1. McMurdo Station (08/14/16 – 04/22/17)

Solar data of the SUV-100 spectroradiometer discussed in this quality control report were measured between 08/14/16 and 04/22/17 and were assigned to Volume 26. There was no site visit during this period. Up to 4/22/17, the system performed normal and its sensitivity was stable to within ±2.5%. From 4/22/17 onward, communications between the system control computer and the "Spectralink" module that controls the monochromator and digitizes the signal of the system's PMT stopped working. The problem has not been resolved as of this writing. The datasets consists of 17,202 solar spectra.

The system's PSP radiometer that was installed during the reporting period had the serial number of 32760F3 and its calibration factor was 7.575 $\times 10^{-6}$ V/(W m^{-2}).

1.1. Irradiance Calibration

On-site irradiance standards used during the reporting period were the lamps M-543, 200W011, 200W019, 200WN007, and 200WN008.

Lamps M-543, 200W011, and 200W019 have been in service for a long time. They were recalibrated in 2013 against lamp 200WN003 using absolute scans performed at McMurdo during the January 2013 site visit. Lamp 200WN003 was the traveling standard at this time. The 2013 calibrations of lamps 200W011 and 200W019 were used for processing of solar data from the reporting period.

Lamp M-543 burned unstable during most of the Volume 22 and 23 periods (September 2012 – April 2014) but was reasonably stable thereafter. The lamp was recalibrated against site standards 200WN007 and 200WN008 using absolute scans performed on 1/30/15. It was again recalibrated against site standard 200W011 using absolute scans performed on 2/1/16. This last calibration was used for processing of solar data of the reporting period.

Lamps 200WN007 and 200WN008 were left at McMurdo in January 2014. The two lamps are considered long-term standard and are only used during site visits.

The five on-site standards were compared with the traveling standard 200WN014 during the last site visit in February 2016 (see previous Quality Control report). At this time, the scales of spectral irradiance of the five on-site standards agreed on average to within ±0.5% with the scale of the traveling standard.

Lamps M-543, 200W011, 200W019, and 200WN007 were compared with each other at the beginning of the reporting period, on 8/15/2016. Figure 1 shows the percentage difference of the lamps' calibration relative to the average of all lamps. The scales of irradiance of all lamps agree to within 1.5%.

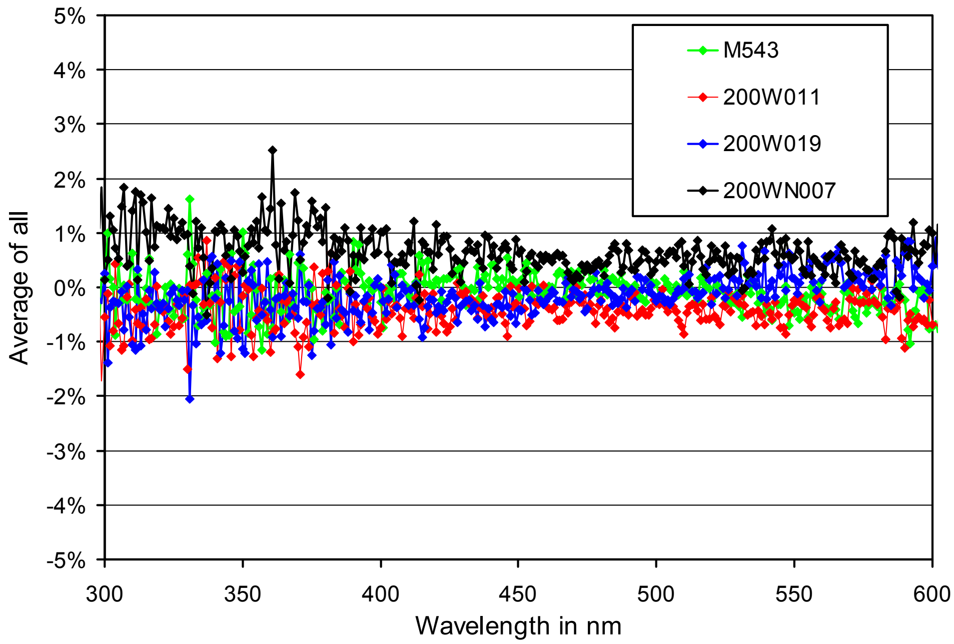

Figure 1. *Comparison of McMurdo on-site standards M-543, 200W011, 200W019, and 200WN007 using absolute scans performed on 8/15/2016.*

1.2. Instrument Stability

The temporal stability of the SUV-100 spectroradiometer was assessed by (1) analyzing measurements of the internal reference lamp, (2) analyzing absolute scans using the on-site standards, (3) comparing SUV-100 measurements with data of the collocated GUV-511 radiometer, and (4) comparing with results of a radiative transfer model. Results of the four methods are reviewed below.

Figure 2 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. TSI readings decreased by about 2.5% during the reporting period, indicating that the internal lamp was getting dimmer. For a perfectly stable system, TSI and PMT measurements would track each other in response to a change in the lamp's output. In actuality, PMT measurements at both wavelengths increased by about 2% between 14 August 2016 and the end of October 2016, and decreased thereafter by about 4%. By pairing solar scans with scans of the internal response scan performed on the same day as the solar measurements, changes of the system's sensitivity (as indicated by changes in PMT current and/or monochromator throughput) are corrected.

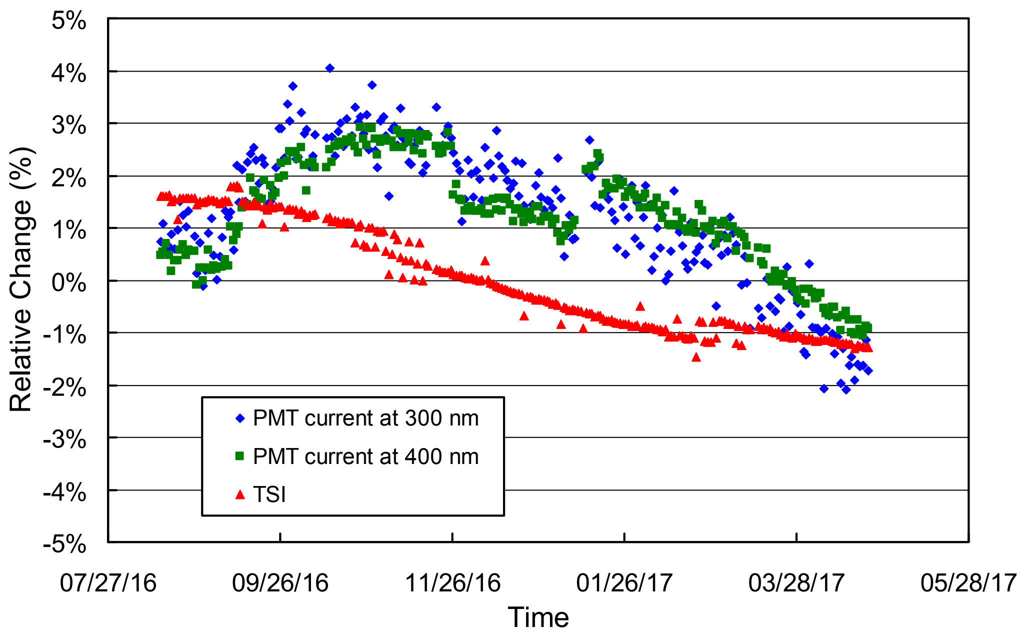

Figure 2. *Measurements of the SUV-100's TSI sensor and PMT currents at 300 and 400 nm. Data are shown as relative change.*

Examination of scans of the on-site standards confirmed that the system was quite stable during the reporting period. Normal calibration procedures were applied, resulting in four calibration periods, labeled P1 - P4 (Table 1). Figure 3 shows ratios of irradiance spectra assigned to the internal reference lamp during these periods relative to the spectrum of Period P1. Changes in responsivity were smaller than 4% in the UV-B, about 2-3% in the UV-A and less than 2% in the visible.

Table 1: Calibration periods for McMurdo Volume 26 SUV-100 data.

Period name	Period range
P1	08/14/16 – 10/08/16
P2	10/09/16 – 01/10/17
P3	01/11/17 – 03/29/17
P4	03/30/17 – 05/01/17

Figure 4 shows the ratio of measurements of the 340 nm channel of the GUV-511 radiometer, which is installed next to the SUV-100 system, and final SUV-100 measurements. The latter were weighted with the spectral response function of the GUV's channel. The ratio is normalized and should ideally be one. The graph indicates that GUV and SUV measurements are consistent to within about ±5%; the standard deviation of the ratio is 2.2%. Times when the calibration changed are indicated by vertical lines.

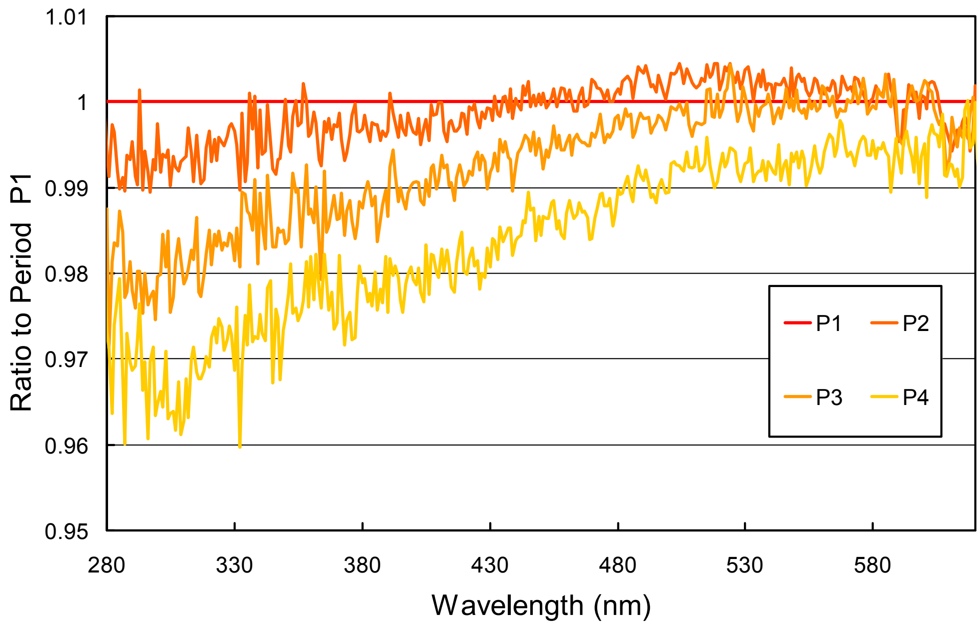

Figure 2. *Ratios of spectral irradiance assigned to the internal reference lamp during Periods P2 through P4, relative to Period P1.*

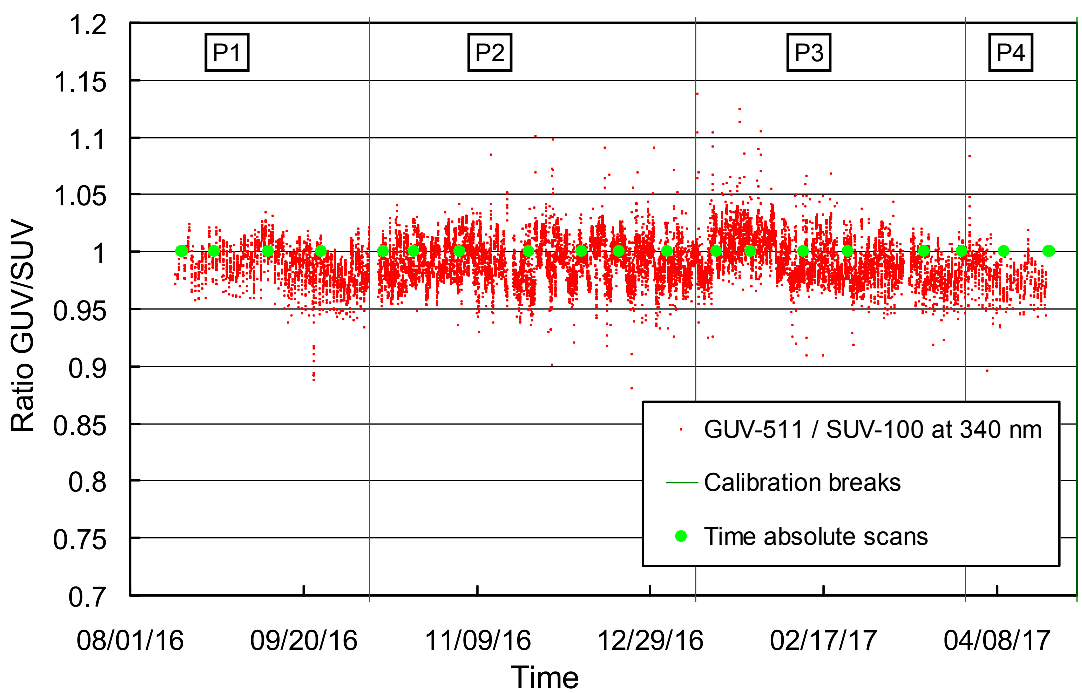

Figure 3. *Ratio of GUV-511 (340 nm channel) and SUV-100 measurements. Green vertical lines indicate times when the SUV-100 calibration was changed. The times when "absolute" calibration scans of the SUV were performed are also indicated.*

As part of Version 2 processing, clear-sky measurements are routinely compared against results of a radiative transfer model (e.g., Bernhard et al., 2004). The median of measurement/model ratios, calculated from all clear-sky data of a given volume, is typically constant to within ±2% from volume to volume. Figure 4 show these "median ratios" for Volumes 17 – 26. It can be seen that the ratio of Volume 2 data (red) is by and large consistent with those of the earlier Volumes.

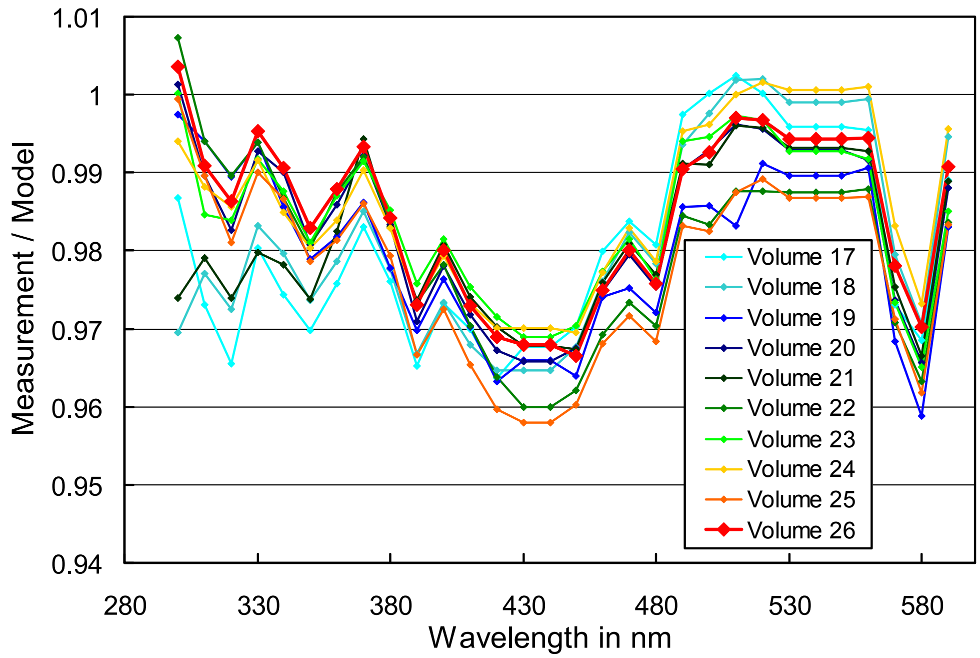

Figure 4. *Median measurement/model ratios calculated from clear-sky solar measurements for data of Volumes 17 – 26. Ratios were averaged over 10 nm intervals (305-315, 315-325, ... 585-595 nm) before the median was calculated. There is a systematic, wavelength-dependent bias between measurement and model, however, this bias varies to within ±2% for the ten volumes, confirming that the irradiance scale used for processing of Volume 26 data is consistent within this range with that used for earlier volumes.*

1.3. 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 functions calculated with this algorithm.

Figure 6 indicates the wavelength accuracy of final Version 0 data for six wavelengths in the UV and visible, which was established by running the Version 2 Fraunhofer-line correlation method a second time. Shifts are typically smaller than ±0.1 nm, but these residuals are not uniformly distributed over the reporting period. Instead shifts vary between +0.1 nm and -0.1 nm with a periodicity of about 14 days. The reason of this periodicity could not be unambiguously identified. For some periods, there is some correlation with the timing of absolute scans, but not for all periods. (During absolute scans, the system scans up to 700 nm while the standard terminal wavelength during solar scans is 605 nm. It is possible that scanning over the longer range affects the wavelength mapping of the monochromator.)

The wavelength correction was further improved when processing Version 2 data by breaking the dataset into 65 sub-periods with different correction functions. Figure 7 shows the residuals of the wavelength offsets for the Version 2 dataset. The improvement of the wavelength accuracy compared to the Version 0 dataset is (Figure 6) is obvious.

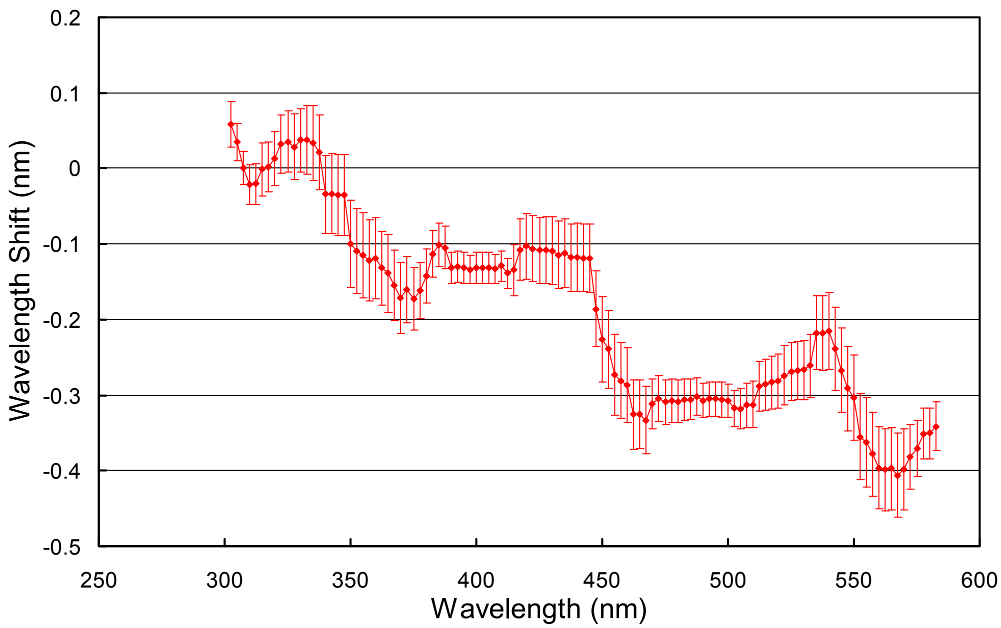

Figure 5. Monochromator non-linearity correction function for the Volume 26 period. Error bars indicate the 1σ-variation.

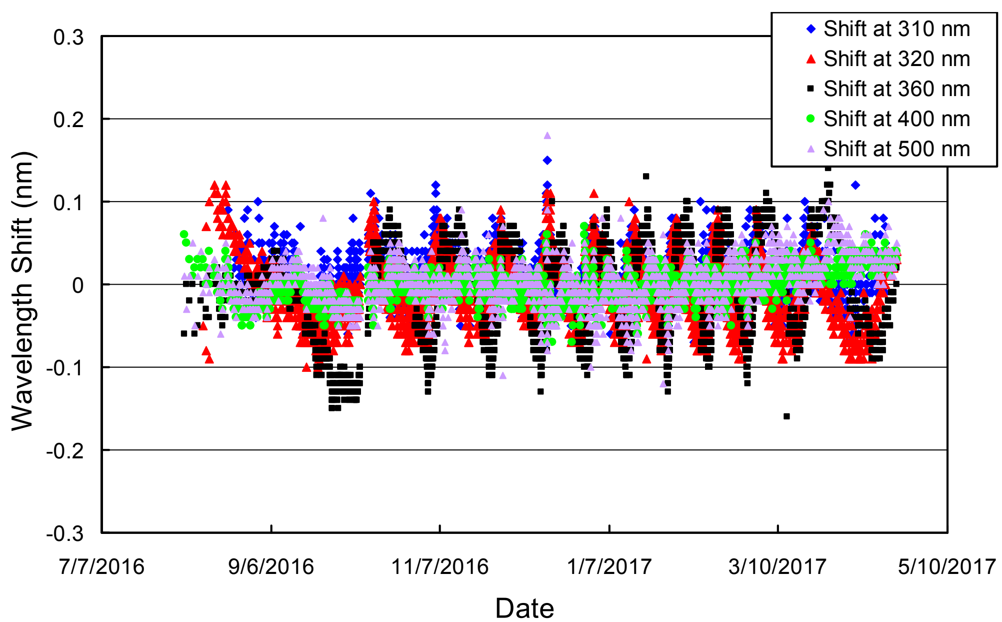

Figure 6. *Check of the wavelength accuracy of Version 0 data at six wavelengths by means of Fraunhofer-line correlation. The plot is based on hourly measurements.*

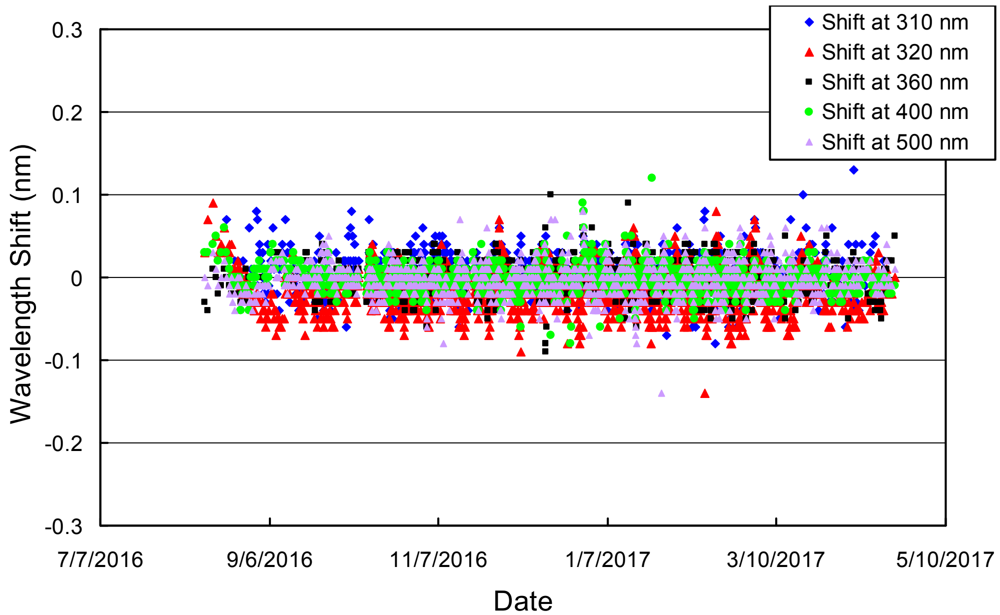

Figure 7. *Check of the wavelength accuracy of* *Version 2* *data at six wavelengths by means of Fraunhofer-line correlation. The plot is based on hourly measurements.*

1.4. Missing data

Table 2 provides a list of days that have substantial data gaps, plus indications of their causes.

Table 2: Days with substantial data gaps.

Date	Reason
10/09/16 – 10/11/16	Monochromator wavelength shifted by several nanometers. Data unrecoverable.
11/18/16 – 11/19/16	Monochromator wavelength shifted by several nanometers. Data unrecoverable.
03/12/17 – 03/13/17	GPS set incorrect time. Raw data were overwritten.
04/23/17 – 04/30/17	Computer unable to communicate with system.

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.