5.6. Barrow, Alaska (01/13/16 – 07/25/16)

This section describes quality control of solar data recorded at Barrow between 01/13/16 and 07/25/16. A total of 10,581 scans of the SUV-100 spectroradiometer were assigned to the Barrow Volume 26 dataset.

The system was stable during the reporting period and data are generally of very good quality. However, operational on-site support was limited, leading to several periods where no data are available. A list of missing SUV-100 data is provided in Section 5.6.4. The instrument was decommissioned and removed from its location at the end of the reporting period.

5.6.1. Irradiance Calibration

The site irradiance standards of the reporting period were the lamps M-699, 200W009, and 200W042, which were also used in 2012, 2013, 2014, and 2015.

Lamp 200W042 was calibrated in June 2007 at BSI with four 1000-Watt FEL lamps provided by the Central UV Calibration Facility (CUCF) at Boulder. This calibration procedure was complicated by the fact that the irradiance scale of the four FEL lamps refers to the detector-based scale of the National Institute of Standards and Technology established in 2000 (NIST2000; Yoon et al., 2002), whereas all solar data of the NSF UVSIMN refer to the source-based NIST scale from 1990 (NIST1990, Walker et al., 1987). The NIST2000 scale is about 1.3% larger than the NIST1990 scale. Data of certificates issued by CUCF were converted to the NIST1990 scale before the calibration was transferred to the site standard.

Lamps M-699 and 200W009 were originally calibrated by Optronic Laboratories (OL) in March 2001. Both lamps were brought to San Diego in 2007 and recalibrated against lamps 200W028 and 200W022. (Lamp 200W028 was the San Diego site standard at this time; lamp 200W022 is BSI's long-term standard, which preserves the OL scale from March 2001.)

The three lamps were compared with the traveling standard 200W017 in June 2013. At this time, the calibrations of lamps 200W009 and 200W042 agreed to within ±1.0% with that of the traveling standard. The difference between the calibrations of lamp M-699 and the travelling standard was slightly worse but still within the range of the uncertainty of calibration standards.

Comparisons of the three on-site lamps with each other performed during 2014 suggested that the calibration of lamp 200W009 has drifted and that this lamp is no longer burning stable. Analysis of absolute scans performed during 2015 and 2016 confirmed that the lamp is now unstable. The calibration of solar data from 2016 is therefore based on measurements of lamps M-699 and 200W042 only.

5.6.2. Instrument Stability and Calibration

The radiometric stability of the SUV-100 spectroradiometer was monitored with calibrations utilizing the two "good" site irradiance standards, daily "response" scans of the internal lamp, by comparison with measurements of the GUV-511 multifilter radiometer, and by comparisons with results of a radiative transfer model.

The stability of the internal lamp is monitored with the TSI sensor, which is independent from possible monochromator and PMT drifts. By logging the PMT currents at several wavelengths during response scans, changes in monochromator throughput and PMT sensitivity can be detected. Figure 5.6.1 shows changes in TSI readings and PMT currents at 300 and 400 nm that were derived from response scans performed between 1/1/16 and 7/25/16. During this time, the output of the internal lamp as indicated by the

TSI sensor was stable to within ±1%. The PMT currents show a similar pattern indicating that monochromator and PMT were stable at about the ±1.5% level.

The reporting period was broken down into two calibration periods. The spectral irradiance assigned to the response lamp for the two periods differed by less than 2%. These data indicate that the through-the-collector sensitivity of the system changed by less than 2% during the reporting period. Table 5.6.1 provides more information on these periods.

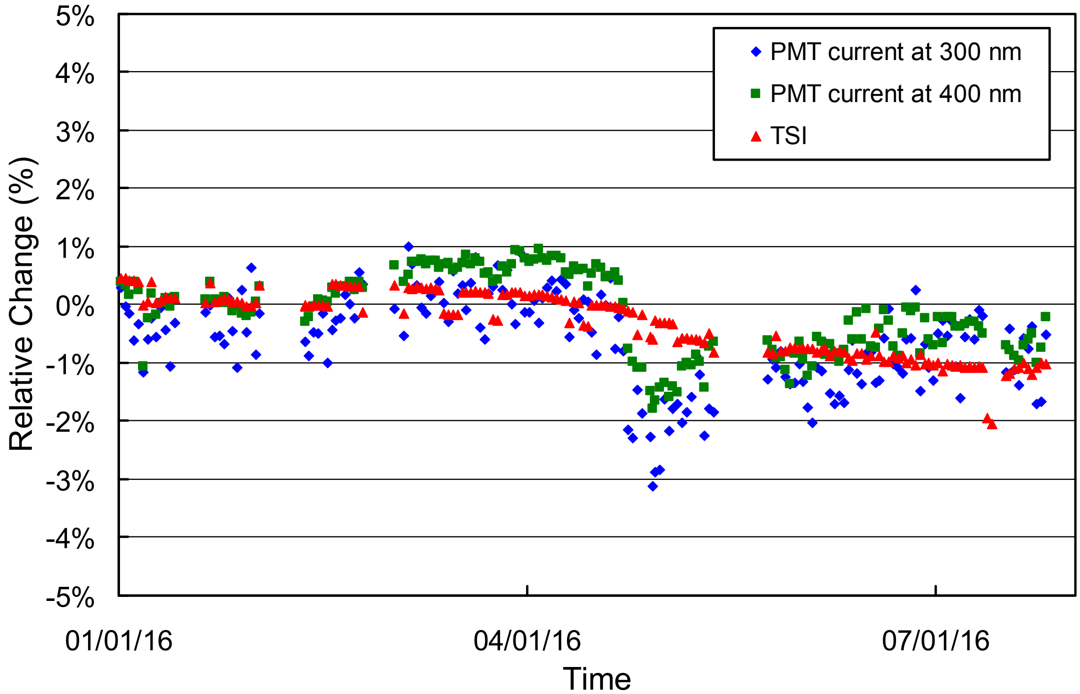

Figure 5.6.1. *Time-series of PMT current at 300 and 400 nm, and TSI signal. All data were extracted from measurements of the internal irradiance standard and are normalized to their average.*

Table 5.6.1. Calibration periods for Barrow Volumes 26.

Period name	Period range	Number of absolute scans	Remarks
P1	01/01/16 – 04/27/16	2	
P2	04/28/16 – 07/25/16	2	

SUV-100 data were also compared to measurements of the collocated GUV-511 radiometer. The ratio of GUV and SUV data at 340 nm as a function of time is shown in Figure 5.6.2. GUV and SUV measurements agree to within ±3% up to the end of May 2016. Ratios June and July appear noisier because clouds have a larger effect on downwelling UV radiation in the summer when the ground is snow-free.

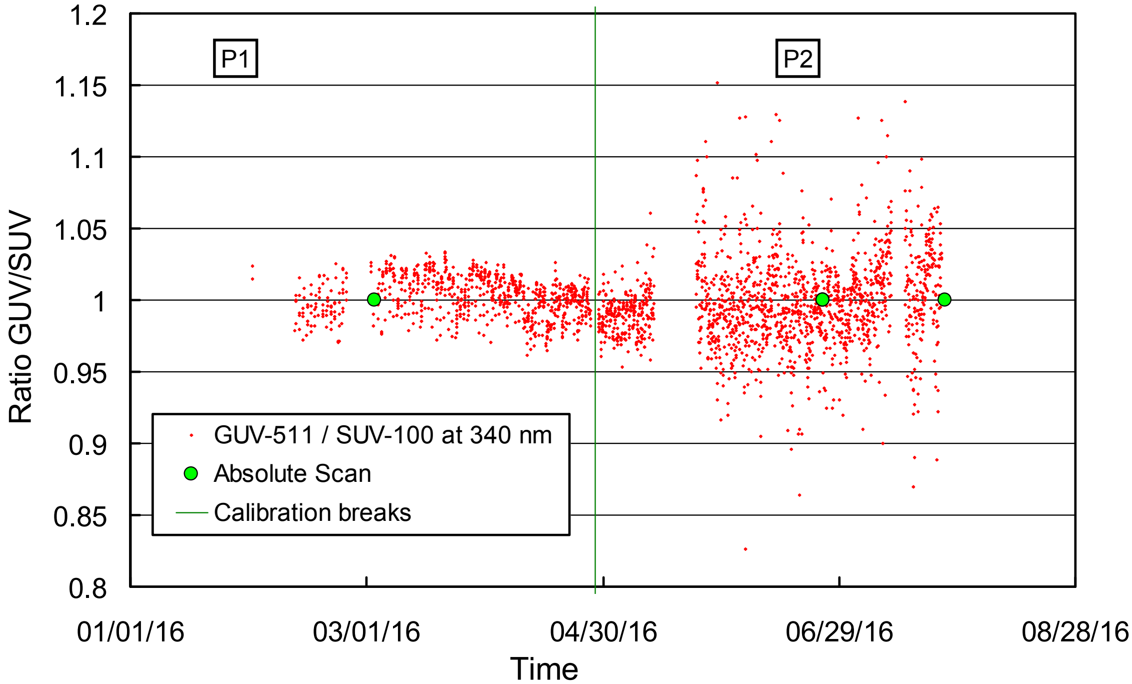

Figure 5.6.2. *Ratio of GUV-511 measurements of the 340-nm channel to SUV-100 measurements. The latter were weighted with the spectral response function of the 340-nm GUV-511 channel. Times of absolute scans and calibration breaks are also indicated.*

As a last check of data quality, SUV-100 measurements were compared with radiative transfer calculations. These calculations are part of Version 2 processing (uv.biospherical.com/ NSF/Version2/). The ratio of measured and modeled data was generally within the range observed in past years.

5.6.3. 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. Figure 5.6.3 shows the differences in the wavelength offset of the 296.73 nm mercury line between two consecutive wavelength scans. A total 158 pairs, measured between 1/1/16 and 7/25/16, were evaluated. The change in offset was smaller than ±0.035 nm in 94% of all cases. Larger offsets were observed and corrected when the instruments wavelength registration was manually changed.

The function used to correct the non-linearity of the monochromator's wavelength drive is shown in Figure 5.6.4. It was calculated with the Version 2 Fraunhofer line correlation method (*Bernhard et al*., 2004). Data were corrected with these functions and tested again with the correlation method. Results for four wavelengths in the UV and one in the visible are shown in Figure 5.6.5. Residual shifts in the UV are typically smaller than ±0.05 nm. The average standard deviation for all wavelengths between 310 and 590 nm is 0.039 nm. The wavelength accuracy of the Version 2 data set is slightly better.

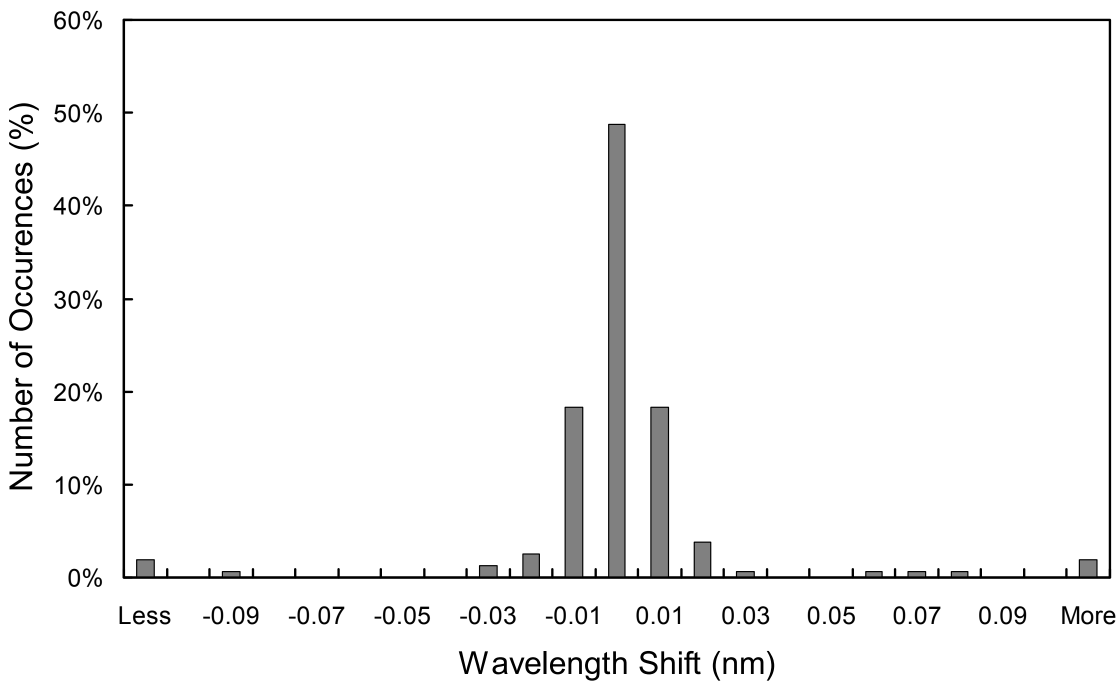

Figure 5.6.3. *Differences in the measured position of the 296.73 nm mercury line between consecutive wavelength scans. The x-labels give the center wavelength shift for each column. Thus the 0-nm histogram column covers the range -0.005 to +0.005 nm. "Less" means shifts smaller than –0.105 nm; "more" means shifts larger than 0.105 nm.*

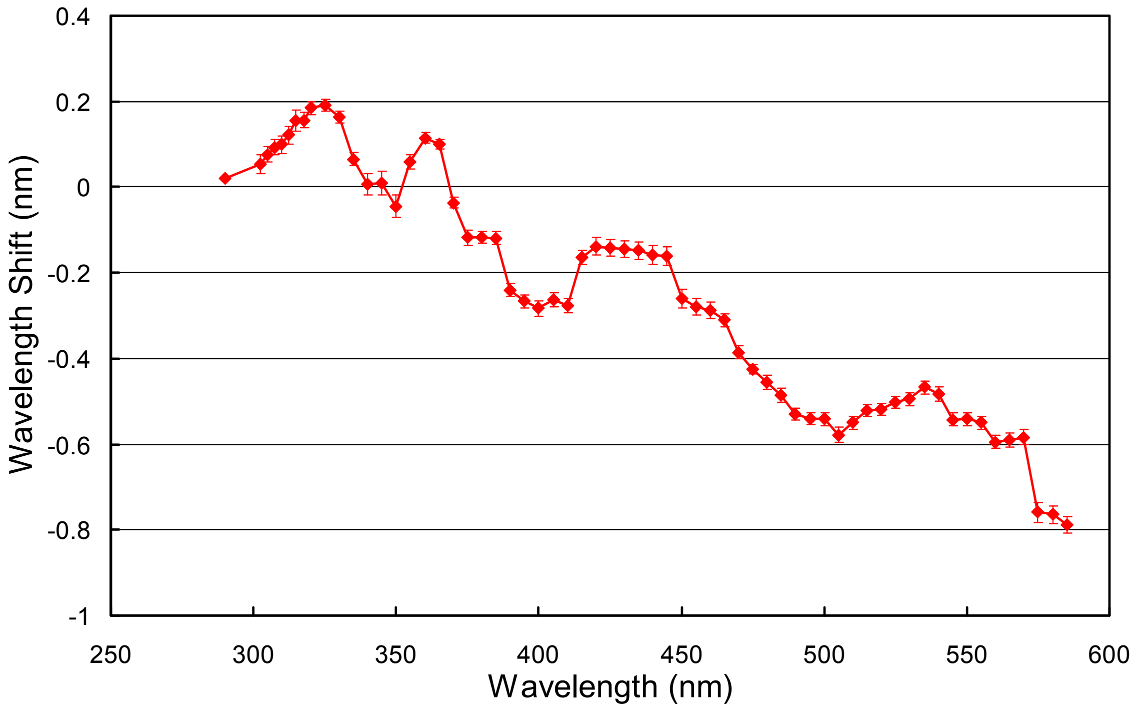

Figure 5.6.4. *Monochromator non-linearity correction function for Barrow Volume 26. Error bars indicate the standard deviation of the data contributing to this plot.*

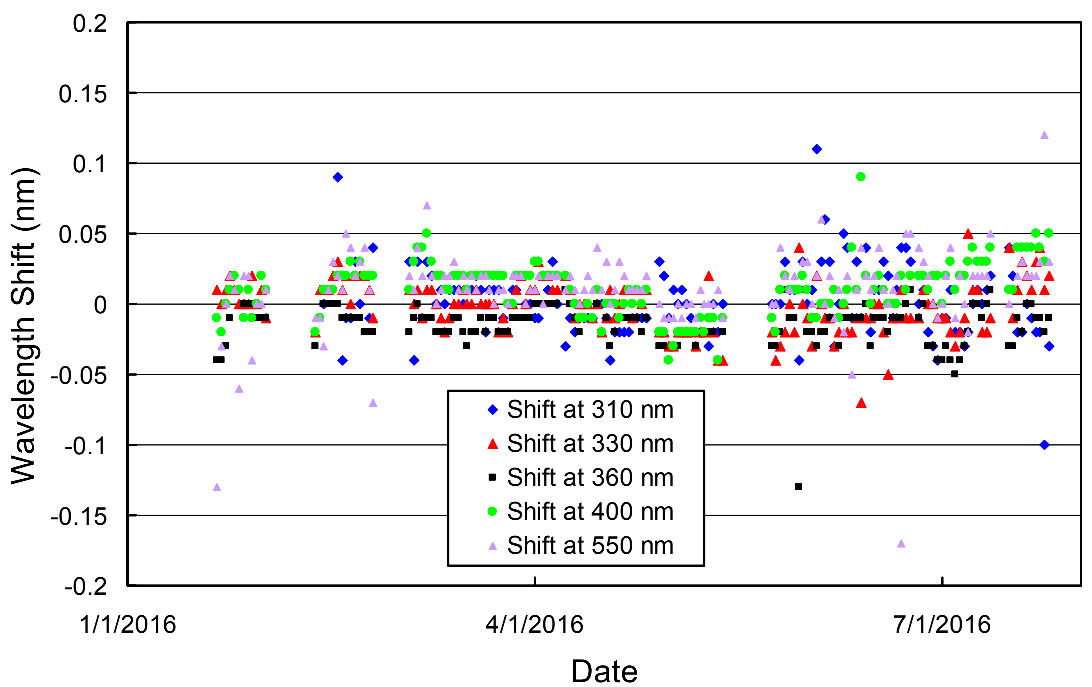

Figure 5.6.5. *Wavelength accuracy check of final data at four wavelengths in the UV and one in the visible by means of Fraunhofer-line correlation. The noontime measurement has been evaluated for each day of the reporting period when the Sun was above the horizon.*

5.6.4. Missing Data

A total of 10,581 scans are part of the Barrow Volume 26 dataset (01/13/16 – 07/25/16). Periods that are missing are listed in Table 5.6.2.

Table 5.6.2. Missing data Barrow Volume 26 dataset.

Period	Reason
01/14/16 – 01/19/16	Unknown
02/02/16 – 02/10/16	Wavelength position of monochromator lost for unknown reasons
02/25/16 – 03/01/16	Unknown
04/27/16 – 04/28/16	Software or network error
05/13/16 – 05/22/16	Unknown
07/13/16 – 07/14/16	System overheated due excess temperatures in the laboratory

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.