SORCE SIM Data Release Version 19

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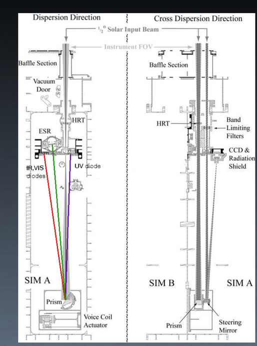
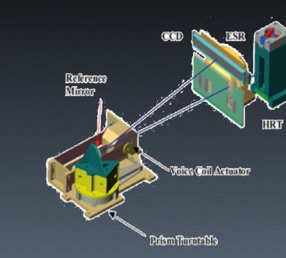
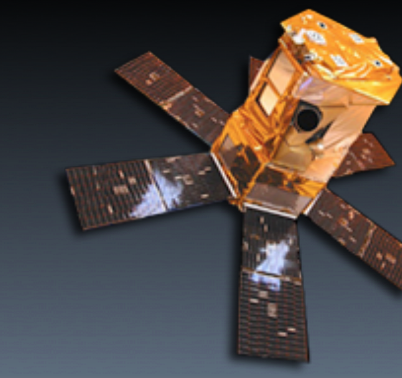
http://lasp.colorado.edu/home/sorce/







Introduction

The SORCE SIM data version 19 was released in November 2013. The data in LISIRD covers the wavelength range from 310 to 2412 nm from 2003/04/14 to 2011/05/10, including the first year of the mission up to the start of the power cycling of the instrument. The data on the SORCE website covers the same time range but starts at 240nm with partial overlap with SOLSTICE.

SIM Degradation factors

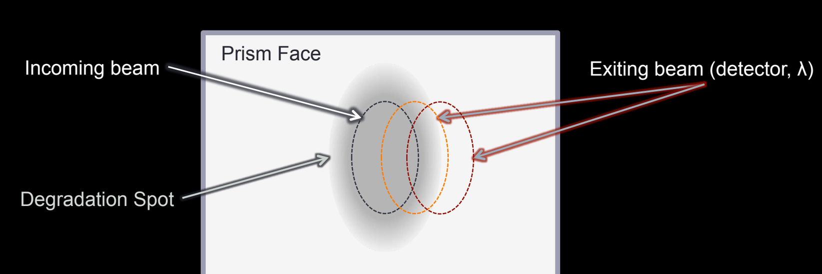
The change in prism transmission due to prolonged solar exposure is by far the largest contributor to the instrument degradation. The ESR gain and increased scattered remain negligible while the loss of diode responsivity is tracked by comparing with the ESR data.

Our prism degradation model is a function of wavelength, solar exposure, calendar time and instrument geometry:

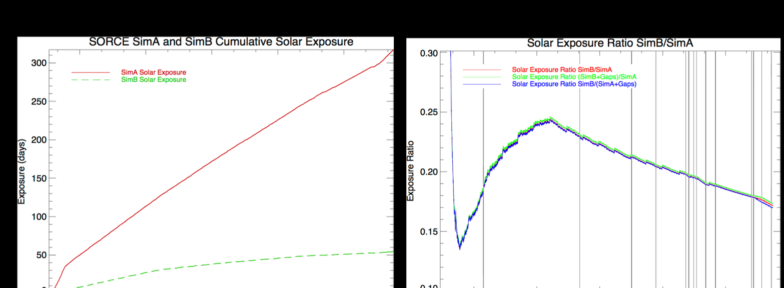
1 / { (1-a)*exp[-Kappa(λ)C(t)] + a*exp[-Kappa(λ)C(t)/2] }

Where C(t) combines the solar exposure and the clock time dependencies. The geometric factor *a* is dependent on the rotation angle of the prism. When the exiting beam sees no degradation, *a*=1.0 and when the exiting beam overlaps the entrance beam, a=0.0.

The degradation model is evaluated by comparing two identical spectrometers in the same physical, chemical and thermal environment, used at different rates of solar exposure. The model is validated when measurements of the sun at the same time with both spectrometers result in same calibrated irradiance



Simulated prism degradation spot with outline of incoming and outgoing beams for two different prism rotation angles.



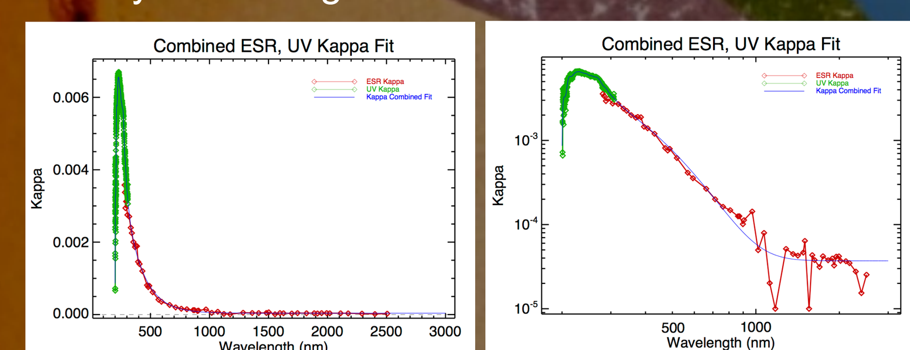
Accumulated solar exposure for SimA and SimB (left) and their ratio (right) with the occurrences of the many safehold events shown as vertical lines.

Changes from version 17

- New processing software: better maintainability, changeability and processing speed
- Calibrated/corrected issues with prism encoder for first year of mission
- Much improved temperature correction to photodiode responsivity
- Improved accuracy of the solar exposure record
- Improved wavelength dependent prism degradation function - Kappa(λ)
- Improved prism degradation time-dependent function
- New prism degradation models, geometric raypaths and irradiance offsets determined for each segment between safehold events

Calibration

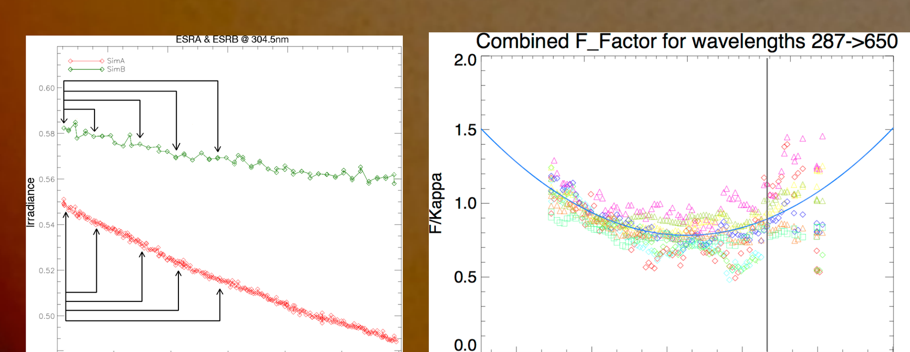
- Kappa obtained over the most stable time period of the mission by combining ESR and UV diode



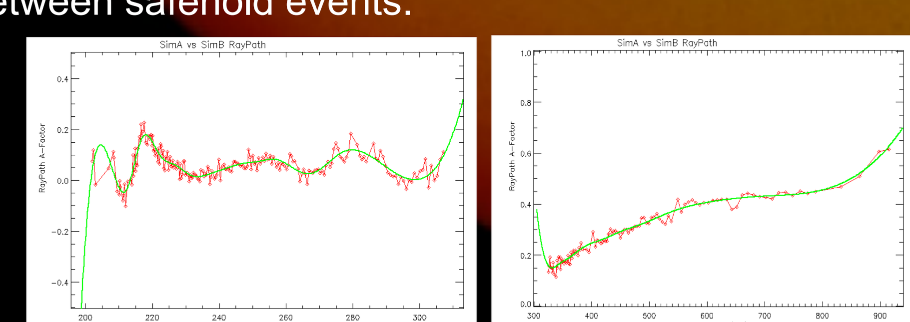
- Time dependent effect NOT related to Solar exposure is determined by comparing ratios of measured irradiances taken at time t_0 and t_1 for both instruments:

$$I_{A0}=E_0 e(-k\cdot F\cdot SE_{A0}),\ I_{A1}=E_1 e(-k\cdot F\cdot SE_{A1}),\ I_{B0}=E_0 e(-k\cdot F\cdot SE_{B0}),\ I_{B1}=E_1 e(-k\cdot F\cdot SE_{B1})$$

$$(I_{B0}/I_{B1}) / (I_{A0}/I_{A1}) = \exp\{-k\cdot F\cdot(\Delta SE_{A0\to 1} - \Delta SE_{B0\to 1})\}$$

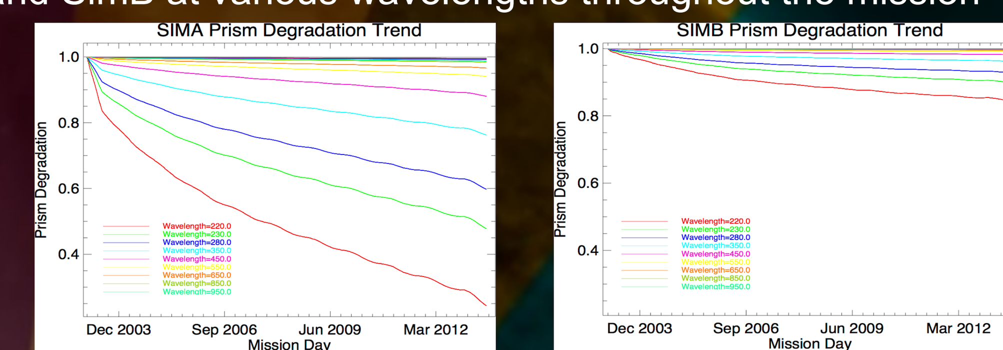


- Raypaths are determined for each detector as a function of wavelength (prism rotation angle) for each time segment between safehold events.

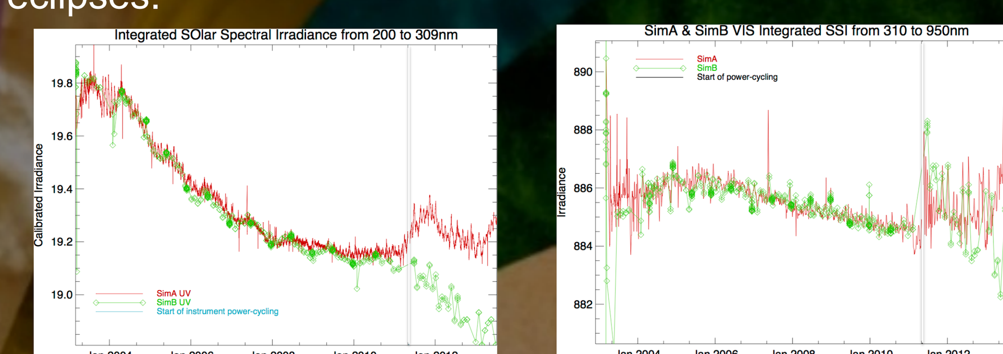


Results

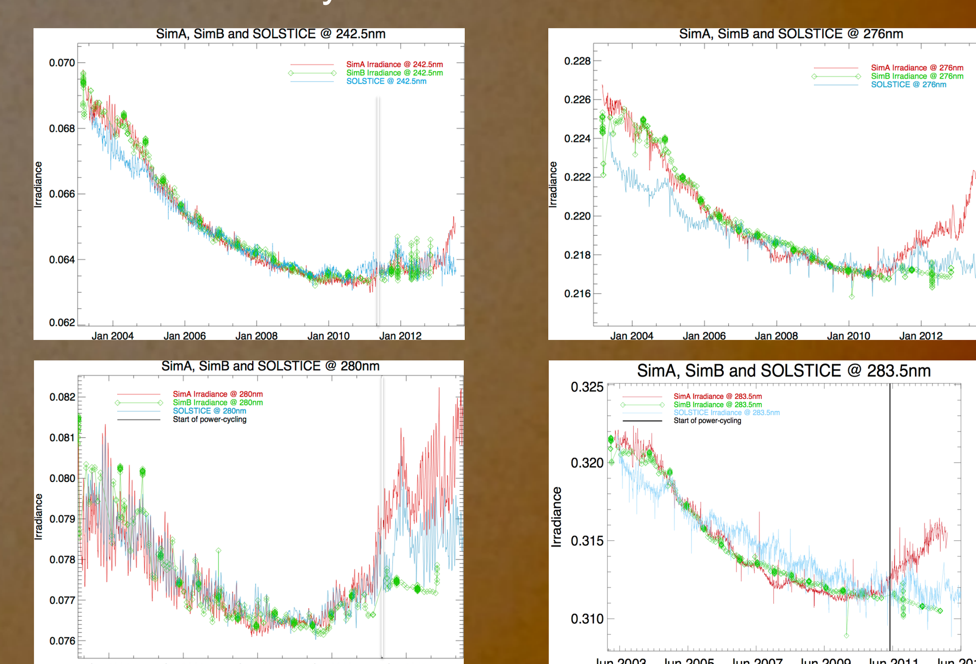
The figures below show the measured degradation for SimA and SimB at various wavelengths throughout the mission



We have very good agreement between the integrated calibrated irradiance for SimA and SimB up to the time when the instrument started being power-cycled during eclipses.



In the overlap wavelength range between SIM and SOLSTICE, we have excellent agreement at certain wavelengths but not as good at other wavelengths. Work continues to identify the cause of these differences.

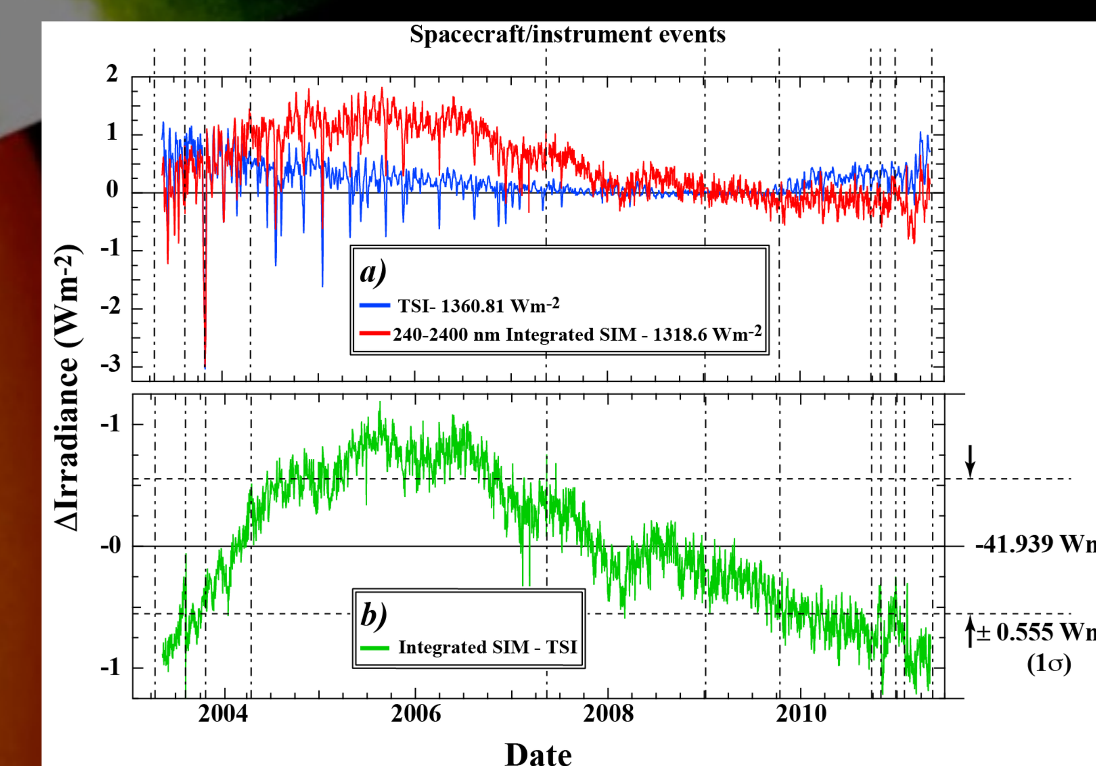


Plans for version 20

- Implement dynamic wavelength shifter to account for thermal/mechanical stresses from power cycling
- Refine temperature correction to photodiode responsivity
- Refine estimates of photodiodes degradation with mission time
- Investigate a time dependent change in the wavelength dependent prism degradation Kappa(λ,time)
- Projected to improve:
  - Ability to perform SimA/SimB comparisons
  - Determination of geometric raypath through the prism
  - Agreement between the ESR and diode data throughout the entire mission

TSI vs Integrated SSI

We assess the amplitude of possible common-mode errors (affecting both instruments) by integrating the SSI and comparing it against the TSI. The figure below shows the integrated SSI over 240-2400nm (97% of TSI) with the shifted TIM measurements. The lower image shows the differences in irradiance with the TIM data. The 1σ over the whole SORCE mission is 0.555 Wm^{-2} corresponding to a one standard deviation in the fractional difference from TSI of 400ppm over 1226 spectral bins. This can be reproduced by a 0.6 prism drive step uncertainty.



Estimated long-term uncertainty

Since the safehold events affect the trends in the degradation in different detectors and time regimes differently, we estimate the long-term trends between each safehold separately. The trends are deduced from the scatter of the differences in calibrated irradiances from SimA and SimB time series. The plots show the fractional differences for the UV, VIS and IR detectors and the 1σ and 2σ fractional Noise Equivalent Irradiance. Most of our uncertainty falls close to a 2σ NEI.