The Analysis of Improved Laboratory Measurements in the Recalibration and Reevaluation of the SORCE SIM Data Record

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YEAR ONE

- Focused on the reanalysis and recalibration of the SORCE SIM data record using newly obtained laboratory measurements of instrument witness and component-level characterizations and calibrations resulting in a higher fidelity optical model of SIM.
- Updated prism Sellmeier from lab measurements of glass sample and optimization of optical model (small effect).
- Updated photo-diode temperature correction. Lab measurements showed very similar (but not identical) temperature effect between TSIS diodes and calibration used for SORCE processing (small effect)
- Update to diffraction (and optical model) made difficult because of undocumented final baffle location metrologies

YEAR TWO

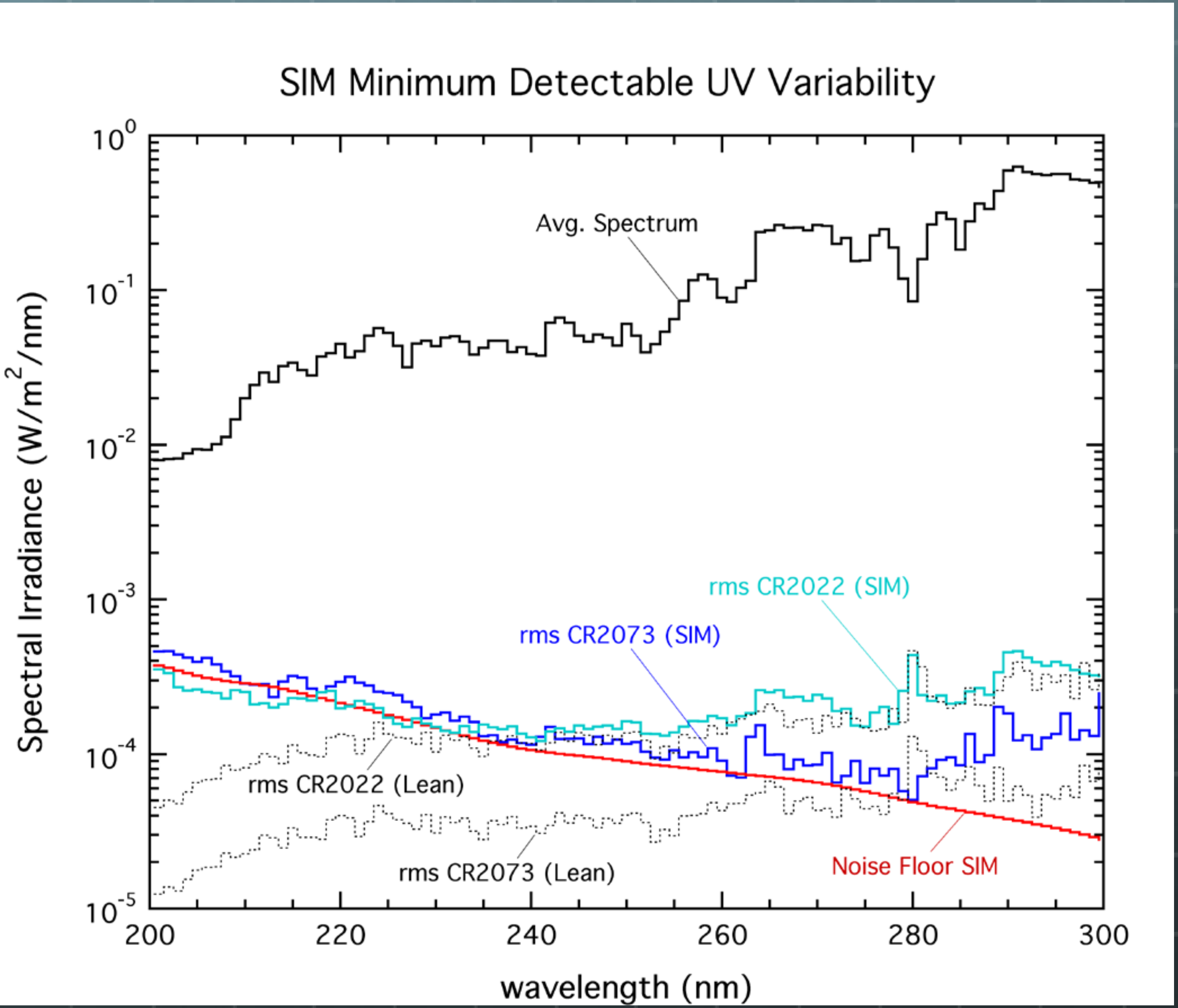
- Refinement of the instrument line shape function analysis is still in-progress
- Developing new analysis codes to understand the impact of the diffraction uncertainties in the absolute scale of the SORCE SIM spectral irradiance..
- Improving the constraints on the early mission degradation and stability corrections

Assumptions for a two-instrument design

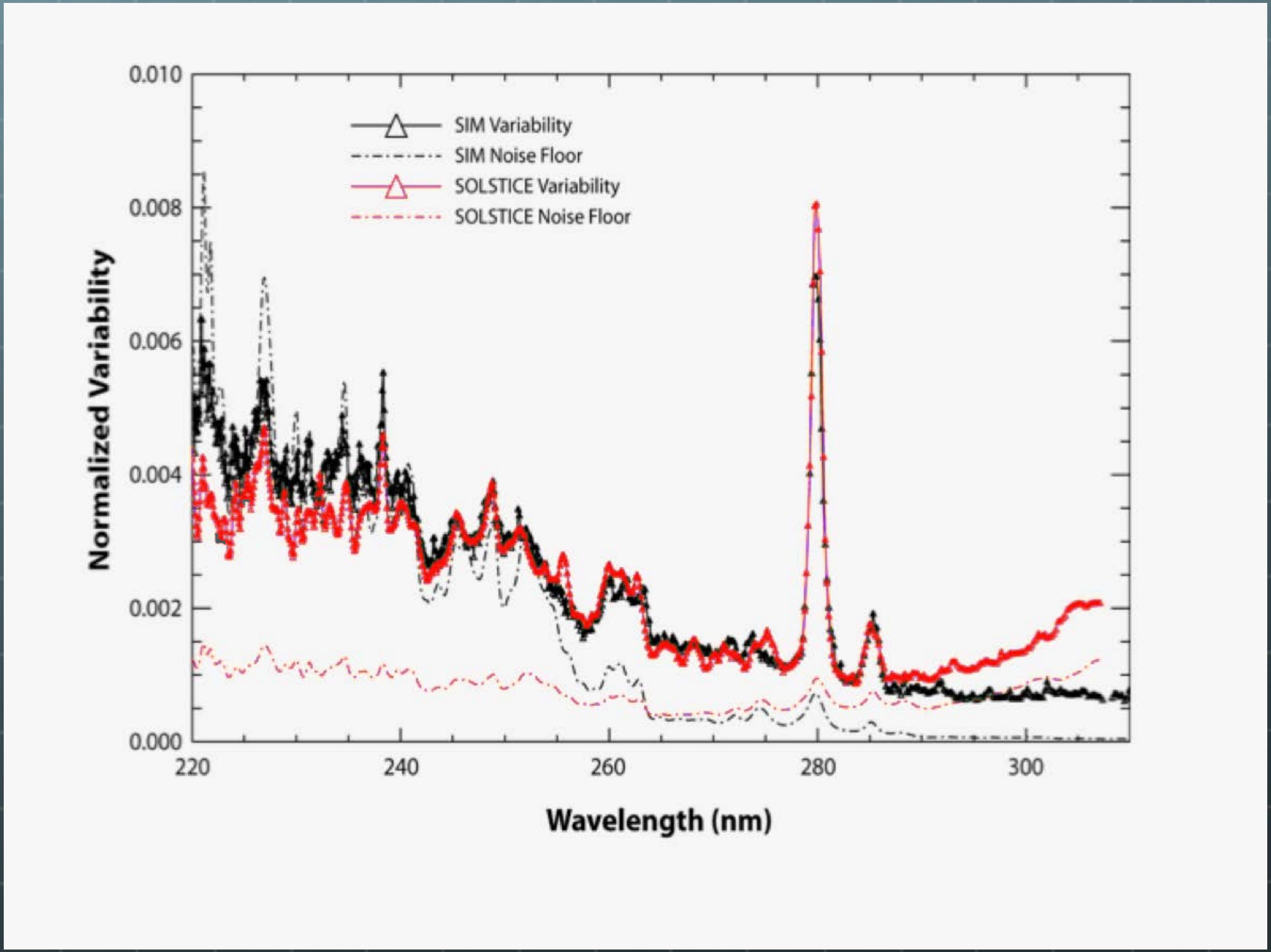
- The corrected irradiance measured from both instruments at the same time should be equal
- Both instruments are exposed to the same level of contaminants throughout the mission
- The amount of degradation on the prism is ONLY a function of the amount of contaminants present at any time AND the cumulative solar UV exposure
- The photodiodes degrade in an identical fashion for both instruments over time

The impact of the SIM noise equivalent irradiance (NEI) in the 200-300 nm range.

Carrington Rotation 2022 [12 Oct-08 Nov 2004] Active period, Solar variability above NEI for $\lambda \geqslant 245$ nm
Carrington Rotation 2073 [3 Aug-30 Aug 2008] Quiet period, Solar variability above NEI for $\lambda \geqslant 280$ nm



Observational comparisons of SORCE SIM and SOLSTICE variability show that for wavelengths below ~260 nm the SOLSTICE UV variability should be used.



Early mission degradation re-analysis

The long-term (over a decade SSI record) shows better agreement with the model predictions for the SC 24 (2009-present) and for the most part, they statistically agree within the measurement and model uncertainties.

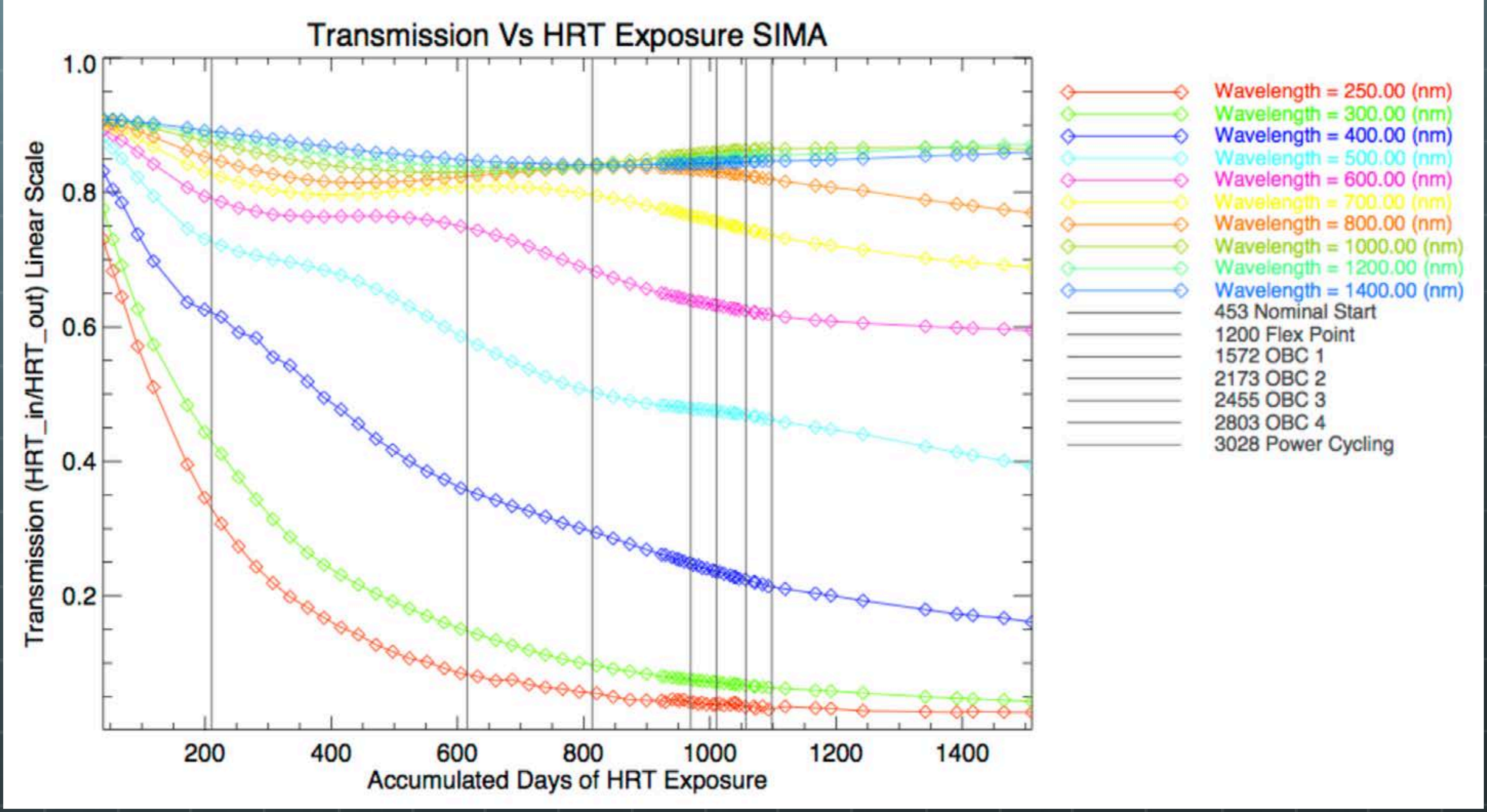
- degradation is occurring at a greatly reduced rate and thus the corrections are less sensitive to the longer-term exposure
- early mission has a combination of higher contamination (due to early phase outgassing) and higher exposure rates due to frequent calibration comparisons (during an active sun)
- very non-linear solution to the cumulative degradation corrections early in the mission
- Exploring HRT degradation and applicability to prism
- Adding time variability to the spectral degradation factor *Kappa*

SIM Hard Radiation Trap (HRT) Degradation Analysis

Extensive usage of HRT early in mission shows rapid degradation.

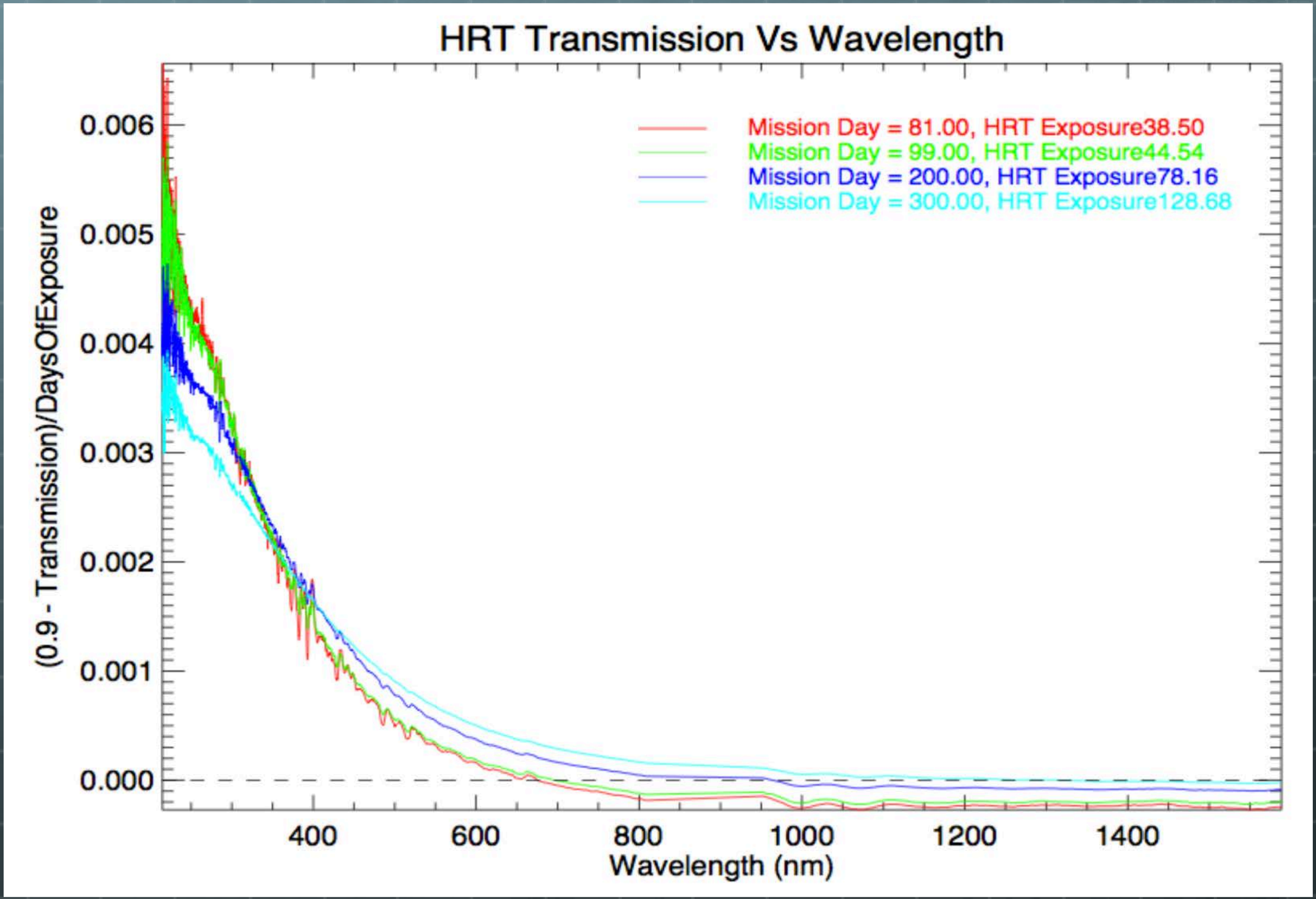
Effect resembles interference coating evolving as thickness of deposited material increases

Starting to investigate impact on prism vs λ

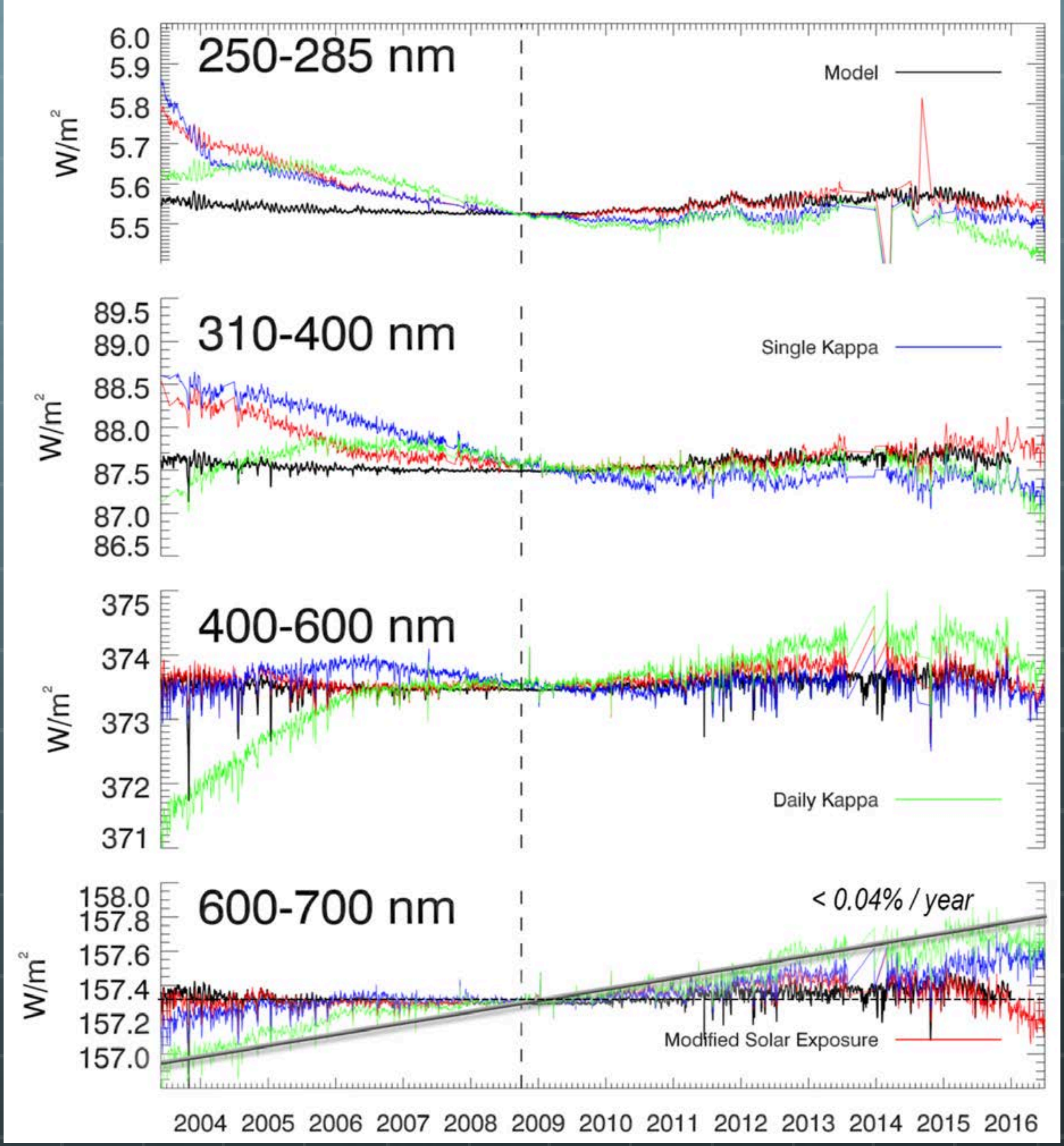


SIM Hard Radiation Trap (HRT) Degradation Analysis

Derived full wavelength dependence of the SIM A HRT degradation for early mission exposure during a period covering the first year of SORCE operations.



Degradation correction sensitivity analysis



Black data is the NRLSSI

Blue curve is average Kappa over stable instrument operations (2004/4/21 to 2007/5/13) with time variability *f'*

Green curve results from a new Kappa obtained from coincident SIM A and SIM B observations

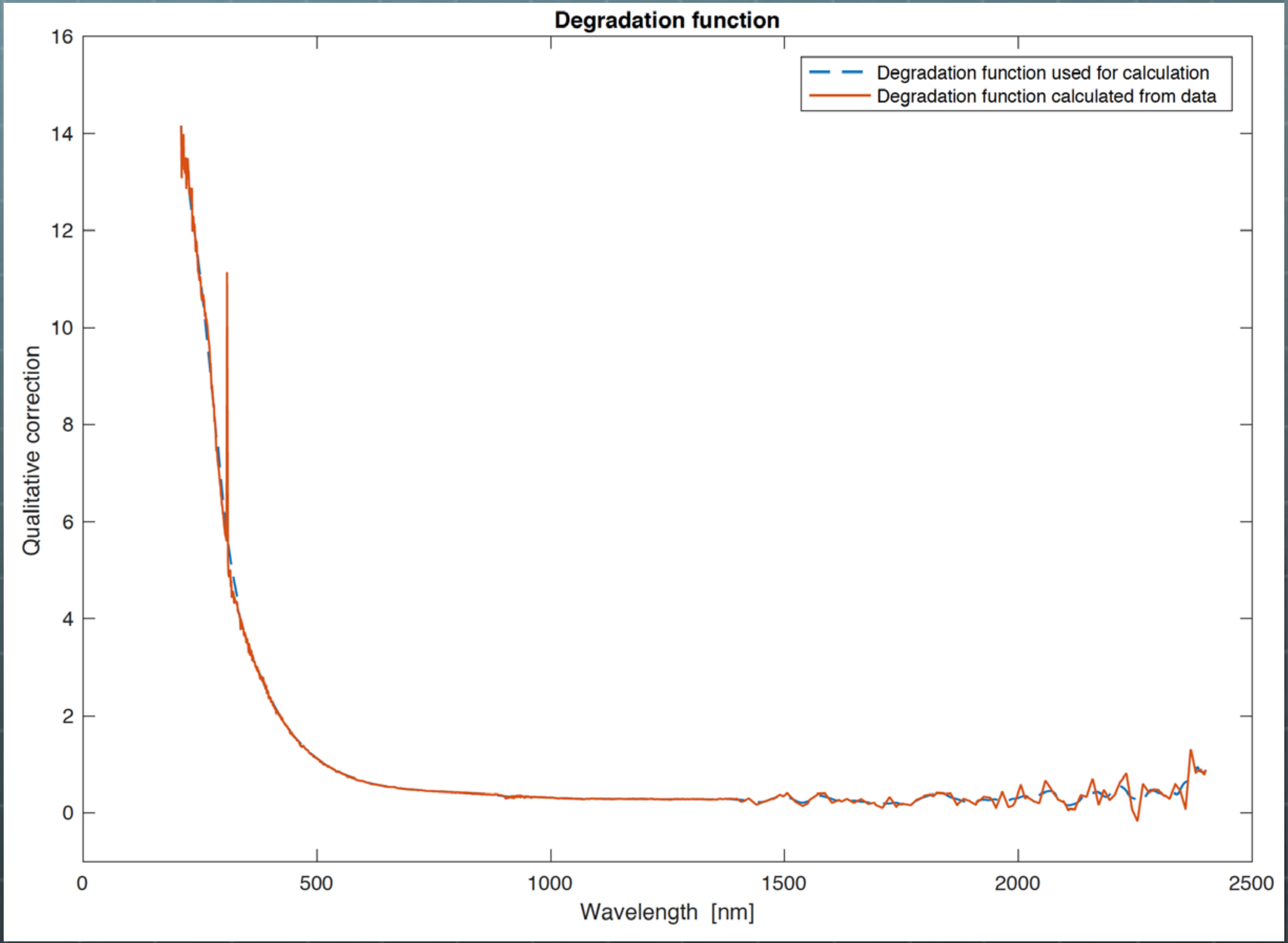
Red curve uses a modified solar exposure data to account for differences in the early mission kappa function

Alternative degradation approach

- Check the sensitivity of the degradation between the two channels by using ratios of the uncorrected irradiance against common solar variability periods, referenced to the fractional changes predicted by the SATIRE-S semi-empirical model
- Calculated a correction factor to force match integrated SIM SSI and TIM TSI over the early mission time frame

$$DegNorm_{\lambda} = \frac{I_{SIM\_Uncorr}(T_0) - I_{SIM\_Uncorr}(T_{end})}{I_{SIM\_Uncorr}(T_0)} - \frac{I_{SATIRE-S}(T_0) - I_{SATIRE-S}(T_{end})}{I_{SATIRE-S}(T_0)}$$

$$CorrectionFactor(t) = \frac{TSI_{TIM} - TSI_{SIM}}{\int I_{SIMUncorrected} \cdot DegNorm_{\lambda}\, d\lambda} \text{ where } TSI_{SIM} = \int_{210}^{2400} I_{SIM\_Uncorrected}\, d\lambda \quad (\sim 95\% \text{ } TSI_{TIM})$$



Degradation function
Degradation function used for calculation
Degradation function calculated from data
Qualitative correction
Wavelength [nm]
16
14
12
10
8
6
4
2
0
0
500
1000
1500
2000
2500