

SORCE-SIM Release Notes for Version 26, Level 3 data products (v1.0, 02/07/20)

SORCE-SIM data Version 26 (V26) appears in three locations, on the

- 1) LISIRD website (see: <http://lasp.colorado.edu/lisird/sorce/>),
- 2) SORCE website (see: <http://lasp.colorado.edu/home/sorce/data/>) and
- 3) NASA DAAC (see: https://disc.gsfc.nasa.gov/datasets/SOR3SIMD_026/summary/).

Table 1 below gives a description of available time and wavelength ranges for each location.

Time Range	Wavelength Range (nm)		
	04/14/2003 - present	240 – 2400	300 – 2400
	SORCE	LISIRD	NASA DAAC

Table 1: V26 Time and wavelength ranges for each repository location.

An IDL reader for the ASCII formatted data present on the SORCE web site is available at: http://lasp.colorado.edu/home/sorce/data/lasp.colorado.edu/sorce/file_readers/read_lasp_ascii_file.pro

V26 Calibration Changes:

V26 of SORCE SIM employs the same correction algorithms as V25 with the following changes:

- 1) The database system was moved from Sybase to Oracle. This involved a significant effort in porting all existing JAVA and IDL code.
- 2) A new dark diode DN calculation was implemented in the Level 0 → Level 1 processing pipeline (uncorrected irradiance).
 - a. The V25 dark values were interpolated from darks taken immediately before and after a scan. These values were NOT written into the database, preventing direct verification of the darks used in processing.
 - b. V26 processing takes all darks on a single day and interpolates for a specific scan. This provides a larger and higher-resolution dataset for more precise interpolation. The interpolated dark values are written into the Oracle database during processing. This provides a complete dataset of both the measured and interpolated darks. Figure 1 below compares the V25 (red), V26 (blue), and high-res (grey) dark values.

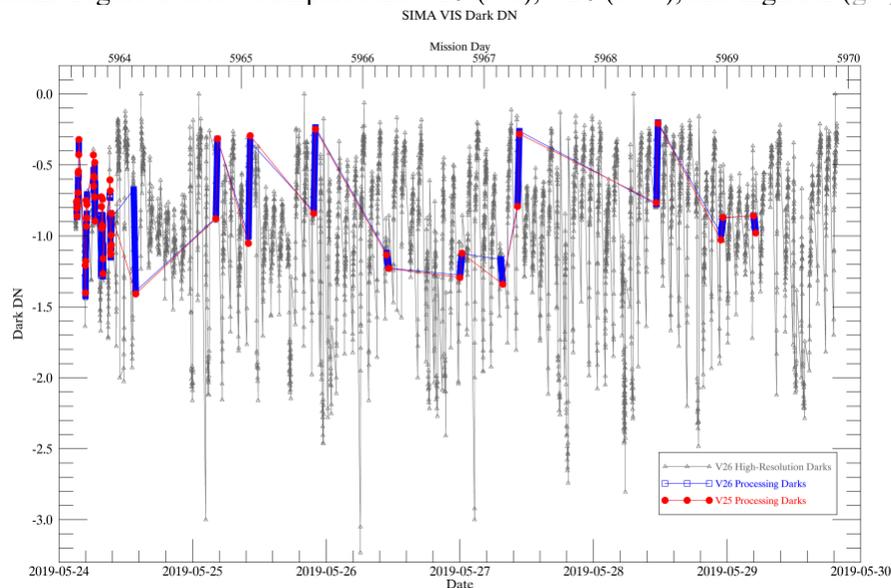


Figure 1: SIMA VIS V25 (red) vs V26 (blue) dark DN values vs Time. V26 values were derived using all available data (grey), while the V25 processing only used data immediately before and after the scan. Calendar date is given on the bottom axis, and SORCE mission day (SD) is given on the top axis.

3) V26 CCD shifts.

- a. CCD shifts are now filtered so that zero-valued and un-physical CCD shifts (values outside of the range: $-250 < \text{CCD shifts} < 250$) are now excluded from being inserted into the database. This prevents those values from being used during processing. As in V25, when a CCD position is not available for a particular scan, the last valid CCD position is used during processing.
- b. The V26 SIMB CCD shift algorithm now uses unsmoothed values for all time periods. SIMA CCD shift values are unsmoothed after 03/28/2019; SORCE Day (SD) 5907. Figure 2 shows a comparison of the VISB CCD shifts at 398nm; V25 (red) & V26 (blue). Figure 3 shows the effects of the new CCD shifts on VISB irradiance. The CCD shift correction is applied at Level 0 \rightarrow Level 1 processing (uncorrected irradiance).
- c. CCD shifts that were smoothed in V25 used a “last 18” smoothing. For the IR, this produced a situation where the smoothed CCD shifts were not a good representation of the actual CCD shifts. This can be seen in Figure 4 from 2014—2019.

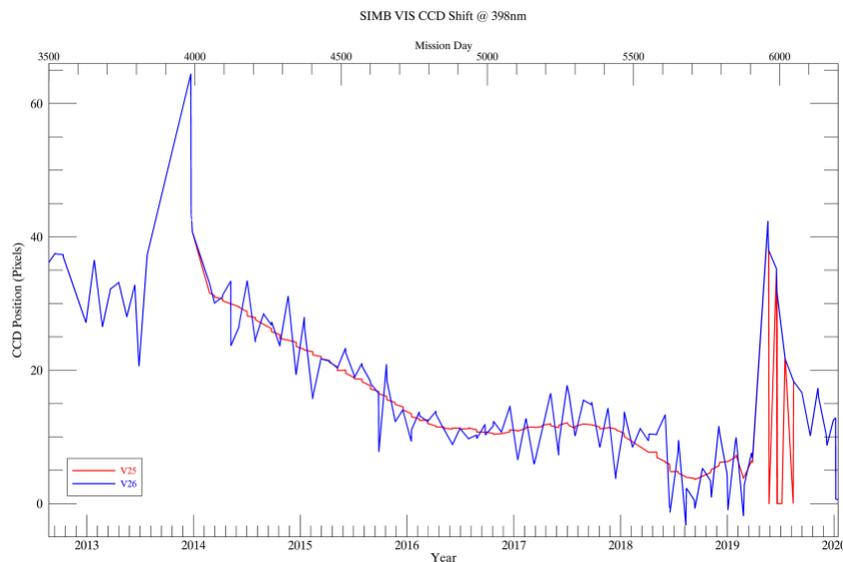


Figure 2: VISB CCD shifts (398 nm) used in V25 (red) is shown versus the un-smoothed V26 CCD shifts (blue). The V25 CCD shifts used a smoothing algorithm that was not used for V26. See Figure 3 for the effects on irradiance.

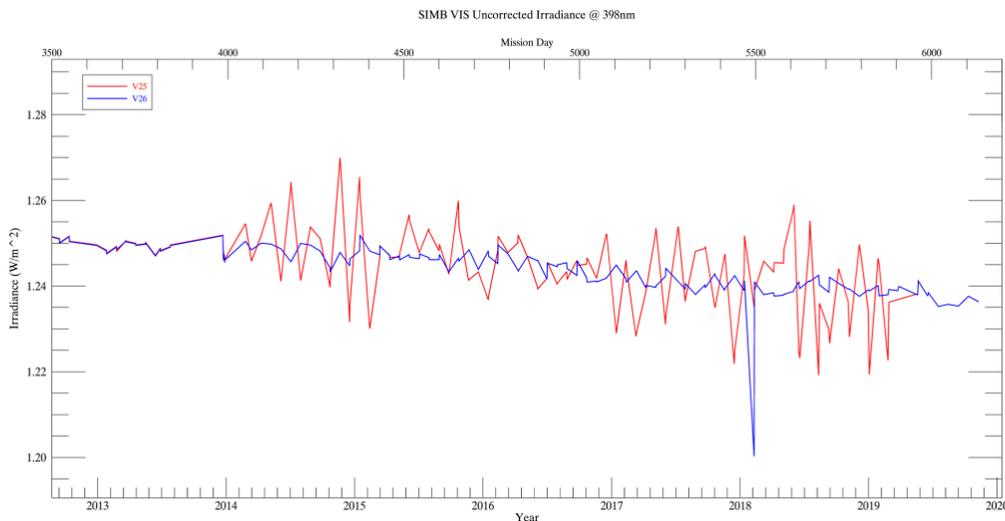


Figure 2: The V25 VISB irradiance (red) is shown versus the V26 VISB irradiance (blue). Note the greatly reduced noise when using the non-smoothed V26 CCD shifts (see Figure 2).

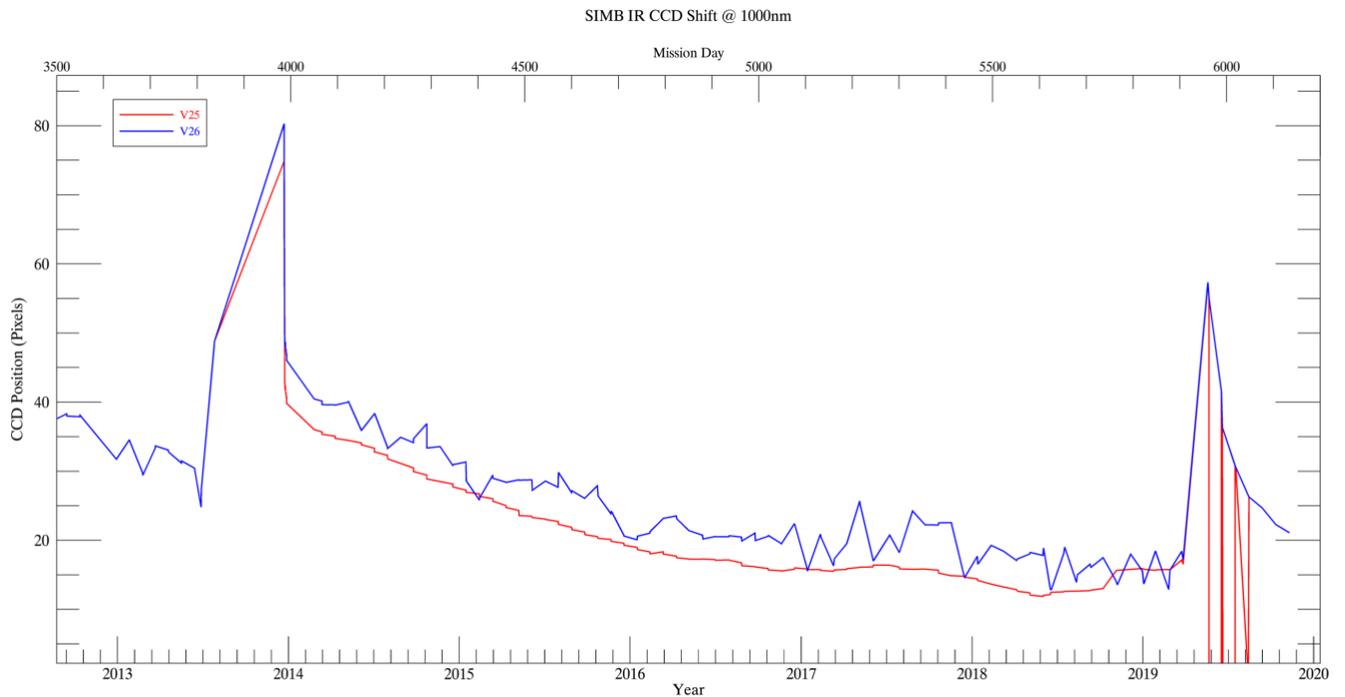


Figure 3: SIMB VIS CCD shifts (1000 nm) used in V25 (red), versus the un-smoothed V26 CCD shifts (blue). See 4c) V26 CCD shifts (above) for additional comments.

4) Degradation Column:

- a. The degradation column in the UV/VIS overlap (306—310 nm) has been modified for V26 to use SIMB data at 306—310nm. In some cases, the SIMB data showed signs of saturation and was excluded. In V25, the degradation column in this region simply used the degradation value at 306 nm for the UV range of 306—310 nm.
- b. The degradation column used for V26 retained the same algorithm as the V25 degradation column (see [SORCE SIM V25 Internal Release Notes](#)). However, the use of SIMB uncorrected irradiance made with unsmoothed CCD shifts changed the calculated value of the f-function in both the VIS and UV diodes, which in turn changed the calculated values of the degradation columns. Because the SIMB uncorrected irradiance now has less noise, the comparison to SIMA uncorrected irradiance yields an f-function that is not as noisy as the V25 f-function. Figures 5 and 6 compare the V25 and V26 f-functions at 240 and 748 nm, respectively.
 - i. The smoothing near the edge was modified to use the /edge_truncate option in the IDL smooth command, instead of /edge_mirror. This produces more realistic values near the edges. This can be seen on the left edge of Figure 5.

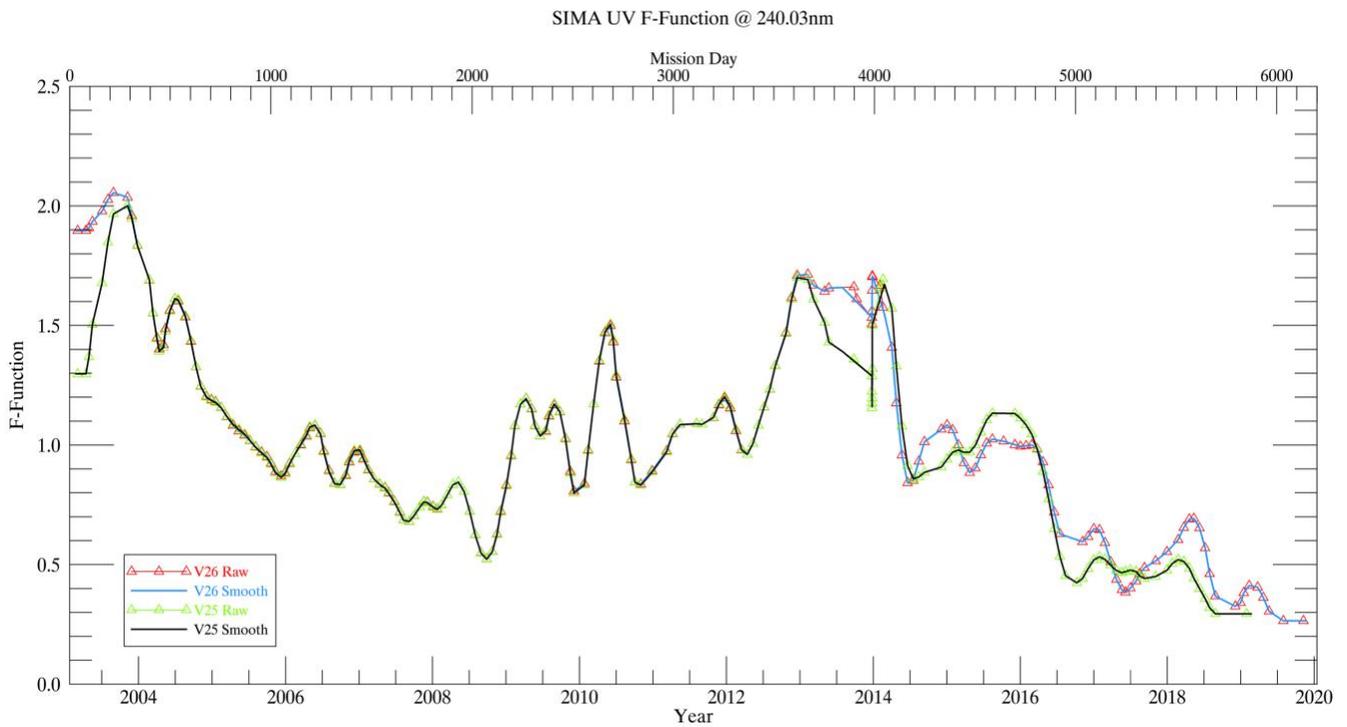


Figure 4: The SIMA UV V25 raw (green) and smoothed (black) f-function values versus time are compared to the V26 raw (red) and smoothed (blue) values at 240 nm. The use of unsmoothed CCD shift values reduces the noise in the V26 uncorrected irradiance and f-function. Note the changes due to improved smoothing near Mission Day = 0-200.

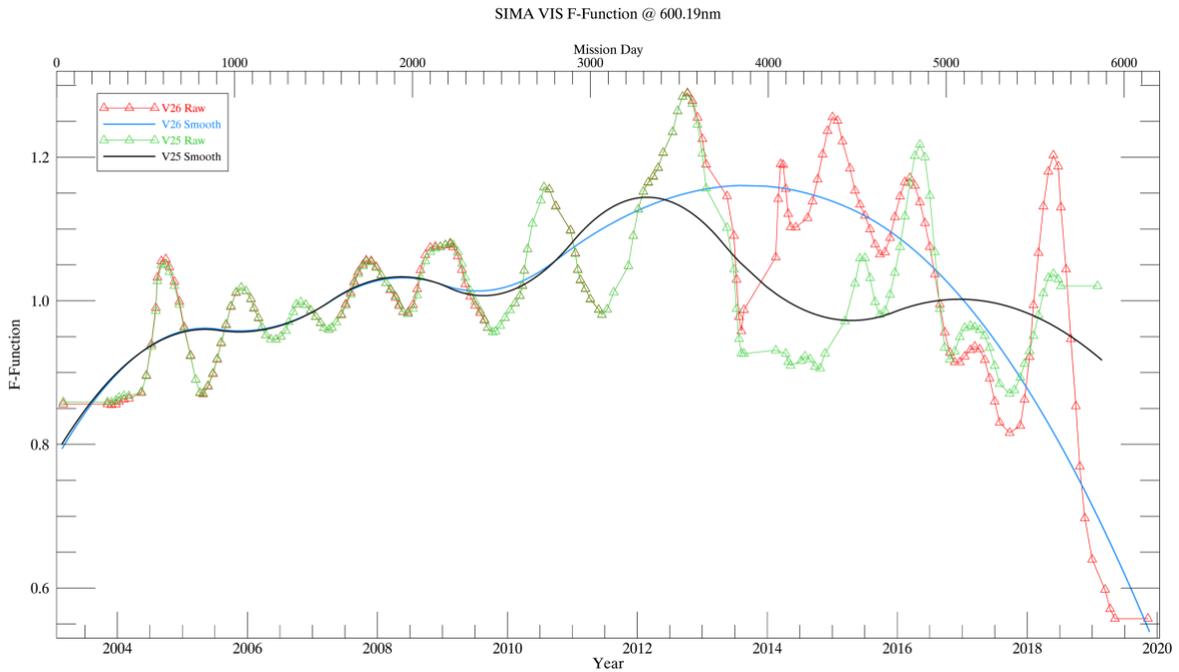


Figure 5: The SIMA UV V25 raw (green) and smoothed (black) f-function values versus time are compared to the V26 raw (red) and smoothed (blue) values; at 600 nm. The use of unsmoothed CCD shift values reduces the noise in the V26 uncorrected irradiance and f-function.

- 5) The VIS diode degradation correction for V26 is greatly improved over V25. Figure 7 compares the ESR calibrated irradiance for SD2728 and SD5996 for SIMA and SIMB. Figure 8 compares the V25 and V26 diode degradation rates. The effects on spectral irradiance are shown in Figure 9.
- a. The diode degradation coefficients used in V25 were a direct copy of the V24 diode degradation coefficients. The V24 coefficients were calculated using ESR full scan data from before SD3000. This provided non-optimal results as the applied diode degradation correction was extrapolated ~10 additional years. During this time (~3000 days), the ESR has remained remarkably stable (see Figure 7).

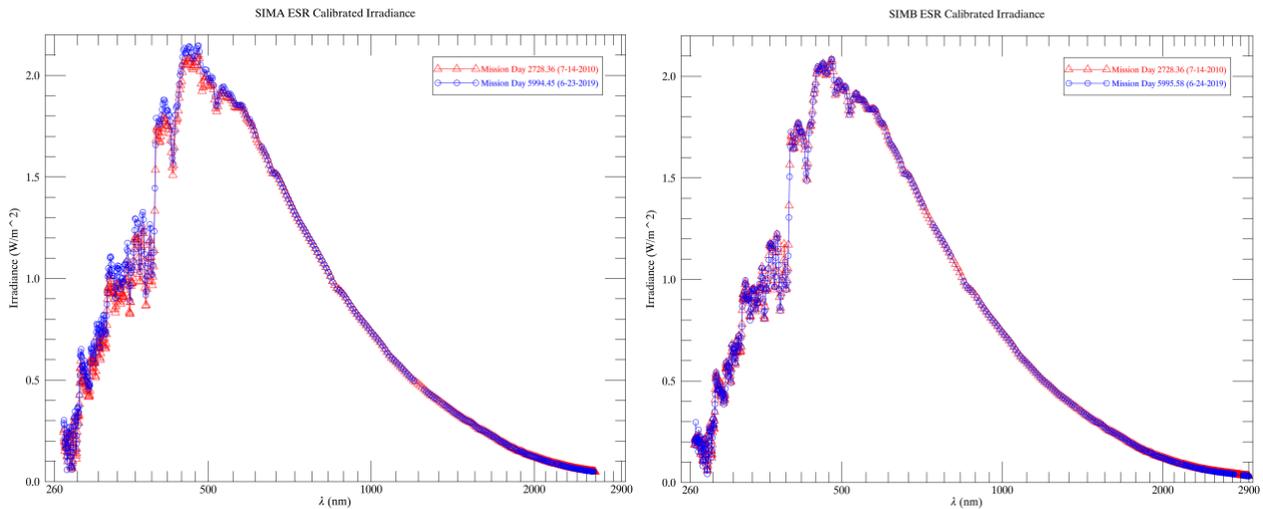


Figure 6: ESRA (left) and ESRB (right) comparisons of uncorrected irradiance for SD2728 (7-14-2010, red) and SD5996 (6-24-2019, blue). The stable nature of the ESR allows it to be used as an irradiance standard for calculating the VIS diode degradation in V26.

- b. The V26 degradation is determined by comparing irradiance from the VIS diode to recent ESRA/B full scans. ESRA/B full scans were taken in December 2018, and ESRA/B full scans were taken in June 2019. Both sets were taken at the short-eclipse points of the SORCE orbital path. Prior to these full scans, the last ESRA full scan was taken in February 2011 and the last ESRB full scan was taken in July 2010. With the new data, new degradation coefficients were calculated for the entire mission.
- c. The V26 degradation differs from V25 most significantly in the DO-Op time period at wavelengths > 500nm. When applied to the irradiance, the new degradation significantly improves the trend of the irradiance at long VIS wavelengths when compared to V25.

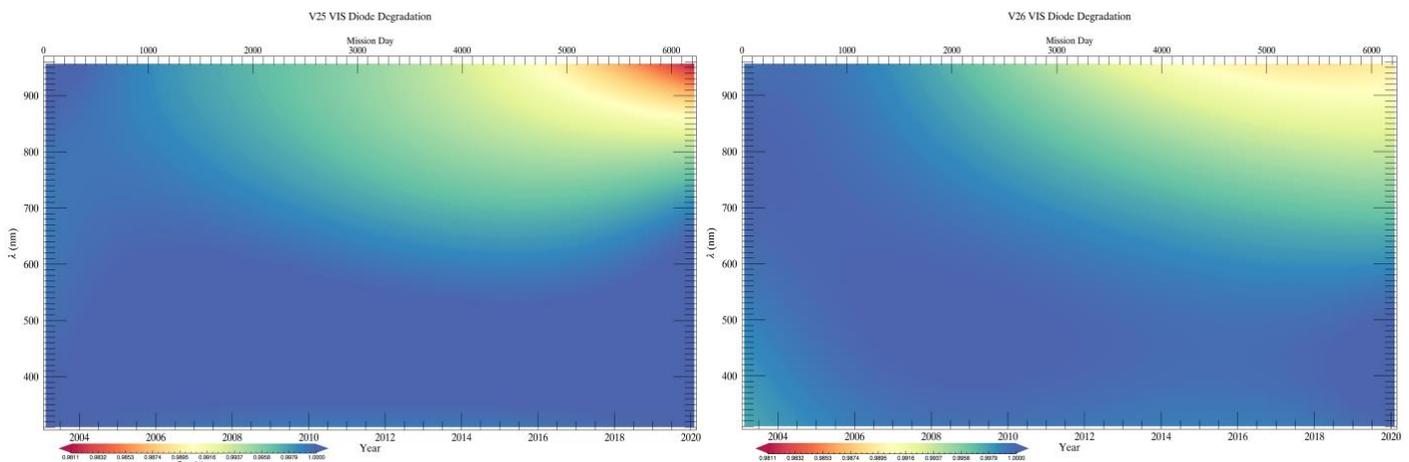


Figure 7: V25 (left) and V26 (right) contour surface of diode degradation vs. wavelength vs. time. The units are total diode degradation at the time and wavelength indicated. For example, on Jan. 1, 2020, the V25 degradation at 950 nm (upper right) is 0.9811, or a 1.89% decrease in sensitivity, while for V26 the degradation is 0.9916 (0.84%).

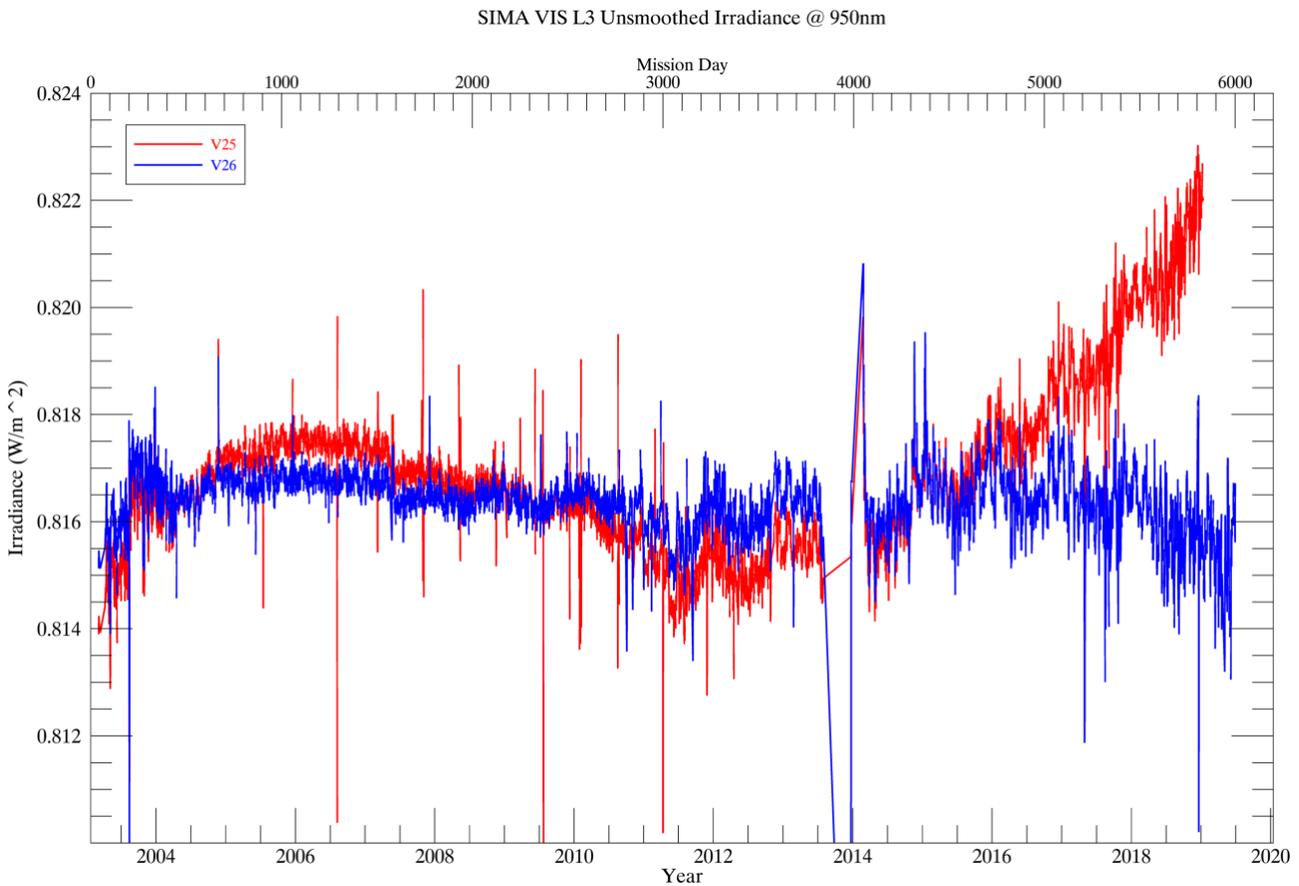
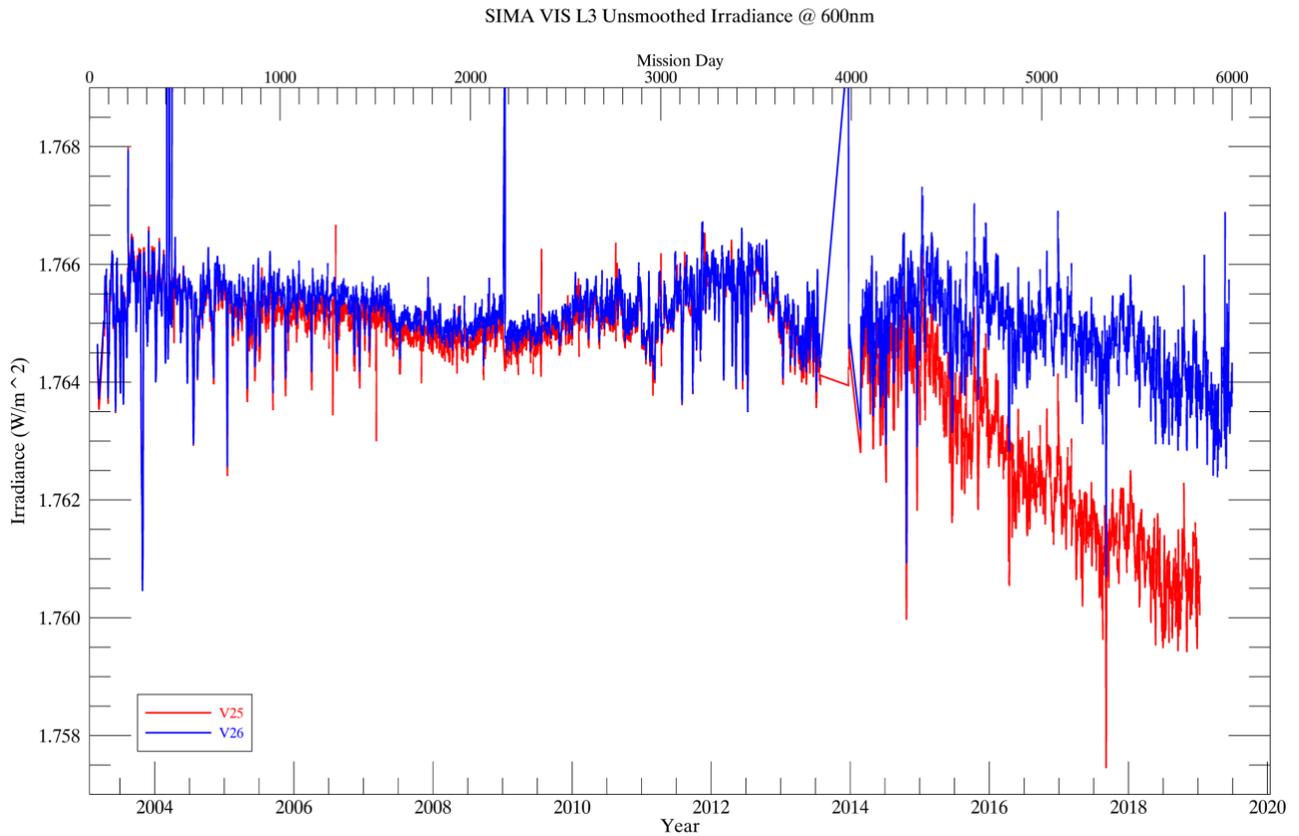


Figure 8: SIMA VIS V25 (red) and V26 (blue) Level 3 (L3) irradiance vs. time at 600nm (top) and 950nm (bottom). Year is given on the lower axis, and Sorce Mission Day (SD) is given on the top axis. As can be seen, the V26 VIS diode degradation improvements fix obviously erroneous trends in the V25 data.

- 6) Three new On-board Computer (OBC) “Jump” corrections were included in V26 to account for spacecraft temperature excursions at SD5915, SD5945, and SD6004. One V25 jump correction boundary was moved from SD5555 to SD5545 (typo in calibration file). The net effect of the jump corrections, in terms of integrated Solar Spectral Irradiance (SSI), are given in Figure 10.

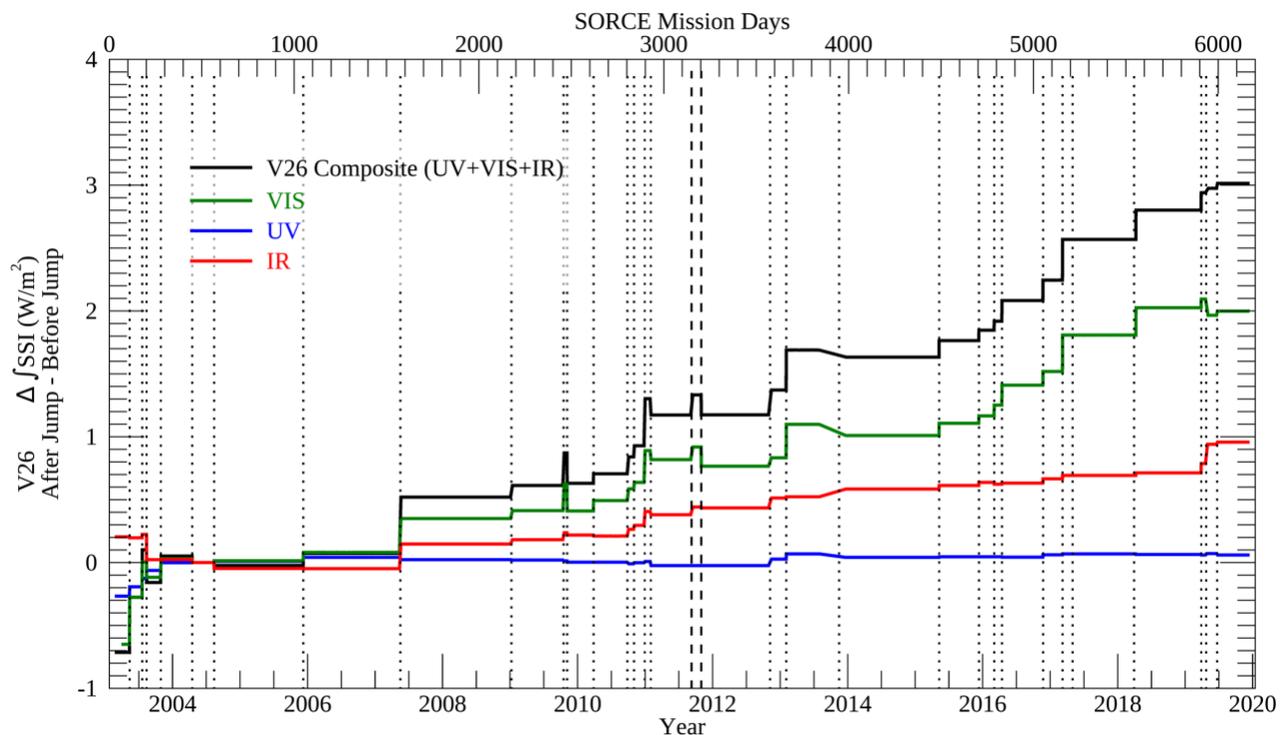


Figure 9: Cumulative “Jump” corrections for each SIMA diode (and a composite) showing the integrated SSI V26 irradiance adjustments as a function of SORCE mission day (SD) and calendar year. Vertical lines show the timestamp where an individual OBC/jump correction is applied.

- 7) New Alephs were calculated for all modes. This flux calibration step is performed for each release and converts from corrected to calibrated irradiance.
- a. Due to diode degradation improvements, the V26 VISA aleph shows the most change from V25. These alephs are shown in Figure 11.

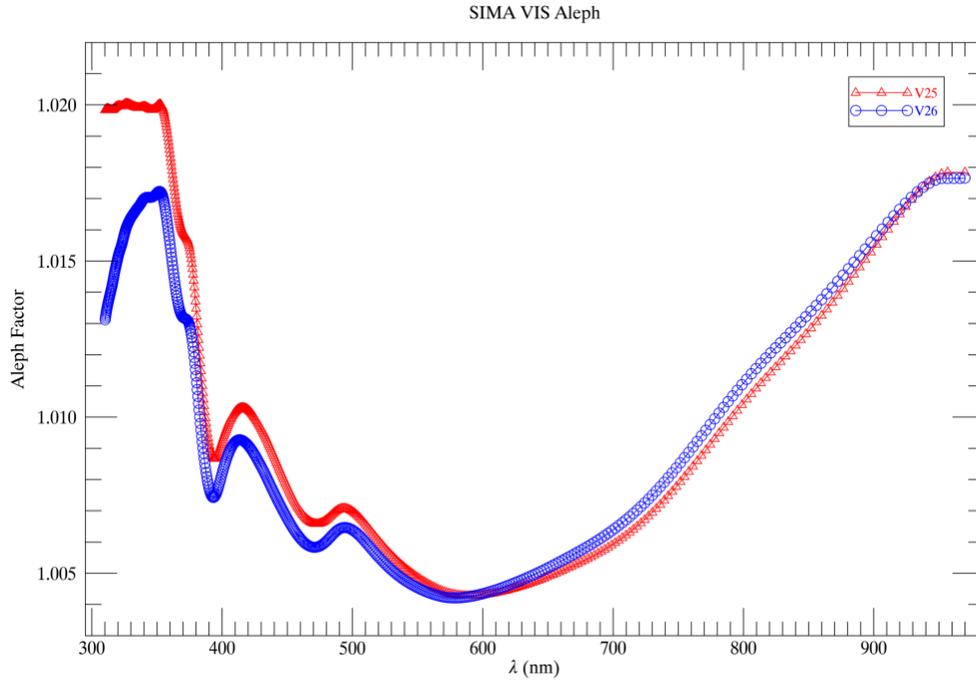


Figure 10: V25 (red) and V26 (blue) VIS-A Aleph corrections.

- b. For V26, the UV alephs were modified in the 306--310 nm range differently than in V25. For V25, the UV aleph for this wavelength range was set to the 306nm value. For V26, the aleph in this range is a linear connection from the 306nm value to the value that forces the UV irradiance to match the VIS irradiance at 310nm. Figure 12 shows the results of this calibration.

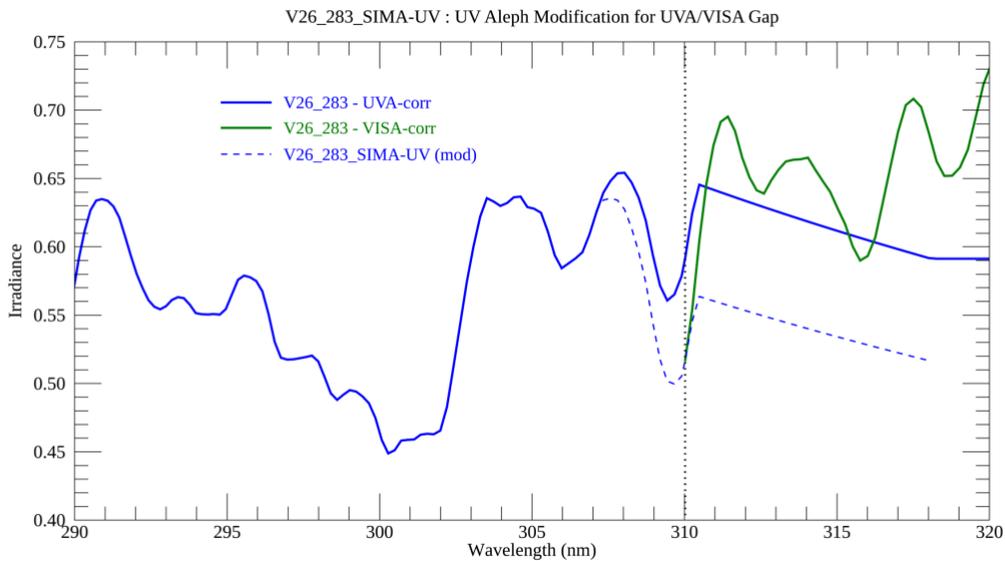
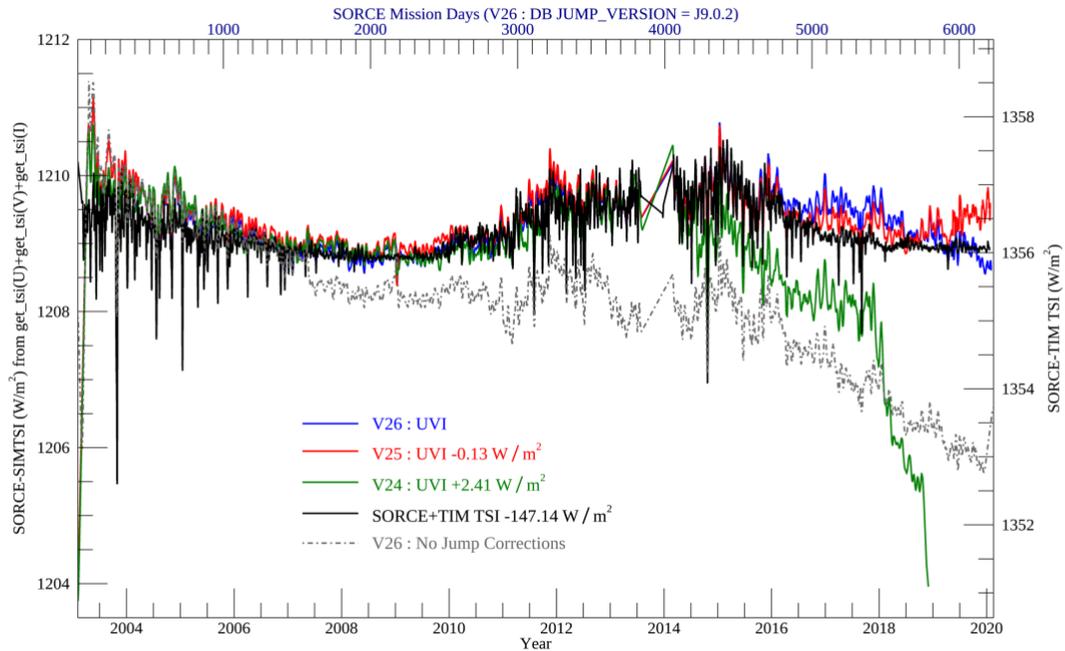


Figure 11: The solid lines show the V26 UV-A (blue) and VIS-A (green) irradiance of our internal test version 283. As shown, the UV irradiance in this test version does not match the VIS irradiance at 310nm. The V26 UVA aleph was updated to ensure an irradiance match between the UV and VIS channels, this is shown in the blue dashed line

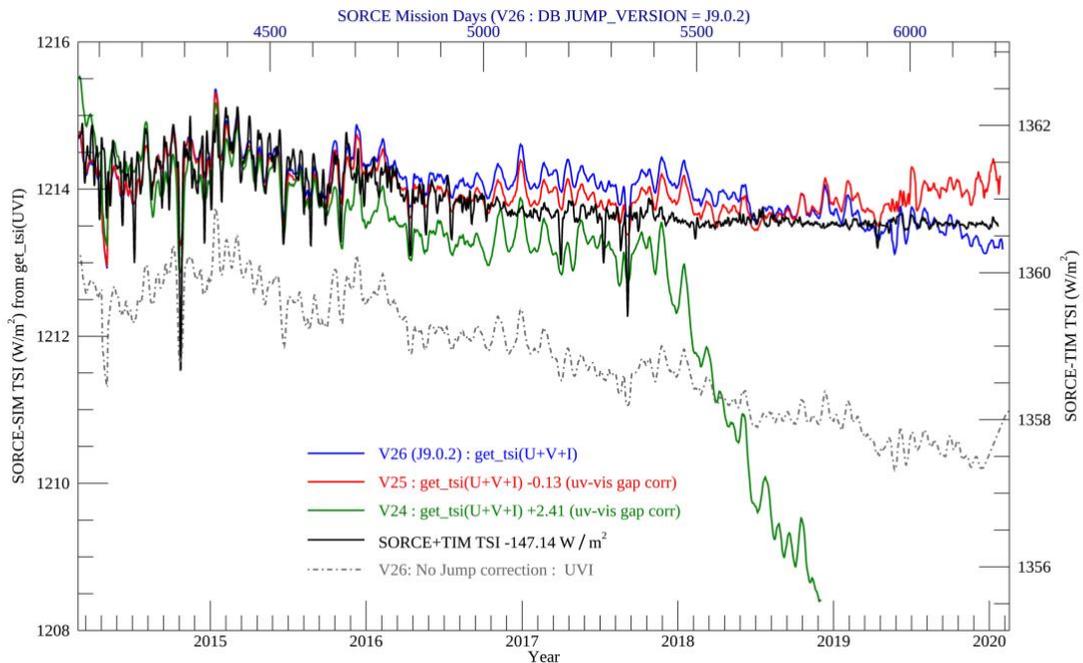
Comparisons of *SORCE-SIM* V24, V25, & V26 integrated SSI (iSSI) and *SORCE-TIM* V18 TSI are given in Figure-13, and 14.

- For display purposes, 147.14 W/m² has been subtracted from the TIM TSI to account for the different bandpasses. The original TIM scale is on the right axis.
 - This offset was calculated during the solar minimum defined as SD 2000 ± 250 days.
- Due to the inclusion of the 306—310 nm band in the UV starting with V25, V24 has an additional offset of +2.41 W/m²; while V25 is offset from V26 in the UV iSSI by -0.13 W/m².



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Figure 12: SIM V24 (green), V25 (red) and V26 (blue) integrated Solar Spectral Irradiance (iSSI) vs. *SORCE+TIM* TSI V18 (black) by calendar year and *SORCE* mission day (SD, top). Also shown is the “no jump correction” V26 data (grey). *SORCE-SIM* iSSI is a combination of the UV, VIS & IR channels from 240—1600 nm.



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Figure 13: Same as Figure 13, except only the Day-Only Operations (DO-Op) portion of the *SORCE* mission is shown.

Calibration Algorithm Details:

SORCE-SIM users should consult the V21--V25 version notes for calibration algorithm details at <http://lasp.colorado.edu/home/sorce/instruments/sim/sorce-sim-data-products-release-notes/>.

Full data acquisition records:

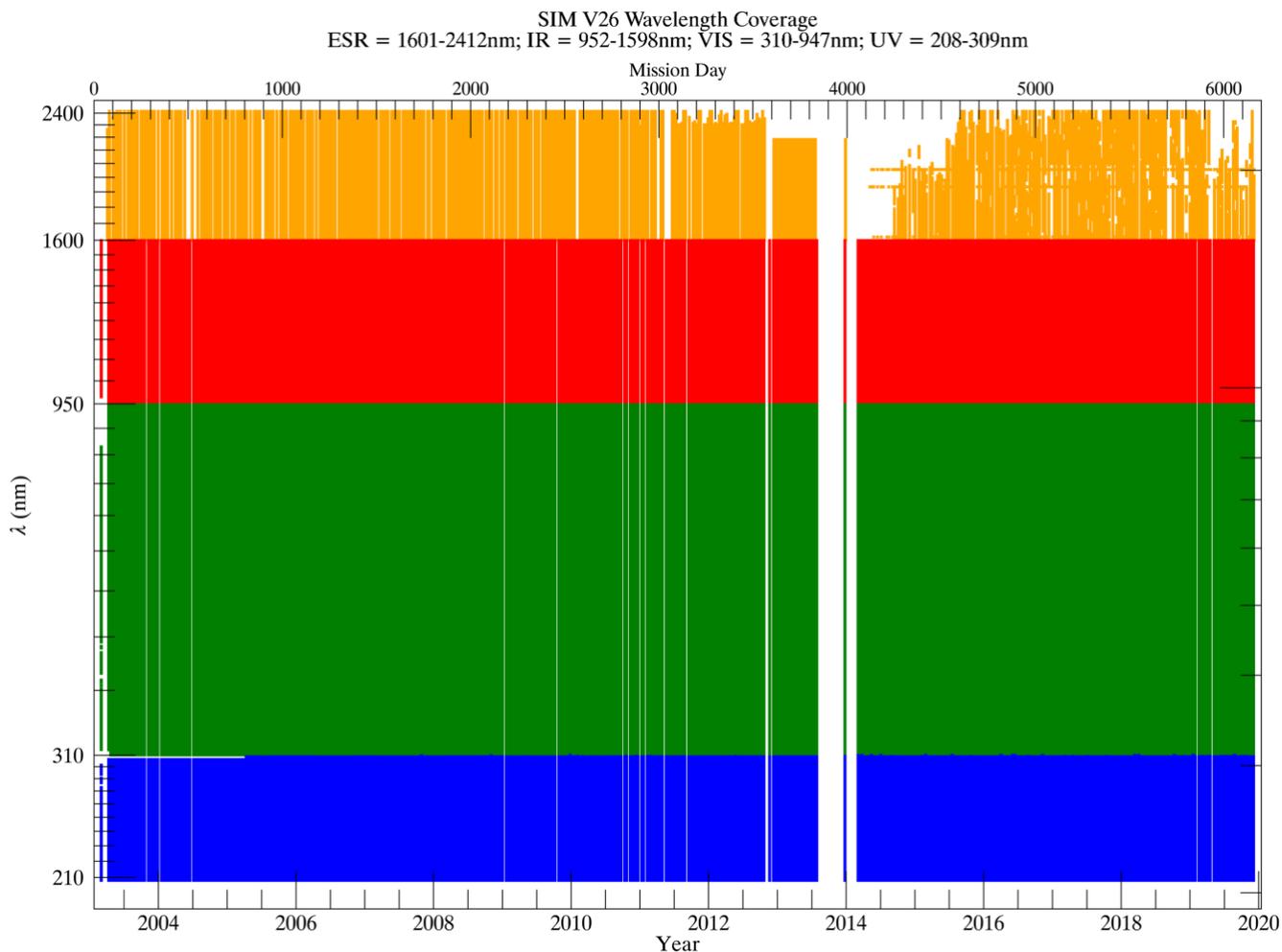


Figure 14: Shows the data acquisition record for all SORCE-SIM-A instrument modes from 01/23/2003, the beginning of the mission (SD0), to 12/07/19 (SD6162). Note the decreased ESR coverage ($1600 < \lambda < 2400$ nm) during the SORCE Day-Only Operations mode (DO-Op), March 12, 2014 (SD4065) – present, and the change in UV wavelength coverage (including 306–310nm) starting on April 4, 2005 (SD800).

Revision History—

1.0: 02/07/2020 – Steven Penton, James Mothersbaugh, Stéphane Béland, and Laura Sandoval

- Initial Draft