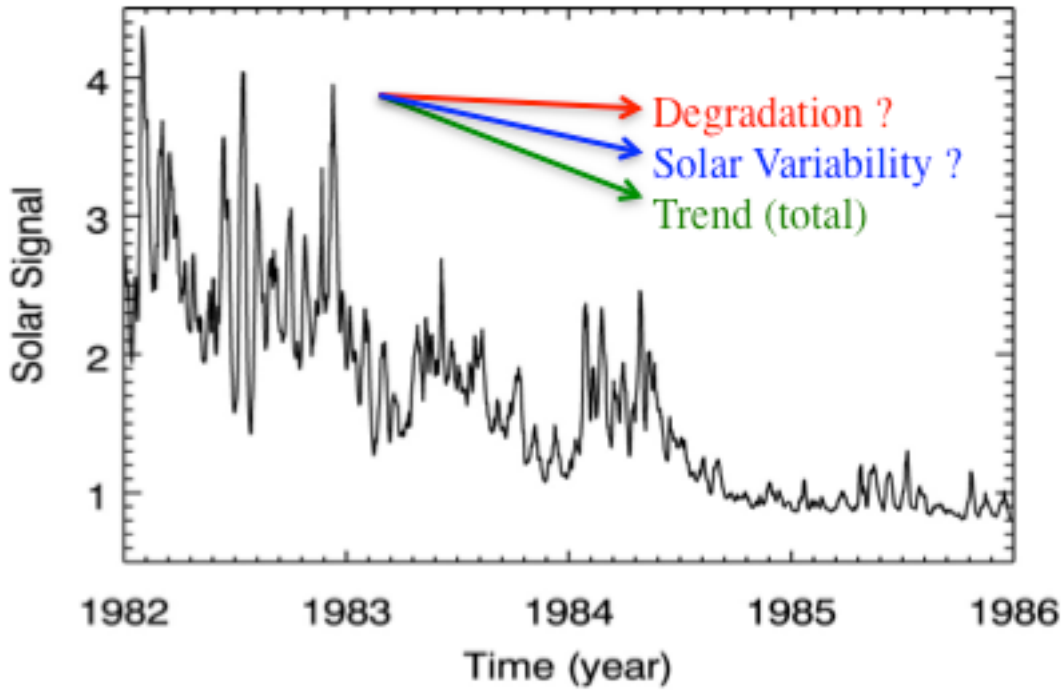
SORCE



DECOUPLING DEGRADATION AND SOLAR CYCLE VARIABILITY

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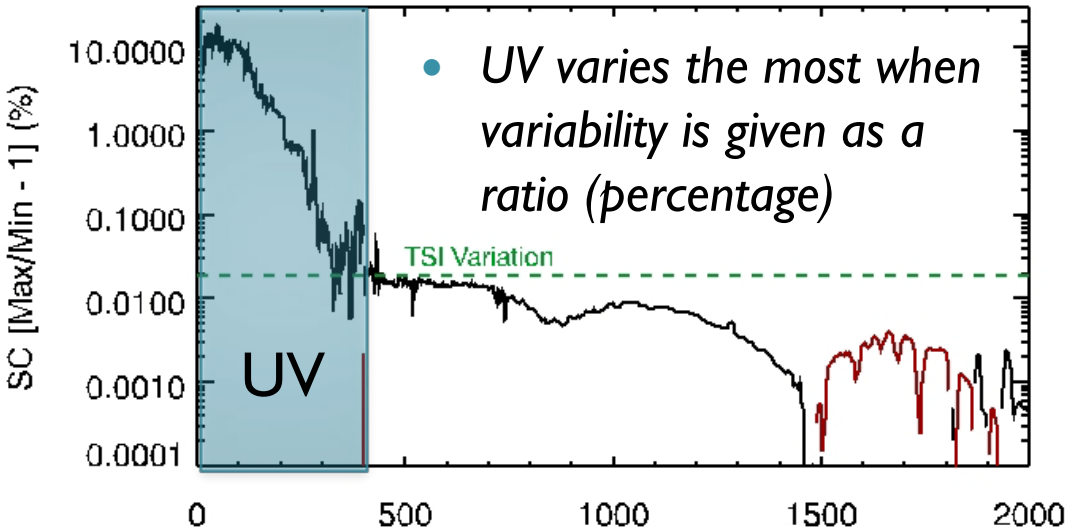
Topics

NRL-SSI & SIM Differences

Decouple Trends

Results

NRL SSI model variability



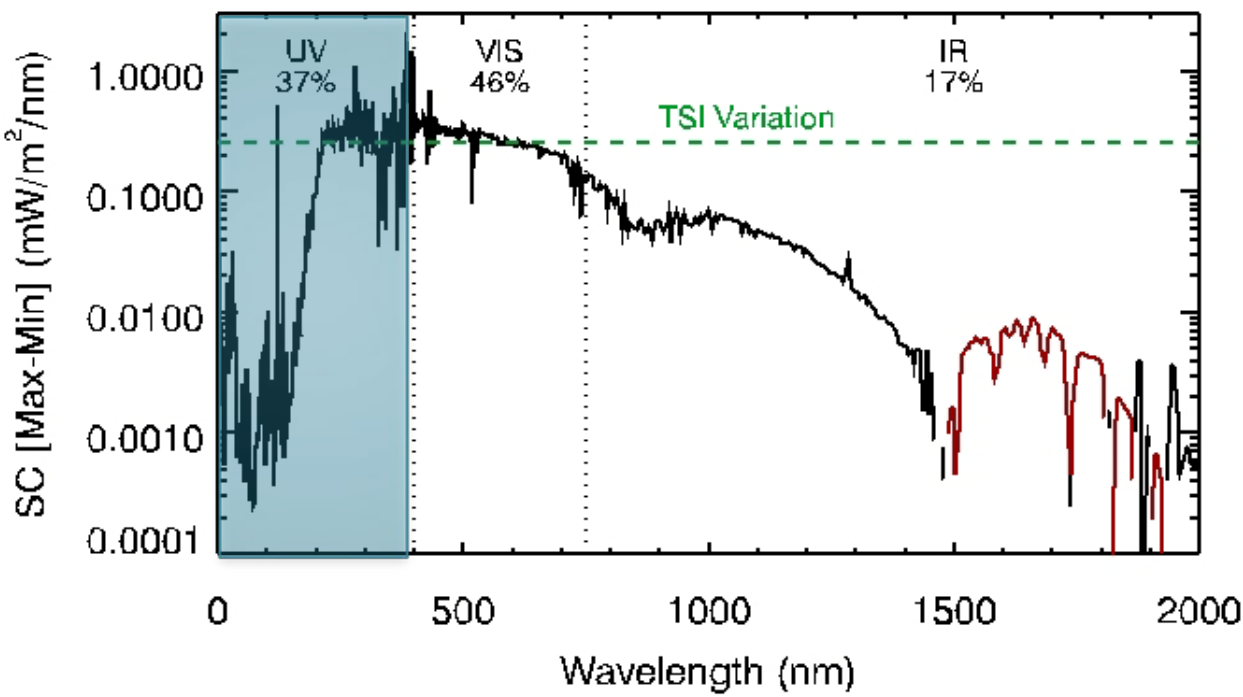
- *UV varies the most when variability is given as a ratio (percentage)*

- *However…*

Variability given in energy units is more appropriate for climate studies

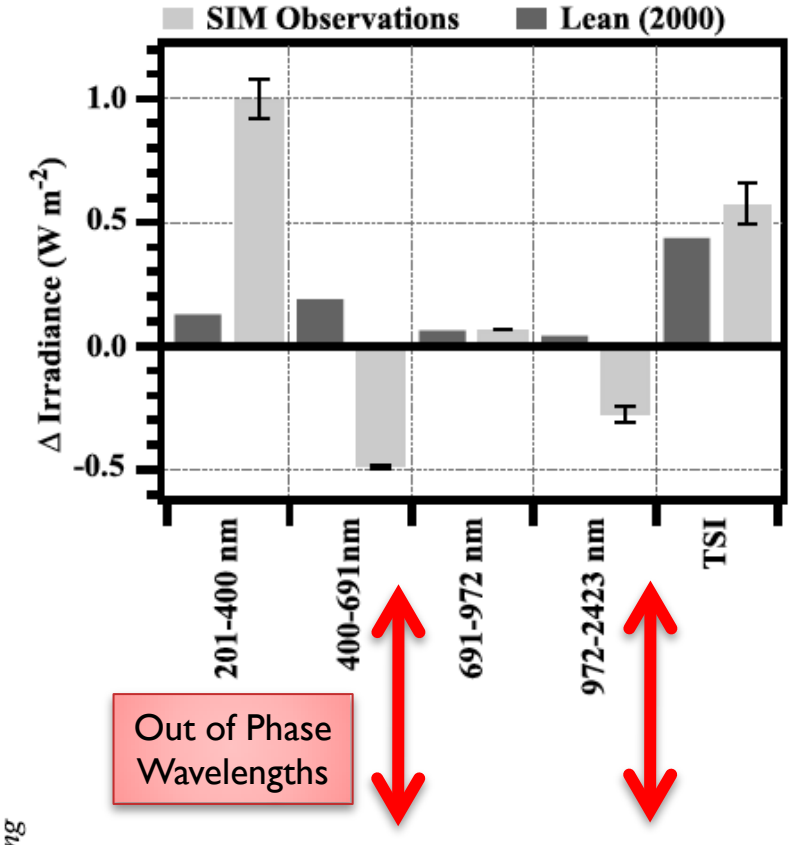
Note that red lines are variations that are out of phase with the solar cycle.

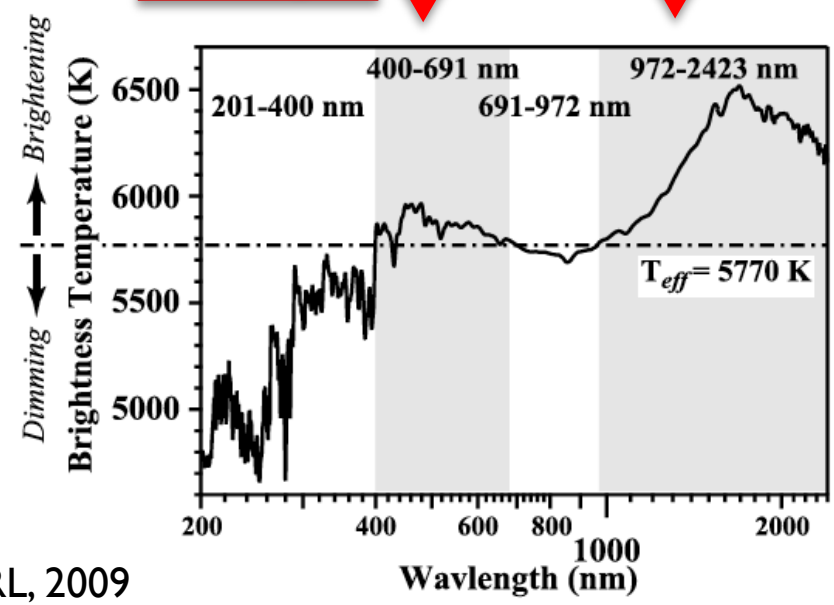
Solar Cycle (SC) variability from the NRL SSI model (J. Lean)



new SSI variability results from SORCE

- *In addition to the infrared, some visible wavelengths are out of phase with the solar cycle*
- *Also, there is more UV variability than expected*
- Are the SIM and model differences possibly related to unresolved instrument trends?
  - *Checking these results is challenging as SORCE SIM is the only daily SSI observations at > 400 nm*
  - *Other validation techniques are needed than direct comparisons*

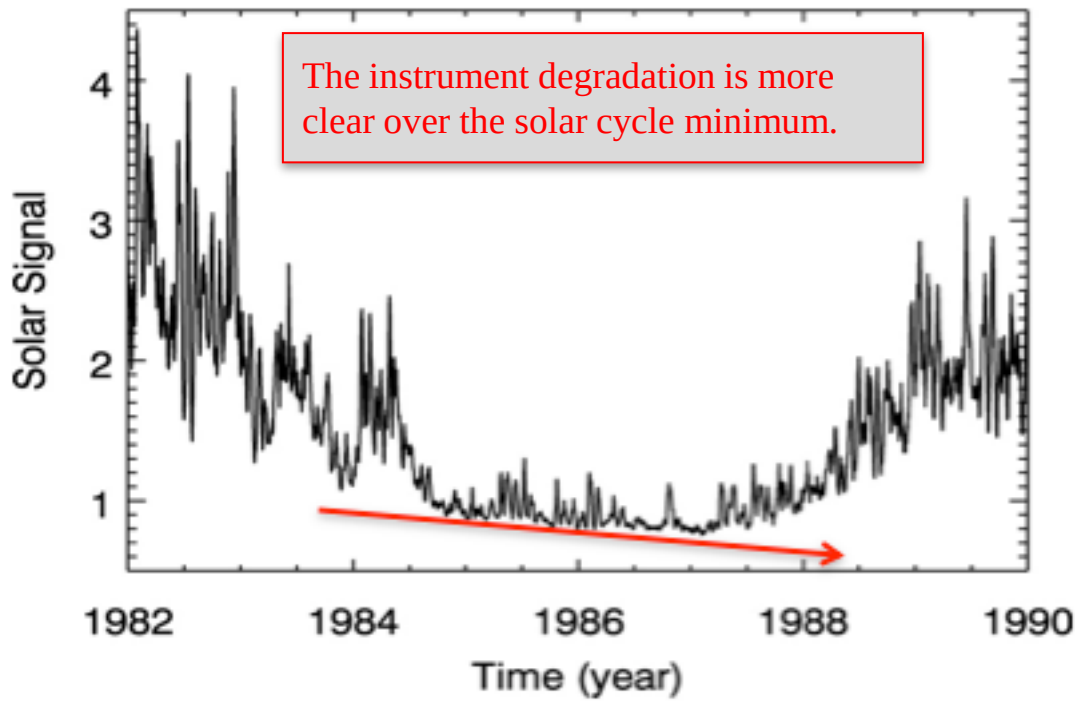




Figures from J. Harder et al., GRL, 2009

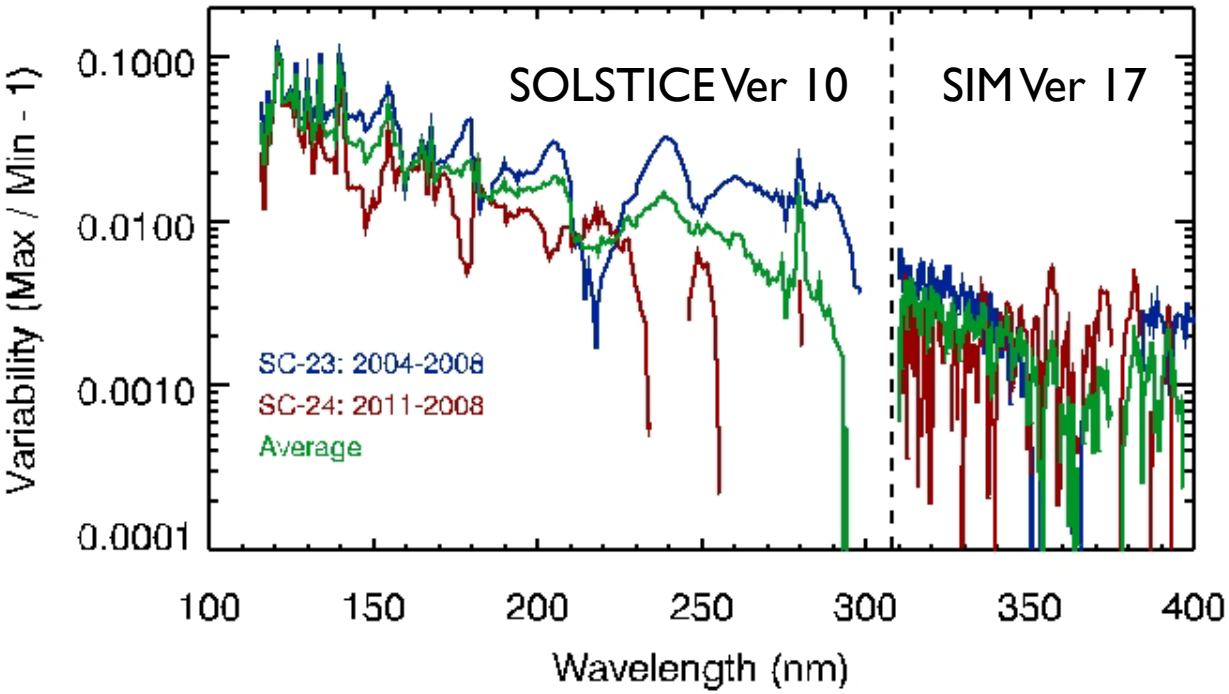
Trending across solar cycle minimum could perhaps provide new validation

- The solar cycle trend switches direction before and after cycle minimum, but instrument degradation trend is expected to continue across the minimum.
- Trending over both declining and rising phases of the solar cycle can help clarify, or at least bound, how much of the trend is due to instrument degradation.



Estimate of Degradation: Method 1 Average Declining Phase and Rising Phase

- *Simple technique that does not require raw (untrended) data but assumes degradation is linearly changing over a period of few years*
  - *this assumption is more reasonable if the early mission data are not used while the instrument degradation trend is changing more rapidly*
- *This analysis was done for SME, TIMED SEE, UARS SOLSTICE & SUSIM, SORCE SOLSTICE & SIM. The SORCE results are shown in this figure.*



large differences for $\lambda > 230$ nm

27-day averages
Max-1: 2005/278
Min : 2008/333
Max-2: 2010/187

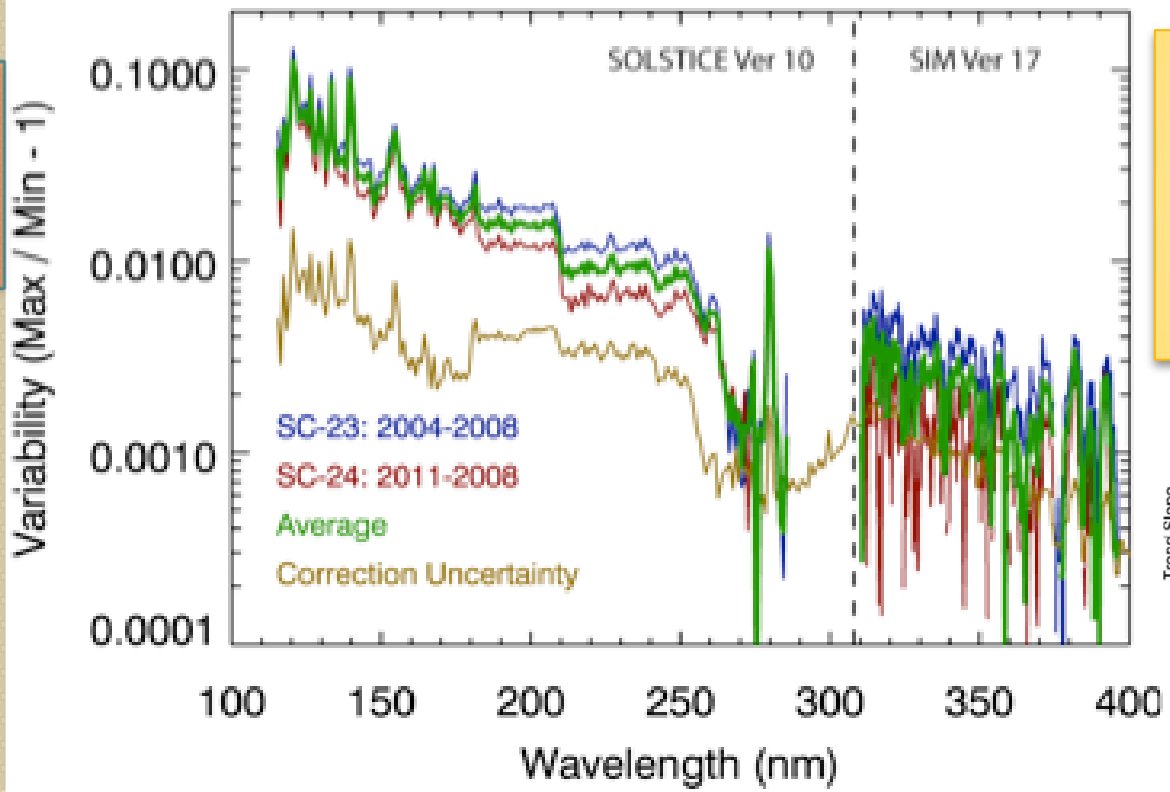
Estimate of Degradation Method 2
Fit degradation for days of "same solar level"

- *Much more analysis for this method (works for corrected or untrended data):*
  1. *identify "same solar levels" before and after solar cycle minimum*
  2. *fit trend (exponential and/or linear) across cycle minimum*
  3. *correct the irradiance time series with this trend fit* (**provides trend uncertainty**)
- *SME, TIMED, UARS, and SORCE analysis done: SORCE results shown here*

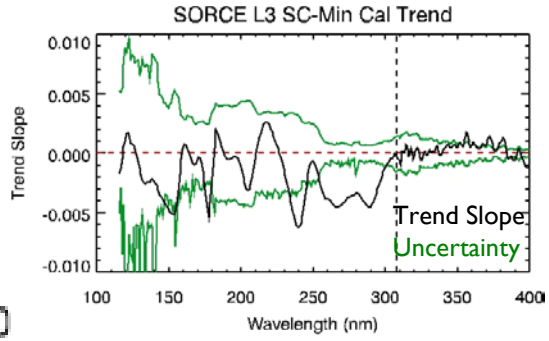
NRL-SSI & SIM Differences

Decouple Trends

Results

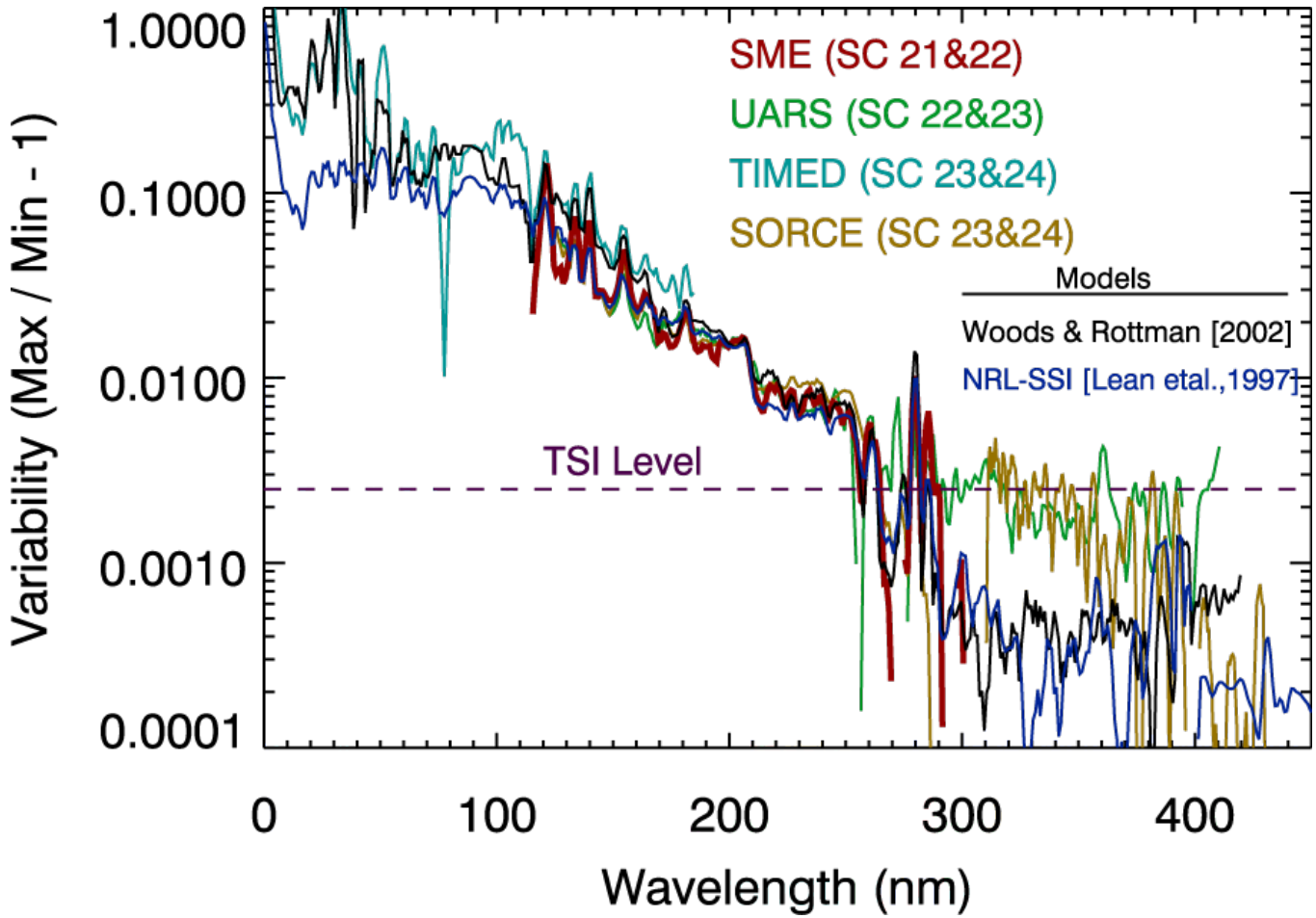


These results are better than Method #1 up to 290 nm, but uncertainty is about same as variability amount for $\lambda > 270$ nm



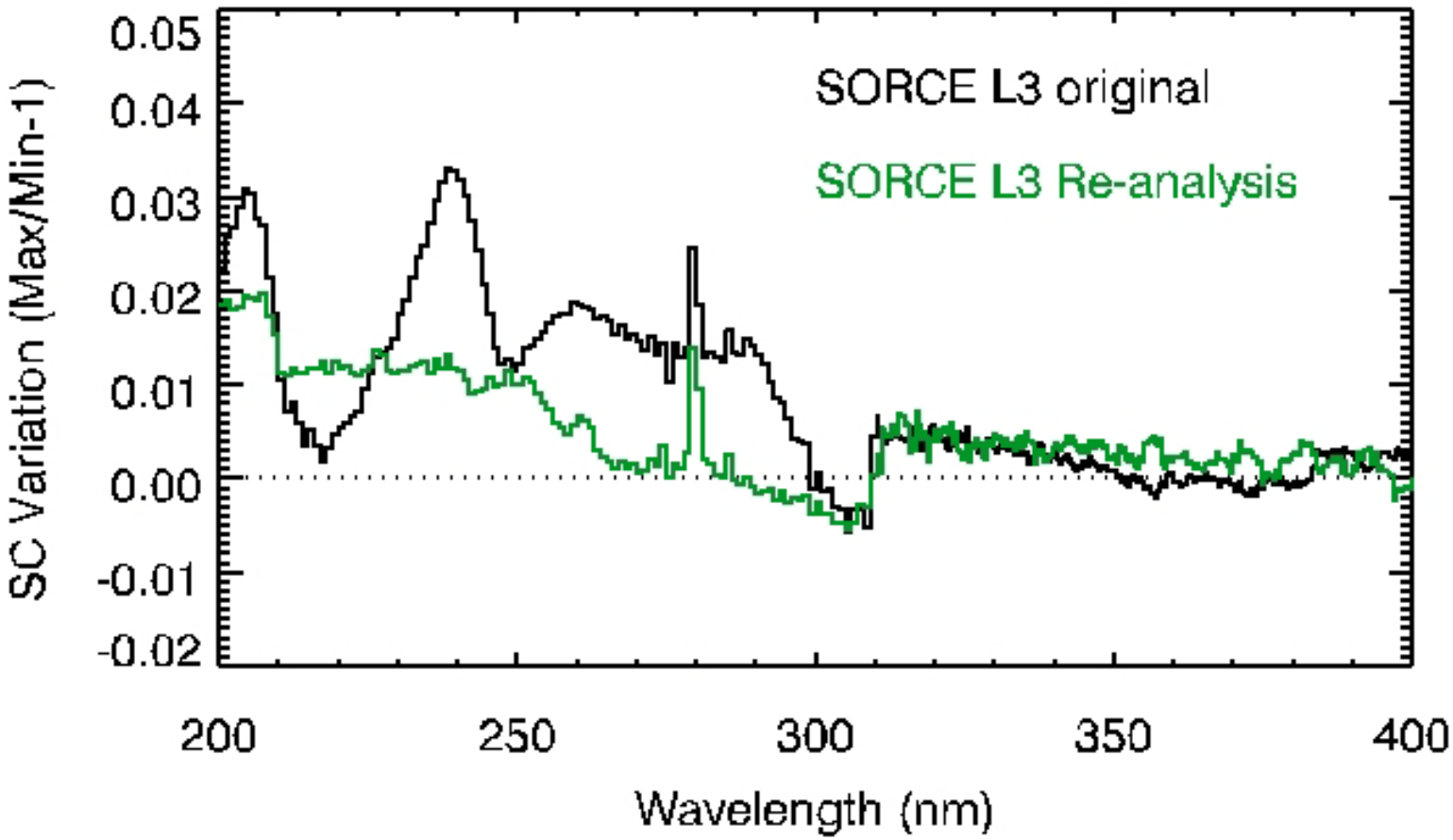
Comparison of all missions show consistency for 4 different solar cycles

- *Empirical models (Lean, Woods) and observations are in good agreement for wavelengths shorter than 290 nm*
- *Models appear to significantly underestimate variability above 290 nm*



Solar Cycle Variability Comparison: Differences are mostly for SOLSTICE

- Original SORCE L3:
  - SOLSTICE Version 10 and SIM Version 17

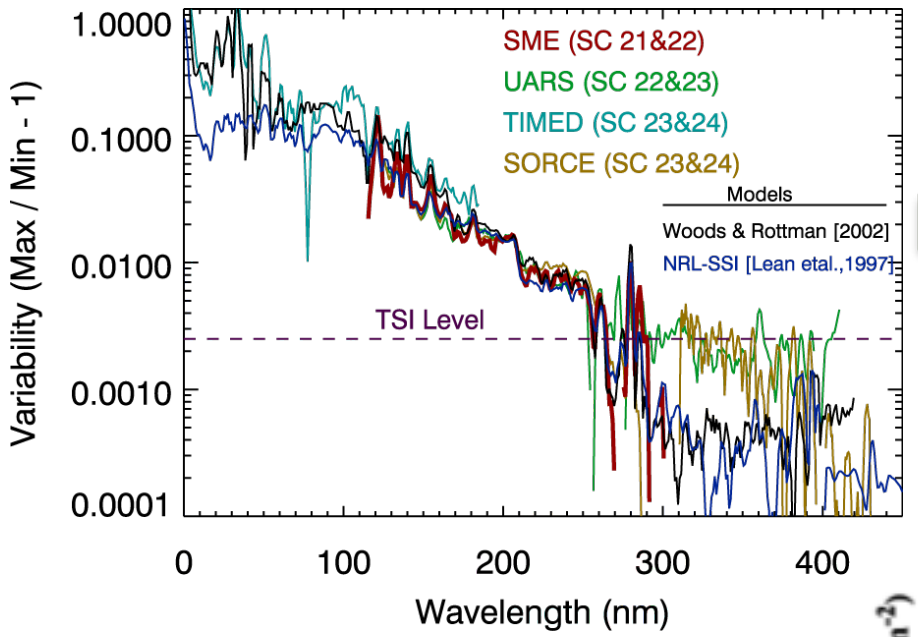


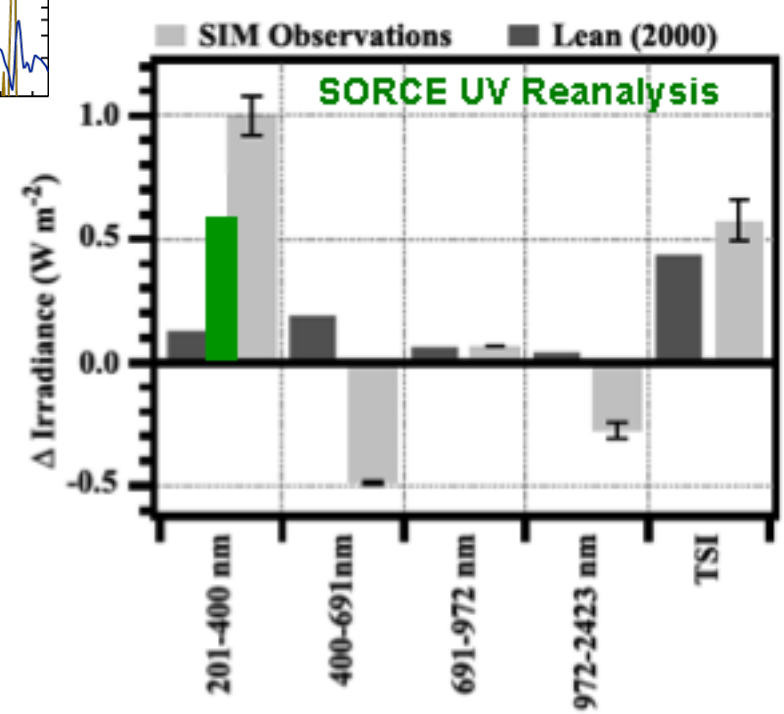
This reanalysis indicates less variability than Harder et al. 2009 but still much larger than Lean 2000 model

NRL-SSI & SIM Differences

Decouple Trends

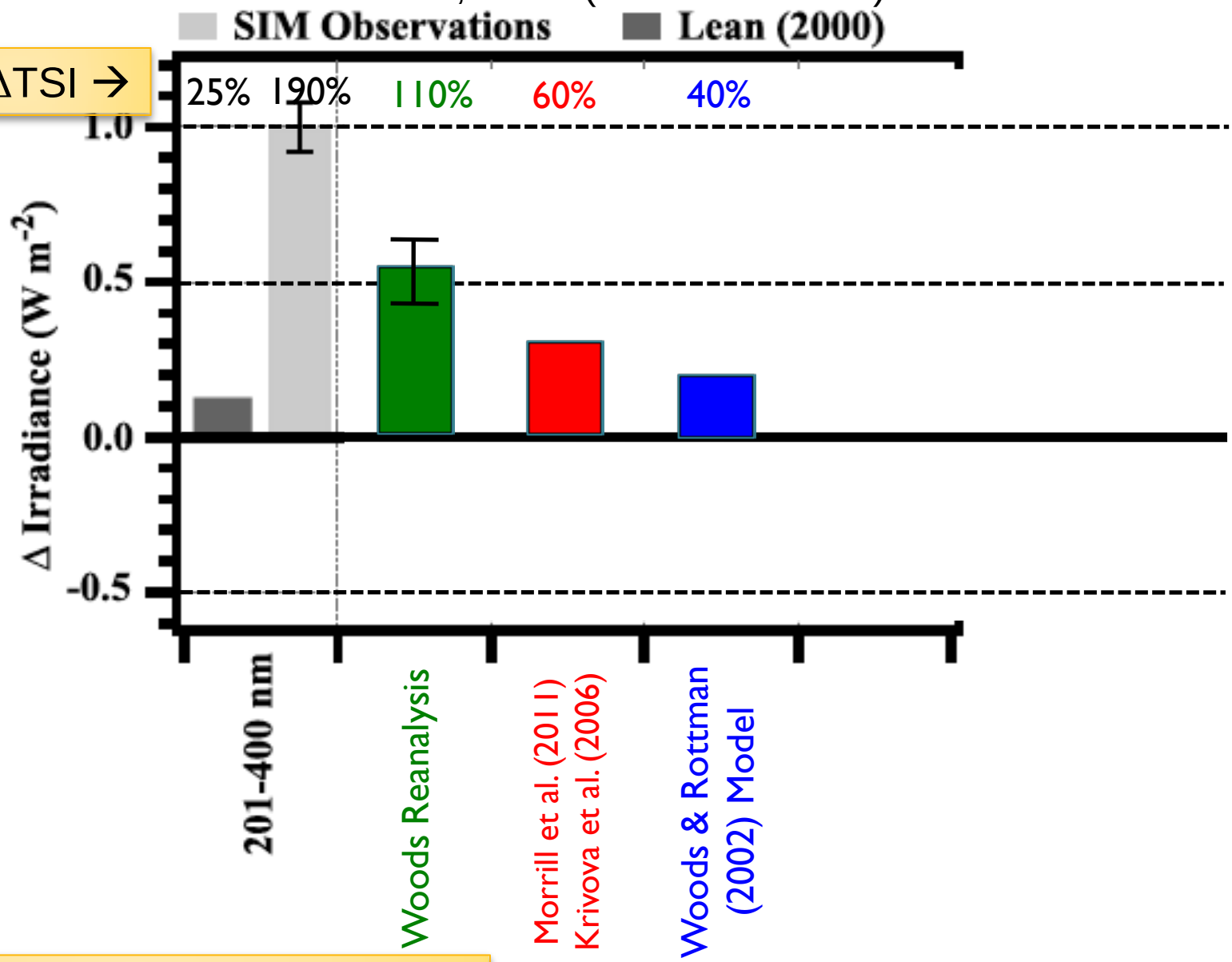
Results





Comparison of UV variability from recent papers

Harder *et al*., 2009 (4/2004 – 2/2008) **ΔTSI=0.523 W/m²**



NRL-SSI & SIM Differences

Decouple Trends

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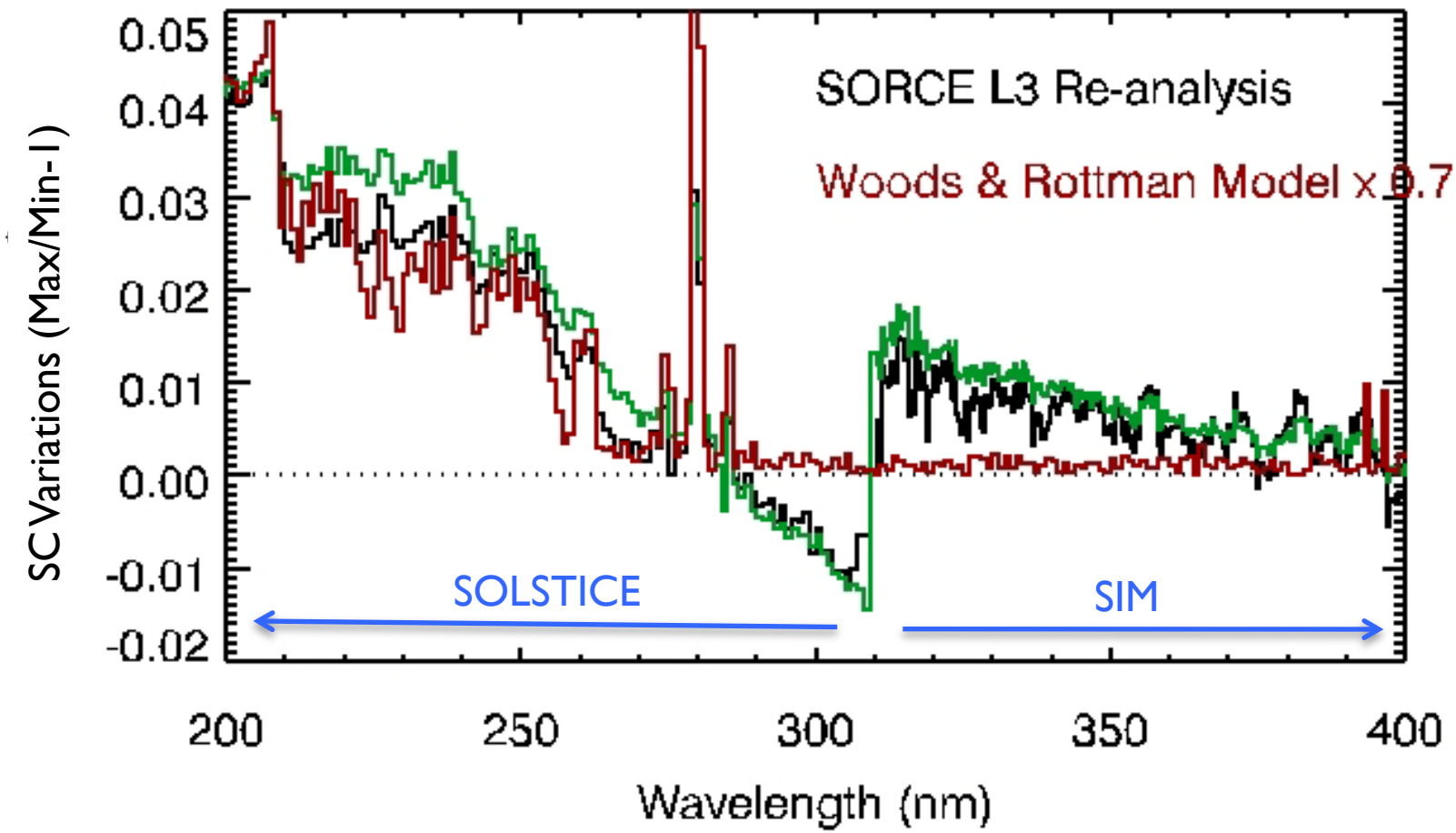
Note that 0-200 nm cycle variability is ~3% of ΔTSI

Solar Cycle Variability Comparison: Differences are most obvious > 290 nm

- Re-analysis (different dates used) shown in black and green
- Woods and Rottman (20023) Model comparison shown in red (normalized the model cycle variability at 200 nm)



SORCE L3 (SOL-Ver10, SIM-Ver17) Results

Some unexpected trends over the SC minimum (top plot)

Note trends for SOLSTICE near 270 nm and SIM > 1300 nm

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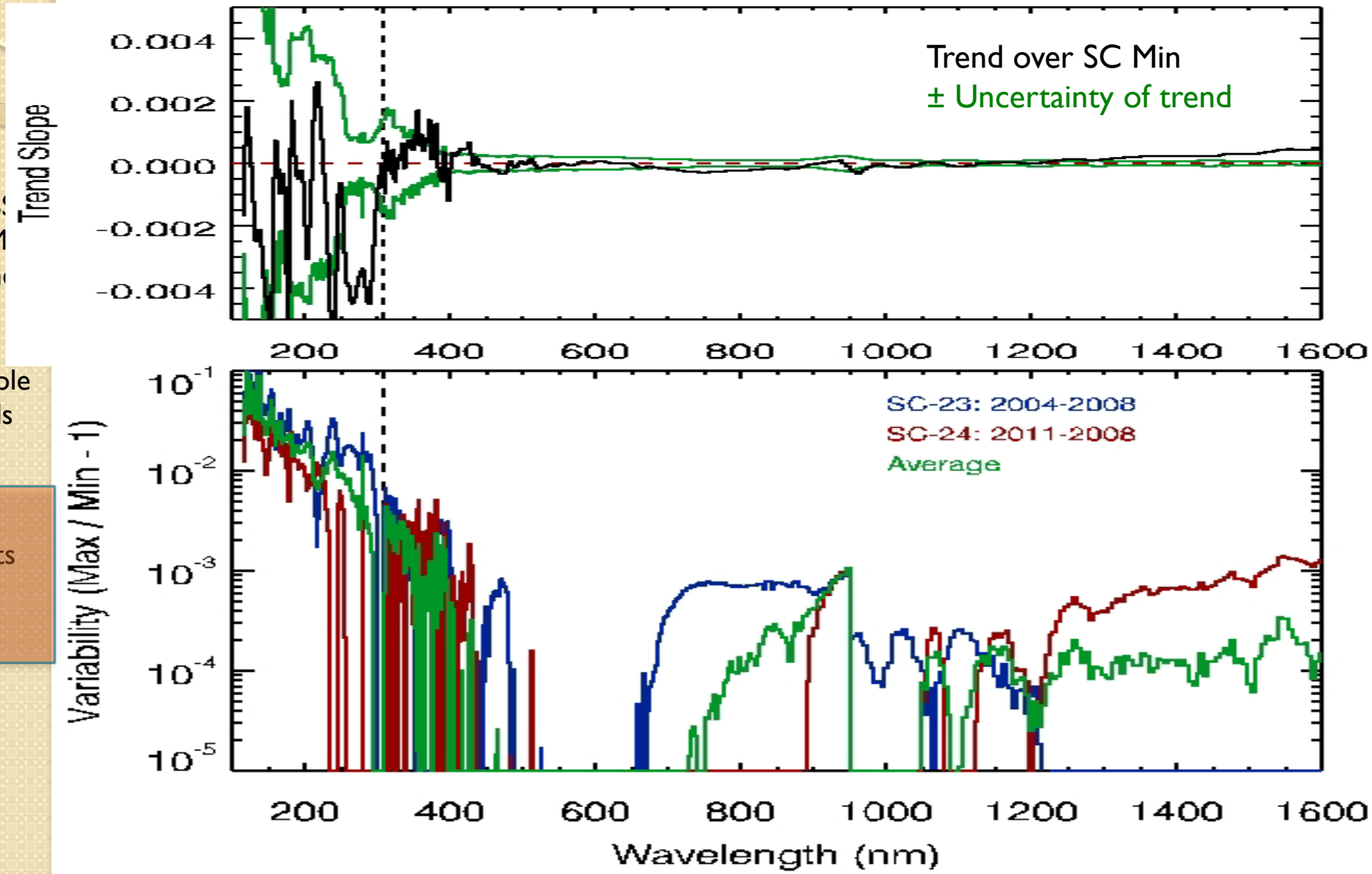
& SIM
Differen

Decouple Trends

Results



SORCE L3 (SOL-Ver10, SIM-Ver17) Results

Note most results are larger than the correction uncertainty

Negative (out-of-phase) solar cycle variations still present.

UARS (Woods & Rottman, 2002) results similar at < 285 nm.