3. Amundsen-Scott South Pole Station (9/15/23–3/28/24)

This report describes quality control of solar data recorded at Amundsen-Scott South Pole Station between 9/15/23 and 3/28/24. The period resulted in a total of 17,098 solar scans from the SUV-100 spectroradiometer, which were assigned to Volume 33. There was no site visit by NOAA personnel during this period. As in the past, the accuracy of solar data from the SUV-100 system was assured based on comparisons with measurements of the station's GUV-541 radiometer plus results of radiative transfer model calculation. The latter are part of the SUV-100's Version 2 dataset.

The sensitivity of the system was extraordinary stable over the reporting period; only one calibration file was required. However, the wavelength stability of the SUV-100 monochromator was degraded as in the last years, requiring frequent adjustment of the system's wavelength registration during post-processing.

The dark current of the SUV-100 system was abnormally low and the noise in dark current was increased for unknown reasons for the following periods: 9/16/23–9/18/23, 10/7/23–10/8/23, 3/13/24, and 3/25/24–2/28/24. As a consequence, the noise in calibrated measurements was also increased for these periods, which is particularly apparent in measurements below 310 nm. Measurements that are affected by increased noise also tend to be too high below this wavelength. Affected spectra were flagged in the Version 2 dataset. The effect on weighted data, such as the UV Index, is minor.

Since 2014, measurements of the 320 nm channel of the GUV-541 radiometer (S/N 29239) that is installed next to the SUV-100 spectroradiometer drifted greatly. GUV data products therefore have to be produced without utilizing measurements of this channel. A comparison of calibrated GUV and SUV data performed during the Volume 26 season indicated that the quality of GUV data products is only marginally affected by the omission of the 320 nm channel. Solar data of the GUV are therefore part of the published datasets.

The system's PSP radiometer was installed during the site visit in January 2020. Its serial number is 27228F3 and it has a calibration factor of 8.332 $x10^{-6}$ V/(W m^{-2}).

3.1. Irradiance Calibration

The on-site irradiance standards available for calibrating the SUV-100 spectroradiometer during the reporting period were the lamps M-666, 200W021, 200W013, 200WN005 and 200WN006. Lamps M-666, 200W021, and 200W013 are "working standards," which are used on a regular basis. Please see previous Operations Reports on the history of these lamps. Lamps 200WN005 and 200WN006 were left at the South Pole in March 2014. Both lamps are designated "long-term" standards and are typically only used during site visits. Both lamps were calibrated by CUCF in August 2013 (see below). Both lamps were not used during the reporting period because there was no site visit.

In early 2020, the chain of calibrations applied to solar data of the NSF and NOAA monitoring networks between 1996 and 2019 was re-evaluated (Bernhard and Stierle, 2020). This analysis suggested that the scale of spectral irradiance of NIST standard F-616 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 29–33 were scaled upward accordingly; however, Version 0 data of these volumes remain traceable to the original scale of the primary standard F-616.**

Figure 1 shows a comparison of calibration scans with the working standards performed throughout the reporting period. There are some random fluctuations from one scan to the next, but all scans are consistent to within about ±1.5%, demonstrating both the excellent stability of the SUV-100 system and the consistency of the working standards' scale of spectral irradiance.

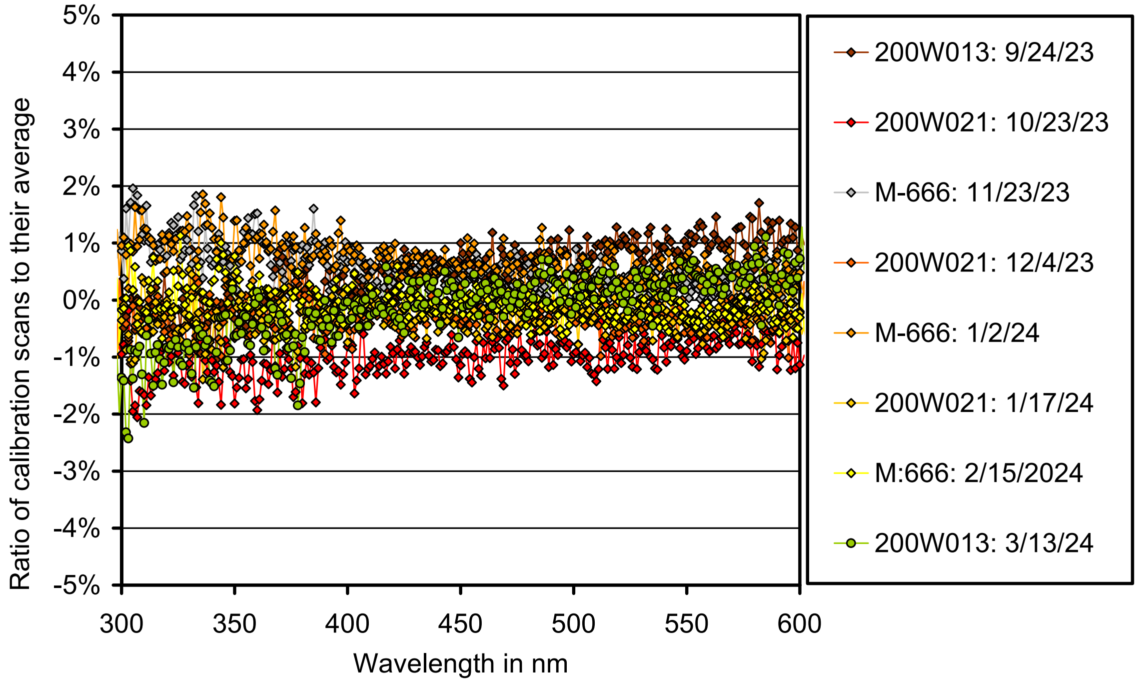

Figure 1. *Comparison calibration scans of South Pole working standard M-666, 200W021, and 200W013 during the reporting period.*

3.2. Instrument Stability

The temporal stability of the spectroradiometer's sensitivity was assessed with (1) bi-weekly calibrations utilizing the on-site standards, (2) daily "response" scans of the internal irradiance reference lamp, (3) comparison with data of the collocated GUV-541 radiometer, and (4) model calculations, which are part of the "Version 2" data edition (Bernhard et al., 2004).

The internal reference lamp of the SUV-100 system is monitored with a filtered photodiode with sensitivity in the UV-A range, called "TSI". This photodiode has proven to be very stable over time and its measurements therefore allow to decouple temporal drifts of the internal lamp from changes in the SUV-100's responsivity. These changes may be caused by variations in monochromator throughput or PMT sensitivity. Figure 2 shows changes in TSI readings and PMT currents at 300 and 400 nm, which were derived from the daily scans of the internal lamp during the reporting period. TSI measurements decreased by less than 1% during the reporting period, indicating that the lamp was virtually stable. PMT currents at 300 and 400 nm showed slightly more variability, which are in the normal range of past year's observations.

The GUV-541 radiometers was calibrated vicariously against SUV-100 Version 0 data. Calibration factors were established in the same way as those of previous volumes. Since the GUV-541 is a very stable instrument, it can be used to assesses drifts in the calibration of the SUV-100 over time. Calibration factors of the last eleven years (Volumes 23 –33) agree to within ±1.4% (±1σ) for all GUV channels, with exception of the drifting 320 nm channel. Furthermore, the GUV calibration factors established for the reporting period (Volume 33) differ by only 0.31%, –0.04%, –0.21% and –1.00% for the GUV's 305, 313, 340, and 380 nm channel, respectively, from the average of these factors calculated from data of Volumes 23 – 32. This result confirms the good consistency of calibrations over time.

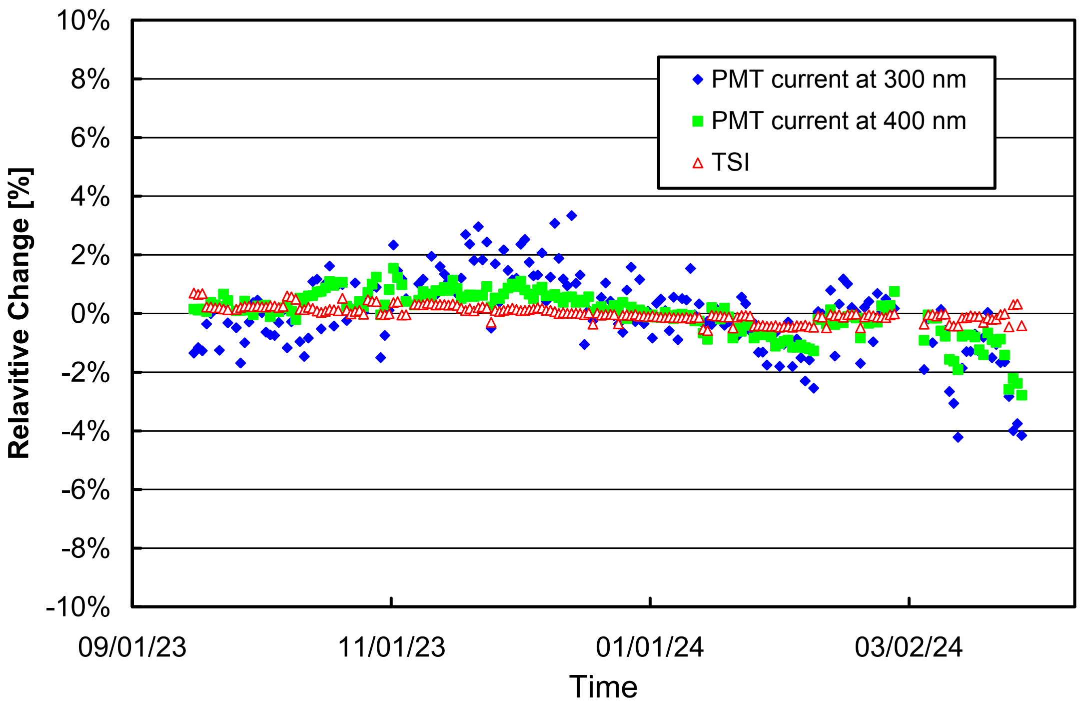

Figure 2. *Time-series of PMT current at 300 and 400 nm, plus the TSI signal, derived from daily measurements of the SUV-100's the internal irradiance standard. Data are normalized to the average of the whole period.*

A comparison of GUV-541 and SUV-100 measurements through the reporting periods allows to detect anomalies in SUV-100 data. Accordingly, Figure 3 shows the ratio of GUV-541 (340 nm channel) and SUV-100 measurements. The latter were weighted with the spectral response function of the GUV's 340 nm channel. The ratio was normalized to its average and should ideally be equal to one at all times. The graphs indicates that GUV and SUV measurements are generally consistent to within ±5%. The few outliers can be explained by shading from obstacles (e.g., air sampling masts) that are in the field of view of the instruments. Because GUV and SUV radiometers are not positioned at exactly the same location, the shadows from these obstacles fall on the collectors of the two instruments at different times. Scans affected by shadowing from stacks were flagged in the SUV-100 Version 2 dataset, removed from the GUV datasets, but remain part of the SUV-100 Version 0 dataset. The ratio tends to be low at the start and end of the reporting period. This bow-shaped feature is normal and caused by uncertainties in GUV data when the solar elevation is very low. The upper envelope of the ratio is composed of data collected during clear-sky periods while lower ratios refer to overcast conditions. (Data used for the plot are based on a preliminary cosine error correction, which is less sophisticated than that used for Version 2 SUV data. For example, it does not take the effect of clouds into account).

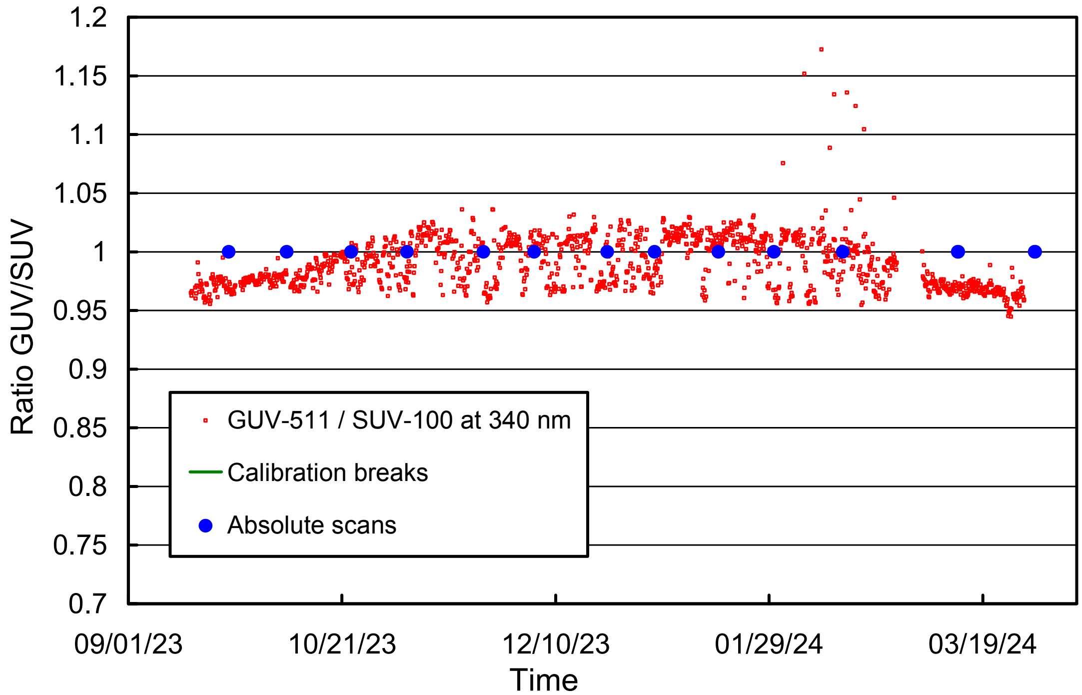

Figure 3. *Ratio of GUV-541 (S/N 29239) measurements (340 nm channel) with SUV-100 measurements. SUV-100 data were weighted with the spectral response function of this GUV channel.*

3.3. Wavelength Calibration

The wavelength stability of the system was monitored with the internal mercury lamp. Information from the daily wavelength scans was used to homogenize the dataset 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). The resulting correction function is shown in Figure 4.

Figure 5 indicates the wavelength accuracy of Version 0 data for five wavelengths in the UV and visible range. The plot was generated by applying the Fraunhofer-line correlation method to the corrected data. Residual wavelength shifts are typically smaller than ±0.10 nm, but there is still a noticeable day-to-day variability.

The wavelength accuracy was further improved when processing Version 2 data by breaking the dataset into 102 periods and calculating separate correction functions for each period. Figure 6 indicates the wavelength accuracy of Version 2 data. A significant improvement in the wavelength uncertainty can be observed when comparing Figures 5 and 6. The standard deviation of the residual wavelength shifts indicated in Figure 6 is smaller than 0.032 nm at all wavelengths.

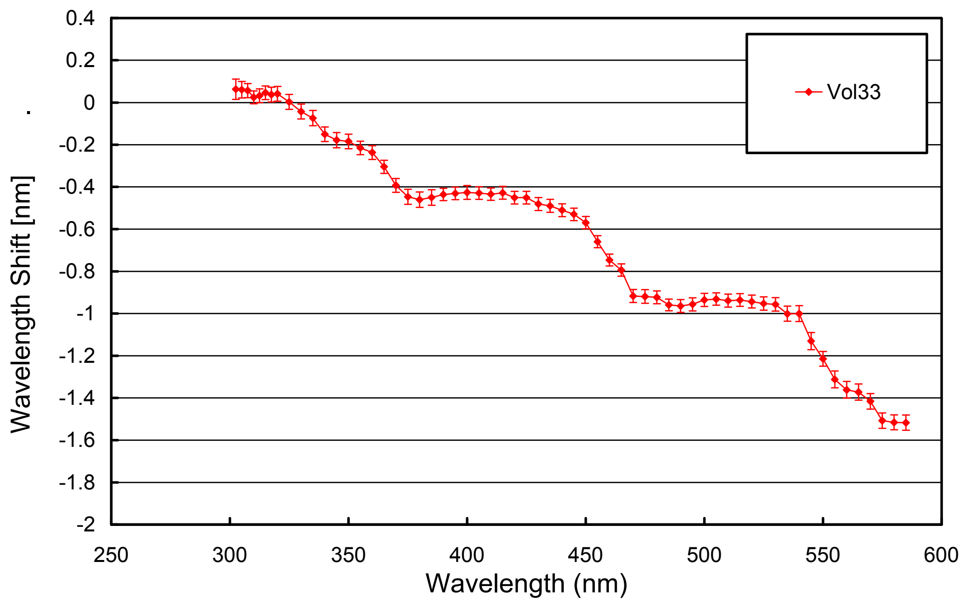

Figure 4. *Monochromator non-linearity correction functions.*

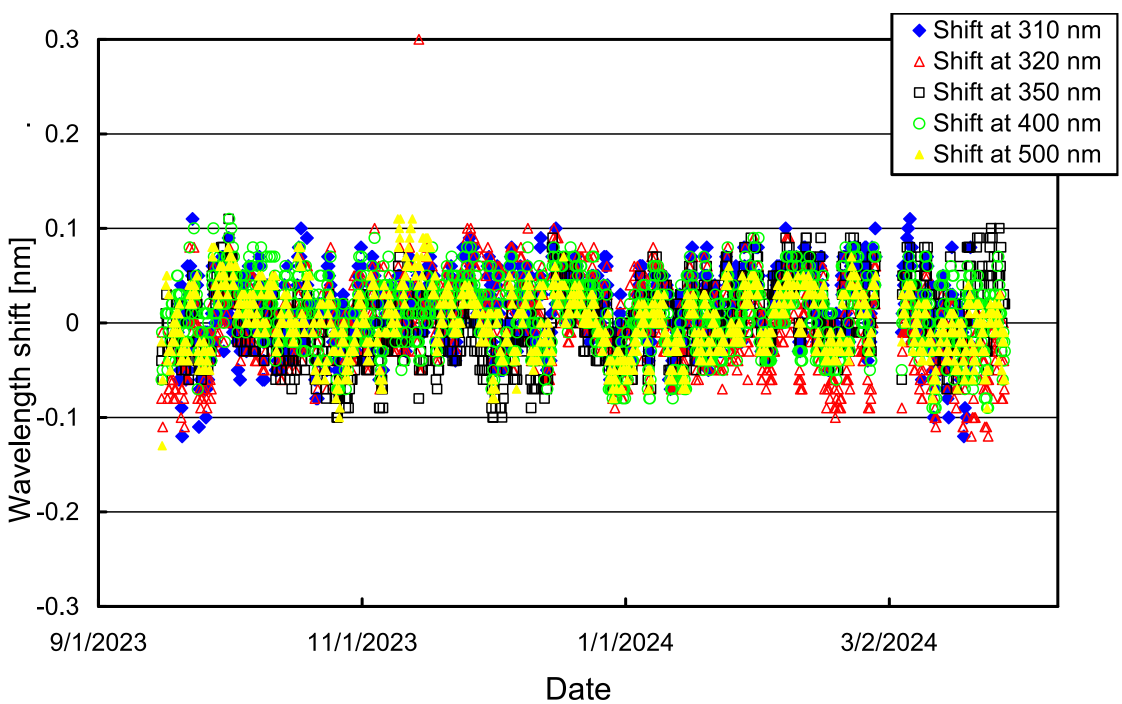

Figure 5. *Wavelength accuracy check of Version 0 data at five wavelengths by means of Fraunhofer-line correlation.*

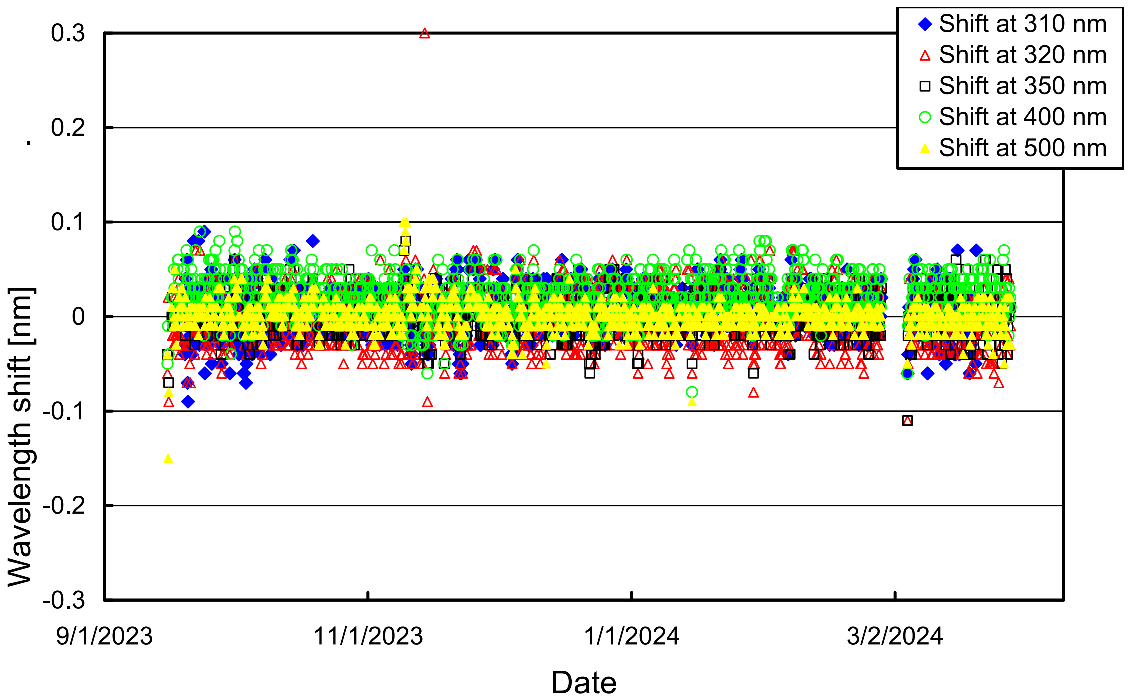

Figure 6. *Wavelength accuracy check of Version 2 data at five wavelengths by means of Fraunhofer-line correlation.*

3.4. Missing data

There are no SUV and GUV data for the period 2/28/24–3/4/24 because the software recording the raw data was not running during the period. There are no other major data gaps in the remainder of the reporting period.

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. https://doi.org/10.1029/2004JD004937

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