2. Palmer Station (06/01/21 – 05/31/22)

This sections describes quality control of solar data recorded at Palmer Station between 06/01/21 and 05/31/22. This period resulted in a total of 13,555 solar scans, which were assigned to Volume 31. Like in the previous year, the system suffered from communication problems between the system's computer and the "Spectralink" subsystem that controls the monochromator. A total of 84 "Resetting Spectralink DTR" errors were reported. Errors clustered between 10/2/21 and 10/15/21, between 11/11/21 and 11/26/21, and between 2/10/22 and 2/22/22. Most errors occurred between 22:00 and 23:40 UT. 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. A contributing factor to the large number of Spectralink errors could be the Spectralink's aging power supply.

Data analysis further revealed that the cosine error of the instrument's diffuser changed considerably since the Vol 30 period. This change is surprising because the system was not serviced during the last two years because of the COVID-19 pandemic. The cosine error correction of Version 2 data was adjusted accordingly, and the accuracy of Version 2 UV data is not degraded. However, during the few clear-sky periods that occurred at Palmer Station, Version 0 data have a significant azimuth dependence, in particular at wavelengths in the visible range.. This problem affects about 200 scans. The effect on measurements taken during overcast periods is negligible. Still, Version 2 data should be used for all periods because of their greater accuracy.

Instead of performing four scans per hour as in the past, the system only measured three scans per hour (indexed at the hour, and 20 and 40 minutes past the hour.) The reduced schedule was the consequence of a "major" upgrade of the Windows 10 Operating System that was installed on 1/18/21. As of this writing, there is still no fix available for this issue.

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 were erratic and were not published.

On 12/4/21, a solar eclipse was visible from Antarctica. At Palmer Station, the eclipse started on 6:34:43 and ended on 8:12:04 UT. The eclipse maximum (magnitude of 0.948) occurred on 7:22:50 UT. The solar zenith angle at the eclipse maximum was at 85.1° and the UV irradiance was therefore very low. For example, measurements of the UV Index were in the noise. Figure 1 shows measurements of spectral irradiance at 380 nm by the SUV-100 and GUV-511 radiometers. The two datasets are in good agreement. Note that GUV-511 data have a time resolution of 1 minute while SUV-100 spectra are measured every 20 minutes. Note also that the y-axis is logarithmic.

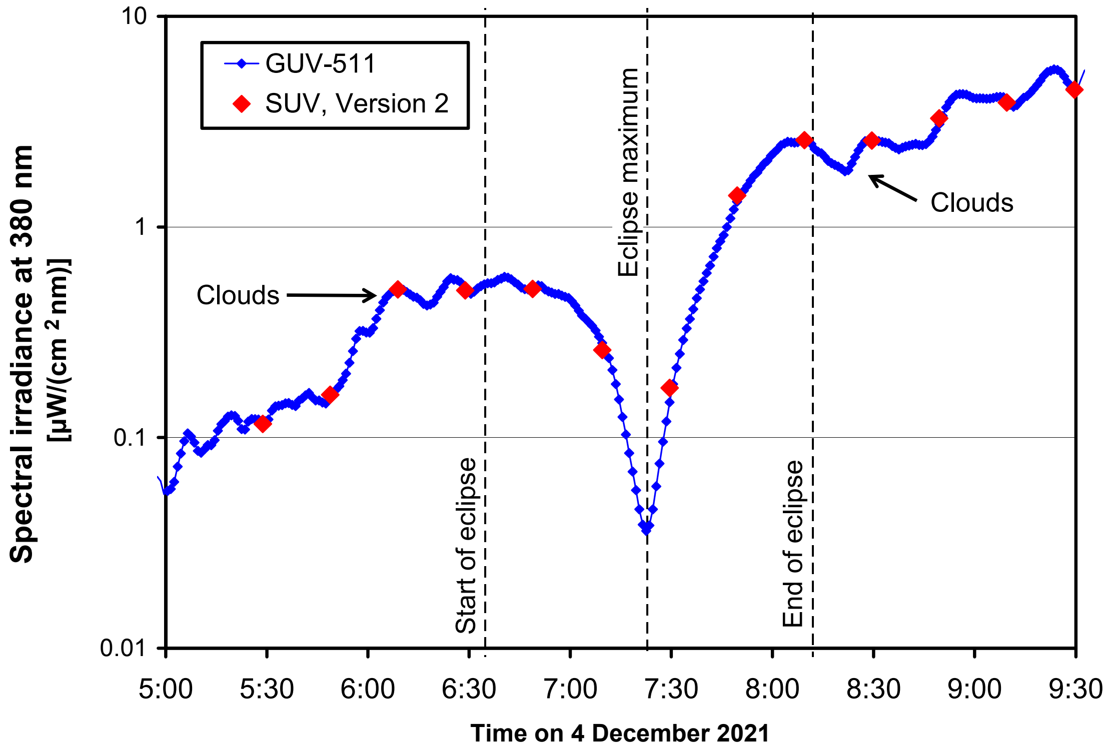

Figure 1. *Spectral irradiance at 380 nm at Palmer Station during the solar eclipse of 12/4/21. Measurements by the SUV-100 spectroradiometer (Version 2 data) and GUV-511 radiometer are in good agreement. Note that measurements were affected by clouds and the y-axis is logarithmic because the Sun was only 4.9° above the horizon at the time of eclipse maximum. At that time, spectral irradiance at 380 nm was only 0.09% of that observed at noon on this day.*

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 used for data of Volumes 28–31.

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 is –2% at 300 nm, –1% at 375 nm, and less than ±0.5% between 420 and 600 nm. **Version 2 solar data of Volume 31 were**

scaled upward accordingly; however, Version 0 remain traceable to the original scale of the primary standard F-616.

Figure 2 shows a comparison of working standard 200W007 with long-term standard 200WN009 performed on 9/25/21. The scales of spectral irradiance of the two lamps agree almost ideally. While also lamps M700 and M765 were run on this day, the responsivity of the system changed abruptly by 3% between the scans of lamps M765 and 200W007. Hence, comparisons of the working standards M700 and M765 with the long-term standard 200WN009 cannot be provided. However, the three working standards were also compared with each other on 7/2/21, 12/17/21, and 3/26/22, and on all three occasions, the scales of spectral irradiance of the three lamps agreed to better than ±1%, confirming that the calibration of solar data of the Volume 31 period stands on solid ground.

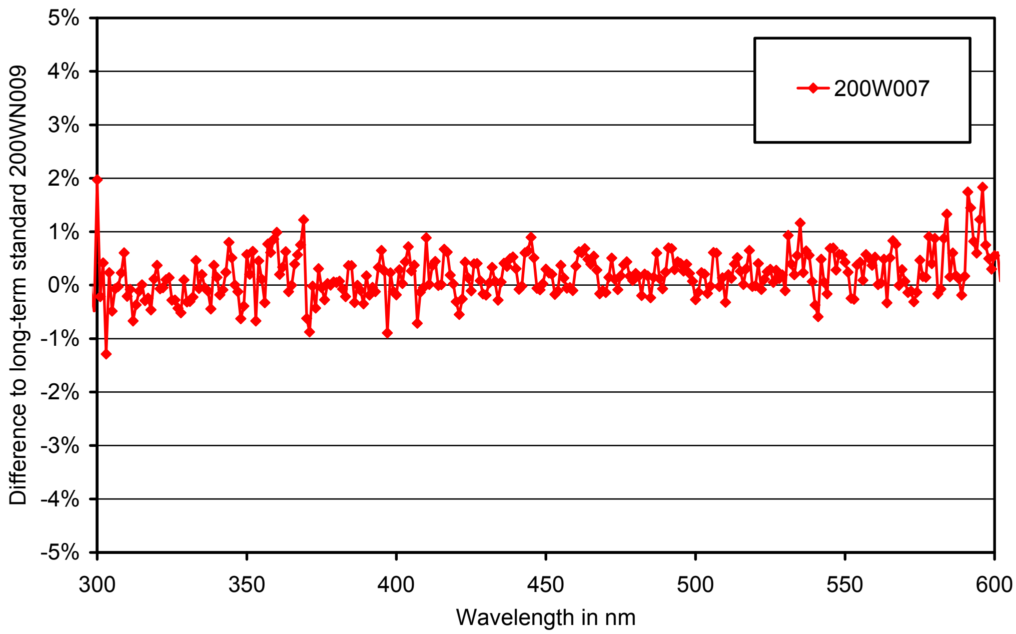

Figure 2. *Comparison of the calibration of on-site standards 200W007 with long-term standard 200WN009 on 9/25/2021.*

To confirm the irradiance scale of solar measurements of the SUV-100 spectroradiometer chosen for the reporting period, the GUV-511 radiometer, which 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, and PAR channels that were calculated between 2013 and 2022 are in agreement to within ±1.9% (±2σ). This result confirms the excellent consistency of SUV calibrations over time. (Of note, changes of the GUV channels at 320 nm 380 nm are larger than changes of the other channels because of known drifts of these channels.)

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)).

Figure 3 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 6/1/21 and

5/31/22. TSI measurements decreased by about 2% during this period, indicating that the internal lamp became darker by this amount. Of note, fluctuation at the 0.5% level in the TSI measurements are the result of the resolution of the digitally-controlled 12-bit power supply that powers the lamp. PMT currents at 300 and 400 nm decreased by 3% and 5%, respectively. A slightly larger change at shorter wavelength is expected as the lamp's color temperature shifts to lower values when it becomes darker. There was a temporary change in the PMT currents by about 2.5% between 9/8/21 and 6/26/21. The reason could not be identified but the calibration was adjusted accordingly.

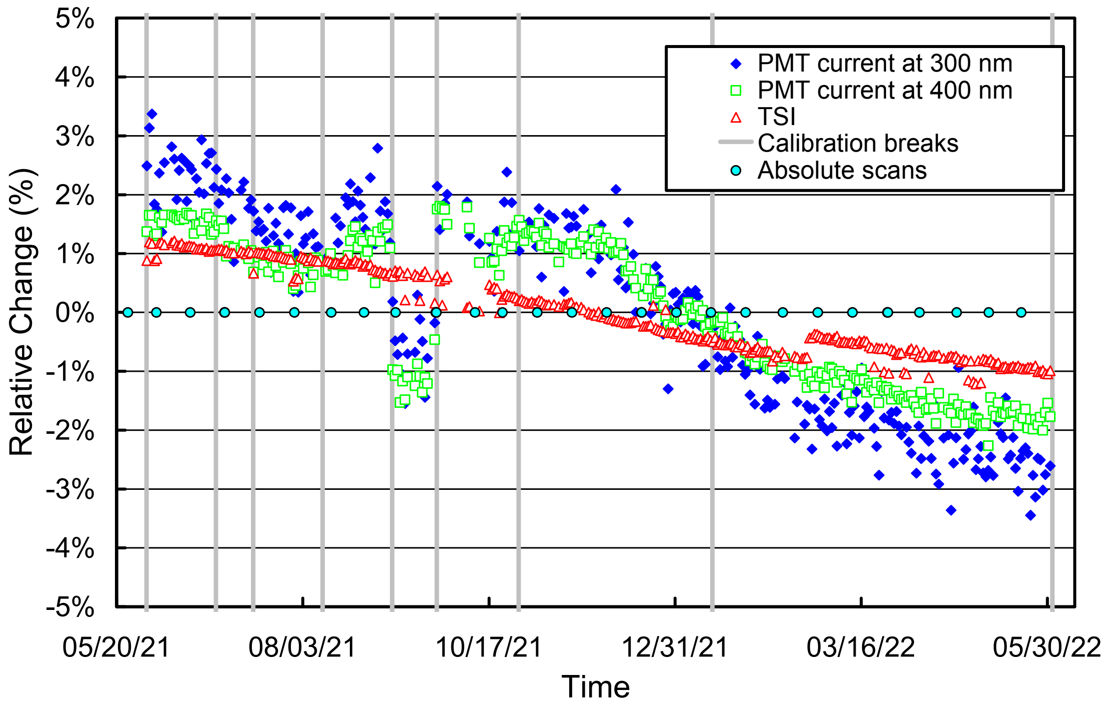

Figure 3. *Time-series of PMT current at 300 and 400 nm, and TSI signal. All data were extracted from measurements of the internal irradiance standard and are normalized to their average. Calibration break points (Table 1) and times of absolute scans are also indicated.*

The reporting period was divided into eight calibration periods, labeled P1 – P8 (Table 1). Figure 4 shows ratios of the calibration functions applied during Periods P1 through P8 relative to the function of Period P1.

Table 1. Calibration periods for Palmer Volumes 31.

Period name	Period range	Number of absolute scans
P1	06/01/21 – 06/28/21	2
P2	06/29/21 – 07/13/21	3
P3	07/14/21 – 08/10/21	2
P4	08/11/21 – 09/07/21	2
P5	09/08/21 – 09/25/21	3
P6	09/26/21 – 10/28/21	4
P7	10/29/21 – 01/14/22	6
P8	01/15/22 – 05/31/22	11

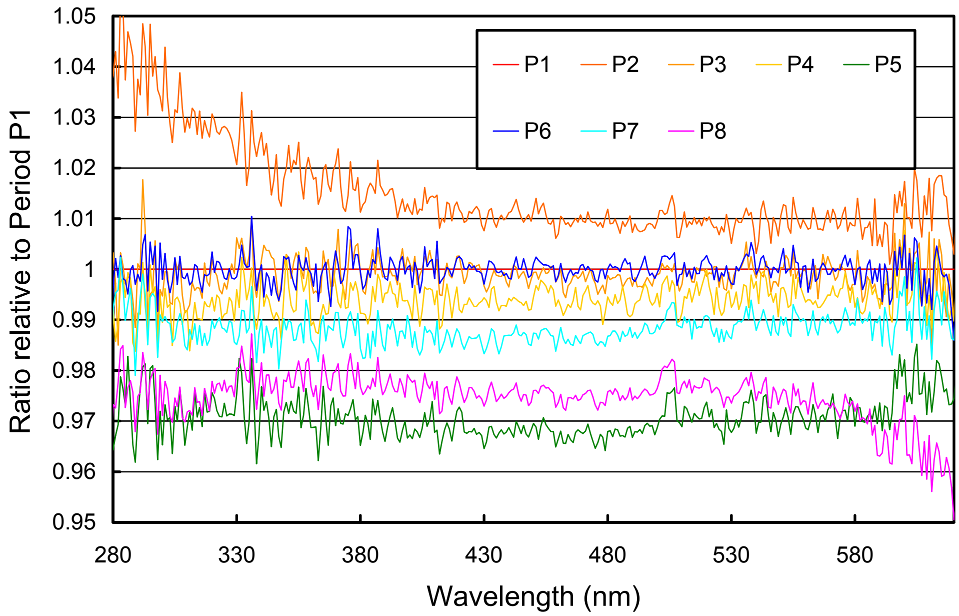

Figure 4. *Ratios of spectral irradiance assigned to the internal reference lamp for periods P1 – P8, relative to Period P1.*

The suitability of the selected calibration break points was checked by comparing calibrated SUV-100 measurements with GUV data. Figure 5 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 (grey 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 5 also shows a few short periods when the ratio is abnormally high. 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. GUV and SUV are consistent to within ±3.1% (±1σ), even when periods with snow effects are included. SUV measurements potentially influenced by snow are part of the Version 0 and 2 datasets, but have been flagged in the Version 2 dataset.

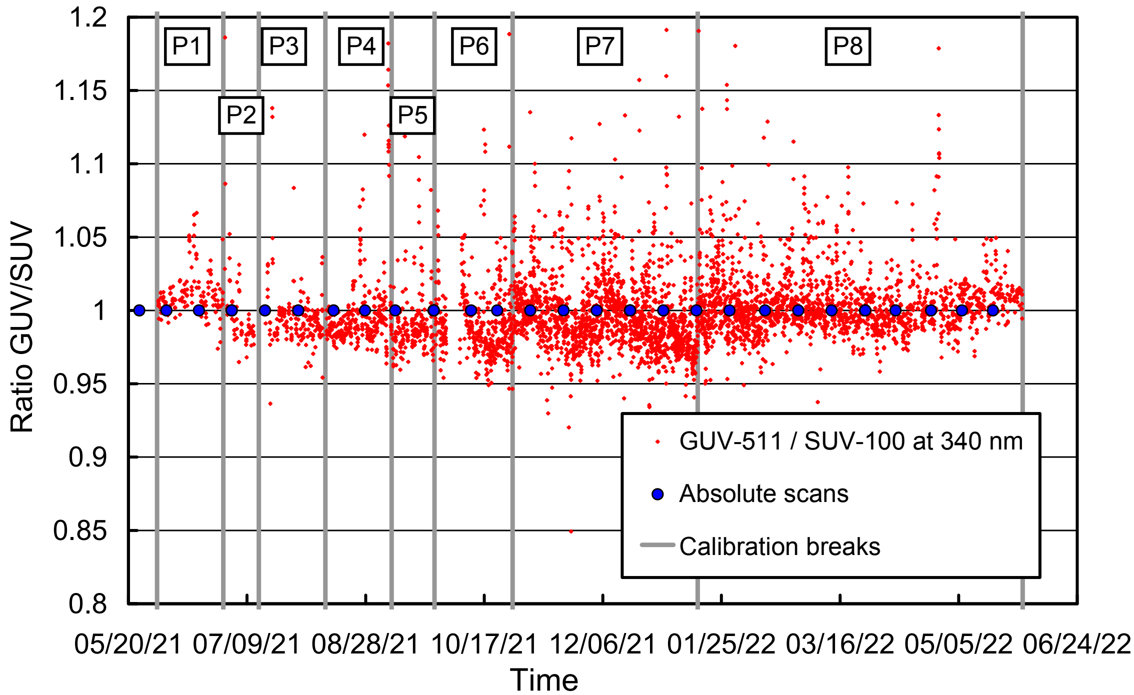

Figure 5. *Ratio of GUV-511 measurements at 340 nm with SUV-100 measurements. The latter were weighted with the spectral response function of the GUV-511's 340 nm channel.*

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 6 shows the correction function calculated with this algorithm. Figure 7 indicates the wavelength accuracy of Version 0 data for five wavelengths in the UV and visible range, obtained by running the Fraunhofer-line correlation method for a second time. Shifts are typically smaller than ±0.1 nm. (The standard deviations for wavelengths between 305 and 400 nm are 0.034 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 8 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 0.024 nm.

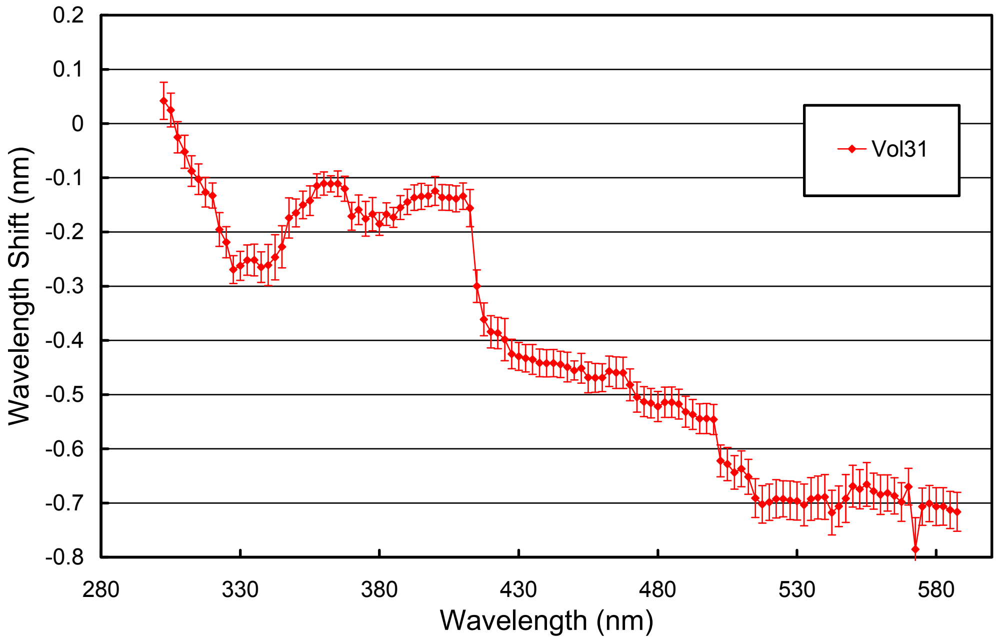

Figure 6. *Monochromator mapping function. Error bars indicate 1-σ variation.*

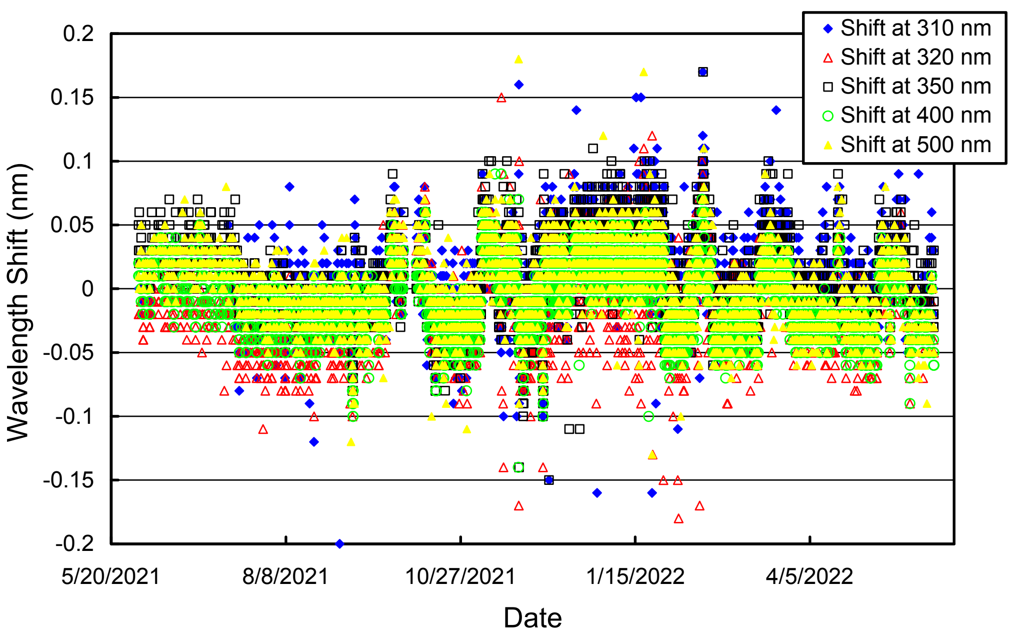

Figure 7. *Wavelength accuracy check of Version 0 data at five wavelengths by means of Fraunhofer-line correlation. Measurements were evaluated in hourly increments.*

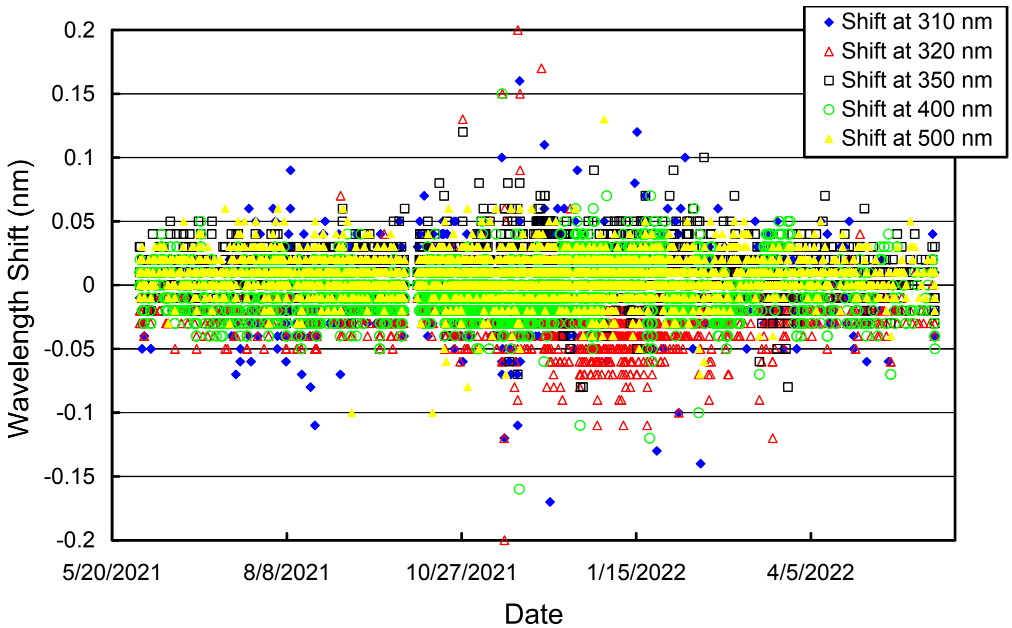

Figure 8. *Same as Figure 7 but for* *<u>Version 2</u>* *data.*

2.4. Missing data

Table 2 provides a list of missing days in the published dataset.

Table 2. Days with no data.

Date	Reason
6/9/21	Communication problem Spectralink – Computer
7/7/21	Communication problem Spectralink – Computer
8/10/21	Communication problem Spectralink – Computer
9/15/21	Communication problem Spectralink – Computer
9/23/21	Communication problem Spectralink – Computer
10/1/21 – 10/5/21	Spectralink not working correctly
12/16/21	Communication problem Spectralink – Computer

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.