2. Palmer Station (06/01/17 – 06/30/18)

This sections describes quality control of solar data recorded at Palmer Station between 06/01/17 and 06/30/18. This period resulted in a total of 19,611 solar scans, which were assigned to Volume 27. There was no site visit during the reporting period. By and large, the system operated normally and there are only very few data gaps (Section 2.4). However, the internal lamp was unstable during eleven "response" scans. It is not clear whether the cause of this instability was the lamp itself or a poor connection between the lamp's terminals and posts. Affected response scans were not used for processing of solar data and the problem has no impact on the quality of solar measurements.

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. Lamps 200WN009, and 200WN010 are "long-term" standards, which 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 is run every other year during site visits when all on-site lamps and traveling standard are being compared. During the reporting period, lamp 200WN009 was run once and results of the comparison with the other lamps are discussed below.

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 relevant to the reporting period is lamp 200WN014. However, the lamp was not operated at Palmer Station because there was no site visit. The lamp 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 Palmer Station did not result in a significant step-change.

Lamps 200W007, M700, and M765 were compared with the long-term standard 200WN009 on 9/24/17. Figure 1 shows results for data collected on this day. The scales of spectral irradiance of lamps M700 and M765 agree with the scale of 200WN009 to within ±0.6% on average. In the UV, the scales of 200W007 and 200WN009 also agree within this range, however, the difference in the visible is larger.

Lamps 200W007, M700, and M765 were also compared with each other on 7/2/17, 12/17/17, and 3/29/18. the scales of M700 and M765 agreed with each other to within ±0.6% on average on all three occasions while the measurements of lamp 200W007 showed more variability.

Overall, measurements with lamp 200W007 showed less stability and a larger difference to the long-term standard. For this reason, absolute scans of lamp 200W007 were not used for processing solar data for the reporting period. The calibration of solar data is only based on absolute scans with lamps M700 and M765.

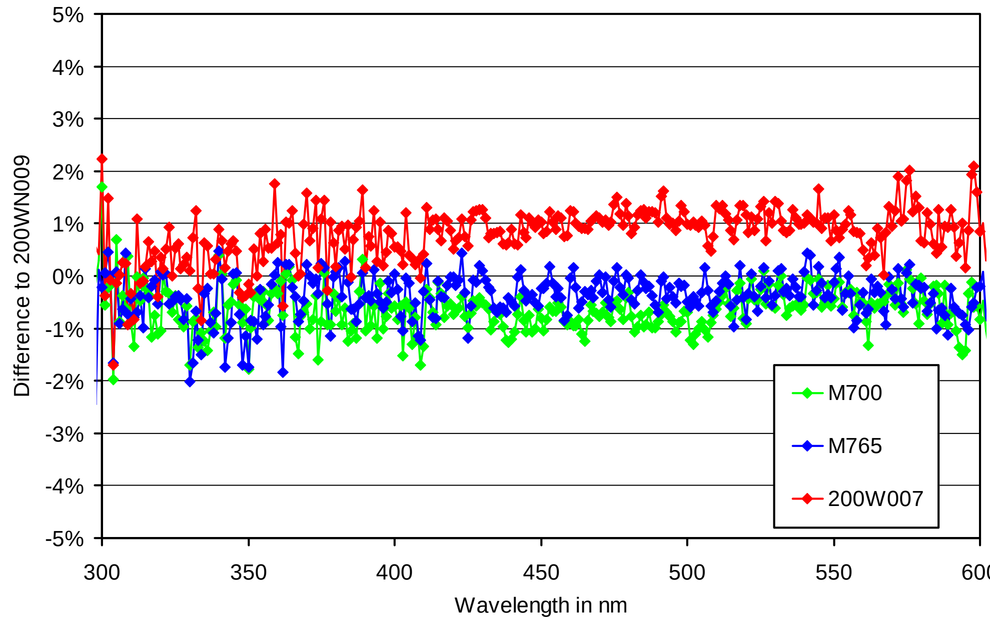

Figure 1. *Comparison of the calibration of on-site standards M700, 200W007, and M765 with long-term standard 200WN009 on 9/24/2017.*

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 – 2018 are in agreement to within ±0.85%. (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 6/1/17 and 6/24/18. TSI measurements decreased by about 4.5% during this period, indicating that the response lamp became darker. PMT currents track the change of the TSI measurements generally well, indicating that the monochromator throughput was stable. 11 response scans were affected by instability of the internal lamp. Data points that are affected by this instability are indicated by arrows in Figure 2. Associated response scans were not used for processing of solar data.

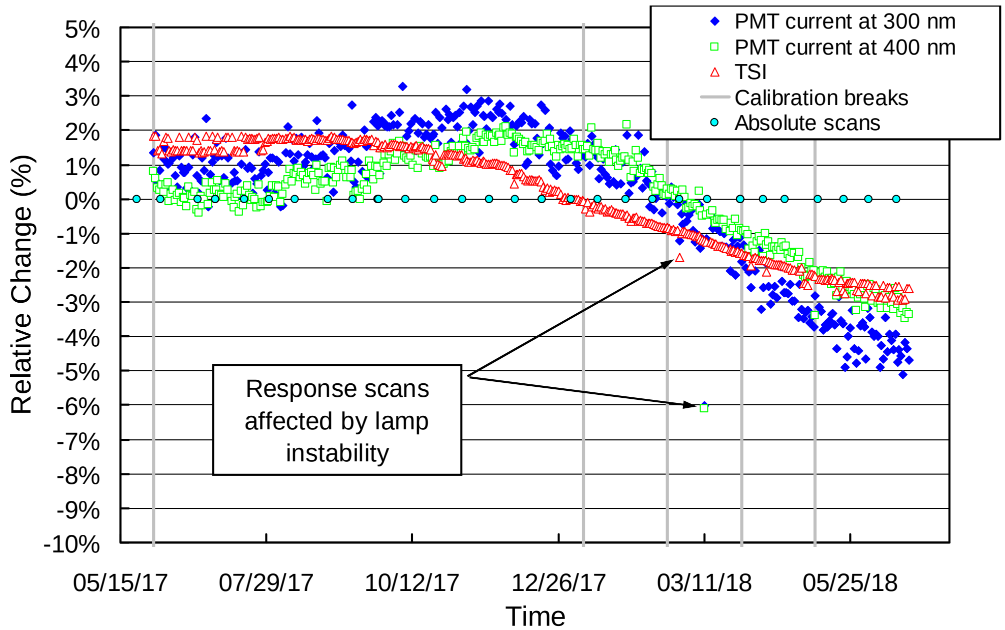

Figure 2. *Time-series of PMT current at 300 and 400 nm, and TSI signal. All data were extracted from measurements of the internal irradiance standard and are normalized to their average. Calibration break points (Table 1) and times of absolute scans are also indicated. Arrows point to data points that were affected by the instability of the internal lamp.*

Changes in the system's sensitivity were corrected by adjusting calibration break points accordingly. The reporting period was divided into five calibration periods, labeled P1 – P5 (Table 1). Figure 3 shows ratios of the calibration functions applied during Periods P1 through P5 relative to the function of Period P1. Because Periods P2 through P5 are only based on two or three absolute scans, ratios are comparatively noisy. Data of these periods were therefore smoothed to reduce random uncertainties. Smoothed ratios are indicated by heavy lines in Figure 3.

Table 1. Calibration periods for Palmer Volumes 27.

Period name	Period range	Number of absolute scans
P1	06/01/17 – 01/07/18	15
P2	01/08/18 – 02/19/18	2
P3	02/20/18 – 03/29/18	2
P4	03/30/18 – 05/06/18	3
P5	05/07/18 – 06/30/18	2

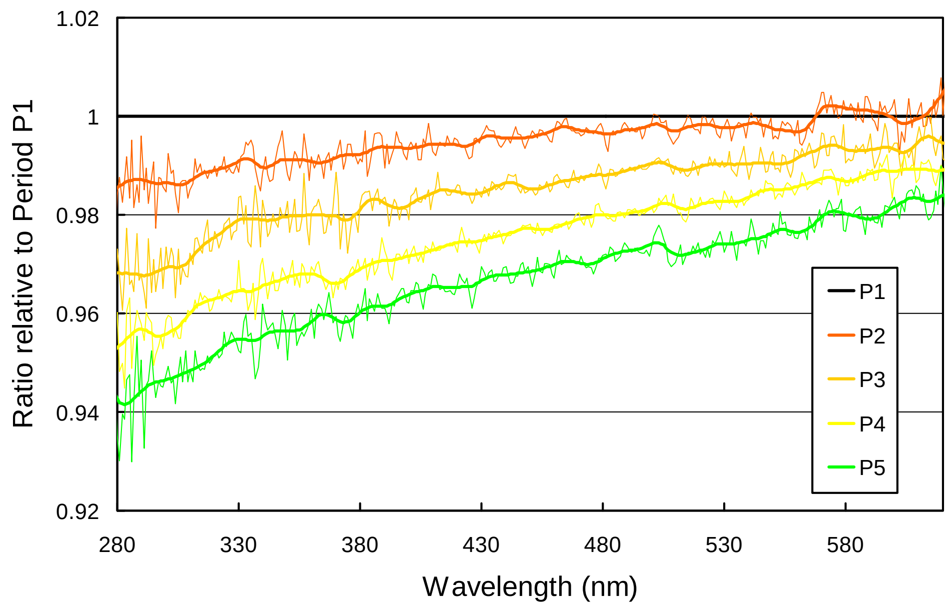

Figure 3. *Ratios of spectral irradiance assigned to the internal reference lamp for periods P1 – P5 relative to Period P1. Heavy lines indicate smoothed ratios.*

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. There are virtually no step-changes at times of calibration breaks (green vertical lines), indicating that solar data of the SUV-100 have been appropriately corrected. GUV and SUV measurements typically agree to within ±5%. However, Figure 4 also shows a few short periods when the ratio is abnormally high (e.g., on 6/20/17, 8/16/17, 8/28/17, 8/31/17, 9/9/17, 9/15/17, 9/17/17, 9/18/17, 9/19/17, 9/22/17, 10/3/17, 10/18/17, 10/25/17, 11/2/17, 11/2/17, 5/29/18). On these days, snow was presumably covering the irradiance collector of the SUV-100 spectroradiometer for short periods. GUV measurements are less affected by snow because the instrument is heated to a higher temperature. Hence, the ratio of GUV and SUV measurements is high after heavy snowfall until the SUV collector is again free of snow. When removing periods affected by snow, GUV and SUV are consistent to within ±2.2% (±1σ). SUV measurements influenced by snow are part of the Version 0 and 2 datasets and have been flagged in the Version 2 dataset.

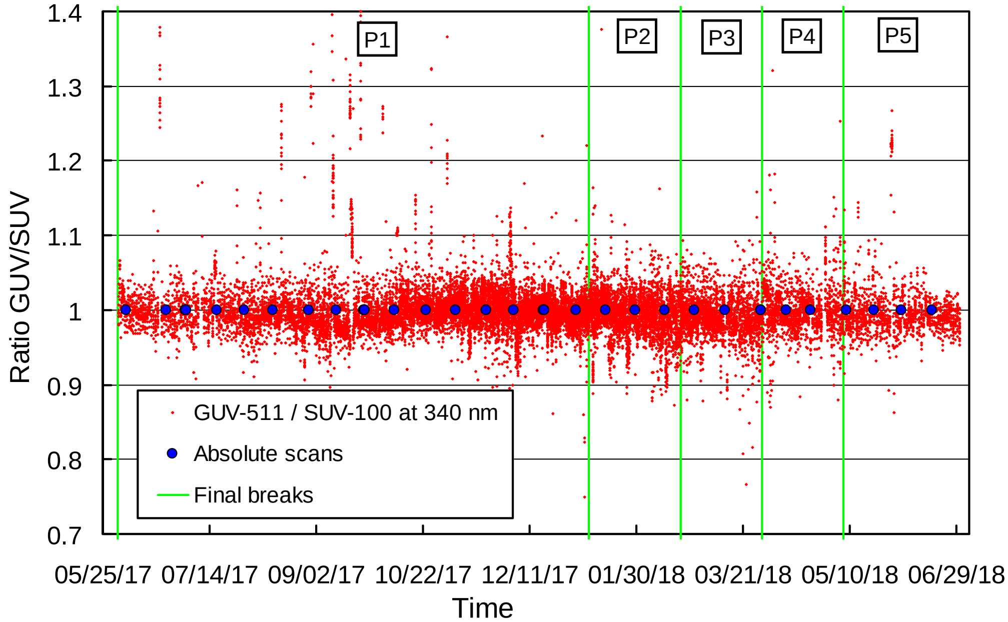

Figure 4. *Ratio of GUV-511 measurements at 340 nm with final SUV-100 measurements. The latter were weighted with the spectral response function of the GUV-511 340 nm channel. Narrow clusters of vertical data points are caused by snow covering the SUV-100 collector.*

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 ±0.06 nm. (The standard deviations for wavelengths between 305 and 400 nm are 0.027 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 0.019 nm.

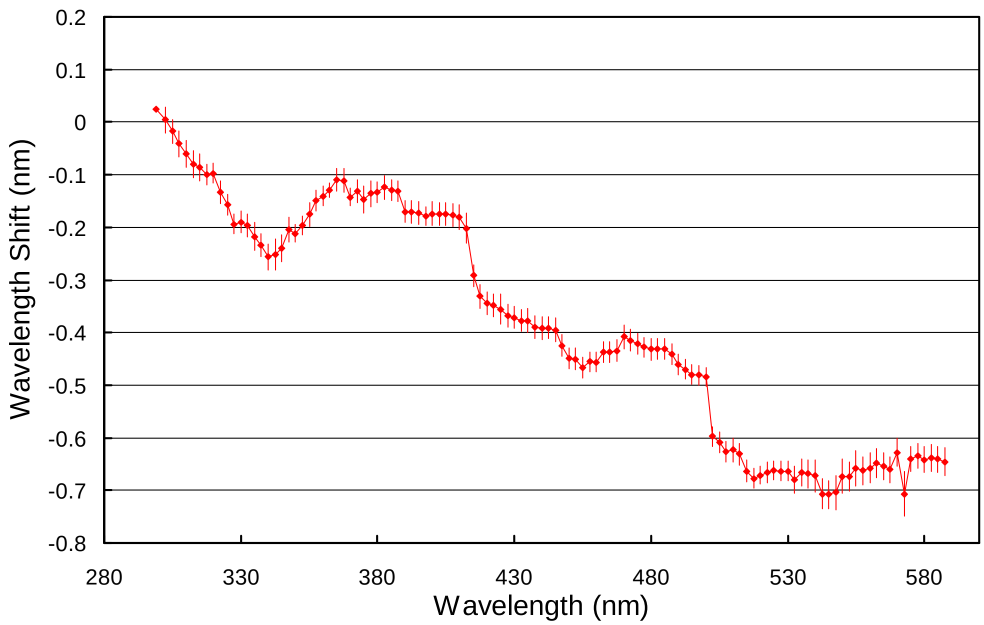

Figure 5. *Monochromator mapping function. Error bars indicate 1-σ variation.*

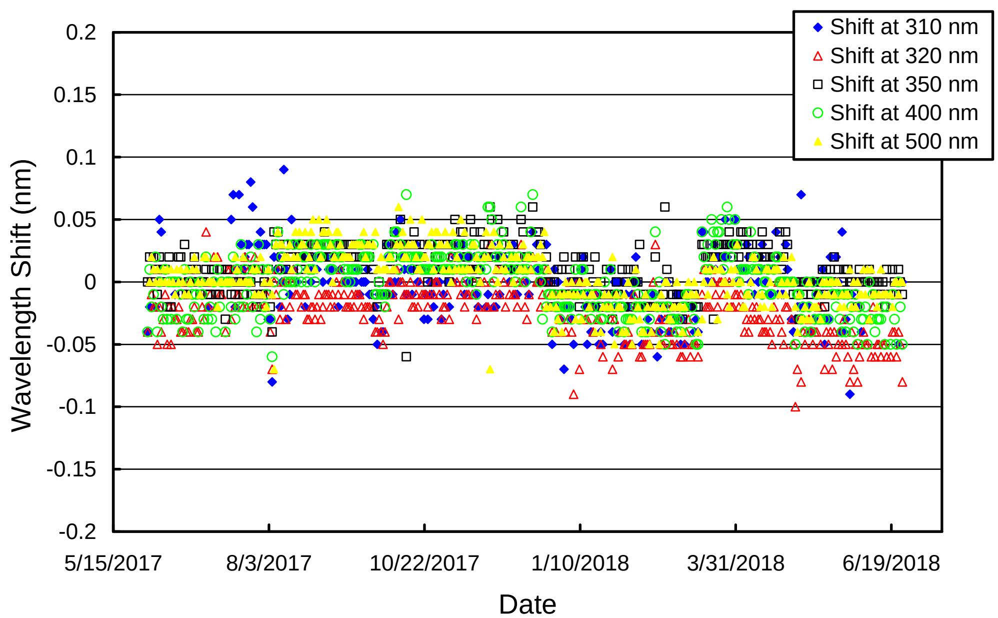

Figure 6. *Wavelength accuracy check of the final Version 0 data at five wavelengths by means of Fraunhofer-line correlation. Noontime measurements from every day of the year have been evaluated.*

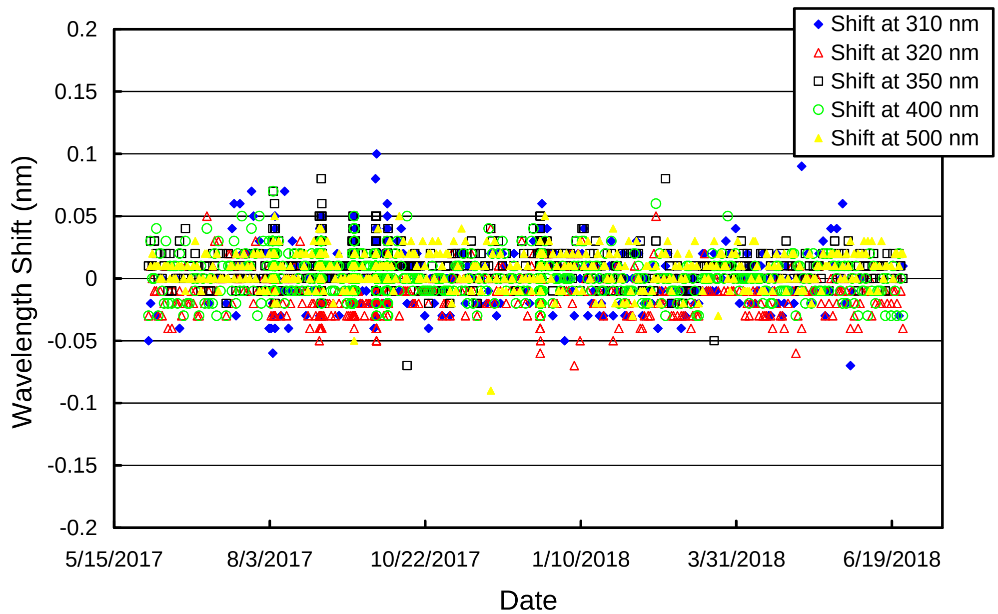

Figure 7. *Same as Figure 6 but for Version 2 data.*

2.4. Missing data

Table 2 provides a list of days that have substantial data gaps, and indicates their causes.

Table 2. Days with substantial data gaps.

Date	Reason
07/10/17	GPS time reset
03/12/18 – 03/13/18	Large monochromator wavelength offset
04/23/18	Power outage
04/27/18	Erratic computer reboots (fixed by installing Windows updates)

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.