# 5.6. Barrow, Alaska (01/13/15 – 11/28/15)

This section describes quality control of solar data recorded at Barrow between 01/13/15 and 11/28/15. A total of 8,303 scans of the SUV-100 spectroradiometer were assigned to the Barrow Volume 25 dataset.

The system was stable during the reporting period, however, the collectors of the SUV-100 and GUV-511 radiometers were not regularly cleaned because of limited operational support. As a consequence, the responsivities of the instruments changed by up to 20% during some periods. Affected data could not be corrected and were not published. A list of missing SUV-100 data is provided in Section 5.6.4. Data from the GUV-511 instrument were not published, however, these data were vital in assuring the quality of SUV-100 measurements.

## 5.6.1. Irradiance Calibration

The site irradiance standards of the reporting period were the lamps M-699, 200W009, and 200W042, which were also used in 2012, 2013, and 2014.

Lamp 200W042 was calibrated in June 2007 at BSI with four 1000-Watt FEL lamps provided by the Central UV Calibration Facility (CUCF) at Boulder. This calibration procedure was complicated by the fact that the irradiance scale of the four FEL lamps refers to the detector-based scale of the National Institute of Standards and Technology established in 2000 (NIST2000; Yoon et al., 2002), whereas all solar data of the NSF UVSIMN refer to the source-based NIST scale from 1990 (NIST1990, Walker et al., 1987). The NIST2000 scale is about 1.3% larger than the NIST1990 scale. Data of certificates issued by CUCF were converted to the NIST1990 scale before the calibration was transferred to the site standard.

Lamps M-699 and 200W009 were originally calibrated by Optronic Laboratories (OL) in March 2001. Both lamps were brought to San Diego in 2007 and recalibrated against lamps 200W028 and 200W022. (Lamp 200W028 was the San Diego site standard at this time; lamp 200W022 is BSI's long-term standard, which preserves the OL scale from March 2001.)

The three lamps were compared with the traveling standard 200W017 in June 2013. At this time, the calibrations of lamps 200W009 and 200W042 agreed to within ±1.0% with that of the traveling standard. The difference between the calibrations of lamp M-699 and the travelling standard was slightly worse but still within the range of the uncertainty of calibration standards.

Comparisons of the three on-site lamps with each other performed during 2014 suggested that the calibration of lamp 200W009 has drifted and that this lamp is no longer burning stable. Analysis of absolute scans performed during 2015 confirmed that the lamp is now unstable. The calibration of solar data from the 2015 is therefore based on measurements of lamps M-699 and 200W042 only.

Figure 5.6.1 shows a comparison of the three on-site standards performed on 8/5/15. At this time, the scales of spectral irradiance of lamps M-699 and 200W042 agreed to within ±0.5% while that of lamp 200W009 is low by 2-3%.

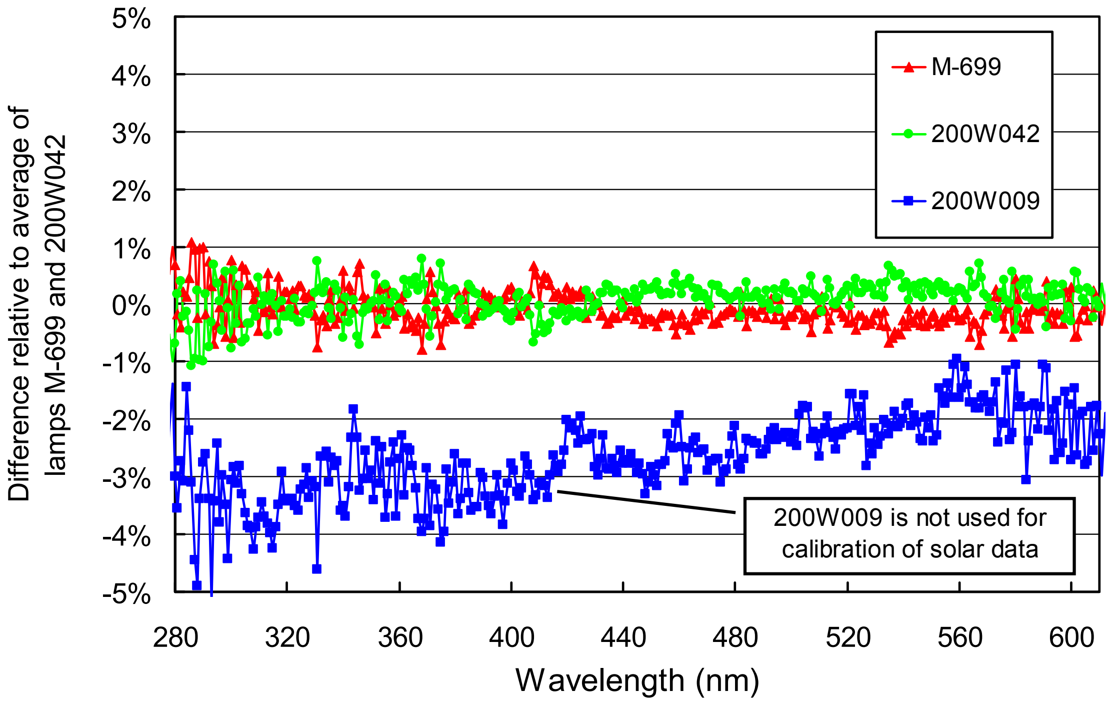


**Figure 5.6.1.** *Comparison of on-site lamps M-699, 200W042, and 200W009 on 8/5/15.*

### 5.6.2. Instrument Stability and Calibration

The radiometric stability of the SUV-100 spectroradiometer was monitored with calibrations utilizing the two "good" site irradiance standards, daily "response" scans of the internal lamp, by comparison with measurements of the GUV-511 multifilter radiometer, and by comparisons with results of a radiative transfer model.

The stability of the internal lamp is monitored with the TSI sensor, which is independent from possible monochromator and PMT drifts. By logging the PMT currents at several wavelengths during response scans, changes in monochromator throughput and PMT sensitivity can be detected. Figure 5.6.2 shows changes in TSI readings and PMT currents at 300 and 400 nm that were derived from response scans performed between 1/1/15 and 12/31/15. During this time, the output of the internal lamp as indicated by the TSI sensor decreased by about 2.5%. The PMT currents also show a decreasing trend, although the scatter in the data is larger compared to the TSI measurements. These data indicate that that monochromator and PMT were stable at the ±1% level.

The reporting period was broken down into three calibration periods. Table 5.6.1 provides more information on these periods. Figure 5.6.3 shows the ratios of the irradiance assigned to the internal reference lamp in Periods P1B and P2 relative to that applied in Period P1. Data were smoothed to reduce measurement noise. These data indicate that the through-the-collector sensitivity of the system changed by less than 5% during the reporting period.

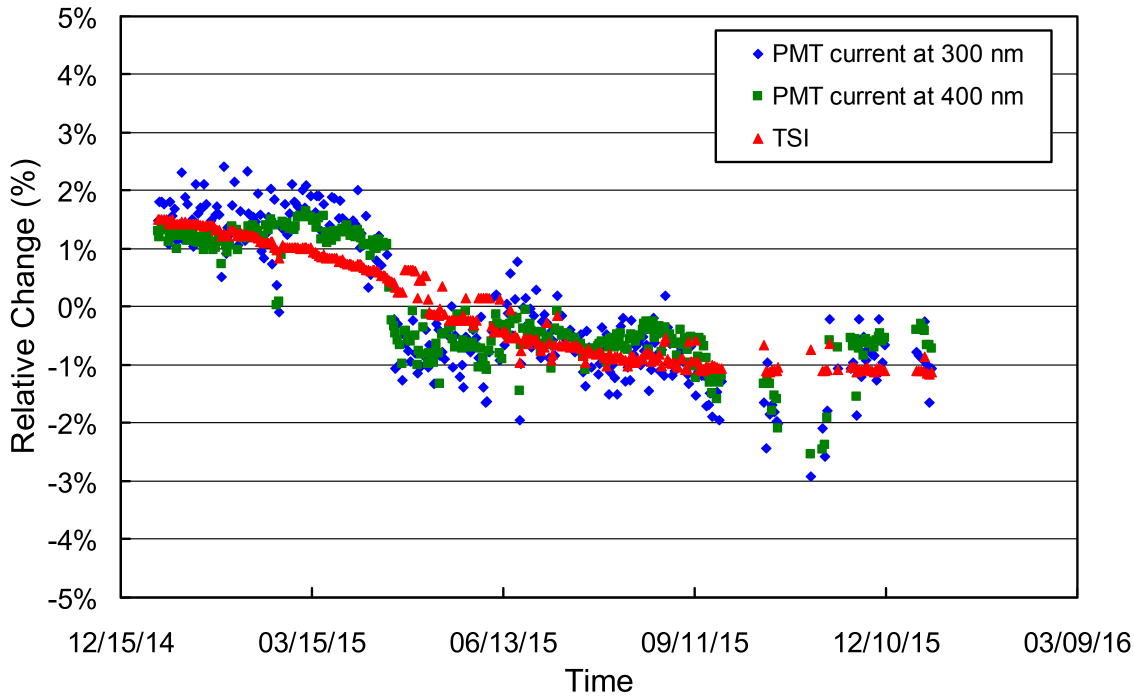


**Figure 5.6.2.** *Time-series of PMT current at 300 and 400 nm, and TSI signal. All data were extracted from measurements of the internal irradiance standard and are normalized to their average.*

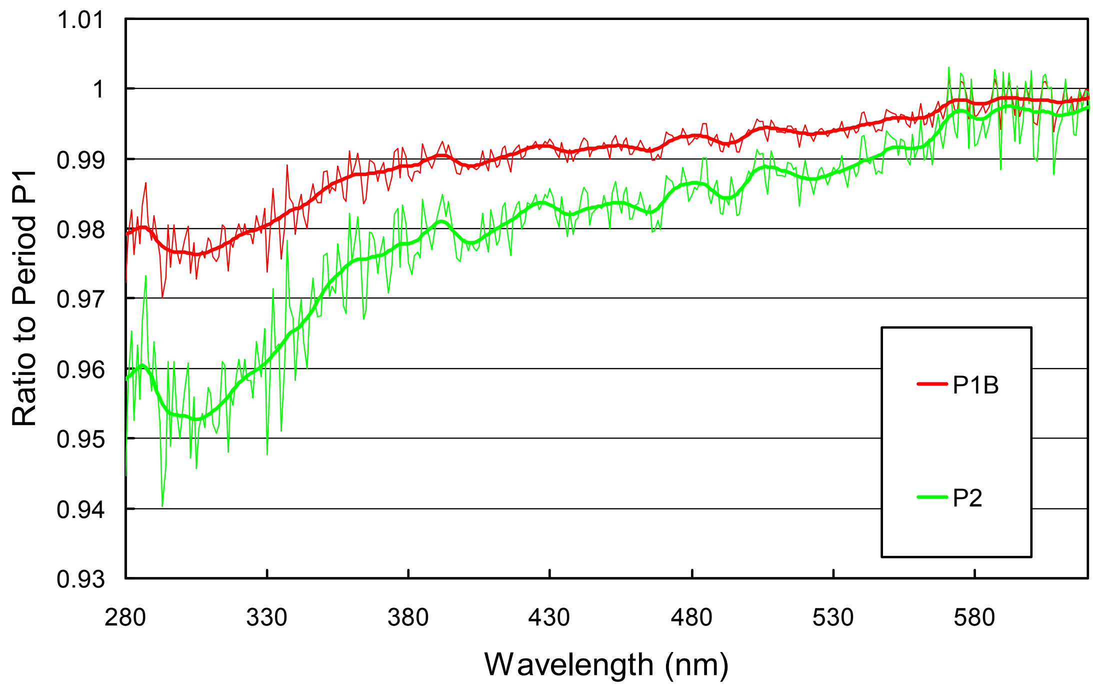


**Figure 5.6.3.** *Ratios of spectral irradiance assigned to the internal reference lamp during the Periods P1B and P2, relative to Period P1. Thin lines indicate raw data while heavy lines indicate smoothed data that were used for the calibration of solar data.*

**Table 5.6.1. Calibration periods for Barrow Volumes 25.**

| Period name | Period range | Number of absolute scans | Remarks |
|---|---|---|---|
| P1 | 01/01/15 – 08/31/15 | 9 | |
| P1B | 09/01/15 – 10/20/15 | 0 | Average of Periods P1 and P2 |
| P2 | 10/21/15 – 12/31/15 | 1 | |

SUV-100 data were also compared to measurements of the collocated GUV-511 radiometer. The ratio of GUV and SUV data at 340 nm as a function of time is shown in Figure 5.6.4. The ratio shows large deviations from one of up to 20%, particular in July and August. These deviations were caused by different levels of soiling of the instruments' collectors. Data affected by soiling were not published and are indicated in blue. Data that were published are indicated in red.

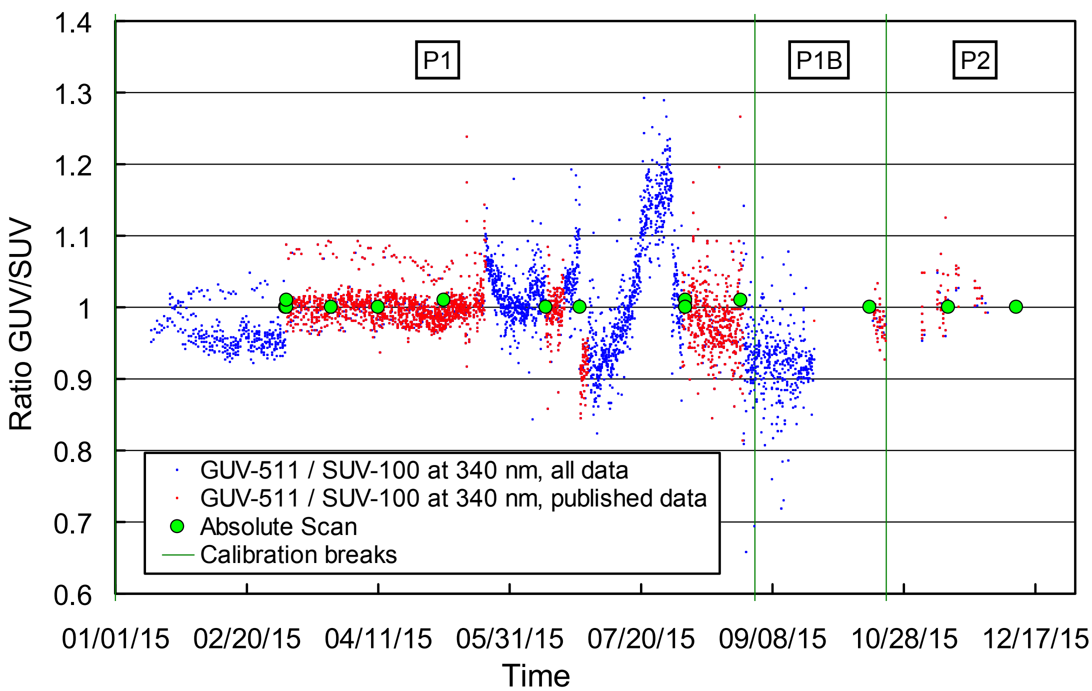


**Figure 5.6.4.** *Ratio of GUV-511 measurements of the 340-nm channel to SUV-100 measurements. The latter were weighted with the spectral response function of the 340-nm GUV-511 channel. Times of absolute scans and calibration breaks are also indicated. Only data from periods indicated by red symbols were published.*

As a last check of data quality, SUV-100 measurements were compared with radiative transfer calculations. These calculations are part of Version 2 processing (uv.biospherical.com/ NSF/Version2/). The ratio of measured and modeled data from the periods unaffected by soiling was generally within the range observed in past years.

### 5.6.3. Wavelength Calibration

Wavelength stability of the system was monitored with the internal mercury lamp. Information from the daily wavelength scans was used to homogenize the data set by correcting day-to-day fluctuations in the wavelength offset. Figure 5.6.5 shows the differences in the wavelength offset of the 296.73 nm mercury line between two consecutive wavelength scans. A total 303 pairs, measured between 1/1/15 and 12/31/15, were evaluated. The change in offset was smaller than ±0.055 nm in 99% of all cases.
The function used to correct the non-linearity of the monochromator's wavelength drive is shown in Figure 5.6.6. It was calculated with the Version 2 Fraunhofer line correlation method (*Bernhard et al*., 2004). Data were corrected with these functions and tested again with the correlation method. Results for four wavelengths in the UV and one in the visible are shown in Figure 5.6.7. Residual shifts in the UV are typically smaller than ±0.05 nm. The average standard deviation for all wavelengths between 310 and 590 nm is 0.039 nm. The wavelength accuracy of the Version 2 data set is slightly better.

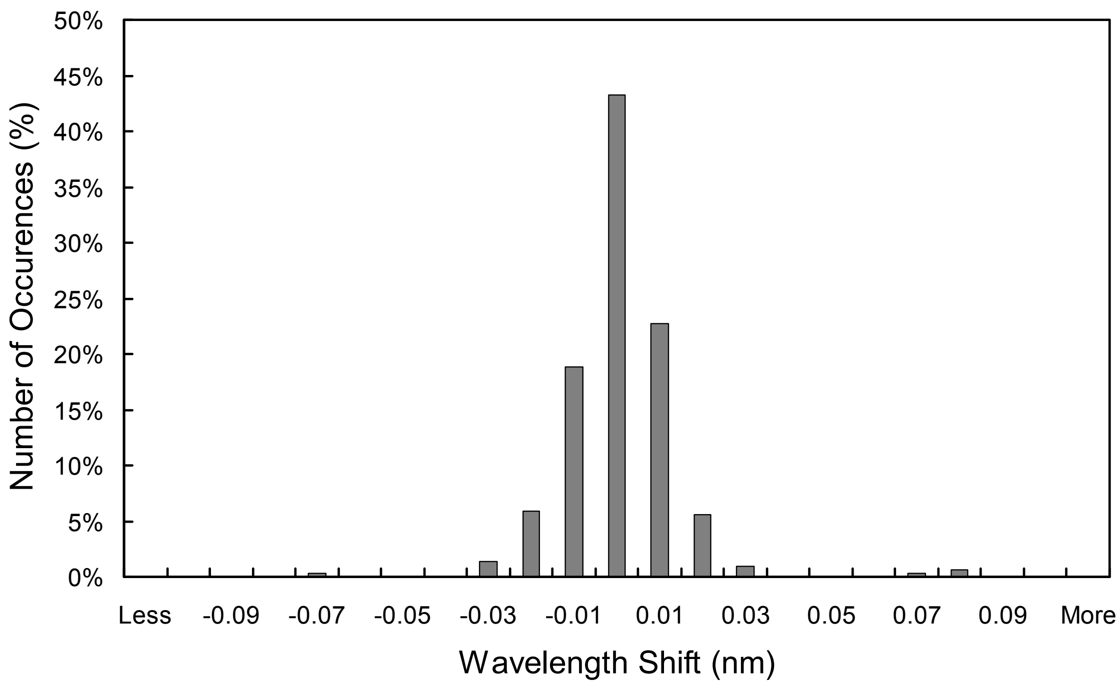


**Figure 5.6.5.** *Differences in the measured position of the 296.73 nm mercury line between consecutive wavelength scans. The x-labels give the center wavelength shift for each column. Thus the 0-nm histogram column covers the range -0.005 to +0.005 nm. "Less" means shifts smaller than –0.105 nm; "more" means shifts larger than 0.105 nm.*

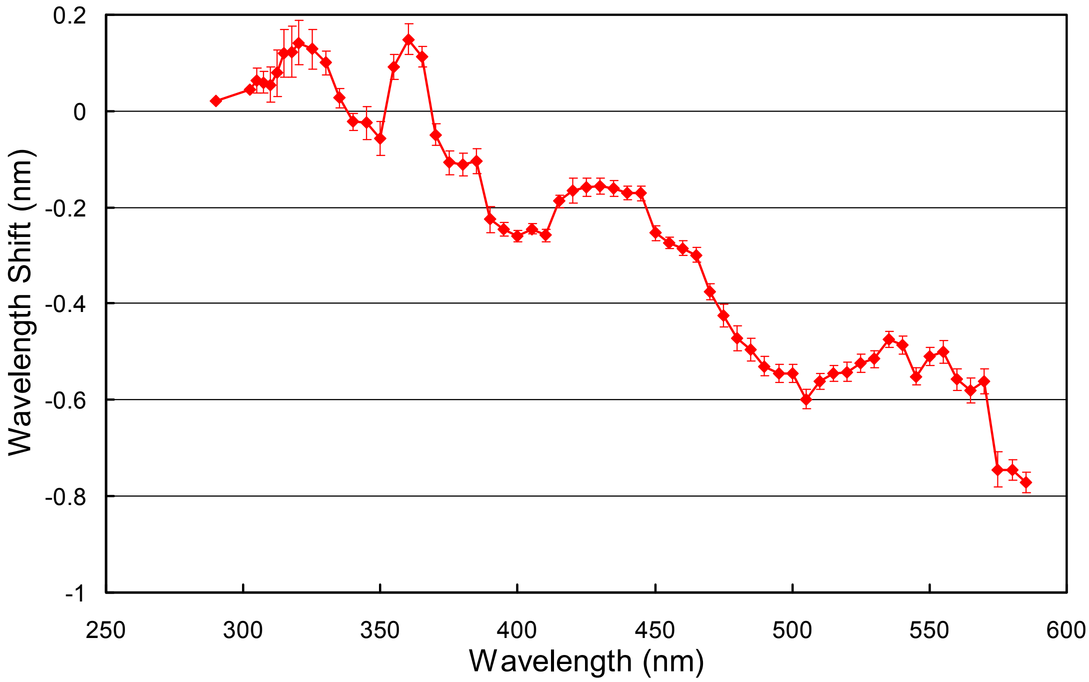


**Figure 5.6.6.** *Monochromator non-linearity correction function for Barrow Volume 25. Error bars indicate the standard deviation of the data contributing to this plot.*

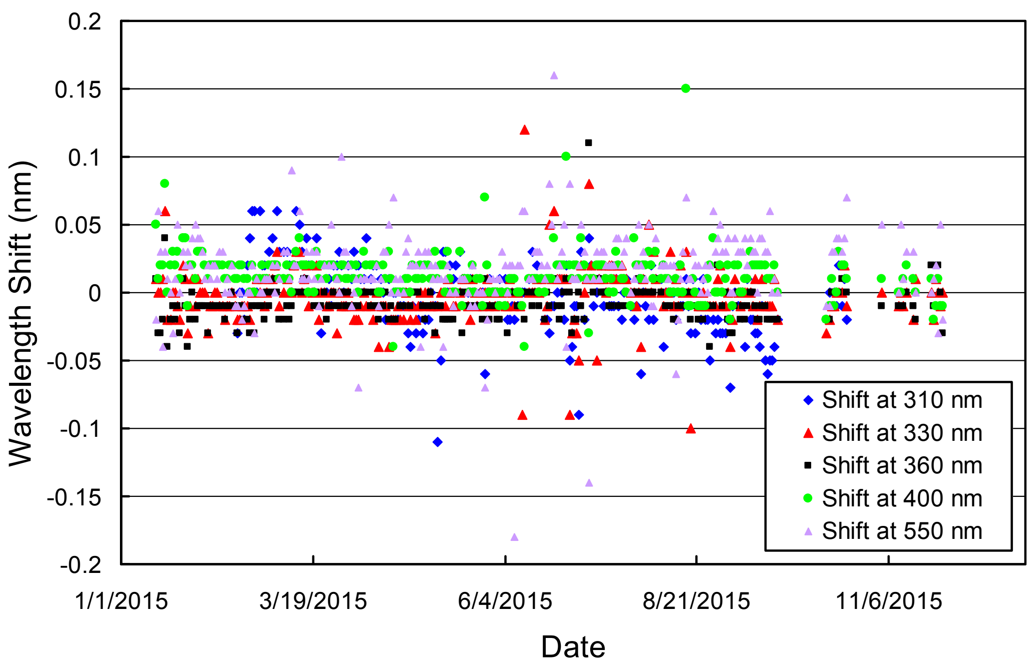


**Figure 5.6.7.** *Wavelength accuracy check of final data at four wavelengths in the UV and one in the visible by means of Fraunhofer-line correlation. The noontime measurement has been evaluated for each day of the reporting period when the Sun was above the horizon. The vertical black line marks the time of the site visit. Note that this graph also includes data from days whose solar data were not published because of collector soiling.*

### 5.6.4. Missing Data

A total of 8,303 scans are part of the Barrow Volume 25 dataset (01/13/15 – 11/28/15). This is only about half the number of scans that is typically published over a one-year period. About half of the scans were not released because of large uncertainties caused by soiling of the instrument's collector. Between September and November, the instrument was not operational for several periods because of lack of funding. Periods that are missing from the Volume 25 dataset are listed in Table 5.6.2.

**Table 5.6.2. Missing data Barrow Volume 25 dataset.**

| Period | Reason |
|---|---|
| 01/21/15 – 03/06/15 | Soiling of collector |
| 05/21/15 – 06/13/15 | Soiling of collector |
| 06/21/15 – 06/26/15 | Soiling of collector |
| 06/27/15 – 08/04/15 | Soiling of collector |
| 08/29/15 – 09/23/15 | Soiling of collector |
| 09/24/15 – 10/11/15 | Instrument not scanning |
| 10/21/15 – 11/02/15 | Instrument not scanning |
| 11/05/15 – 11/09/15 | Instrument not scanning |
| 11/14/15 – 11/15/15 | Instrument not scanning |
| 11/18/15 – 11/21/15 | Instrument not scanning |

## References

Bernhard, G., C. R. Booth, and J. C. Ehramjian. (2004). Version 2 data of the National Science Foundation's Ultraviolet Radiation Monitoring Network: South Pole, J. Geophys. Res., 109, D21207, doi:10.1029/2004JD004937.