Thoughts on Creating a Composite

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Creating a Composite
Purposes of TSI Composite

• Provide consensus TSI data record for
  – Radiative inputs to climate researchers
  – Solar activity correlations & modeling

• Two needs
  – What is absolute value [in W/m² (SI)]?
    • Needed for Earth energy balance
  – What are relative changes with time?
    • Needed for correlating with climate records and with solar activity
    • What are associated uncertainties on changes?
Degradation Corrections Critical for Stability

- Level 1 VIRGO data demonstrate level of variations of individual channels

Level 1 Data (all 4 channels)  
Level 2 Data (VIRGO)
Degradation Corrections Critical for Stability

PREMOS degradation fitted by spline

ACRIMSAT/ACRIM3 Degradation History

Polynomial Fit Order: 6

Sensor A

Sensor B

ACRIM3 degradation fitted by 6\textsuperscript{th} order polynomial

(outdated data version)
Degradation Corrections Critical for Stability

SORCE/TIM Cone B Degradation

Relative Variation (ppm)

Initial Offset = 220.10 ppm
Net Degradation to Date = 197.39 ppm
Ultimate Degradation = 227.60 ppm
Degradation 1/e Time = 1675.55 days
RSS Differences = 11.653 ppm

TIM degradation fitted by exponential
Instrument Data Comparisons Indicate Artifacts

- There remain significant differences between existing instruments
  - ACRIM3 oscillations and VIRGO Keyhole spikes are known problems
Comparisons With Model Also Indicate Artifacts

- There remain significant artifacts in data
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Comparisons With Model Also Indicate Artifacts

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Smoothing Residuals Helps (Somewhat)

- Limited ability to correct time-varying instrument trends
Uncertainties Increase With Gap Duration

• Stability uncertainties may decrease with smoothing duration...
• ...but net uncertainties increase with time
Ideas for Weighting Data Sets

- De-weight time periods of identified problems
- Weight by instrument relative stability variations
  - Works where we have ≥3 measurements
- Weight by net degradation
  - Component of uncertainty proportional to degradation
**Possible Approach (Brute Force)**

1. Determine absolute value based on latest measurements (ACRIM3, PREMOS, SOVAP, TIM, VIRGO)
   - Select temporal region of overlap
   - Compute mean over region weighted by estimated instrument uncertainties

2. Compute offsets and slopes from times of overlap
   - Offset uncertainties decrease with overlap duration and instrument noise
   - Remove slope difference (but from which data set?)

3. Compute slope of running mean of smoothed residuals
   - Determine the slope as function of time from residuals in smoothed running mean to get instantaneous relative uncertainties [ppm/day]
     • Need to select running mean window duration

4. Can compute the integral of the uncertainties in slope between any two selected times to get relative uncertainty [ppm]

**Rationale:** Uncertainties reflect actual time range used
1. Determine absolute value based on latest measurements (ACRIM3, PREMOS, SOVAP, TIM, VIRGO)
   – Select temporal region of overlap
   – Compute mean over region weighted by estimated instrument uncertainties

2. Compute offsets and slopes from times of overlap
   – Offset uncertainties decrease with overlap duration and instrument noise
   – Remove slope difference (but from which data set?)

3. Use estimates relying on temporal mode consistency
   – Bayesian, PCA (SVD), and/or wavelet methods
   – Determine the slope as function of time from residuals in smoothed running mean to get instantaneous relative uncertainties [ppm/day]

4. Can compute the integral of the uncertainties in slope between any two selected times to get relative uncertainty [ppm]

Rationale: Uncertainties reflect actual time range used
Ponderables

• What is value of initial time-dependent weighted uncertainties?
• Does method provide means of knowing relative contributions of each data set?
• What provides final uncertainties?
  – Means of formal propagated uncertainties?
  – Residuals may overemphasize known uncertain periods
Schedule

• Have additional year for effort (thanks to ISSI!)
• Finalize needed inputs for data sets (imminent)
  – List suspect data times
  – Include time-dependent uncertainties for each instrument
• Means of sharing data (completed via ISSI team website)
• Agree on absolute value for solar minimum period (this meeting)
• Consider SVD- and Bayesian-type methods (this meeting & prior)
• First attempts at composite & select approach (this meeting)
• Produce refined composites using all data (after meeting)
• Near-final composite (Dec. 2013)
• Draft of paper (Mar. 2014)
• Final ISSI meeting (April 2014)
• Submit paper (May 2014)
Most Immediate Tasks

• Start with original data sets
• Compare with others or models or operations to identify suspect time periods; attribute uncertainties
  – Expand beyond your own data
• Experiment with means of combining
  – SVD & Bayesian approaches promising
• Select approach and lock down formal computational method