOD. [Frohlich and Lean 1998] [4]**

1 Krivova N. A., L. Balmaceda, and S. K. Solanki, 2007, Reconstruction of solar total irradiance since 1700 from the surface magnetic flux: Astronomy and Astrophysics, v. 467, p. 335-346.

2 Scafetta, N. and R.C. Willson, ACRIM-gap and TSI trend issue resolved using a surface magnetic flux TSI proxy model, Geophys. Res. Lett., 36, L05701, doi:10.1029/2008GL036307

3 Willson R.C., and A.V. Mordvinov, 2003, Secular total solar irradiance trend during solar cycles 21-23: Geophysical Research Letters, v. 30, p. 1199-1202. (doi: 10.1029/2002GL016038).

4 Frohlich C. and J. Lean, 1998, The Sun's total irradiance: cycles, trends and related climate change uncertainties since 1978: Geophysical Research Letters, v. 25, p. 4377–4380. (doi:10.1029/1998GL900157).