

ACRIM3 Observations and Variations of Total Solar Irradiance during solar cycles 21-23

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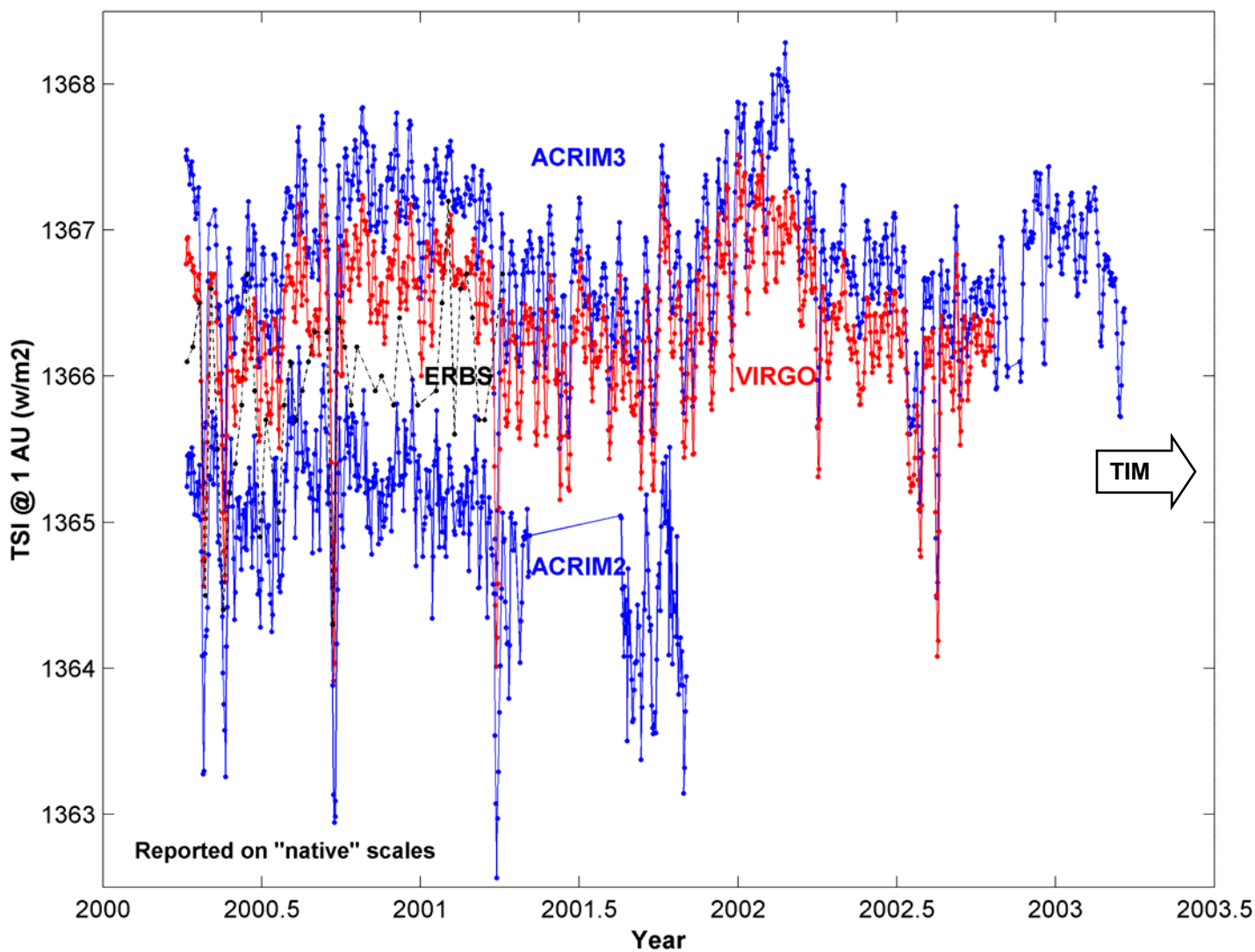
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ACRIM

Active Cavity Radiometer Irradiance Monitor



TOTAL SOLAR IRRADIANCE MONITORING DURING ACRIM3 MISSION



RC Willson - earth_obs_fig2 04/21/2003



ACRIMSAT/ACRIM3 EXPERIMENT STATUS

- **Hardware**
 - **ACRIM3 healthy – all components working correctly**
 - **ACRIMSAT healthy – all systems working well**
 - **JPL ground station healthy – updating automatic operational mode**
- **Degradation self-calibration**
 - **3-sensor comparisons performed at 90 day intervals**
 - **2-sensor comparisons performed at 30 day intervals**
 - **Degradation algorithm updated every 3-sensor comparison**
 - **Lowest rate of degradation of all ACRIM experiments**

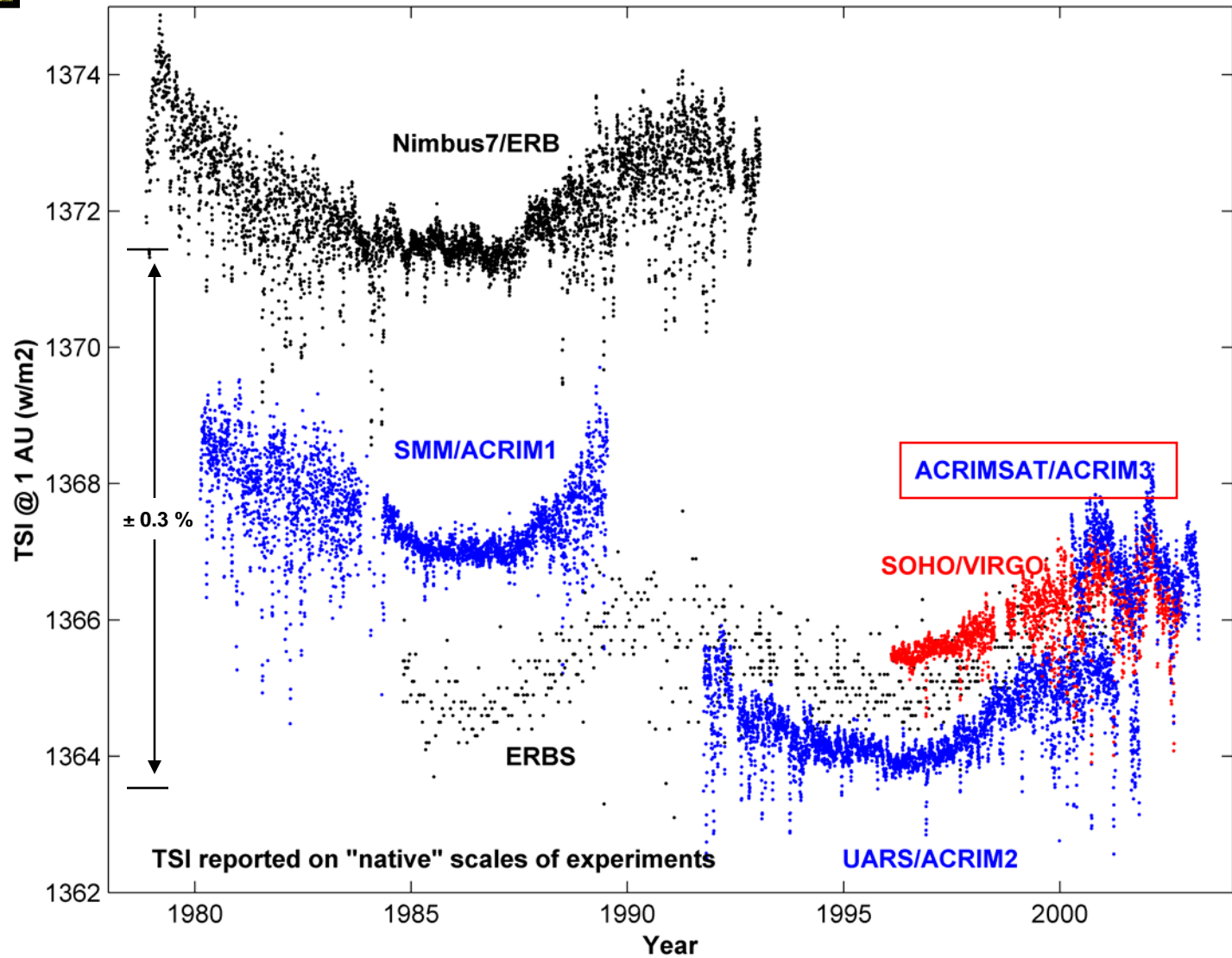


ACRIMSAT/ACRIM3 EXPERIMENT STATUS

- **ACRIM3 results**
 - Processed regularly as level 0 data is received
 - Un-validated results stored by Science Team
 - Level 0 data archived as LaRC DAAC
- **Validated level 2 results**
 - Level 2 results validated using updated degradation algorithm
 - Uplinked to LaRC DAAC after each algorithm degradation update
 - Daily mean time series
 - Shutter cycle summaries (time resolution: 131.072 sec.)
 - Ancillary results: daily mean time series
- **Data availability**
 - LaRC DAAC: http://eosweb.larc.nasa.gov/HPDOCS/access_data.html
 - ACRIM website: <http://www.acrim.com/index.htm>



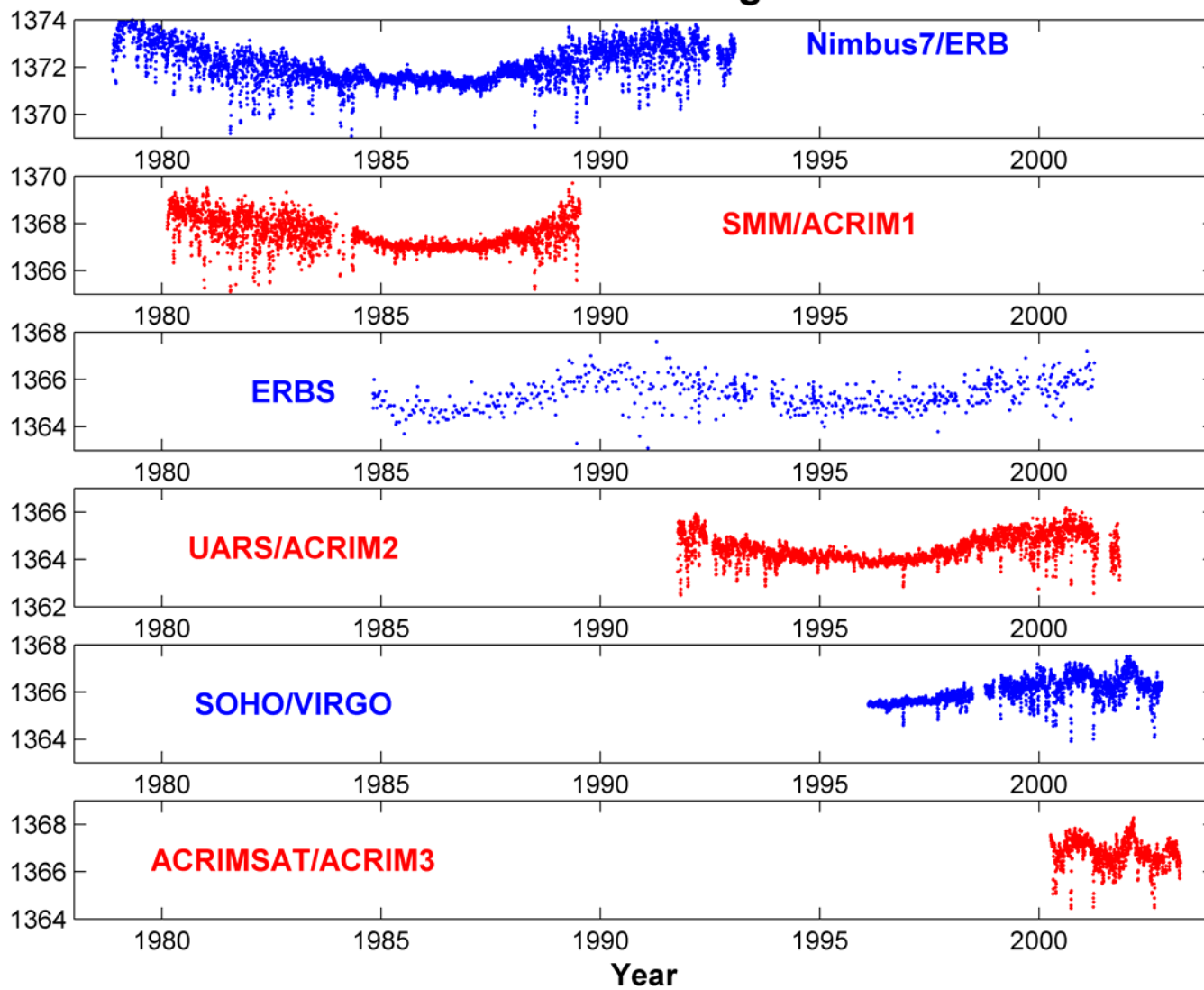
TOTAL SOLAR IRRADIANCE MONITORING RESULTS



RC Willson, earth_obs_fig1 04/03/2003



Total Solar Irradiance Monitoring Results: 1978 - 2003



TSI on "native" scales of experiments: W/m^2 @ 1 AU

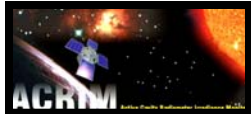
RC Willson, earth_obs_fig4 04/21/2003



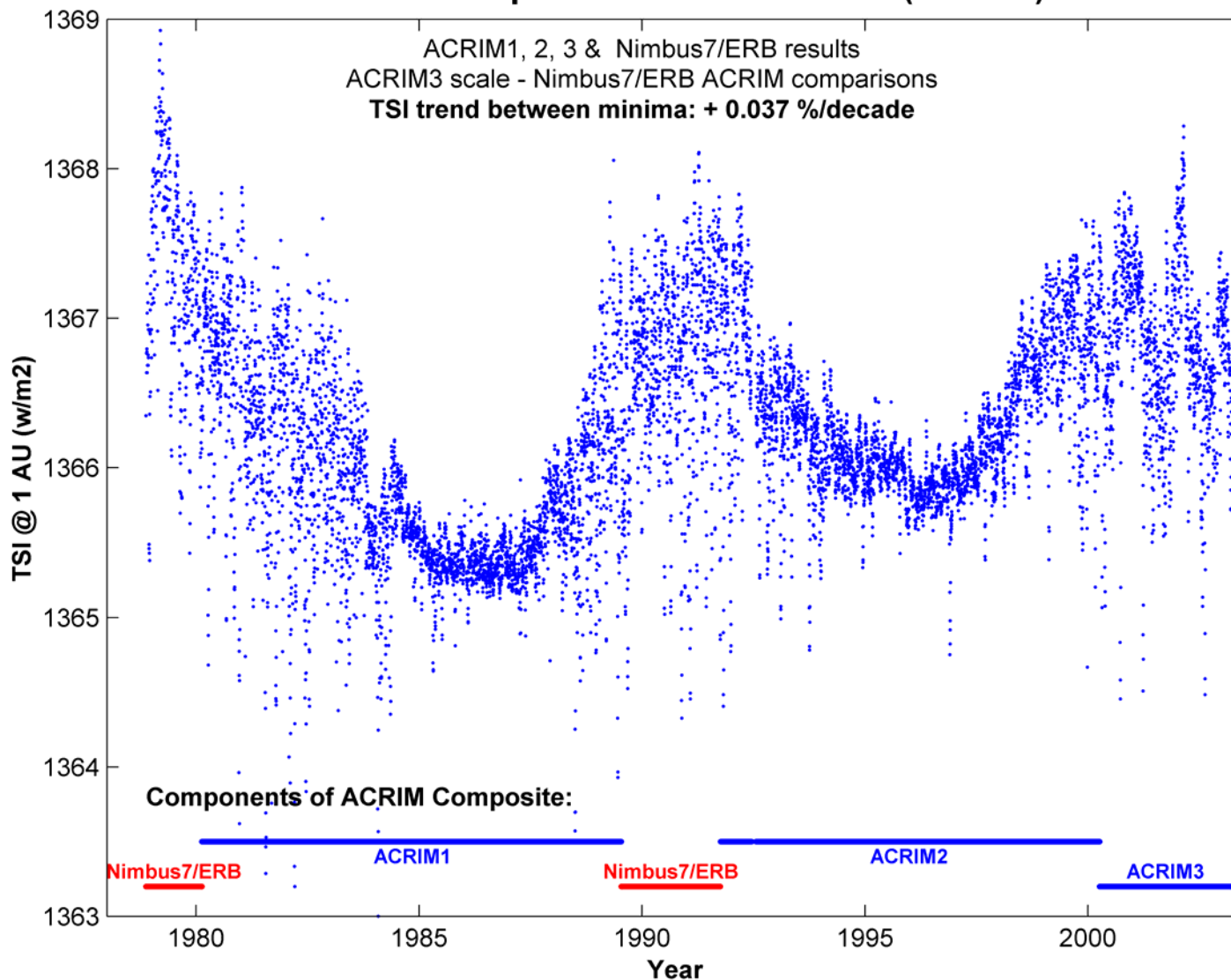
ACRIM Composite TSI Time Series

- Use Nimbus7/ERB, ACRIM1,2,3 and VIRGO results
- Normalize to ACRIM3 scale
- NIMBUS7/ERB comparisons relate ACRIM1 & ACRIM2 results

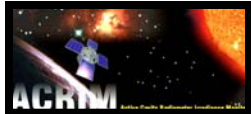
Experiment	Lifetime	NNAA3 Composite Contribution		NNAVA3 Composite Contribution	
Nimbus7/ERB	1978 - 1993	1978-80 1984 (ACRIM1 gap) 1989-91 1992 (ACRIM2 gap)	.0387 .0198 .0925 .0016	1978-80 1984 (ACRIM1 gap) 1989-91 1992 (ACRIM2 gap)	.0387 .0198 .0924 .0016
SMM/ACRIM1	1980 - 1989	1980 - 1989	.3533	1980 - 1989	.3533
UARS/ACRIM2	1991 - 2001	1991 - 2000	.3349	1991 - 1996 1998 - 2000	.2369
SOHO/VIRGO	1996 →	None	0	1996 - 1998	.1195
ACRIMSAT/ACRIM3	2000 →	2000 →	.1197	2000 →	.085
Total SOHO/VIRGO	1996 →	1996 - 1998	0	1996 - 1998	.0991
Total Nimbus7/ERB	1978 - 1993	1978 - 1992	0.1915	1978 - 1992	.1915
Total ACRIM	1980 - 2001	1980 - 2001	0.8085	1980 - 2001	.7094



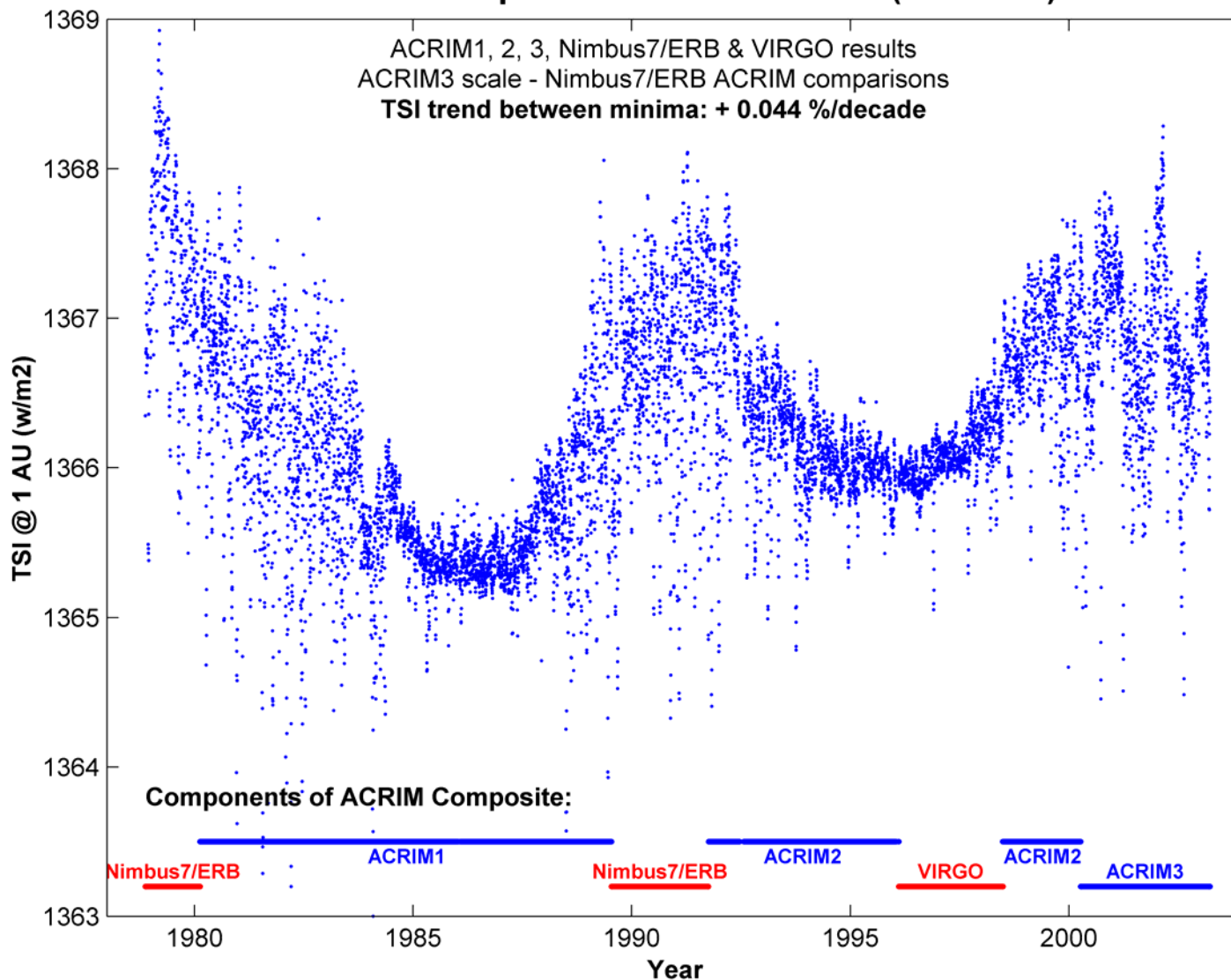
ACRIM Composite TSI Time Series (NNAA3)



RC Willson, earth_observatory_fig9 04/04/2003



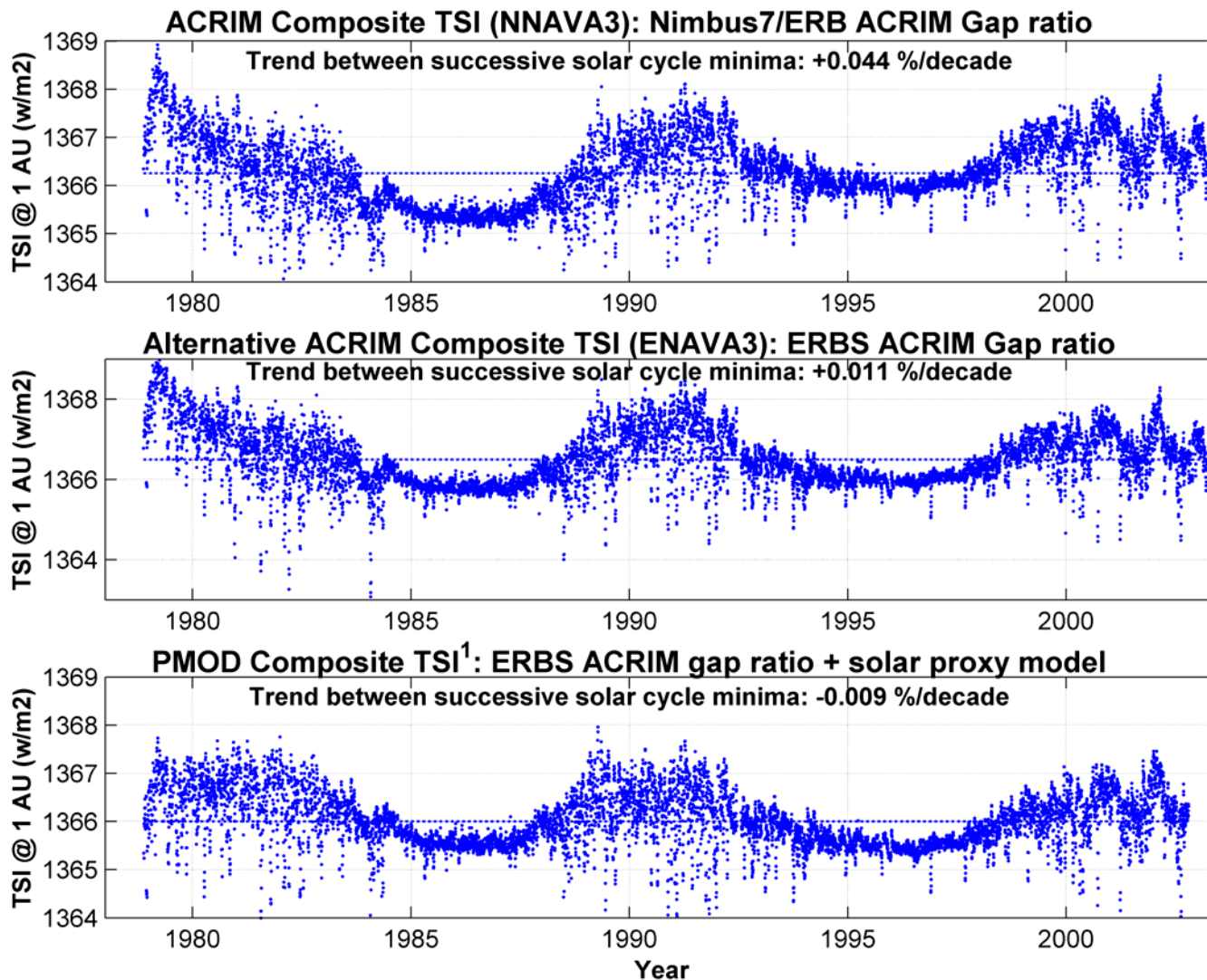
ACRIM Composite TSI Time Series (NNAVA3)



RC Willson, earth_observatory_fig8 04/04/2003

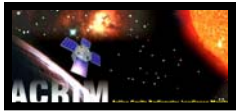


The Composite TSI dilemma: Relate ACRIM1 and ACRIM2 using Nimbus7/ERB or ERBS ?



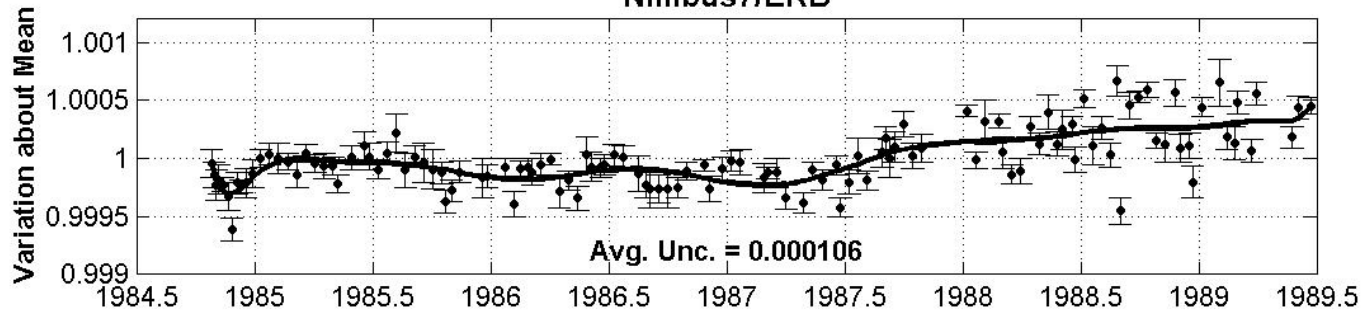
¹(Frohlich & Lean 1998)

RC Willson, coplot_nnava3_enava3_pmod 04/22/2003

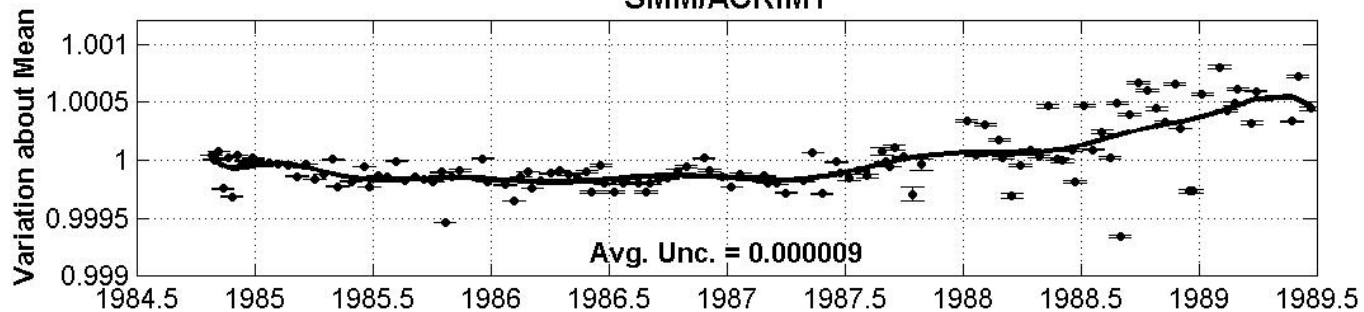


Comparison of Simultaneous Daily Mean Results Nimbus7/ERB, SMM/ACRIM1 and ERBS

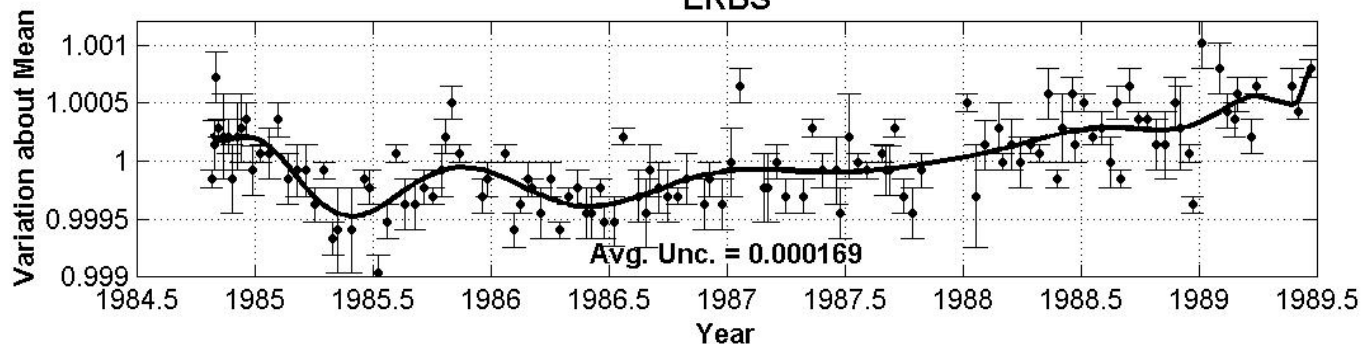
TSI Observations and Uncertainties - ACRIM1 Period Nimbus7/ERB



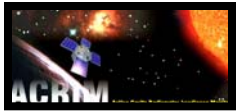
SMM/ACRIM1



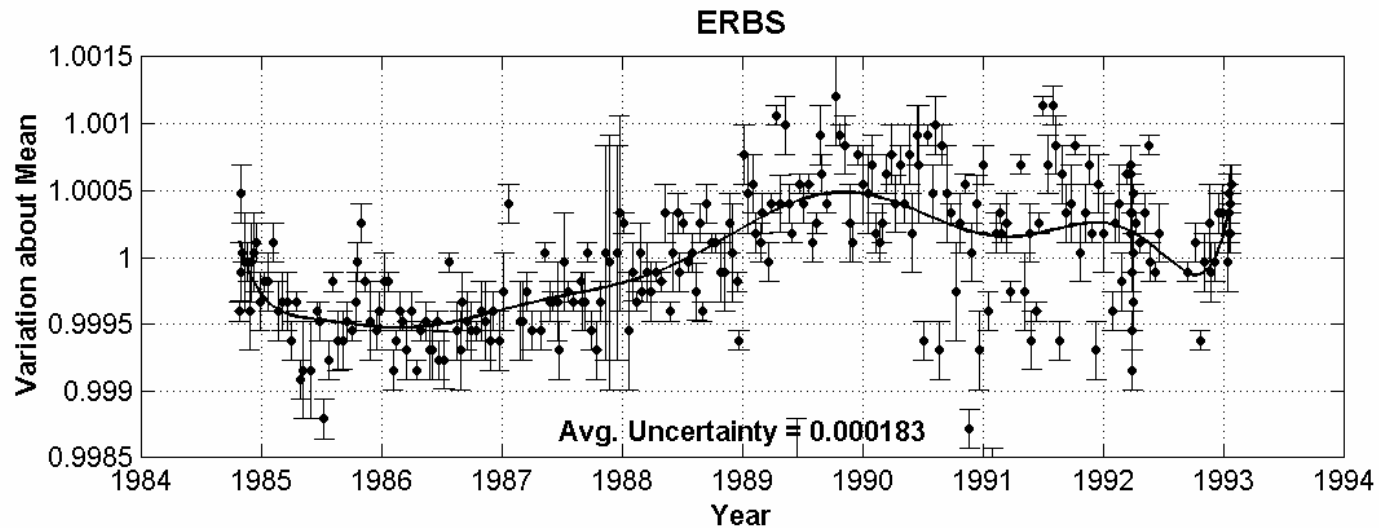
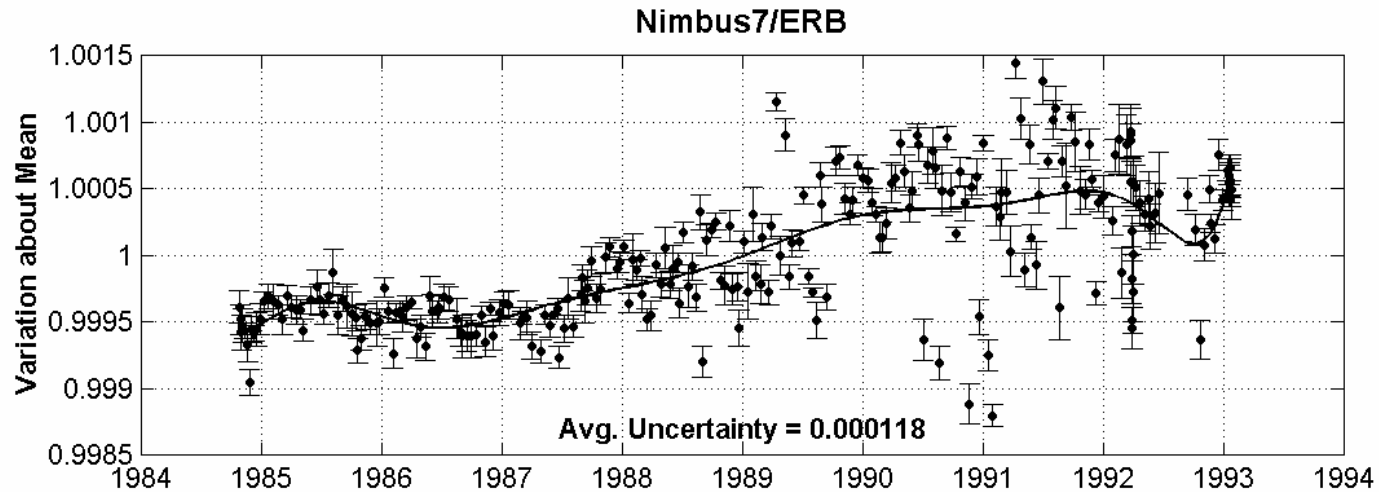
ERBS



RC Willson, coplot_cna1e_3pno_err 12/01



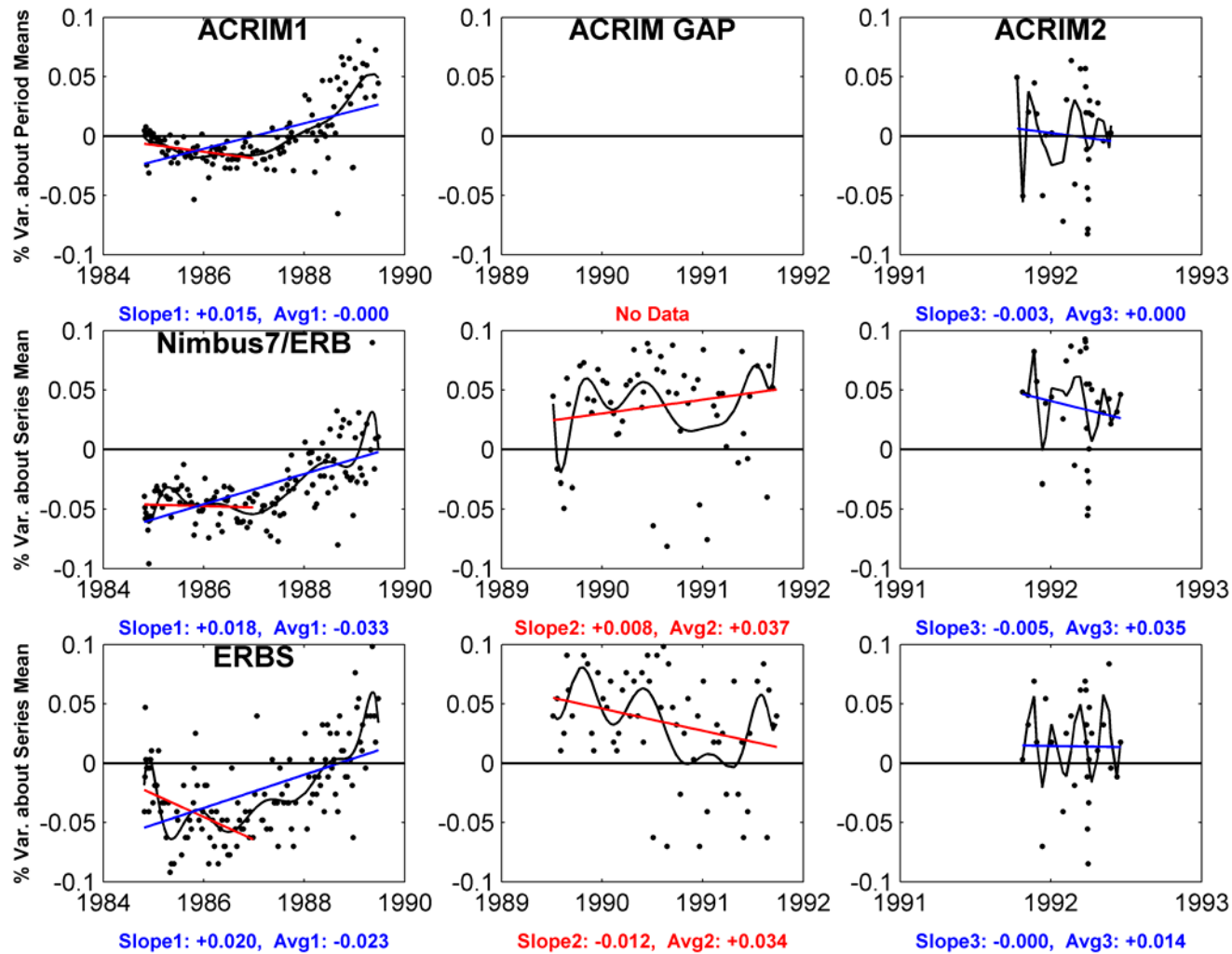
Comparison of Simultaneous Daily Mean Results Nimbus7/ERB and ERBS





Comparison of TSI Observations During ACRIM1, ACRIM Gap and ACRIM2 Periods

Comparison of ACRIM, Nimbus7/ERB and ERBS Results





ACRIM - PMOD Composite TSI time series issues

- **ERBS degraded during ACRIM gap**
- **Nimbus7/ERB – ERBS difference equals ACRIM – PMOD trend difference**
- **PMOD shifted ERB results during ACRIM gap to conform to ERBS**
- **PMOD shift of Nimbus7/ERB results equals ACRIM-PMOD trend difference**
- **PMOD degradation of ACRIM1 results during solar max of cycle 21 based on faulty assumptions about ACRIM ‘spin mode’ and desire to conform PMOD composite to proxy model predictions**
- **TSI solar proxy models are not competitive in precision or traceability with satellite TSI observations**



Comparison of ACRIM and PMOD¹ TSI Composite Time Series Approaches

Composite Time Series	ACRIM	PMOD ¹
Constituent satellite TSI results used in composite	Nimbus7/ERB, ACRIM1,2 & 3, VIRGO	Nimbus7/ERB, ACRIM1 & 2 VIRGO
Modification of published results	None	<p>–Degrades Nimbus7/ERB and ACRIM1 to conform to solar proxy model during solar max of cycle 21</p> <p>–Decreases Nimbus7/ERB during ACRIM gap to conform to ERBS</p> <p>–Uses ACRIM2 results to relate VIRGO data before and after SOHO hiatus in 1998</p>
Derivation of ACRIM1/ACRIM2 ratio	Nimbus7/ERB comparisons	ERBS comparisons (via alteration of Nimbus7/ERB to conform to ERBS)
TSI trend during solar cycle 21-23	+ 0.044 %/decade	No significant trend

¹ (Frohlich & Lean 1998)



TSI Composite Time Series Conclusions

- **'Zero' trend in PMOD composite is an artifact of ERBS degradation during ACRIM Gap**
- **Lower PMOD composite TSI at solar maxima is an artifact of:**

Cycle 21: **Alteration of published ACRIM1 and Nimbus7/ERB results to agree with solar proxy models**

Cycles 22 & 23: **ERBS degradation during ACRIM gap**