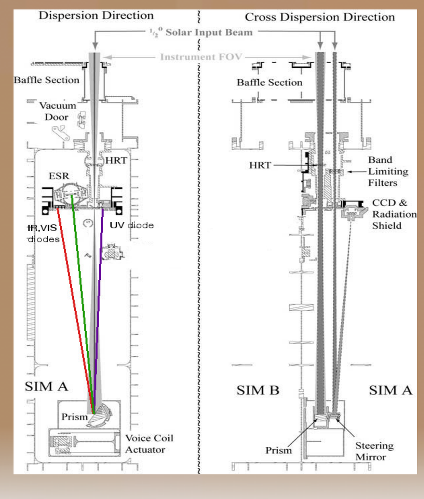

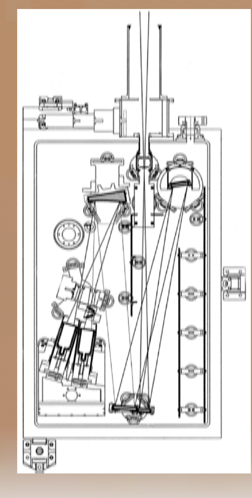

The Latest SORCE SSI Data Release and Degradation Models

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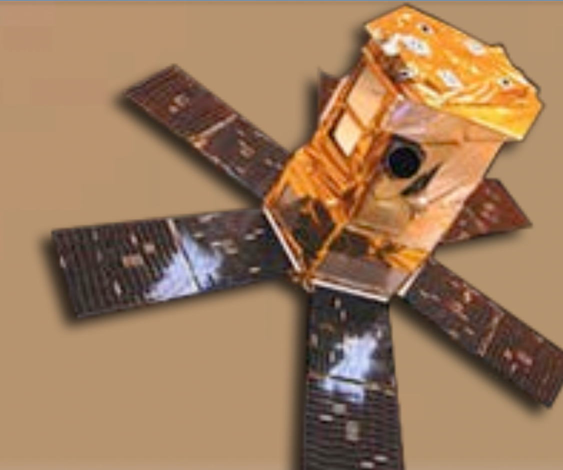

Introduction

The Spectral Irradiance Monitor (SIM) and the SOlar Stellar Irradiance Comparison Experiment (SOLSTICE) instruments on board the Solar Radiation and Climate Experiment (SORCE) mission have been taking daily Solar spectral irradiance (SSI) measurements since April 2003.
This poster covers the improvements made in version 15 of the SOLSTICE data released in November 2015, and the work in progress in preparation of the upcoming release of version 23 of SIM data.

SOLSTICE

SOLSTICE makes daily solar ultraviolet (115-320 nm) irradiance measurements with a 0.1 nm resolution and compares them to the irradiance from an ensemble of 18 stable early-type stars to monitor the in-flight performance of the instrument. Because the stars are many orders of magnitude dimmer than the sun, the instrument uses a much larger entrance aperture for these (a 16 mm diameter compare to a 0.1 mm square). This has the effect of illuminating different portions of the optics depending on the aperture selected. This difference is calibrated in orbit by measuring changes in the observed solar irradiance at various off axis pointing ("haystack analysis").
For version 15, a new correction was introduced to account for the change in the apparent size of the sun on the optics, which changes the instrument's responsivity with the Sun-Earth distance. This second order correction has been a great success in removing the periodic artifact from the data.

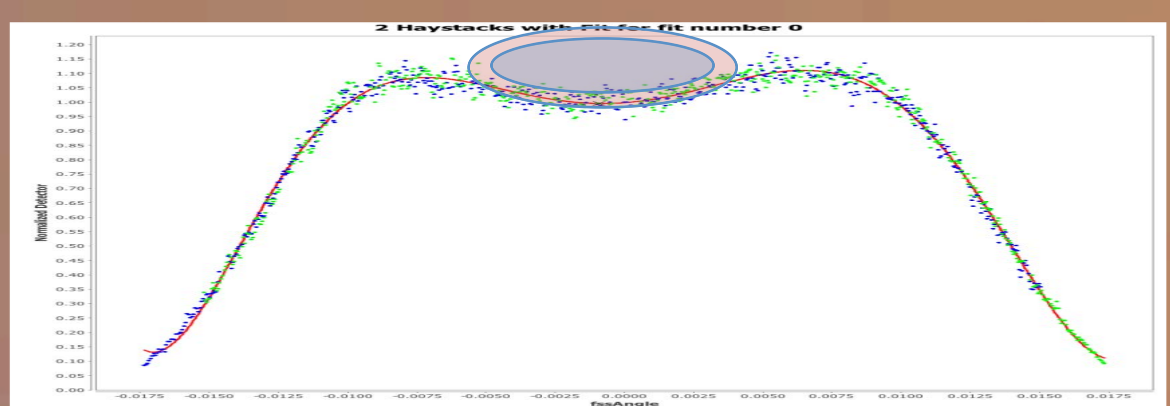

Fig. 1 Using our weekly "haystack" measurements, we calculated a change in the average responsivity over the year.

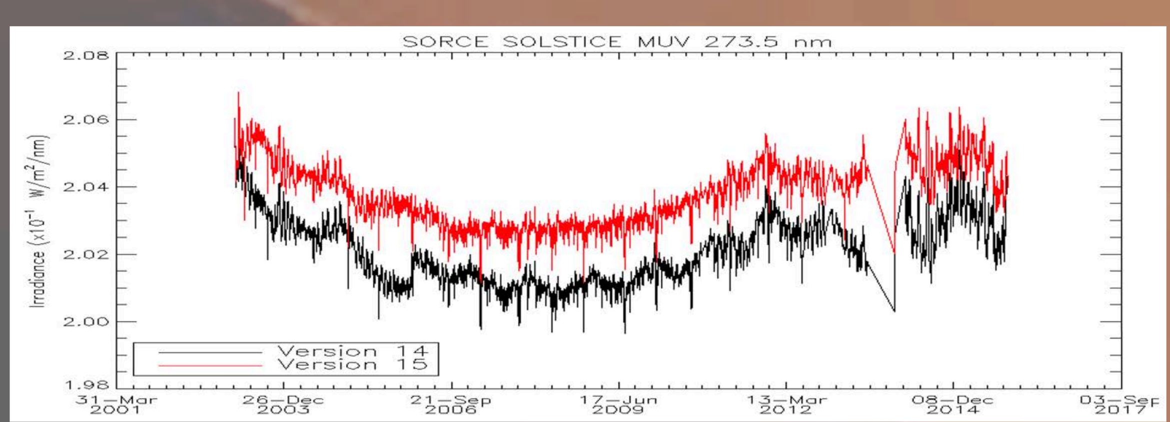

Fig. 2 Improved calibrated irradiance at the time of the slit anomaly and reduced 1AU artifact.

Because of the currently limited battery capacity, as of July 2011, all instruments on SORCE are turned off during the night portion of the orbit. This has prevented any new stellar observations with SOLSTICE and we have been using extrapolated degradation since then.
Two new corrections related to the January 2006 slit anomaly were implemented, with the following effects: the discontinuity in the time series has been removed at most wavelengths, and the degradation correction is now fit separately before and after this event.

An improved wavelength alignment algorithm was also implemented which significantly reduces the scatter in the daily measurements.
Finally, we have corrected for responsivity changes seen after the two extended safe-holds (six weeks in 2011 and six months in 2013). Without stellar measurements to track absolute responsivity, we had to use comparisons to proxy models to estimate short term changes in the instrument. We have applied offsets to the responsivity using the SATIRE-S model. These offsets do not influence long term trends in the data, and we have added to the irradiance uncertainty.

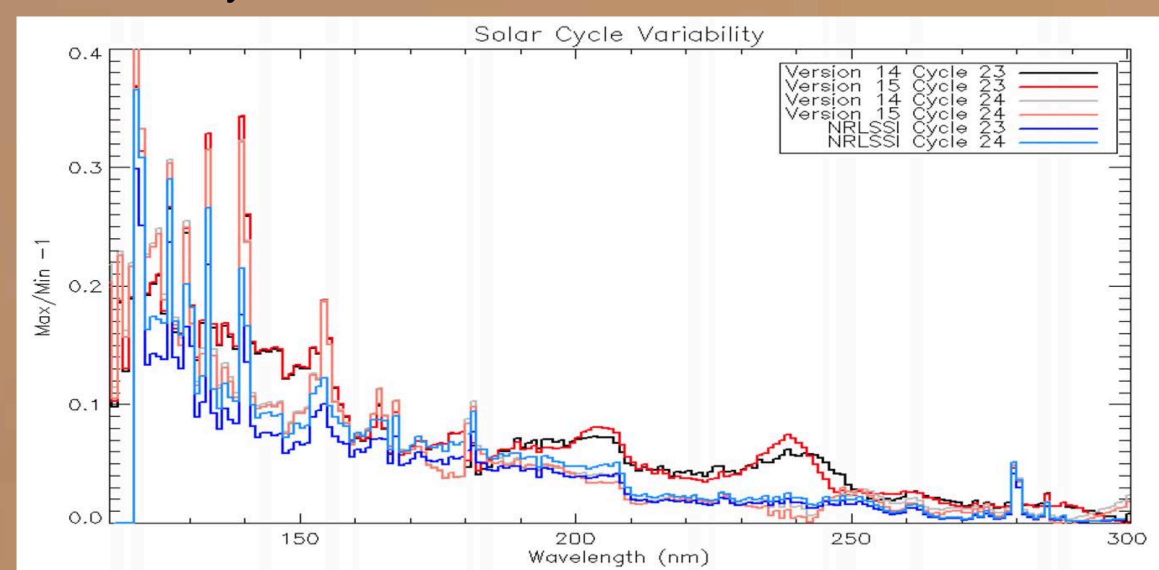

Fig. 3 Solar cycle variability for the new version of SOLSTICE data compared to the previous version and the NRLSSI-1 model for the decline of cycle 23 and the rise of cycle 24.

The solar cycle trends in the current version of SOLSTICE data are very similar to previous versions. The following plot shows the old version (black and gray), the new version (red and salmon), and the NRLSSI-1 model (blue and dodger blue) solar cycle variability for both the decline of cycle 23 and the rise of cycle 24. As before, SOLSTICE data is similar to model predictions for cycle 24, and still shows larger than expected variability in cycle 23.

SIM

SIM makes daily solar irradiance measurements (200-2400nm) with a resolution from 0.25nm in the UV to 33nm in the IR using 3 diodes and an ESR detector. The degradation over the lifetime of the mission is monitored by taking measurements with two identical instrument at different time cadences. The prism degradation is described by the following equation:

$$\left((1-a_{diode})\exp\left(-\kappa(\lambda)C(t)\right)+(a_{diode})\exp\left(-\frac{\kappa(\lambda)C(t)}{2}\right)\right)$$

Version 22 of the SIM data was released in May 2015 and new daily measurements are being calibrated and added to the data record. The calibrated SIM data has to satisfy two necessary conditions: the data from both instruments must match and the integrated SSI must follow the trends measured with TIM. In order to meet these conditions, the solar exposure record for SIMA and SIMB had to be modified. We attribute this to a change in the rate of outgazing material over the lifetime of the mission.

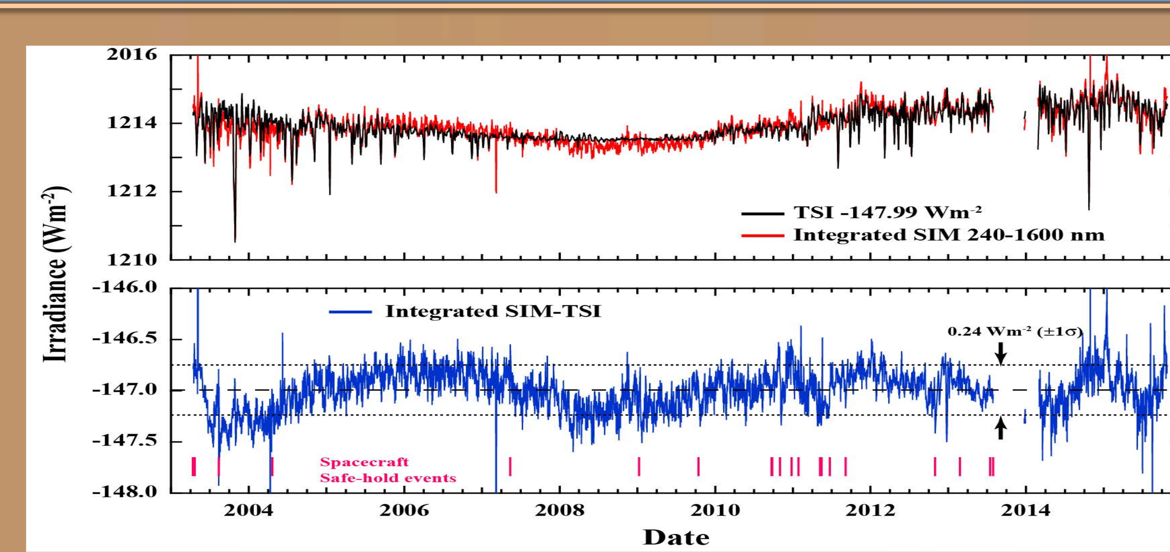

Fig. 4 The SIM data integrated from 240 to 1600 nm is compared the the TSI measurement from TIM. This data agrees with the TSI within a 1σ of ±0.24 Wm^{-2} (±0.24/1213.2 (sim at solar min) = 200 ppm)

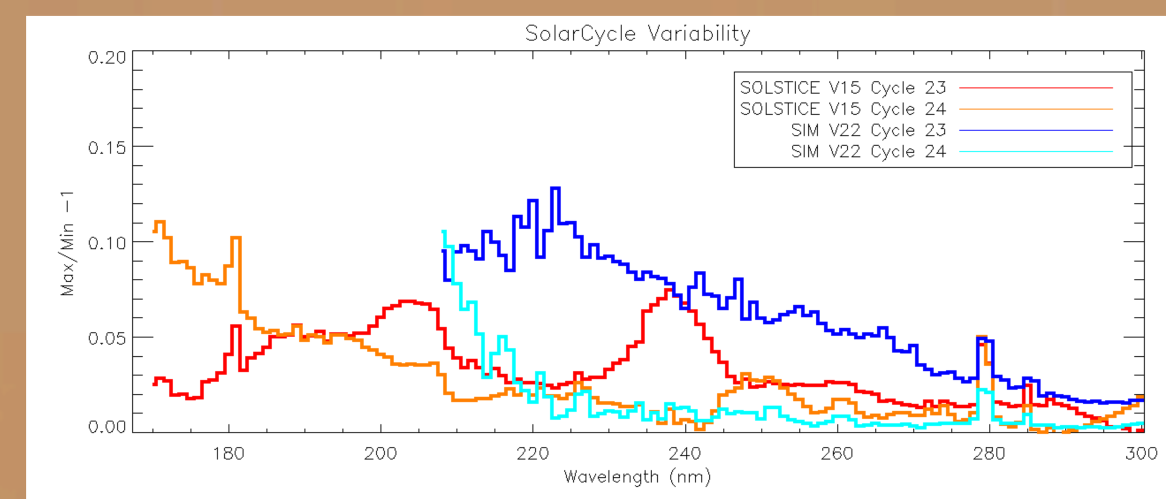

Fig. 5 Solar Cycle Variability of SIM compared to SOLSTICE for the decline of cycle 23 and the rise of cycle 24. Note that we only publish data for SIM from 240.0nm

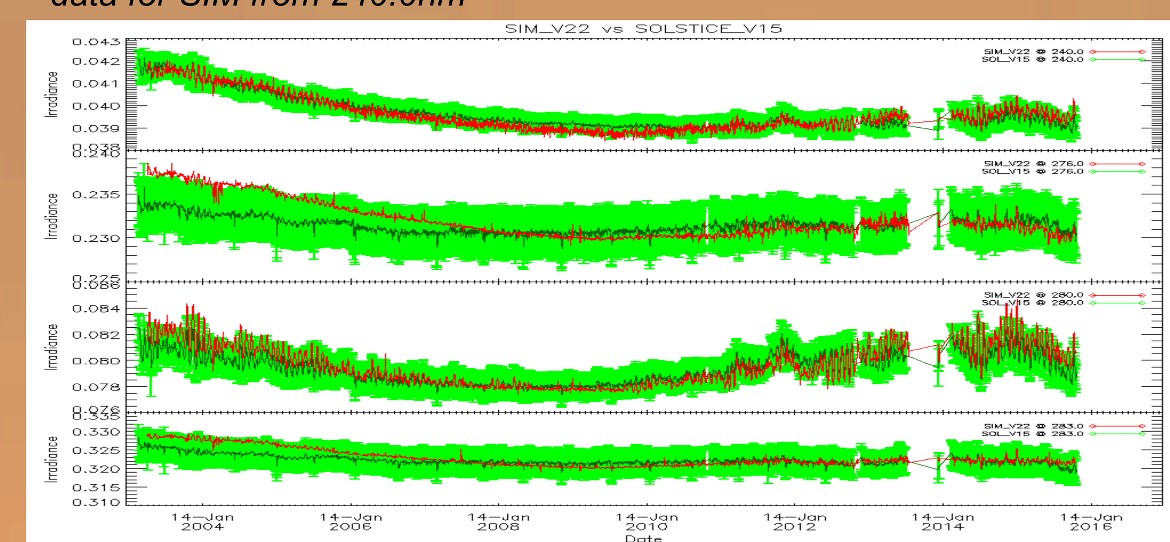

Fig. 6 Comparing SOLSTICE version 15 with the uncertainties and SIM version 22 data at 240, 276, 280 and 293nm (from top to bottom). SIM is showing a larger variability early in the mission.

Current and Future Work

For SOLSTICE version 16: we will continue to analyze the early-mission calibration data to derive the best degradation correction. In the past month, we have begun to take new calibration measurements to correct for the solar-stellar field-of-view, and we are working with the mission operations team to investigate the possibility of resuming some stellar measurements!

Since the release of version 22 of the SIM data in May 2015, a lot of effort was place on implementing a new methodology to better evaluate the degradation as a function of mission day and wavelength for all detectors in both channels. Comparing each common spectra between the two channels, we obtain a time varying Kappa, representing the evolving spectral signature of the obscuring material on the surface of the prism.

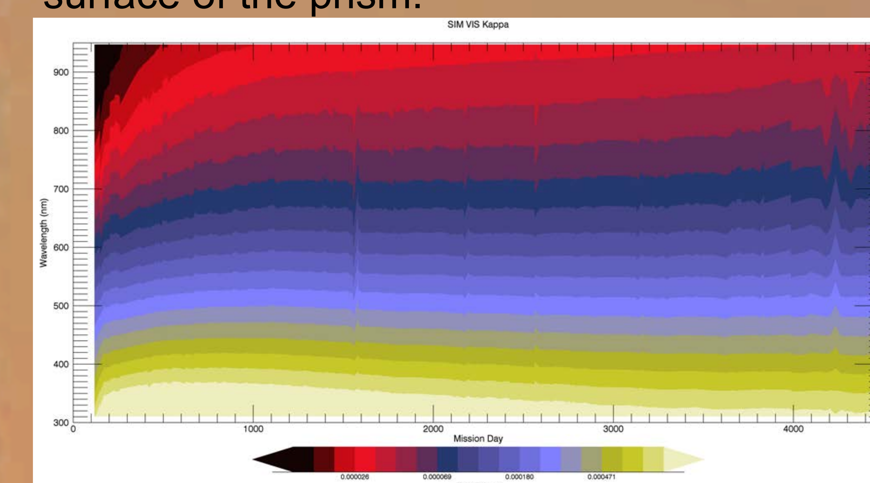

Fig. 7 The time varying Kappa changes with wavelengths and mission time and is not a simple scaling as what was used in version 22.

By forcing the calibrated irradiance at 691nm to be flat throughout the solar cycle, we're able to come up with a modified solar exposure record that keeps the agreement between SIMA and SIMB. This also corrects the discontinuities seen at the OBC events throughout the mission. A new correction was implemented to fix changes seen in our ADC over the life of the mission.
In version 23, we will continue to address:

- the increase in measurement scatter with the ESR detector since the start of the power-cycling operations,
- the different solar exposure records required to fix the trends in each detector
- the apparent excess degradation correction in the UV early in the mission.