3. Amundsen-Scott South Pole Station (9/15/14–3/31/15)

The 2014–2015 data season at Amundsen-Scott South Pole Station is from 9/15/14–3/31/15. This is the period of the year when the solar zenith angle is smaller than 93°. The system was serviced in January 2015 by NOAA personnel. At this time, also on-site standards were compared with a travelling standard. The SUV-100 spectroradiometer worked well during the reporting period. Only a few minor problems were observed (Section 3.4) and the data records are almost complete. A total of 16,316 SUV-100 spectra were measured and assigned to Volume 24.

Data analysis uncovered that the 320 nm channel of the GUV-541 radiometer that is installed next to the SUV-100 spectroradiometer drifted by 30% between September 2014 and February 2015. The change reversed almost completely in March 2015. Because of these excessive drifts, data of the 320 nm channel could not be used. Final GUV data products were therefore produced without utilizing measurements of that channel. A comparison of calibrated GUV and SUV data 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.

Up to 1/23/15, Eppley PSP pyranometer #27228F3 was installed next to the SUV and GUV radiometers. Its calibration constant had been established by NOAA and is 8.47 10^{-6} V/(W/m^2). The instrument was replaced on 1/23/15 with PSP pyranometer #30451F3. The calibration constant of this instrument is 8.21 10^{-6} V/(W/m^2) and was established by Don Nelson of NOAA on 8/15/13.

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. Lamp 200WN004 was used as a traveling standard during the site visit in January 2015.

On-site standards

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 January 2013 site visit 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, and this calibration was also used for this reporting period.

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, 200WN005, 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 the traveling standard 200WN004 using data collected at the start of the January 2015 site visit.

Lamps 200WN004 and 200WN005 were left at the South Pole in March 2014. They are considered long-term standard 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 traveling standard 200WN004 (see below).

Traveling standard

The traveling standard 200WN004 has been calibrated by NOAA/CUCF against lamps 200WN001 and 200WN002 on 3/21/13. 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.

Figure 3.1 shows a comparison of all lamps discussed above. The plot is based on scans performed at the beginning of the site visit in January 2015. The calibrations of lamps M-666, 200W013, 200W021, and 200WN006 agree with the calibration of the traveling standard 200WN004 to within ±1%. The irradiance scale of standard 200WN006 disagrees with that of 200WN004 by up to 2% in the UV and 1.5% in the visible range. These differences are still within the uncertainty of the scale of irradiance represented by these lamps.

Lamps M-666, 200W013, and 200W021 were also compared with each other on 9/11/14 and 3/26/15. Results agreed to within ±1% on both occasions, confirming that the scale of irradiance applied to solar data of the reporting period did not change over this period.

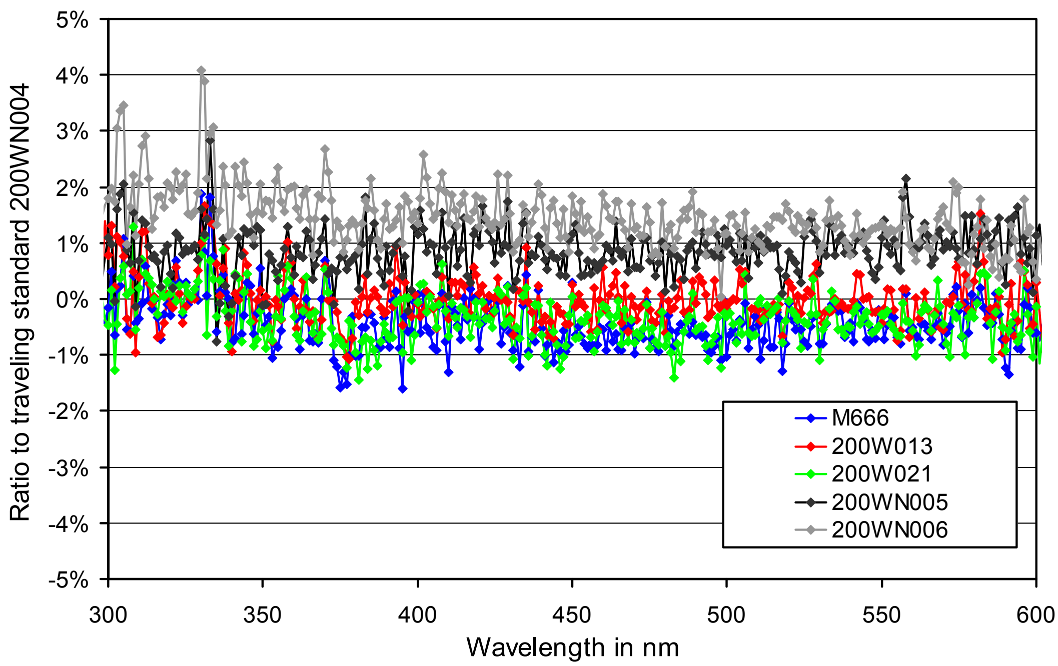

Figure 3.1. *Comparison of South Pole lamps M-666, 200W021, 200W013, 200WN005, and 200WN006 with traveling standard 200W004 at the beginning of the January 2015 site visit.*

3.2. Instrument Stability

The stability of the SUV-100 spectroradiometer over time was assessed by comparison with data of the collocated GUV-541 radiometer and model calculations that are part of "Version 2" data processing. 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 ratios were normalized and should ideally be equal to one. The graphs indicates that GUV and SUV measurements are generally consistent to within ±4%. 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 shadow 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.

Of note, calibration factors of the GUV's 313, 340, and 380 nm channels established referentially against SUV-100 measurements using data of the reporting period agree to within ±0.5% with similar factors established for the 2013/14 period (Volume 23). This excellent agreement confirms the consistency of the SUV-100 calibrations across the two periods. For reasons explained above, GUV data of the 320 nm channel could not be used to assess the stability of the SUV-100 spectroradiometer over the 2013–2015 period.

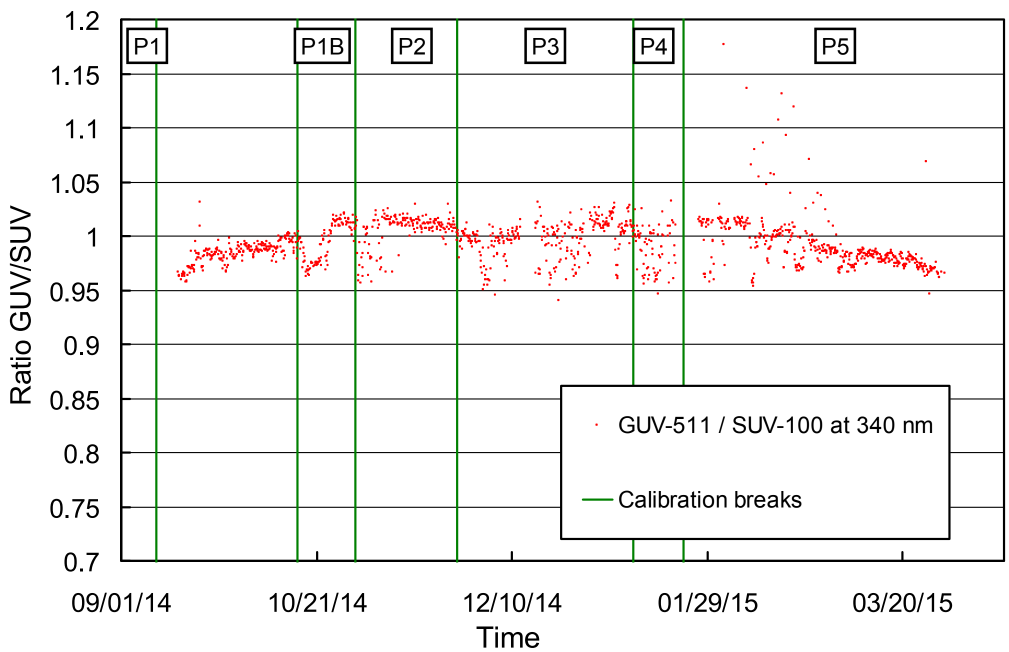

Figure 3.2. *Ratio of GUV-541 #29239 measurements (340 nm channel) with SUV-100 measurements. SUV-100 data were weighted with the spectral response function of this GUV channel. The vertical lines indicate times when the calibration applied to SUV-100 data was changed (see also Table 3.1).*

Six 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. Figure 3.3 shows ratios of these calibration functions relative to the function of the first period. Between September 2014 and the site visit in January 2015, the responsivity of the system gradually changed by approximately 3-5%. The responsivities of periods P4 and P5 differ by about 10-15%. This is a consequence of the system service performed during the site visit when the instrument was dismantled, cleaned, and reassembled. Absolute scans performed between the end of the site visit and the end of the reporting period (3/31/15) were consistent such that only one calibration function had to be applied after the site visit.

Table 3.1 Calibration periods for South Pole data of Volume 24.

Period name	Period range	Number of Absolute Scans	Remarks
P1	09/10/14 - 10/15/14	5	
P1B	10/16/14 - 10/30/14	0	Average of Period P1 and P2
P2	10/31/14 - 11/25/14	4	
P3	11/26/14 - 01/09/15	3	
P4	01/10/15 - 01/22/15	4	
P5	01/23/15 - 06/21/15	12	

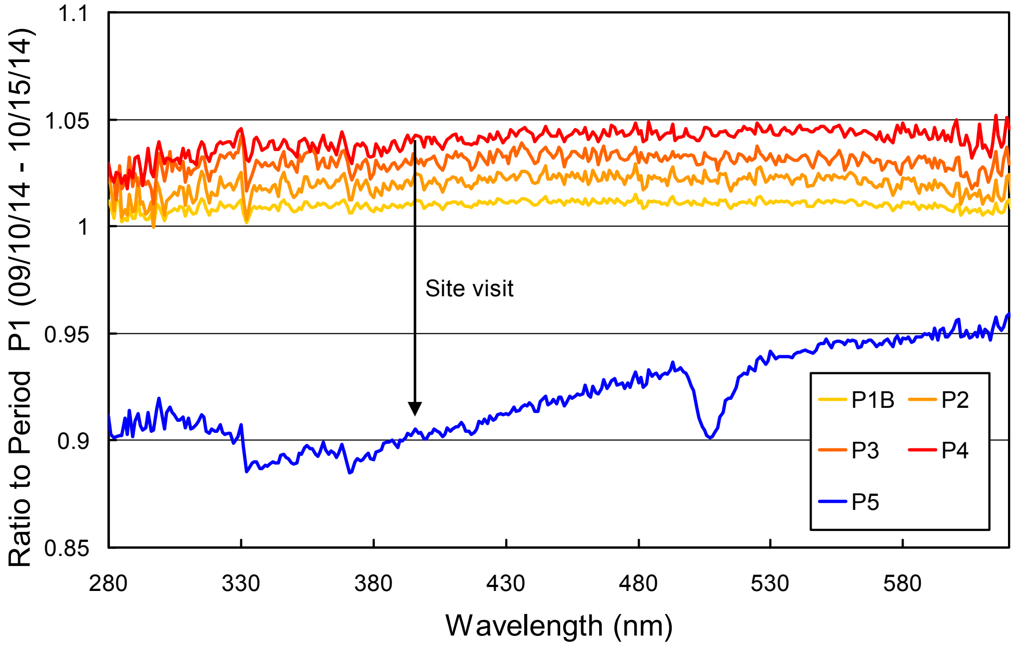

Figure 3.3. *Ratios of spectral irradiance assigned to the internal lamp relative to Period P1 (09/10/14 - 10/15/14).*

3.3. 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. Figure 3.4 shows three correction functions calculated with this algorithm from data of the periods 9/15/14 - 12/24/14 (Period 1), 12/25/14 - 1/22/15 (Period 2), and 01/23/15 - 03/31/15 (Period 3). Note that the instrument was serviced between Periods 2 and 3.

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 to wavelength-corrected data. Before the site visit in January 2015, residual wavelength shifts are typically smaller than ±0.05 nm; the standard deviation of residual wavelength shifts is 0.019 nm. After the site visit, the wavelength stability of the system was reduced; the standard deviation of the residual wavelength shifts doubled to 0.038 nm. However, shifts remained by and large within the target range of ±0.1 nm.

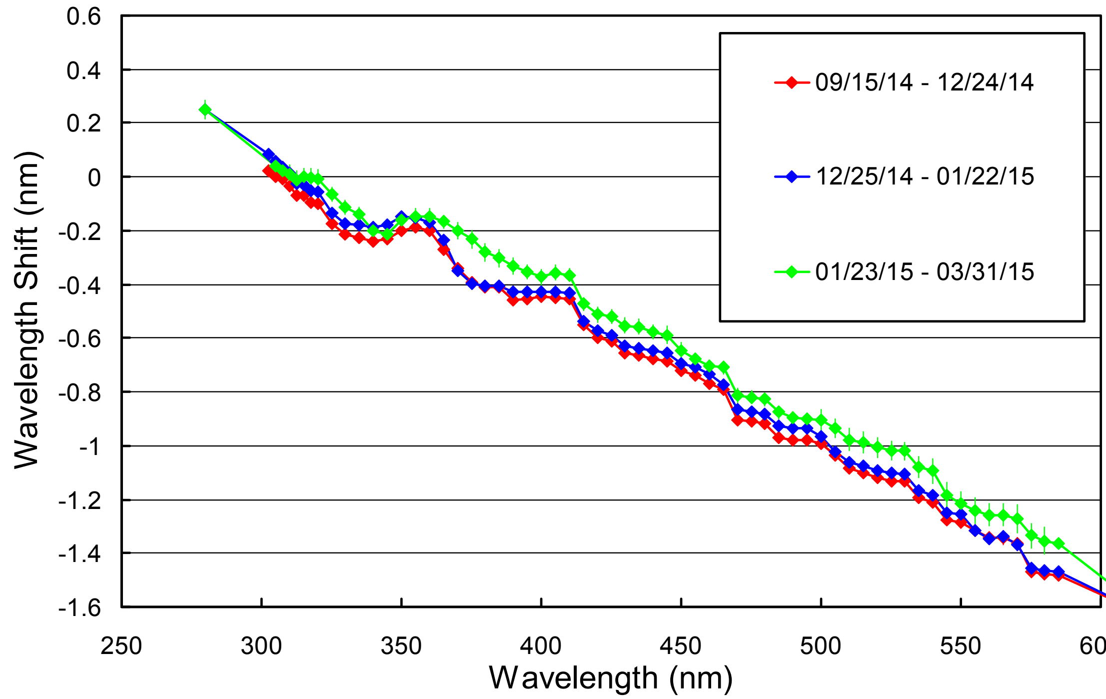

Figure 3.4. *Monochromator non-linearity correction functions for South Pole data of the period 9/15/14 - 3/31/15.*

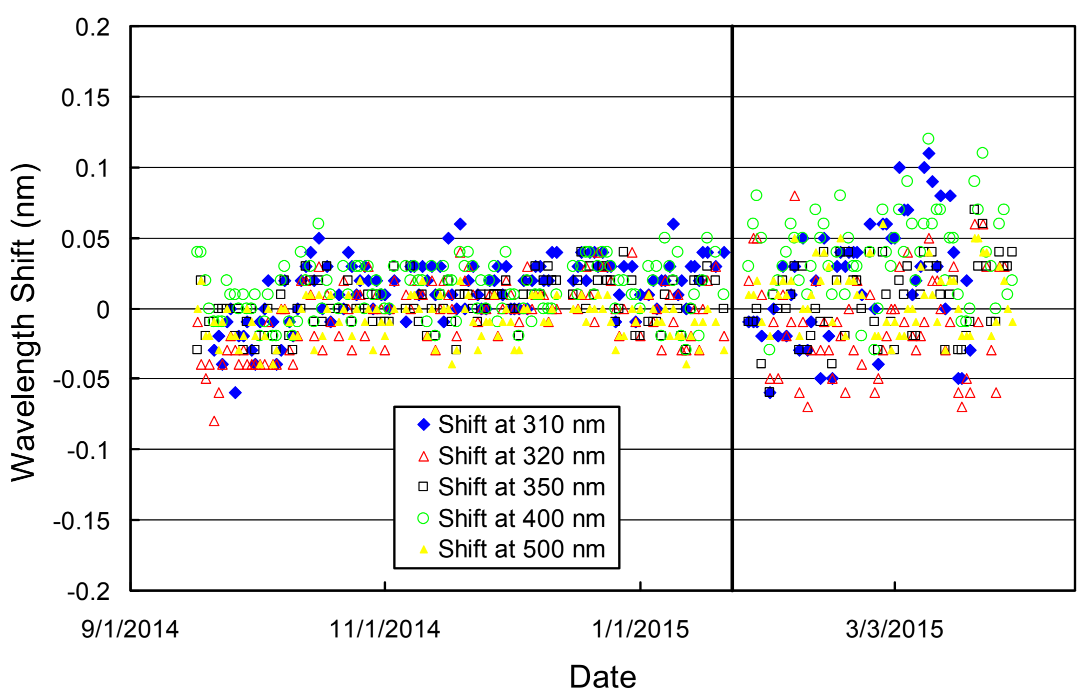

Figure 3.5. *Wavelength accuracy check of final data at five wavelengths by means of Fraunhofer-line correlation. Measurement performed at 00:00 UT were evaluated for each day of the reporting period. The vertical line indicates the time of the site visit.*

3.4. Missing data

Table 3.2 provides a list of days that have substantial data gaps, and indicates their causes.

Table 3.2 Days with substantial data gaps.

Date	Reason
12/12/14 - 12/15/14	Communication error between system control computer and monochromator control unit (Spectralink)
12/23/14	Uninterruptible power supply (UPS) accidentally switched off
12/29/14 - 12/31/14	System control computer rebooted with no apparent cause
01/18/15	Corrupt data archive
01/21/15 - 01/26/15	Site visit
01/31/15	Corrupt data archive
02/08/15	High-voltage mismatch of data and response scan