1. McMurdo Station (08/15/18 – 04/30/19)

Solar data of the SUV-100 spectroradiometer discussed in this quality control report were measured between 08/15/18 and 04/30/19 and were assigned to Volume 28. There was no site visit during this period. The datasets consists of 16,885 solar spectra. The system's PSP radiometer was unit 12257F3 and had a calibration factor of 8.714 $x10^{-6}$ V/(W m^{-2}). Data of the collocated TUVR radiometer were erratic and were not published.

The SUV-100 spectroradiometer performed normally during the reporting period, with three notable exceptions:

- The internal reference lamp of the system failed on 12/18/18. It was replaced with a new lamp on 1/4/19. Changes in the sensitivity of the system could not be monitored during this period by using measurements of the internal lamp. However, comparisons with solar measurements of the co-located GUV radiometer indicate that the system was stable. The quality of solar SUV-100 data is therefore not appreciably affected by the failure of the lamp.
- The electronic board that controls the system's shutter failed on 1/22/19. The component was replaced on 1/31/19. The shutter remained closed during this period and no solar radiation could be detected. There are therefore no solar data from the SUV-100 for this period.
- The system's GPS receiver did not work between 2/18/19 and 3/12/19. As a result, the computer time, which controls the time stamp of solar data, drifted. Immediately before the time-reset on 3/12/19, the computer clock was fast by 15 seconds. Data were not corrected for this time shift.

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, are "working standards" that are used on a regular basis. Lamps 200WN007 and 200WN008 were left at McMurdo in January 2014. Both lamps are designated "long-term" standards and are only used during site visits. The two standards were not used during the reporting period and the scales of irradiance assigned to the three working standards were the same as those applied during the previous (Volume 27) season, specifically:

- Lamps 200W011 and 200W019 had been recalibrated on 6/11/18 against the scale of the two long-term standards 200WN007 and 200WN008.
- Lamp M543 head been recalibrated on 8/8/16 against the working standard 200W011.

Traceability of long-term standards 200WN007 and 200WN008

Lamps 200WN007 and 200WN008 were calibrated by CUCF in August 2013 against lamps 200WN001 and 200WN002. The latter two lamps 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 when 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 did not result in a significant step-change.

The three working standards were compared on 4/22/19 (Fig. 1). The three lamps agreed with each other to within ±1%, suggesting that the three standards have not drifted appreciably since their last calibration.

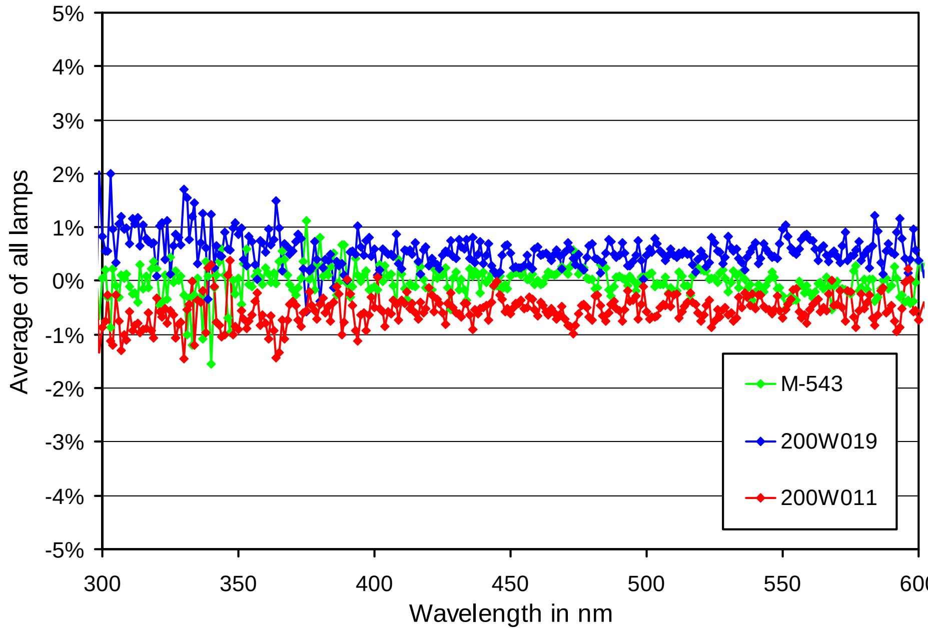

Figure 1. *Comparison of McMurdo on-site standards M-543, 200W011, and 200W019 using absolute scans performed on 4/22/19.*

The scale of irradiance maintained by the five on-site standards was further checked by comparing SUV-100 measurements with data of the collocated GUV-511 radiometer. Like in the last years, the GUV radiometer was vicariously calibrated against the SUV's measurements. Calibration factors established for the GUV's 305, 340, 380 and PAR channels for the 2017/18 period agreed to within 1.0% with those calculated for the reporting period, confirming that the scales of irradiance applied to solar data of the SUV-100 in 2017/18 and 2018/19 are consistent within acceptable limits.

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 solar measurements 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 1.5% between the start of the reporting period and time when the internal lamp failed. TSI readings with the new lamp increased by about 2.5% with the largest change observed during the first week of the lamp's operation. 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 2.5% over the period when the original lamp was in place. PMT measurements coinciding with the new lamp were stable to within ±1%. By pairing solar scans with scans of the internal response lamp that were 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.

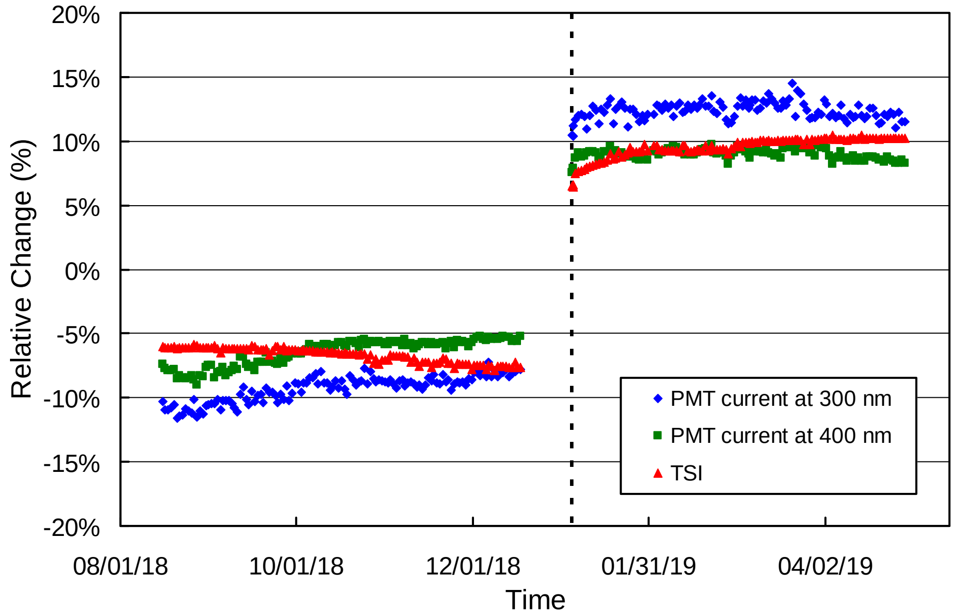

Figure 2. *Measurements of the SUV-100's TSI sensor and PMT currents at 300 and 400 nm. Data are shown as relative change and normalized to the average of the entire period. The broken vertical line indicates the time when the internal lamp was changed.*

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 two calibration periods, labeled P1 and P2 (Table 1). The two periods coincide with the periods when the first and second internal lamp were installed.

Table 1: Calibration periods for McMurdo Volume 28 SUV-100 data.

Period	Period range	Number of absolute scans	Remark
P1	08/15/18 – 01/03/19	10	Up to the time of the internal lamp's replacement
P2	01/04/19 – 04/30/19	9	From the time of the internal lamp's replacement

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 few outliers can be explained by shading from obstacles that are in the field of view of the instruments. Because GUV and SUV radiometers are not positioned at exactly the same location, shadows from these obstacles fall on the collectors of the two instruments at different times. Scans affected by shadowing were flagged in the SUV-100 Version 2 dataset, removed from the GUV dataset, but remain part of the SUV-100 Version 0 dataset.

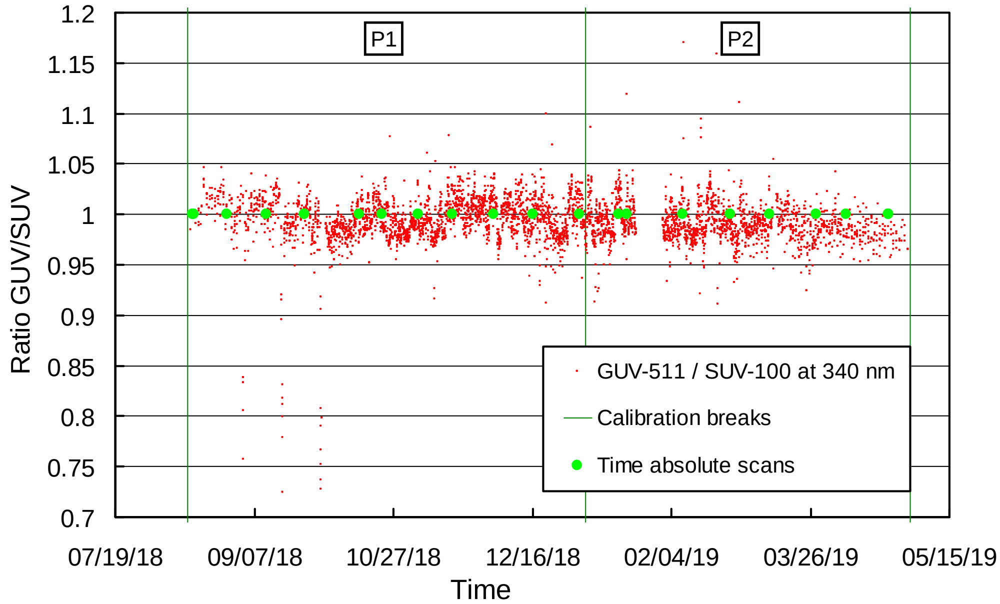

Figure 3. *Ratio of GUV-511 (340 nm channel) and SUV-100 measurements. Green vertical lines indicate times when the SUV-100 calibration was changed. The times when "absolute" calibration scans of the SUV were performed are also indicated.*

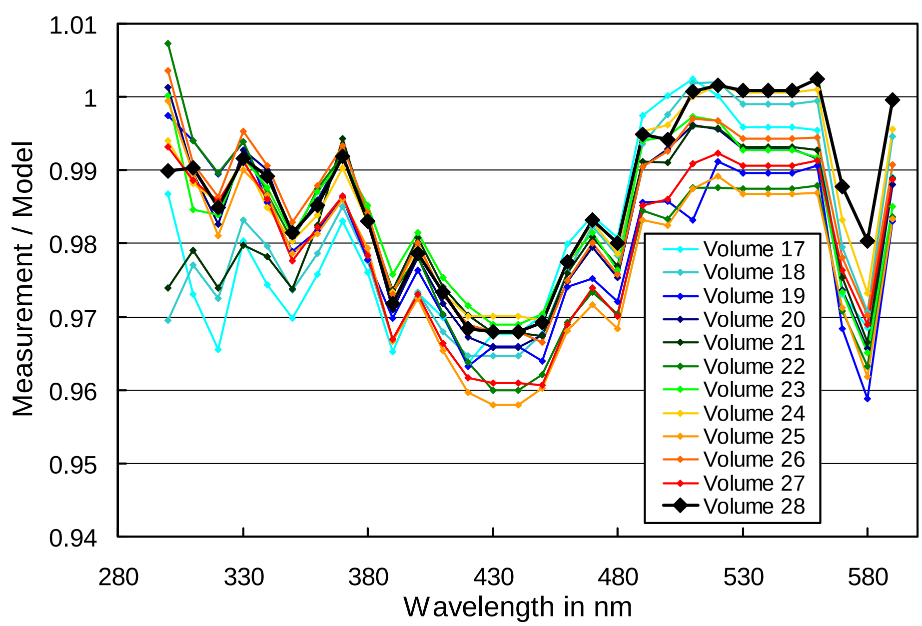

Figure 4. *Median measurement/model ratios calculated from clear-sky solar measurements for data of Volumes 17 – 28. Ratios were averaged over 10 nm intervals (305-315, 315-325, … 585-595 nm) before the median was calculated. There is a systematic, wavelength-dependent bias between measurement and model, partly because of systematic errors of the extraterrestrial spectrum used in the model calculations. However, this bias varies to within ±2% for the twelve volumes shown, confirming that the irradiance scale used for processing of Volume 28 data is consistent within this range with that used for earlier volumes.*

As a 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 – 28. It can be seen that the ratio for Volume 28 (black) is by and large consistent with similar ratios of the 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 range, which was established by running the Version 2 Fraunhofer-line correlation method for 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 and have 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 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 54 sub-periods with a different correction function applied in each sub-period. 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 (Figure 6) is obvious.

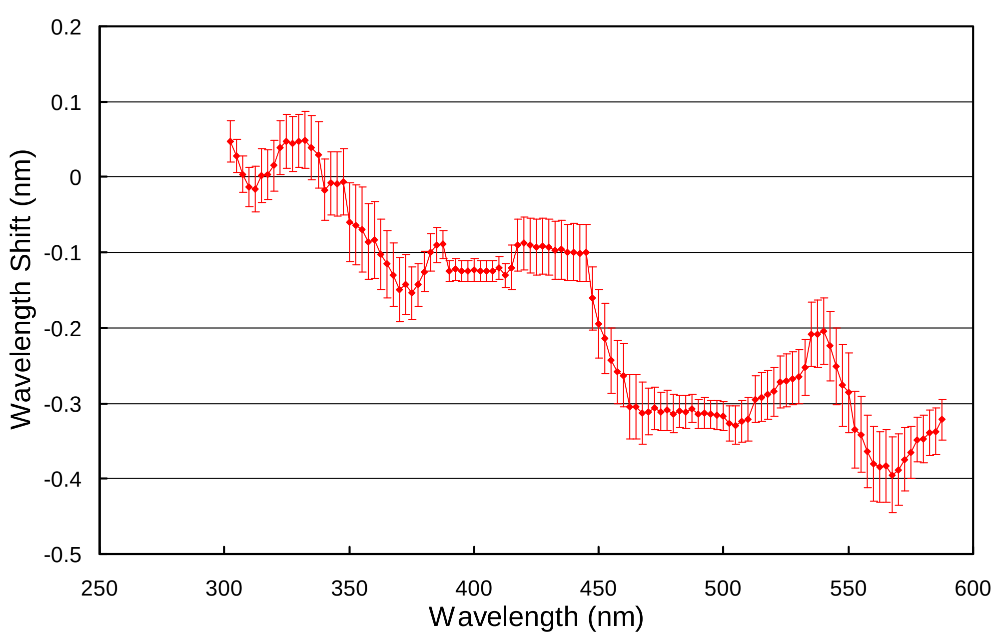

Figure 5. *Monochromator non-linearity correction function for the Volume 28 period. Error bars indicate the 1σ-variation.*

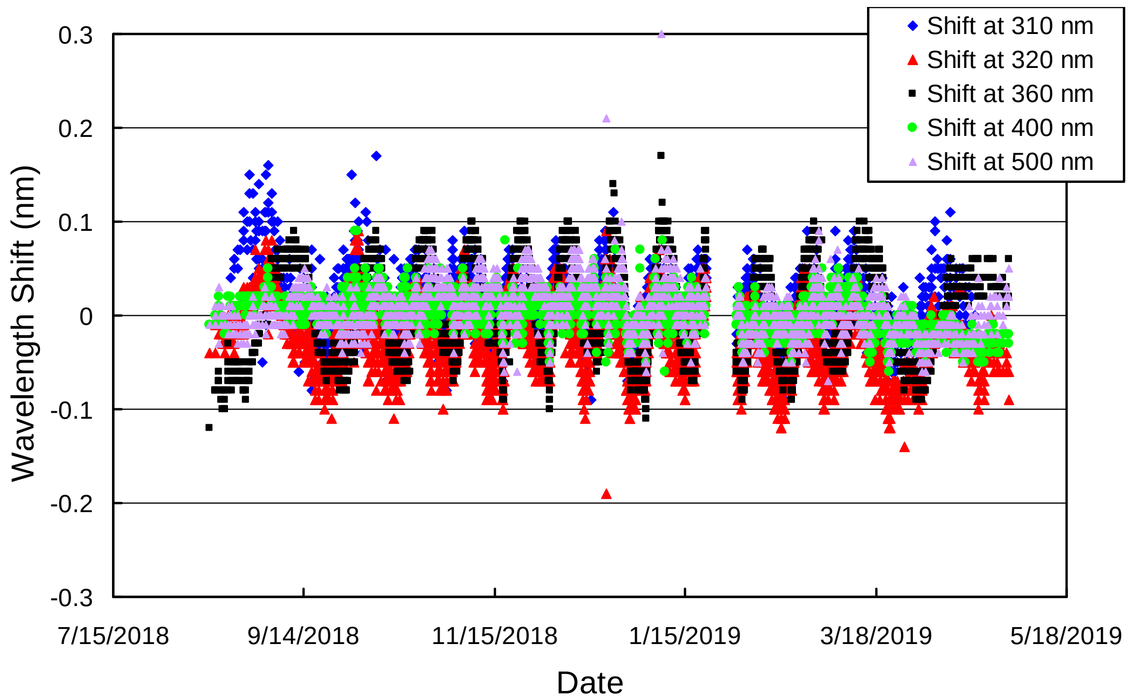

Figure 6. *Check of the wavelength accuracy of* *<u>Version 0</u>* *data at six wavelengths by means of Fraunhofer-line correlation. The plot is based on hourly measurements.*

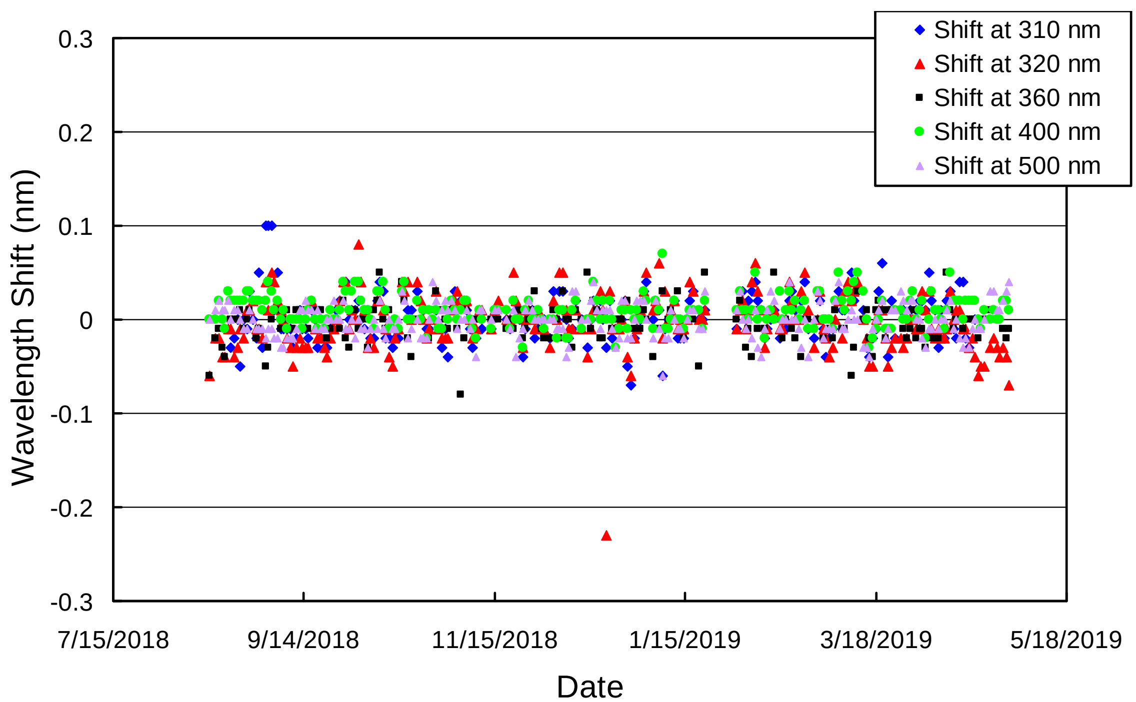

Figure 7. *Check of the wavelength accuracy of* *<u>Version 2</u>* *data at six wavelengths by means of Fraunhofer-line correlation. The plot is based on measurements at 01:00 UT (approximate local solar noon at McMurdo).*

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
01/22/18 – 01/31/18	Failure of shutter driver

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.