2. Palmer Station (08/01/16 – 05/31/17)

This sections describes quality control of solar data recorded at Palmer Station between 08/01/16 and 05/31/17. This period resulted in a total of 16,493 solar scans. The system was inspected and serviced between 03/30/17 and 04/03/17. At this time a Uniblitz shutter was installed. On-site standards of spectral irradiance were compared with traveling standards during this visit. On several days, the system's shutter did not open or close completely, leading to a large changes in responsivity. Affected solar scans were determined by comparing measurements of the SUV-100 spectroradiometer with measurements of the collocated GUV-511 multi-filter radiometer. Approximately 900 solar scans (5% of all scans) had to be removed from the dataset due to this problem. Periods that are affected are listed in Section 2.4.

2.1. Irradiance Calibration

On-site standards

The on-site irradiance standards for the reporting period were the lamps 200W007, M700, M765, 200WN009, and 200WN010. The last two lamps were left at Palmer Station during the March 2014 site visit. It is the intent to run lamp 200WN009 once per year to compare with the other on-site standards. 200WN010 will be run every other year during site visits when all of the station lamps and the traveling standard are compared.

The calibration of lamp 200W007 was established against the former traveling standards 200W017 and 200W038 using absolute scans performed on 5/10/08 ("closing scans" of the Volume 17 period). Lamp M700 was calibrated against lamp 200W007 using scans performed on 9/22/08. Lamp M765 was rotated in its holder sometime between 6/6/11 and 7/4/11 (see Volume 20 report). Since this time, lamp M765 was recalibrated twice against measurements of the site standards 200W007 and M700, namely on 12/17/11 and 9/27/15. The calibration on 9/27/15 was used for processing of solar data of the reporting period.

The "long-term" standards 200WN009, and 200WN010 were calibrated on 12/20/2013 against lamps 200WN001 and 200WN002 using the same procedure as applied to the traveling standard 200WN014 (see below).

Traveling standard traceability

The traveling standard 200WN014 has been calibrated by NOAA/CUCF against lamps 200WN001 and 200WN002 on 1/13/16. Lamps 200WN001 and 200WN002 had in turn been calibrated by Biospherical Instruments in November 2012 against the NIST standard F-616 using a multi-filter transfer radiometer. NIST standard F-616 is traceable to the detector-based scale of irradiance established by NIST in 2000. At the time lamps 200WN001 and 200WN002 were calibrated, they were also compared with the long-term traveling standard 200W017 of the NSF UV monitoring network. The irradiance scales of NIST standard F-616 and lamp 200W017 agreed to within 0.3%. It can therefore be assumed that the change from 200W017 to F-616 as the primary reference for calibrating the SUV-100 instrument at the South Pole did not result in a significant step-change.

The five on-site standard and the traveling standard were compared during the March/April 2017 site visit. Figure 1 shows results for data collected at the end of the visit. Results are referenced against the average of all lamps. The calibrated output of all standards agrees with this reference to better than ±1.0%.

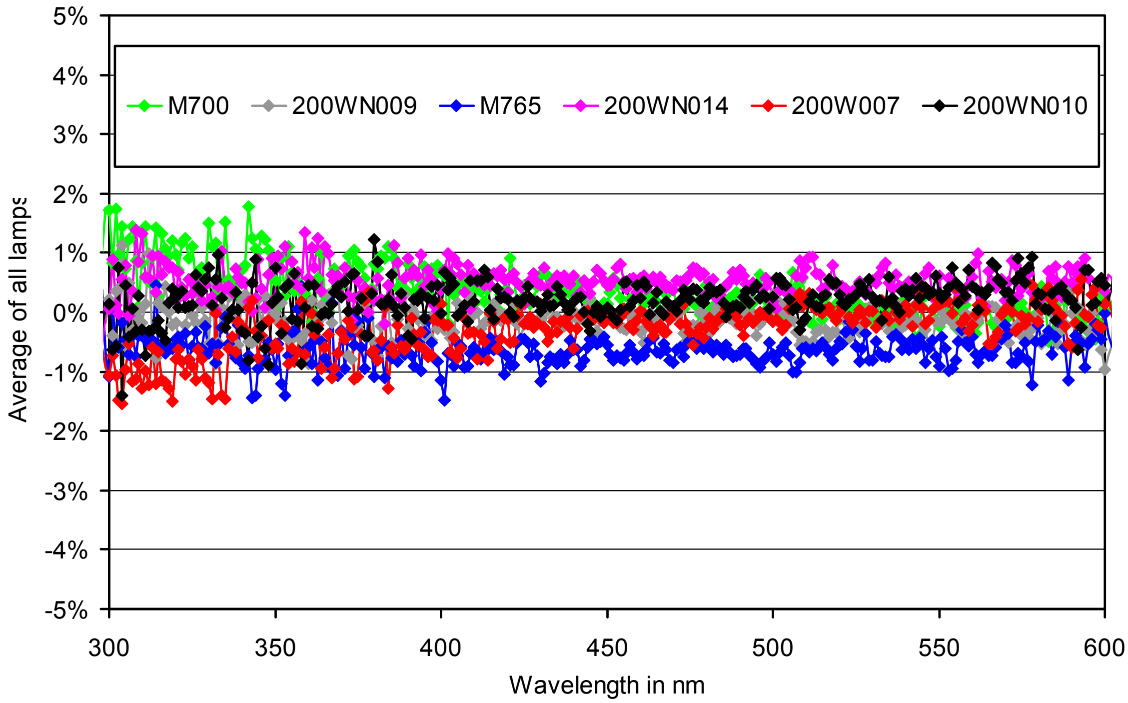

Figure 1. *Comparison of the calibration of on-site standards M700, 200W007, M765, 200WN009, and 200WN010; and the traveling standard 200WN014 on 4/4/2017. Data are reference to the average of the measurements of all lamps.*

Lamps M700, 200W007, and M765 were also compared with each other on three occasions during the reporting period, namely on 9/26/16, 12/15/16, and 3/28/17. Results of the three lamps agreed to within 1.5% on all occasions.

To confirm the irradiance scale of solar measurements of the SUV-100 spectroradiometer chosen for the reporting period, the GUV-511 radiometer that is collocated with the SUV was vicariously calibrated against SUV measurements. Calibration factors calculated with this method were compared with similar factors established during previous years. The analysis showed that calibration factors for the GUV 305, 340, 380, and PAR channels that were calculated for the period 2013 – 2017 are in agreement to within ±0.5%. (The change for the GUV channel at 320 nm is larger because of a known drift of this channel.) This result confirms the excellent consistency of SUV calibrations.

2.2. Instrument Stability

The radiometric stability of the SUV-100 spectroradiometer was monitored with calibrations utilizing the on-site irradiance standards, with daily "response" scans of the internal lamp, by comparison with measurements of the collocated GUV-511 multifilter radiometer, and by comparisons with results of a radiative transfer model (part of "Version 2" data).

Figure 2 shows changes in TSI readings and PMT currents at 300 and 400 nm, derived from response scans performed between 8/1/16 and 5/31/17. Between 8/1/16 and the start of the site visit on 3/30/17, the output of the internal lamp decreased monotonically by 4% as indicated by the TSI sensor. A new lamp was installed during the site visit and TSI measurements of the new lamp were stable to within 1% thereafter. Between October 2016 and May 2017, PMT currents tracked the change of the TSI measurements well, indicating that the monochromator throughput was stable. There are several outliers between 10/26/16 and 1/14/17 caused by the shutter's malfunction. The affected scans were not used for processing solar data.

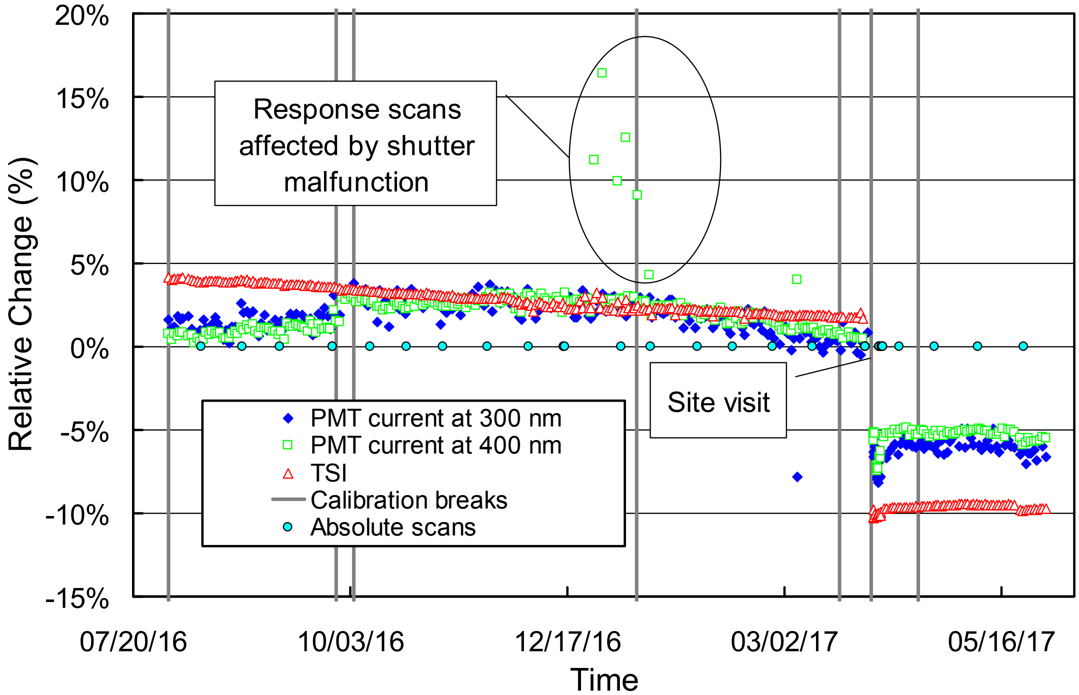

Figure 2. *Time-series of PMT current at 300 and 400 nm, and TSI signal. All data were extracted from measurements of the internal irradiance standard and are normalized to their average. Calibration break points (Table 1) and times of absolute scans are also indicated. The response lamp that was installed during the site visit burns darker, explaining the difference in pre- and post-visit measurements.*

Changes in the system's sensitivity were corrected by adjusting calibration break points accordingly. The reporting period was divided into seven calibration periods, labeled P1 – P6 (Table 1). Figure 3 shows ratios of the calibration functions applied during Periods P1 through P6 relative to the function of Period P1.

Table 1. Calibration periods for Palmer Volumes 26.

Period name	Period range	Number of absolute scans
P1	08/01/16 – 09/27/16	7
P1B	09/28/16 – 10/03/16	0 (average of P1 and P2)
P2	10/04/16 – 01/09/17	9
P3	01/10/17 – 03/20/17	4
P4	03/21/17 – 03/31/17	6
P5	04/01/17 – 04/16/17	6
P6	09/10/15 – 10/04/15	3

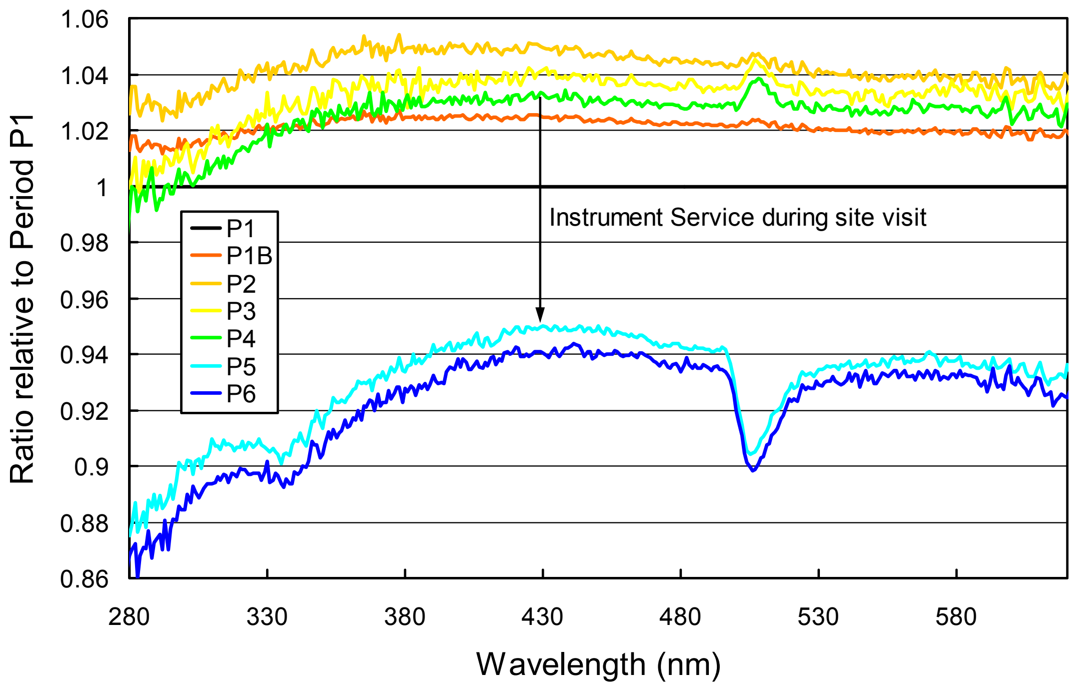

Figure 3. *Ratios of spectral irradiance assigned to the internal reference lamp for periods P1 – P6 relative to Period P1. The site visit occurred between periods P4 and P5.*

The suitability of the selected calibration break points was checked by comparing calibrated SUV-100 measurements with GUV data. Figure 4 shows the ratio of GUV-511 data (340 nm channel) and final SUV-100 measurements, which were weighted with the spectral response function of this channel. The ratio is normalized and should ideally be one. The graph indicates that GUV and SUV measurements are consistent to within ±2.4% (±1σ). There are no step changes exceeding 1.0% between calibration periods. These results indicate that solar data of the SUV-100 have been appropriately corrected. Remaining uncertainty caused by step changes in sensitivity are below 1% for all periods. The figure also indicates that all data affected by the malfunctioning shutter have been removed.

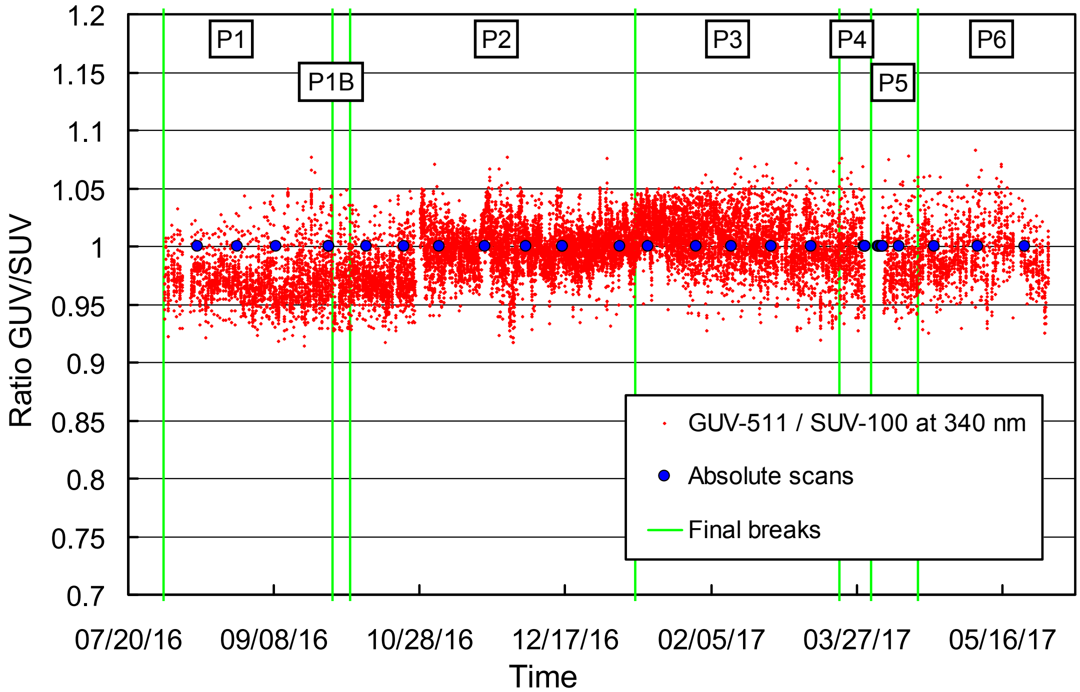

Figure 4. *Ratio of GUV-511 measurements at 340 nm with final SUV-100 measurements. The latter were weighted with the spectral response function of the GUV-511 340 nm channel.*

2.3. 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. The wavelength-dependent bias of this homogenized dataset and the correct wavelength scale was determined with the Version 2 Fraunhofer-line correlation method (Bernhard et al., 2004). Figure 5 shows the correction function calculated with this algorithm. Figure 6 indicates the wavelength accuracy of final Version 0 data for five wavelengths in the UV and visible by running the Version 2 Fraunhofer-line correlation method a second time. Shifts are typically smaller than ±0.1 nm. (The standard deviations for wavelengths between 305 and 400 nm are 0.032 nm on average). The wavelength accuracy was further improved as part of the production of Version 2 data. Figure 7 shows the wavelength accuracy of Version 2 data. The standard deviations for wavelengths between 305 and 400 nm decreased to 0.023 nm.

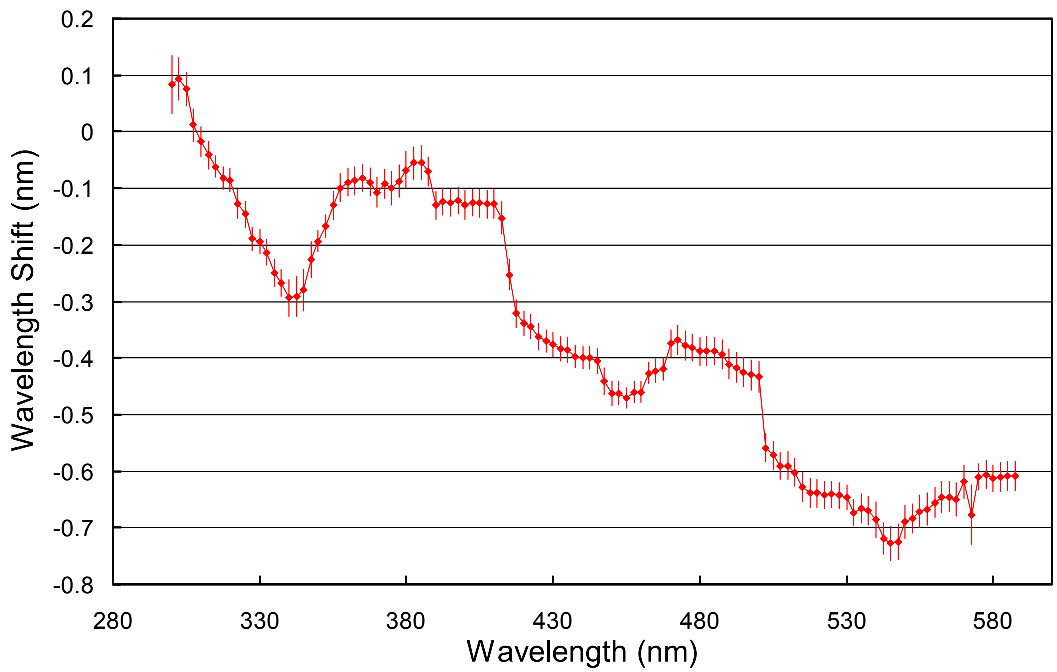

Figure 5. *Monochromator mapping function. Error bars indicate 1-σ variation.*

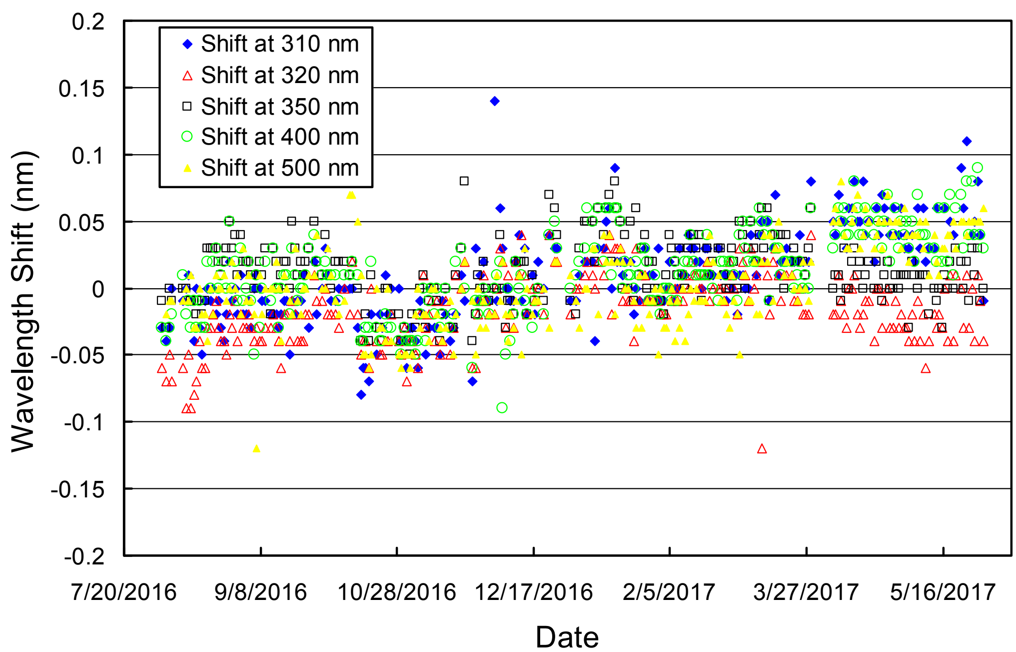

Figure 6. *Wavelength accuracy check of the final Version 0 data at five wavelengths by means of Fraunhofer-line correlation. Noontime measurements from every day of the year have been evaluated.*

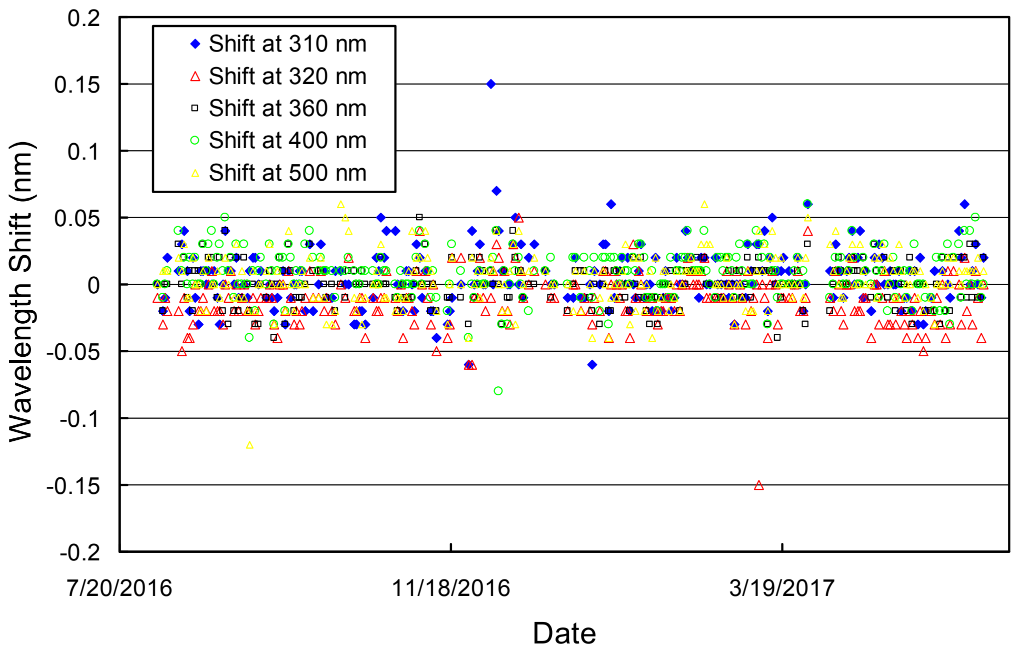

Figure 7. *Same as Figure 6 but for Version 2 data.*

2.4. Missing data

Table 2 provides a list of days that have substantial data gaps, and indicates their causes. About 900 (5%) solar scans were lost due to the malfunctioning shutter before it was replaced during the site visit.

Table 2. Days with substantial data gaps.

Date	Reason
08/03/16	Shutter malfunction
08/07/16 – 08/09/16	Shutter malfunction
09/10/16	Shutter malfunction
09/28/16 – 09/29/16	Shutter malfunction
10/03/16	Shutter malfunction
10/07/16	Shutter malfunction
10/19/16	Shutter malfunction
10/26/16 – 10/27/16	Shutter malfunction
01/03/17	Shutter malfunction
01/21/17	Shutter malfunction
02/09/17	Shutter malfunction
03/29/17 – 04/04/17	Site visit
04/19/17	Unknown
04/22/17	Absolute scan
05/07/17	Absolute scan
05/11/17	Unknown
05/21/17	GPS time reset

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.