2. Palmer Station (07/01/20 – 05/31/21)

This sections describes quality control of solar data recorded at Palmer Station between 07/01/20 and 05/31/21. This period resulted in a total of 15,281 solar scans, which were assigned to Volume 30. The system suffered from communication problems between the system's computer and the "Spectralink" subsystem that controls the monochromator. Between the start of the reporting period and 3/30/21, 155 "Timeout getting echo from Spectralink" errors were reported. As a consequence, the wavelength position of the monochromator was frequently lost, resulting in significant data gaps (Section 2.4). The cause of this problem is still under investigation and could be related to the upgrade of the system's operating system from Windows 7 to Windows 10 during the 2019 site visit in accordance with new cyber-security standards by NSF and NOAA. It is possible that the driver for the computer's communication card that controls peripheral system components is not reliable under Windows 10. A contributing factor to the large number of Spectralink errors is the Spectralink's aging power supply. Of note, at the beginning of April 2021, the errors stopped for no obvious reason.

The system's PSP radiometer was unit 30450F3 and has a calibration factor of 8.885×10^{-6} V/(W m^{-2}), which was established on 11/1/17. TUVR data from 01/12/21 onward were erratic and were not published.

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 the traveling standard are compared with each other. Lamp 200WN009 was used once during the reporting period; lamp 200WN010 was not used.

The long-term standards 200WN009 and 200WN010 were calibrated on 12/20/2013 against lamps 200WN001 and 200WN002. See the last Operations Report for details.

The working standards 200W007, M700, M765 were recalibrated during the preparation of Volume 28. The same calibrations were also used for data of the reporting period (Volume 30).

In early 2020, the chain of calibrations applied between 1996 and 2019 to solar data of the NSF and NOAA monitoring networks was re-evaluated (Bernhard and Stierle, 2020). This analysis suggested that the scale of spectral irradiance of NIST standard F-616, which has been used as the primary standard since 2013, is low compared to the scale of primary standards used before 2013. This bias ranges between –2% at 300 nm, –1% at 375 nm, and less than ±0.5% between 420 and 600 nm. **Version 2 solar data of Volume 30 were scaled upward accordingly, however, Version 0 remain traceable to the original scale of the primary standard F-616.**

Figure 1 shows a comparison of all lamps performed on 9/22/20. The scales of spectral irradiance of all lamps agree to within ±0.2% on average. Lamps 200W007, M700, and M765 were also compared with each other on 7/1/20 and agreed at a similar level. Similar comparisons on 12/17/20 and 3/26/21 showed perfect agreement between the scales of spectral irradiance between lamps 200W007 and M765, however, the scale of lamp M700 was different by about 1%, suggesting that lamp M700 burns somewhat unstable. A similar instability of this lamp had been observed during the previous "season", and affected scans were not used for the processing of solar data.

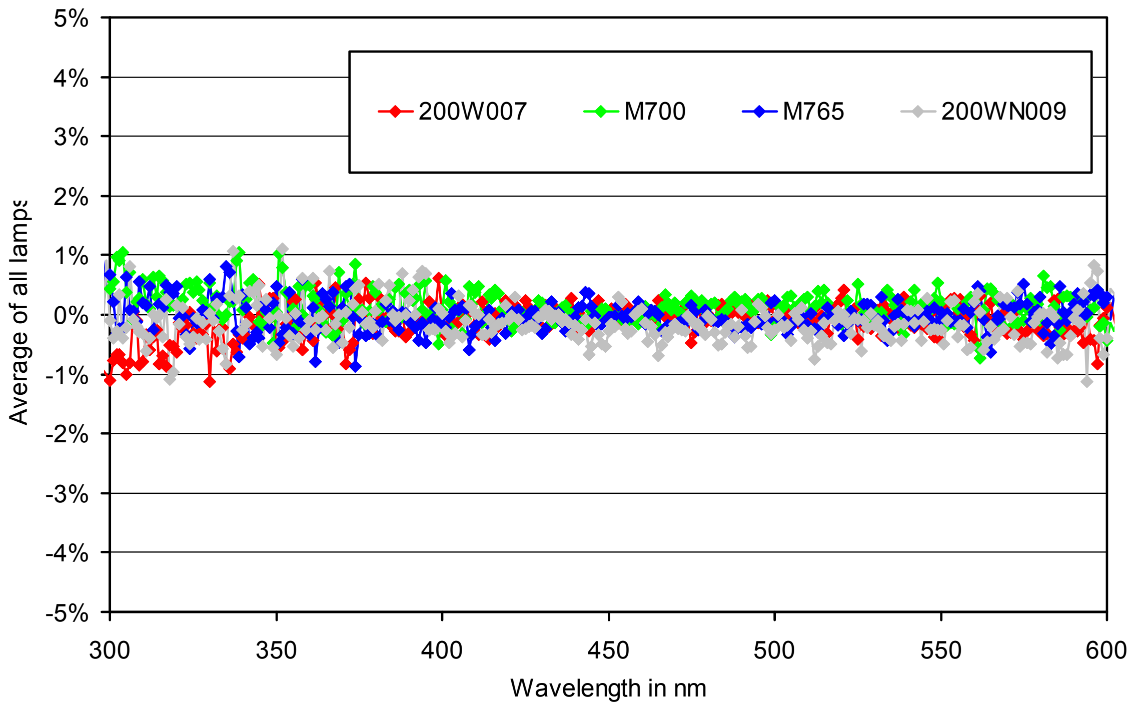

Figure 1. *Comparison of the calibration of on-site standards 200W007, M700, and M765 with long-term standard 200WN009 on 9/22/2020.*

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 between 2013 and 2021 are in agreement to within ±1.7% (±2σ). This result confirms the excellent consistency of SUV calibrations over time. (Of note, the change of the GUV channel at 320 nm is larger than the change of the other channels because of a known drift of this channel.)

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, see Bernhard et al. (2004)).

Error! Reference source not found. shows results from measurements of the internal lamp. Specifically, readings of the instrument's TSI sensor (a filtered photo diode with sensitivity mostly in the UV-A) are compared with measurements of the SUV-100's PMT at 300 and 400 nm, derived from response scans performed between 7/1/20 and 5/31/21. TSI measurements decreased by about 3% during this period, indicating that the internal lamp became darker by this amount. PMT currents decreased by about the same amount but the variability is larger. There was a change in the PMT currents by about 2% on 5/8/21. The reason could not be identified but the calibration was adjusted accordingly.

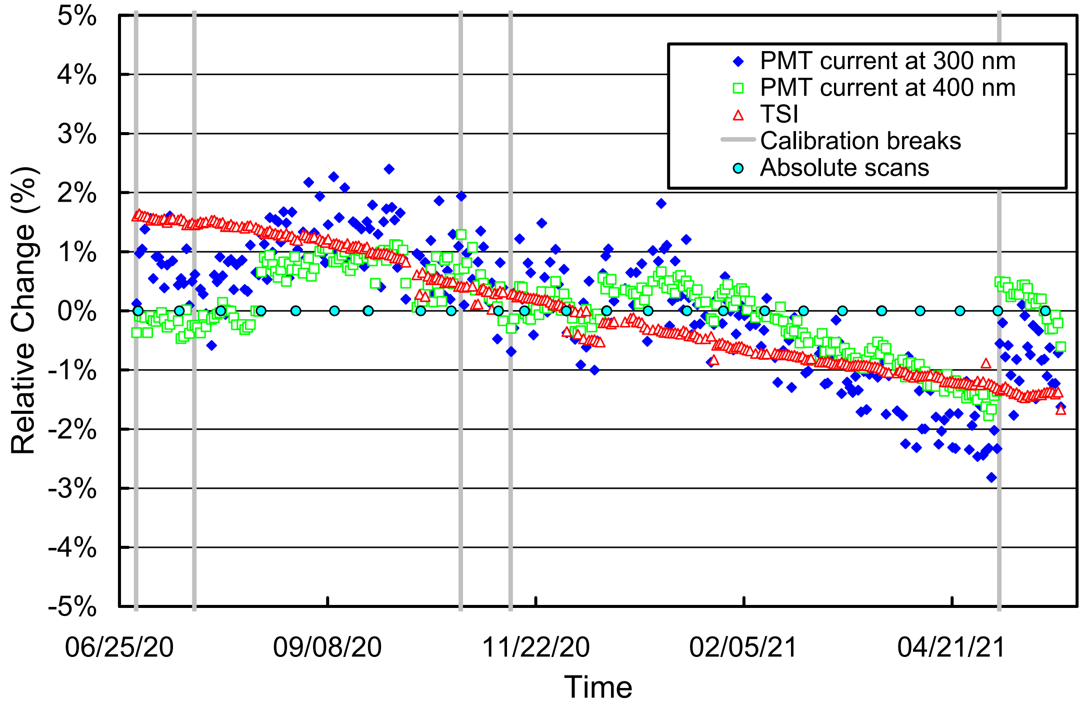

Figure 2. *Time-series of PMT current at 300 and 400 nm, and TSI signal. All data were extracted from measurements of the internal irradiance standard and are normalized to their average. Calibration break points (Table 1) and times of absolute scans are also indicated.*

The 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.

Table 1. Calibration periods for Palmer Volumes 30.

Period name	Period range	Number of absolute scans
P1	07/01/20 – 07/21/20	3
P2	07/22/20 – 10/25/20	8
P3	10/26/20 – 11/12/20	1
P4	11/13/20 – 05/07/21	4
P5	05/08/21 – 05/31/21	2

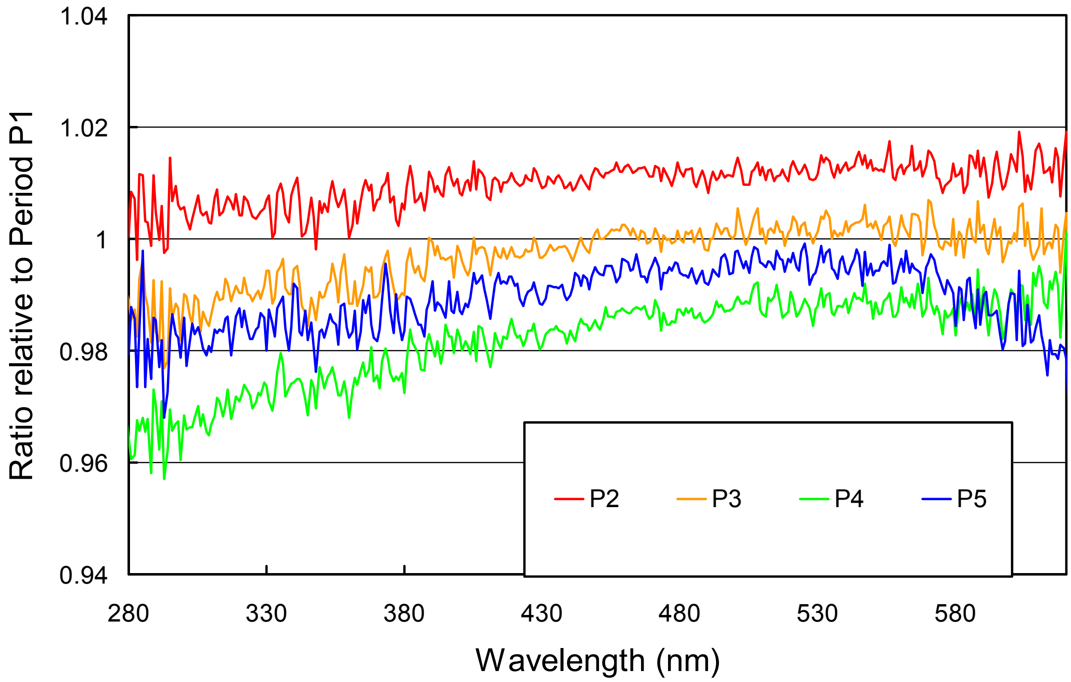

Figure 3. *Ratios of spectral irradiance assigned to the internal reference lamp for periods P1 – P7, relative to Period P1.*

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 no step-changes at times of calibration breaks (green vertical lines) that exceed 2%, 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., 10/19/20, 10/25/20–10/28/20, 10/30/20–11/01/20, 12/01/20–12/02/20, 01/02/21–01/03/21, and 01/27/21–01/28/21). During these periods, snow was likely covering the irradiance collector of the SUV-100 spectroradiometer. 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 disregarding periods affected by snow, GUV and SUV are consistent to within ±2.3% (±1σ). SUV measurements influenced by snow are part of the Version 0 and 2 datasets, but have been flagged in the Version 2 dataset.

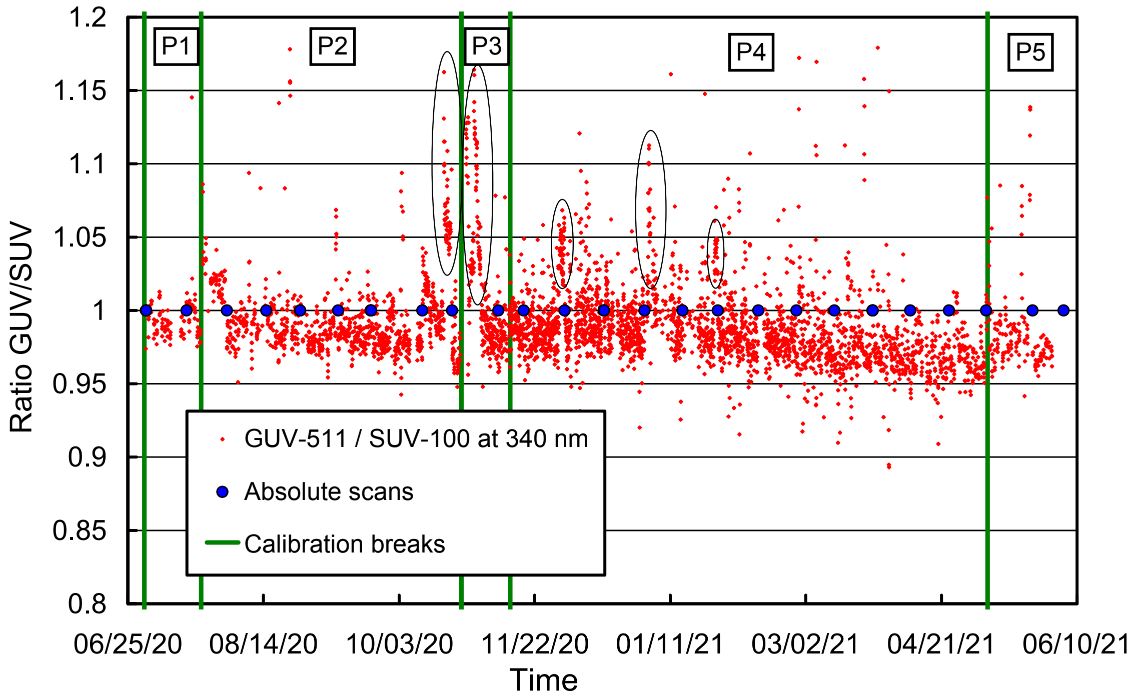

Figure 4. *Ratio of GUV-511 measurements at 340 nm with SUV-100 measurements. The latter were weighted with the spectral response function of the GUV-511's 340 nm channel. Narrow clusters of vertical data points marked by ellipses are likely caused by snow covering the SUV-100 collector.*

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 ±0.1 nm. (The standard deviations for wavelengths between 305 and 400 nm are 0.030 nm on average). There are many small steps in this time series because the system's monochromator frequently lost its wavelength position due to the communication problem between the computer and Spectralink module mentioned in the introduction. 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. There are no step-changes and the standard deviations for wavelengths between 305 and 400 nm decreased to 0.023 nm.

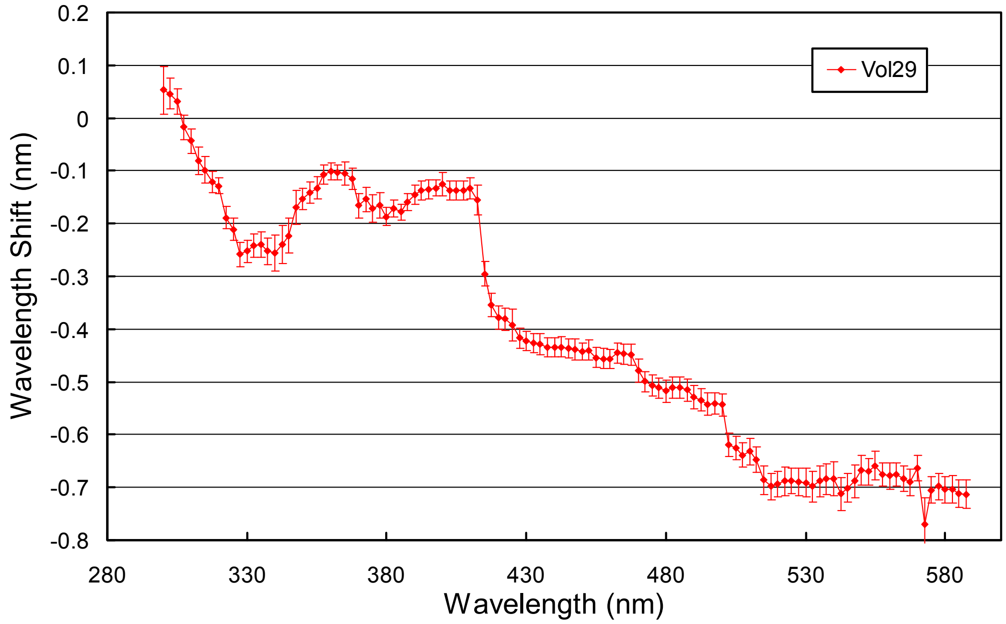

Figure 5. *Monochromator mapping function. Error bars indicate 1-σ variation.*

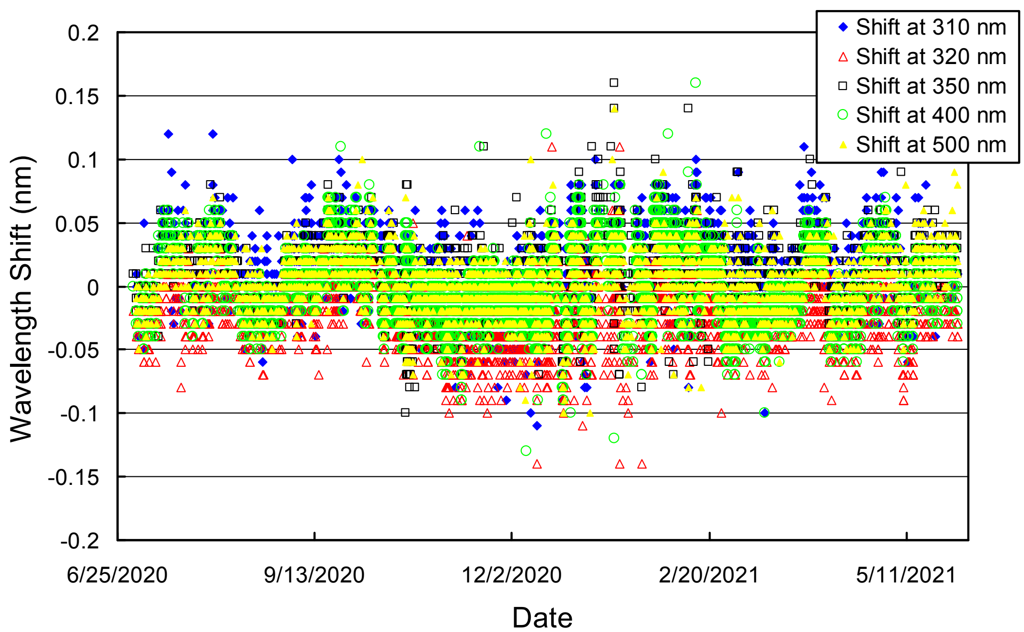

Figure 6. *Wavelength accuracy check of the final* <u>*Version 0*</u> *data at five wavelengths by means of Fraunhofer-line correlation. Measurements were evaluated in four-hour increments.*

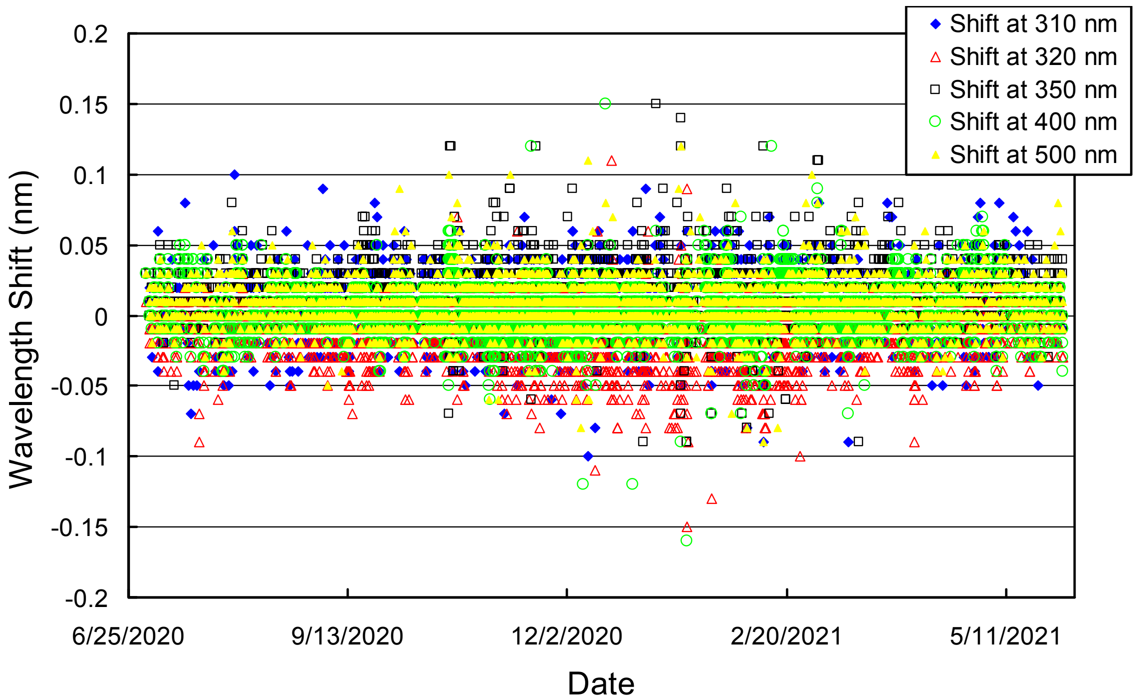

Figure 7. *Same as Figure 6 but for Version 2 data.*

2.4. Missing data

Table 2 provides a list of days with missing data and indicates the cause of data gaps.

Table 2. Days with substantial data gaps.

Date	Reason
7/24/20	Communication problem Spectralink – Computer
8/12/20	Communication problem Spectralink – Computer
8/28/20 – 8/29/20	Communication problem Spectralink – Computer
10/7/20 – 10/9/20	Communication problem Spectralink – Computer
10/23/20 – 10/24/20	Communication problem Spectralink – Computer
12/21/20	Communication problem Spectralink – Computer
1/1/21 – 1/4/21	Communication problem Spectralink – Computer
4/9/21	Calibration scan
4/14/21	Unexplained computer reboot
5/13/21	Calibration scan

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.

Bernhard G. and S. Stierle (2020). Trends of UV Radiation in Antarctica, *Atmosphere*, *11*(8), 795, doi: https://doi.org/10.3390/atmos11080795.