Outline

• SUSIM irradiance and model estimate.
• Comparison of irradiance differences from SORCE and SUSIM.
• Compare SUSIM irradiance differences with differences from two recent SORCE versions.
• Compare SUSIM (data and model) and SORCE time series during the SORCE mission.
  – Long term variability
  – Short term variability
• Comparison of spectra across the last two solar minima.
• Conclusions.
• SUSIM UARS observations were made for ~14 years
• Calibrations included multiple channels, filters, and lamps
• Currently, calibration procedures are being transferred from VMS/VAX to UNIX systems.
SUSIM Irradiance Model

• Linear fit of SUSIM irradiance vs solar proxy
• Mg II index or area of Ca II K plage.
• SUSIM high resolution spectra from 1992 through 1999.
• Slopes were generally positive but some were negative.
• Motivation: To produce long term (~ 100 year) UV irradiance time series from Mt Wilson Ca II K film archive.
SUSIM-Based Irradiance Model: Fit to the Mg II Index
SUSIM-Based Irradiance Model: Fitting Coefficients
Irradiance Differences: SORCE, Lean Model, and SUSIM Estimate

- Comparison of two recent publically available versions of SORCE observations shows large differences.
- Most recent versions: SUSIM and Lean models agree below \( \sim 300-350\text{nm} \); SUSIM and SORCE agree > 350 \text{nm}.
- Most recent version: Below \( \sim 310\text{nm} \) => SOLSTICE, above \( \sim 310\text{nm} \) => SIM.
- Brackets labels a – d are show regions for following time series.
Time Series from Several SORCE Data Versions

• Following slides compare two different publicly available data versions. Headers indicate these version are equally well calibrated.
• Earlier SOLSTICE version (9) is very similar to current version (10).
• Earlier SIM version (15) is significantly different than current version (17).
• Both current and earlier versions show presence of oscillations in phase with the annual period of the earth-sun distance.
• Main issue at hand is degradation corrections.
Comparisons of Time Series from SUSIM and SORCE: 2003-2005

• SUSIM observations during 2003-2005 compared to SUSIM-based estimate from SUSIM observations during 1990’s.
• Overlap between observations and model estimate is remarkably good.
• This overlap indicates that SUSIM observations are internally consistent and validates SUSIM calibration and degradation correction.
Time Series - SUSIM Estimate, SUSIM Obs. and SORCE Obs. (SOLSTICE Ver. 09 & SIM Ver. 15)
Time Series - SUSIM Estimate, SUSIM Obs. and SORCE Obs. (SOLSTICE Ver. 10 & SIM Ver. 17)
Short Term Time Series

• SUSIM observations and SUSIM model agree with SORCE results at shorter wavelengths.
• SUSIM and SORCE observations disagree with SUSIM model at longer wavelengths.
• Magnitude of SIM short term variability is 2 to 5 times larger than SUSIM results.
Separation of Short and Long Time Series: 2004.3-2005.3
Separation of Short and Long Time Series: 2006.0-2007.0
Separation of Short and Long Time Series: 2009.5-2010.5

220–250 nm (a)

260–280 nm (b)

315–335 nm (c)

360–390 nm (d)
Spectra Across the Solar Minimum at specific Mg II Index Values

• Use several Mg II Indices to select dates with the same Mg II index.
• Average SORCE and SUSIM spectra for 27 days around these dates.
• Compare differences between these average spectra with the differences from Haigh et al., 2010.
Example Spectra - SUSIM

SUSIM
27 Day Average

Irradiance [mW/m²/nm]

Date          Mg II Index (NOAA)
              1994.32          0.2660
              1997.62          0.2660

Wavelength [nm]
Example Spectra - SORCE

![Plot of Example Spectra - SORCE](image)

- Date: 2006.44
- Mg II Index (SORCE): 0.2660
- Date: 2010.25
- Mg II Index: 0.2660

Irradiance [mW/m²/nm]

Wavelength [nm]
Irradiance Differences Across Solar Minimum

Mg II Index: 0.2666
Irradiance Differences Across Solar Minimum

Mg II Index: 0.2668
Irradiance Differences Across Solar Minimum
Mg II Index: 0.2663
Irradiance Differences Across Solar Minimum

Mg II Index: 0.2660
Irradiance Differences Across Solar Minimum
Mg II Index: 0.2659
Irradiance Differences Across Solar Minimum

Mg II Index: 0.2648
Conclusions

• SUSIM observations were made for ~14 years. This is the longest calibrated, single instrument, UV spectral irradiance data set.

• SUSIM model based on MgII index only and early SUSIM observations.

• Recent SUSIM observations overlap extremely well with model of SUSIM observations during the previous solar minimum; calibration maintained over solar cycle.

• Comparison of overlapping SUSIM and SORCE observations shows significant disagreement (more below).

• Recent observations by SORCE show significant disagreement with previous observations by other space-based instrumentation.

• Significant changes between SORCE data versions raise questions in the recent observations and the conclusions of significant changes in solar output.
Conclusions

• Comparison of Solar behavior observed by SUSIM and SORCE shows significant differences.
  – The relative change in UV irradiance indicated by SUSIM and SORCE time series are measurably different.
  – SUSIM spectra on either side of the previous solar minimum are very similar; SORCE spectra on either side of the most recent solar minimum significantly different.

• SUSIM and SORCE solar UV irradiance measurements are inconsistent with one another.
  – Accordingly, at least one of SUSIM and SORCE must have significant unresolved calibration problems.
  – Initial evidence presented indicates a higher level of consistency for SUSIM both with itself and with the MgII index.
  – However, more work on both instrument calibrations is needed to resolve these discrepancies.
Extra Slides
Abstract

Understanding the impact of solar variability on terrestrial climate requires detailed knowledge of both solar spectral irradiance (SSI) and total solar irradiance (TSI). Observations of SSI in the ultraviolet (UV) have been made by various space-based missions since 1978. Of these missions, the Upper Atmosphere Research Satellite (UARS) included the Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) experiment which measured the UV SSI from 1991 into 2005. In this talk, we present the UV spectral irradiance observations from SUSIM on UARS during solar cycles 22 and 23 along with results of a recent review of the calibration, stability, and in-flight performance. Another more recent mission is the Solar Radiation and Climate Experiment (SORCE) satellite which carries the Solar-Stellar Irradiance Comparison Experiment (SOLSTICE) and Solar Irradiance Monitor (SIM). Together, the SORCE instruments have measured the UV, Visible, and IR SSI over the period of 2003 to the present. This talk will include a comparison between SUSIM and SORCE during the period of overlapping observations as well as comparisons of UV spectra observed at various times, particularly during the last two solar minima. These comparisons show that the UV observations by SORCE are inconsistent with those measured by SUSIM.
Separation of Short and Long Time Series: 2004.3-2005.3

(a) 220–250 nm
(b) 260–280 nm
(c) 315–335 nm
(d) 360–390 nm