TSIS-1 SIM Release Notes for Version 6, Level 3 data product (2021/06/08)

TSIS-1 SIM (Spectral Irradiance Monitor) Version 6 (V06) data appears in three locations:

1. the LISIRD website (see http://lasp.colorado.edu/lisird/data/tsis_ssi_24hr)
    a. ASCII or CSV
2. the TSIS website (see: http://lasp.colorado.edu/home/tsis/data/)
    a. ASCII and IDL savfile formats
3. the NASA DAAC (see: https://disc.gsfc.nasa.gov/datasets?page=1&source=TSIS-1%20SIM)
    a. ASCII

SIM line spread function (LSF) details are now available on the TSIS-1 website:

- http://lasp.colorado.edu/home/tsis/data/ssi-data/

An IDL (Interactive Data Language) reader for the ASCII formatted data is available at:

- http://lasp.colorado.edu/data/tsis/file_readers/read_lasp_ascii_file.pro

V06 change list:

- Reprocessed UV diode degradation corrections utilizing the latest Channel C calibration scans from April 2021. For the VIS and IR diode degradation corrections (312nm – 1050nm) we are continuing with our extrapolation from the Version 5 release. For some wavelength bands we saw slightly increased noise on the ESR Channel C measurements so we have decided to investigate this further and wait until the next version release to include these measurements.
- Improved degradation model for the UV diode (200 – 312 nm) to incorporate an exponential fit instead of doing a piece-wise linear correction. This reduces day-to-day noise, especially at the shortest wavelengths.
- Changed the obstruction-detection algorithm, which uses the FSSB quad diode, from a set of time-dependent constants to a power-law degradation model. The power-law degradation model includes a sun-distance correction and a 3C below nominal temperature allowance. This new algorithm improves the detection of un-planned obstructions. The power-law coefficients will be re-evaluated and adjusted, if needed, with each future data release.
- Implemented a scan-to-scan wavelength alignment algorithm for all diode scans. Some slight wavelength shifts (with the largest shifts on the order of 0.015% at longer wavelengths ranging to ~10 PPM or less at shorter wavelengths.) were present in earlier data releases, generally associated with temperature fluctuations. The new algorithm uses the derivative of scan irradiances to align to a reference spectrum. The most significant improvements from this algorithm are seen in regions of the UV with steep gradients and slight trending over time seen on the IR diode. Due to the lower signal-to-noise of the ESR detector scans (shorter scan times and higher noise), this algorithm is not utilized for the ESR at this time. We are investigating other options for Improving the ESR wavelength alignment in future releases, such as improving the underlying instrument model and/or calibrations.
- Reanalyzed and improved the diode responsivity temperature corrections. These changes mostly affect the edges of the VIS and IR bandpasses at 850 – 1000 nm, where the temperature effects are most significant.
- Improvement to the limb darkening correction resulting in slightly decreased irradiance values on the order of 0.01% - 0.06% with the larger decreases occurring at longer wavelengths.
- The Channel B prism drive thermistor (PDT), which supplies the temperature monitor for Channel B corrections, has begun to report unreliable temperatures. A historical study of the temperatures

reported by the Channel A, B, and C PDTs show a very strong correlation between them. All Channel B prism drive temperatures measured after 2021/02/21 have been replaced in V06 and V05 data as:

- Channel B = (Channel A + Channel C)/2 – 0.007C

Note to the user: Larger than anticipated temperature fluctuations have been observed, mainly during three time periods: Jan. 13–23, & Nov. 09–24, 2019, and Jan. 11–23, 2020. Data during these time periods show, as yet, uncorrected instrumental effects. The temperature excursions during scans tend to be associated with high beta angles. Analysis is ongoing to extend instrument corrections, with associated uncertainties, into these temperature ranges for use in future data releases.

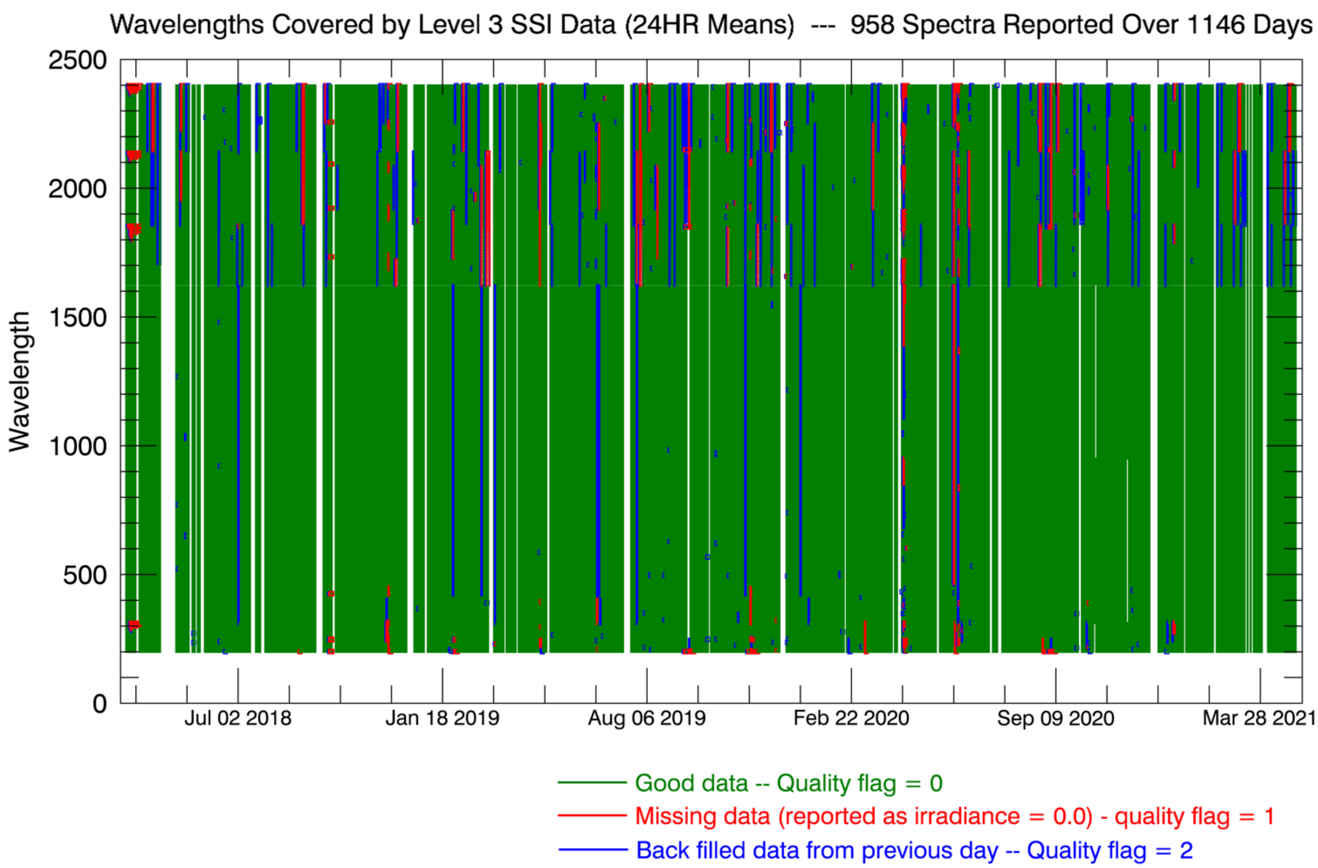
- The temperature effects were primarily observed in ESR secondary channel data. This data is no longer used for creating the degradation models between 400 – 800 nm and 950 – 1050 nm. Therefore, the impact of these temperature excursions have been partially reduced in V06 data.

Table 1 gives a description of the available time and spectral range for TSIS-1 SIM Level-3 (L3) data. Nominally, L3 corrected irradiances have a latency of 25 days to allow for the processing and application of instrument degradation corrections. The data latency is driven by the cadence at which observations on the secondary channel (Channel B), which are used in the degradation correction model, are obtained. This delay may be extended due to scheduling constraints such as ISS operations or periods of high beta angles.

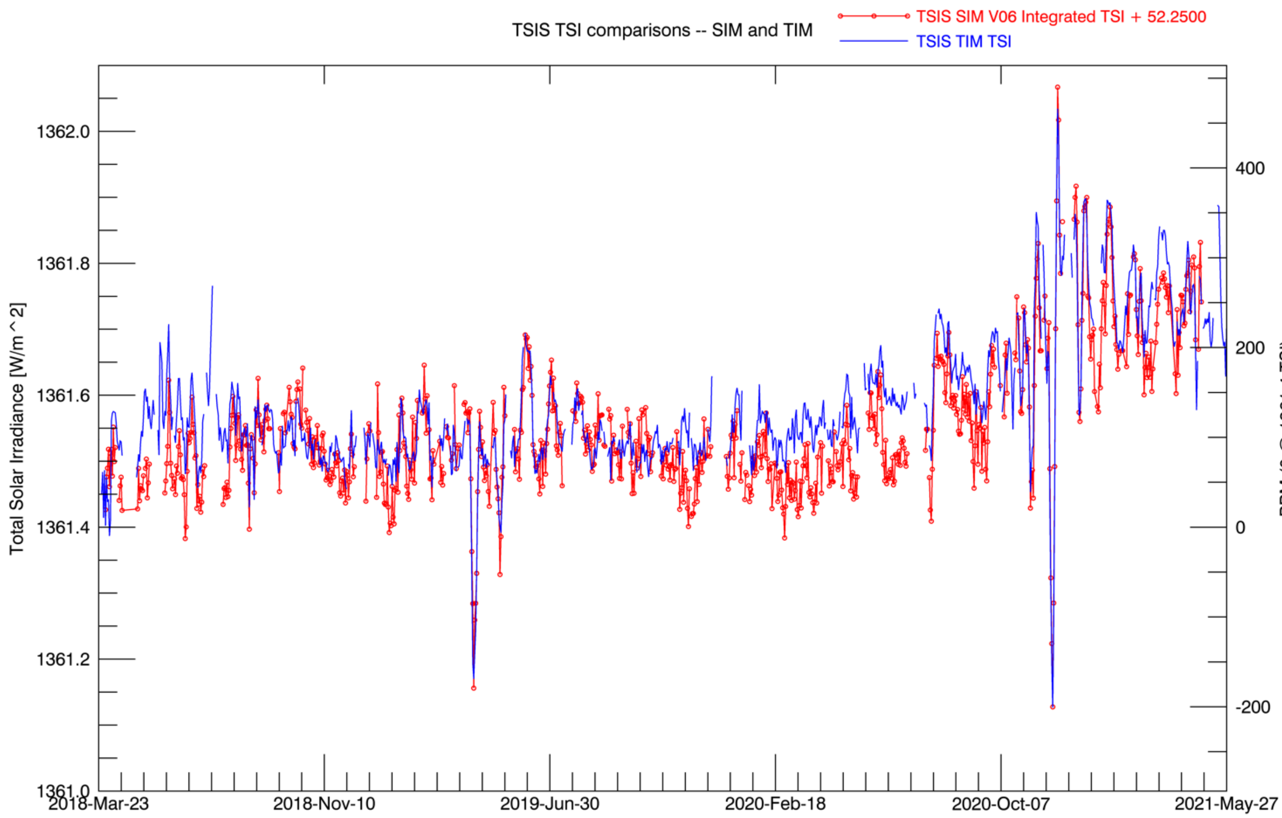
Table 1: Time and spectral range of the dataset.

Time Range	Wavelength Range (nm)
2018/03/14 - present	200 – 2400

Temporal gaps are common in the TSIS-1 SIM data record due to such factors as ISS operational activities (e.g., orbit boost), anomalies (e.g., power outages), and obstructions at extreme beta angles. The ISS obstructions can result in partial or complete loss of spectra for a given day. Early in the mission, spectral gaps also occurred due to instrument planning and operations errors. Figure 1 shows the L3 TSIS-1 SIM 24-hour data acquisition record. Colored points indicate portions of a spectrum that are missing (indicated in the data record with a quality flag = 1), or that have been backfilled from the previous day (quality flag = 2). Backfilling is never done when temporal gaps exceed 1 day.



As of May 4, 2021, the TSIS-1 SIM data are available on 83.6% of days since the beginning of nominal operations on 2018/03/14.



The TSIS-1 SIM TSI in this figure (red) was generated by integrating the reported daily spectrum from 200 – 2400 nm and adding an offset (52.25 W/m^2) to account for bandpasses not measured by SIM. Only complete spectra, with no missing or back filled values, were used. This plot highlights the quality of long-term SIM corrections by comparing the integrated SSI against the TSIS-1 TIM TSI (blue), which has a stability correction uncertainty of ~10 ppm/year. This plot should not be used to evaluate the TSIS-1 SIM absolute calibrations, as the offset (52.25W/m^2) was chosen to match TIM as closely as possible. However, this value is close to the theoretical expected value of ~4% of the TSI that falls outside of SIM's spectral range.

Definition of Uncertainties

Instrument Uncertainty (in Watts/m^2/nm) is a pre-launch measure of instrument spectral irradiance uncertainty with contributions from component and unit-level instrument laboratory characterizations and calibrations with the final end-to-end full spectrum validation of the measured irradiances against a NIST-traceable cryogenic radiometer performed in LASP's Spectral Radiometer Facility. Reported uncertainties represent an upper limit to the calibration accuracy for each spectral band pending the resolution of an additional correction in the polarization dependence of the entrance slit transmission discovered after SIM launch.

Measurement Precision (in Watts/m^2/nm) is derived from a measure of the on-orbit variance in the scan-to-scan repeatability in the observed spectral irradiances. This value is an upper limit of measurement precision.

Measurement Stability (in Watts/m^2/nm) is a relative metric of the overall on-orbit degradation correction uncertainties. It has contributions from uncertainties due to the post-processing of data (including instrument degradation correction) and differences between the observed irradiances of the 3 separate SIM channels. Note: This is reported as 0 after the most recent bi-annual Channel C scans.