3. Amundsen-Scott South Pole Station (9/15/17–3/29/18)

The 2017–2018 data season at Amundsen-Scott South Pole Station is from 9/15/17 to 3/29/18. The system was serviced by NOAA GMD personnel between 1/19/18 and 1/25/18. Operation was affected by the failure of the mercury lamp's power supply on 12/2/16. Because of this problem, "wavelength scans" were only executed at the time of absolute scans and not on a daily basis as usual. The problem was corrected on 12/4/2017 and the performance of daily wavelength scans resumed. The problem was caused by a loose neutral contact in the power socket, which provides power to the mercury lamp's power supply. Variations in the system's wavelength registration could be corrected during processing and the wavelength uncertainty of final solar data is not larger than typical (Figure 3.5).

A total of 16,556 SUV-100 spectra were assigned to Volume 27.

Like for the previous three seasons, 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 had to be produced without utilizing measurements of this channel. A comparison of calibrated GUV and SUV data performed during the previous (Vol26) 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 (S/N 27228F3, calibration factor 8.377 x10-6 V/(W m-2)) was replaced during the site visit with a similar unit (S/N 30451F3, calibration factor 8.34 x10-6 V/(W m-2)).

Of note, a magnitude 0.507 partial solar eclipse occurred on 2/15/2018, which started at 19:24:58 UT and ended at 21:21:16 UT. The maximum eclipse was observed on 20:23:08 UT. At this time, 38.9% of the Sun were obscured by the moon and the resulting change of the solar irradiance at the surface can clearly be seen in the measurements.

3.1. Irradiance Calibration

The on-site irradiance standards used 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" that are used on a regular basis. 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 with the same method as that applied to the former traveling standard 200WN004 (see below).

The traveling standard was lamp 200WN014 and was used during the site visit in January 2018.

Comparisons of calibrations with the various lamps suggested that the three working standards were in need for recalibration. The three lamps were therefore recalibrated against the traveling 200WN014 using absolute scans performed on 1/24/18 and 1/25/18. Solar data of the reporting period are based on these new calibrations.

<u>History of on-site standards</u>
Lamps M-666 and 200W021 have been in service for a long time. Lamp M-666 was originally calibrated against lamps 200W006 and 200W021 using season closing scans of the Volume 9 and opening scans of the Volume 10 periods. Comparisons of lamp M-666 with lamps 200W021, 200W013, 200WN003 and 200WN004 performed during the site visit in January 2013 indicated a systematic bias of lamp M-666 with respect to the four other lamps of about 2% in the UV-B, decreasing to 0% at 600 nm. Lamp M-666 was recalibrated against lamp 200W021 using scans performed during the January 2013 site visit.

The original calibration of lamp 200W021 was established by Optronic Laboratories in September 1998. Lamp 200W013 was introduced in January 2008 and had been calibrated against the former traveling standard M-763 using closing scans of the Volume 17 period. Comparisons with lamps 200WN003, 200WN004, and M-666 during the January 2015 site visit indicated that the calibrations of lamps 200W021 and 200W013 have drifted. Both lamps were recalibrated against the scale of irradiance of lamp 200WN004, which was the traveling standard at the time, using data collected at the start of the site visit in January 2015.

Traveling standard

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. Comparisons of the lamp 200WN014 with the long-term standards of McMurdo and Palmer Station performed during the last two years suggest that this lamp has not drifted since it was calibrated.

Figure 3.1. shows a comparison of lamps M-666, 200W021, 200W013, 200WN005 and 200WN006 with the traveling standard 200WN014 based on absolute scans performed on 24 and 25 January 2018.

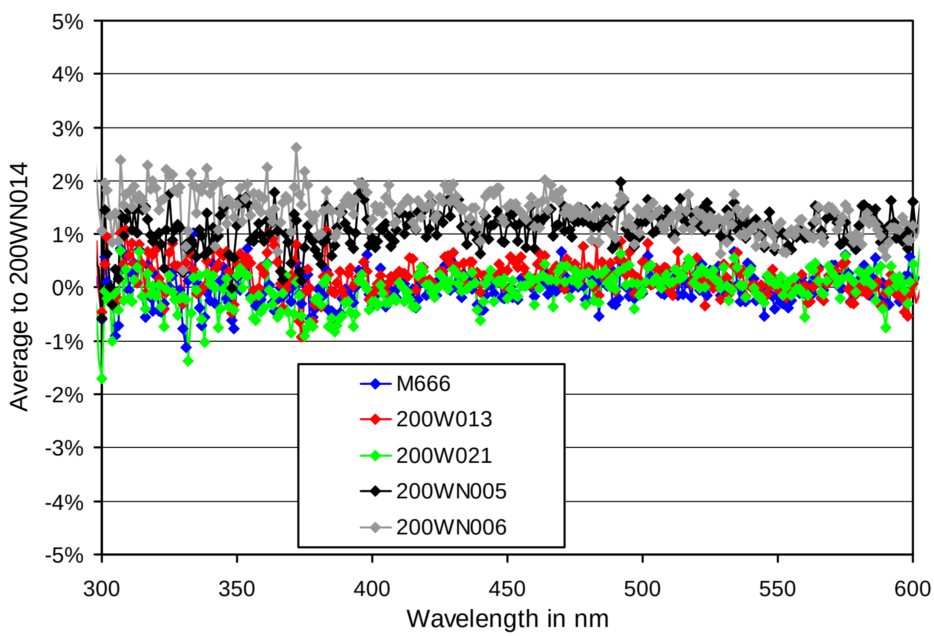

Figure 3.1. *Comparison of South Pole lamps M-666, 200W021, 200W013, 200WN005 and 200WN006 with traveling standard 200WN014 on 24 and 25 January 2018.*

The calibrations of lamps 200W021, M-666, and 200W013 agree with that of the traveling standard ideally because the same absolute scans were used to establish new calibrations for the three working standards (see above). There is a difference of about 1% to 1.5% between the scale of irradiance of these lamps and the scale of the two long-term standard, 200WN005 and 200WN006. A similar offset was also observed when comparing the lamps during the site visit in January 2016 and 2017 (see Volume 25 and 26 reports). The offset between the traveling standard and the long-term standard has not changed since the long-term standards were introduced, indicating that the scale of spectral irradiance applied to solar data of the 2017-2018 season is consistent to that applicable to previous years.

The GUV-541 radiometers was calibrated vicariously against SUV-100 data. Calibration factors of all GUV channels with exception of the drifting 320 nm channel agreed to within ±1.5% with similar factors established during the previous five years (2012 – 2017), providing confirmation of the good consistency of calibrations over time.

3.2. Instrument Stability

The stability of the SUV-100 spectroradiometer within the reporting period was assessed by comparison with data of the collocated GUV-541 radiometer and model calculations that are part of "Version 2" data edition. Figures 3.2 shows the ratio of GUV-541 (340 nm channel) and final SUV-100 measurements. The latter were weighted with the spectral response function of the GUV's 340 nm channel. The ratio was normalized and should ideally be equal to one. The graphs indicates that GUV and SUV measurements are generally consistent to within ±5%. Most 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 falls 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 and removed from the GUV dataset.

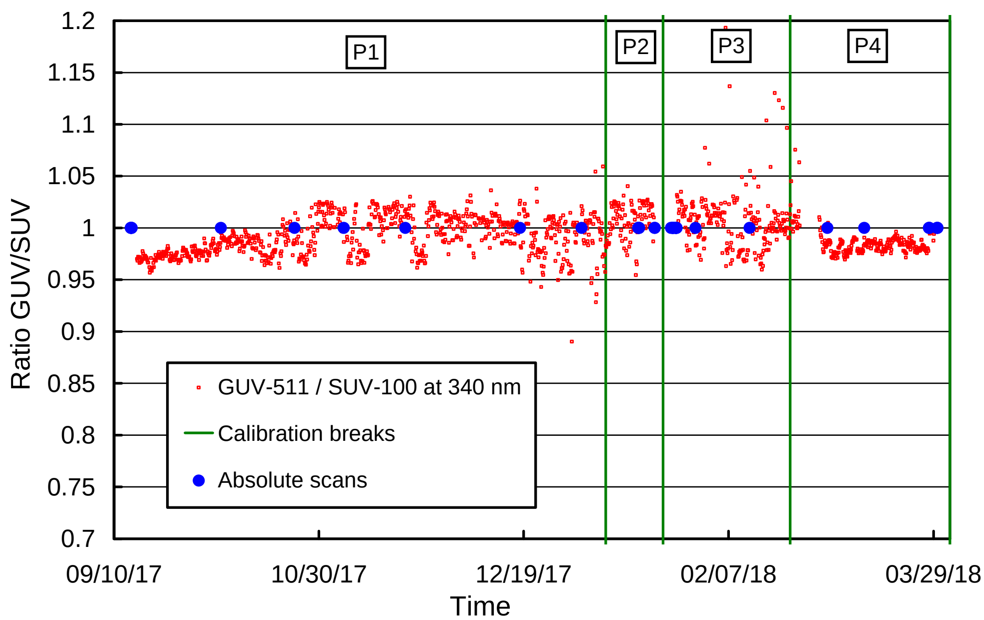

Figure 3.2. *Ratio of GUV-541 S/N 29239 measurements (340 nm channel) with SUV-100 measurements. SUV-100 data were weighted with the spectral response function of this GUV channel. The vertical green lines indicate times when the calibration applied to SUV-100 data was changed (see also Table 3.1).*

Four calibration functions were applied to SUV-100 data of the reporting period. Times when the calibration changed are indicated by vertical lines in Figure 3.2. More information on these calibrations is provided in Table 3.1. Figures 3.3 shows ratios of these calibration functions. The responsivity of the SUV-100 changed by less than 2% for the period before and the period after the site visit.

Table 3.1 Calibration periods for South Pole data of Volume 27.

Period	Period range	Number of absolute scans
P1	09/14/17 – 01/07/18	9
P2	01/08/18 – 01/21/18	5
P3	01/22/18 – 02/21/18	10
P4	02/22/18 – 04/01/18	6

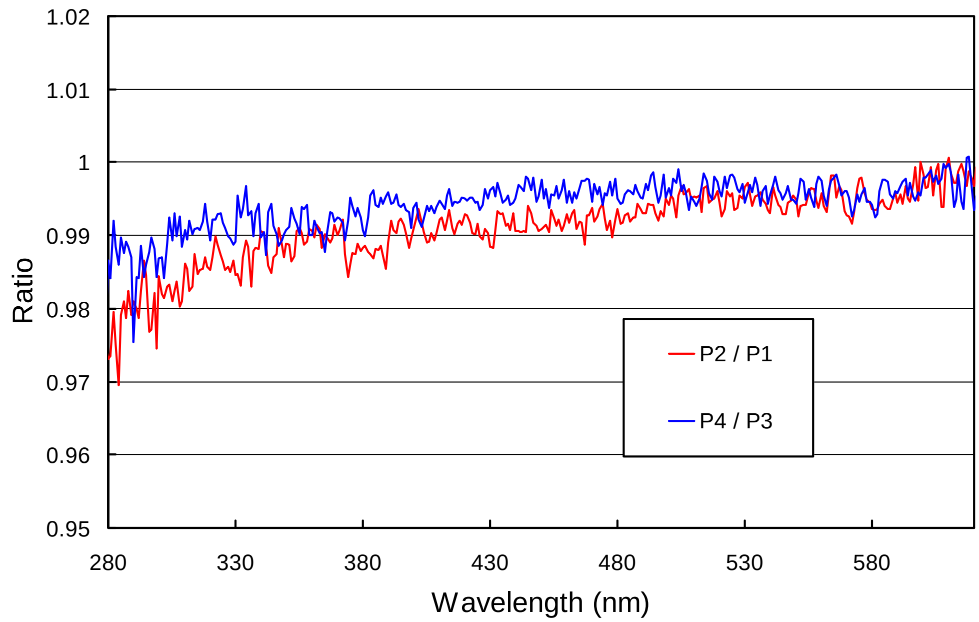

Figure 3.3. *Ratios of spectral irradiance assigned to the internal lamp. Periods P1 and P2 are periods before the site visit while Periods P3 and P4 are periods after the site visit.*

3.3. Wavelength Calibration

Wavelength stability of the system was monitored with the internal mercury lamp. Before 12/5/17, scans of the mercury lamp were only executed at the time of absolute scans because of problems with the lamp's power supply (see above). Thereafter, the lamp was scanned daily and information from these 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. Figure 3.4 shows the correction function calculated with this algorithm.

Figure 3.5 indicates the wavelength accuracy of final "Version 0" data for five wavelengths in the UV and visible range. The plot was generated by applying the Version 2 Fraunhofer-line correlation method for a second time. Residual wavelength shifts are typically smaller than ±0.15 nm. The day-to-day variability is higher than typical, in particular after 12/18/17. the reason for this increased variability is not known. The wavelength accuracy was further improved when processing Version 2 data by breaking the dataset into 38 periods and calculating separate correction functions for each period. Figure 3.6 indicates the wavelength accuracy of final "Version 2" data

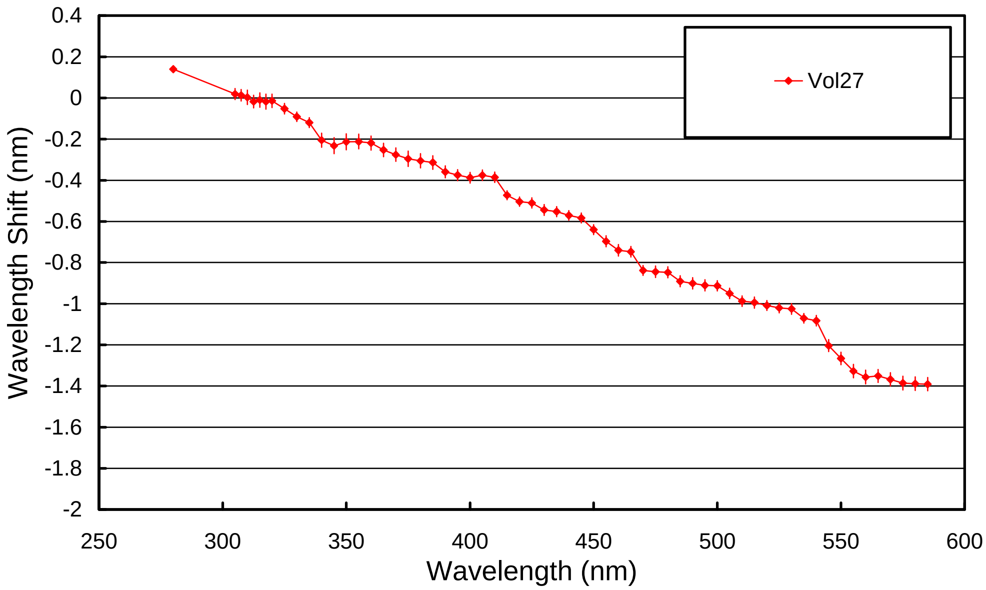

Figure 3.4. *Monochromator non-linearity correction function.*

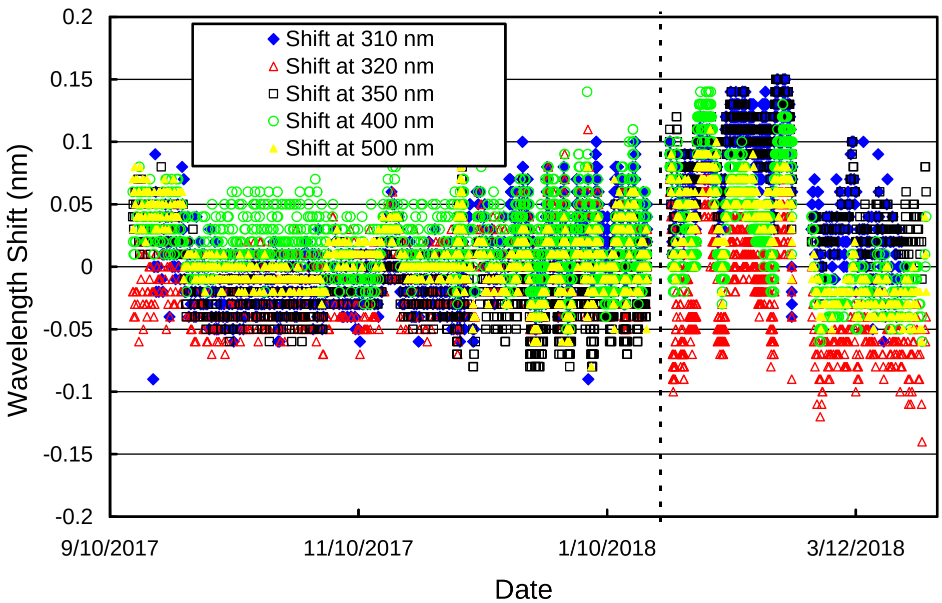

Figure 3.5. *Wavelength accuracy check of* <u>*Version 0*</u> *data at five wavelengths by means of Fraunhofer-line correlation. The vertical broken line indicates the time of the site visit.*

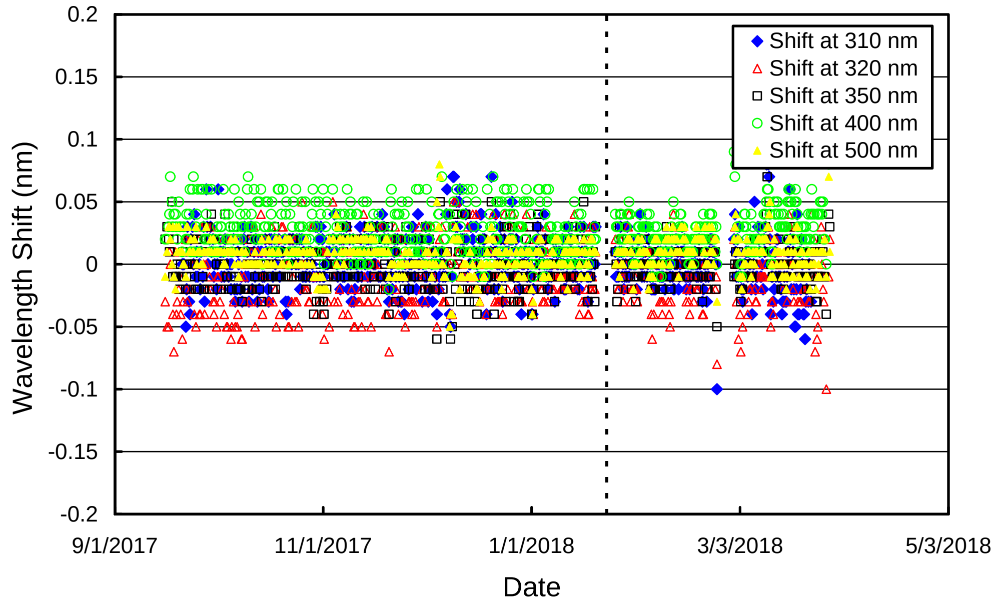

Figure 3.6. *Wavelength accuracy check of* *<u>Version 2</u>* *data at five wavelengths by means of Fraunhofer-line correlation. The vertical broken line indicates the time of the site visit.*

3.4. Missing data

There are no solar data for the period of the site visit between 1/19/18 and 1/25/18. There are also no solar data between 2/25/18 and 2/28/18 due to a communications error between the system's Spectralink controller and the computer. The satellite window was not favorable to correcting the problem remotely. There are no other significant data gaps.