5.3. Amundsen-Scott South Pole Station (1/20/99–1/16/00)

The 1999-2000 season at Amundsen-Scott South Pole Station is defined as the time between the site visits 1/12/99 – 1/19/99 and 1/17/00-1/25/00. The season opening and closing calibrations were performed on 1/15/99 and 1/18/00, respectively. Volume 9 solar data comprise the period 1/20/99–1/16/00. During this time, the system operated without problems and the responsivity remained stable to within ±8%. This uncertainty could be further reduced during data analysis. About 99% of the scheduled data scans are part of the published dataset.

During the site visit in January 2000, the PSP instrument installed at South Pole was replaced by an identical instrument, which had been calibrated recently by Optronic Laboratories. The previously installed PSP was sent to Optronics Laboratories for recalibration. The new calibration factor was applied to the data in the Volume 9 season. New and old factors for the PSP deviate by 1.2%. The direction is such that irradiance values calculated with the new factor are higher.

5.3.1. Irradiance Calibration

The site irradiance standards for the 1999-2000 South Pole season were the lamps 200W006, 200W021, M-763, and M-666. Lamp M-874 was the traveling standard, which was used during season opening and closing calibrations. It was calibrated by Optronic Laboratories in September 1998. Lamps 200W006 and 200W021 have irradiance calibrations of Optronic Laboratories from November 1996 and September 1998, respectively.

Lamp M-763 has an Optronic Laboratories calibration from 1992 and has been in use at South Pole Station since 1992. It was used during the season opening site visit only and then removed from the site. Comparisons with M-874 and 200W006 in January 1998 indicated that M-763 has drifted by about 4% over the years. The lamp was therefore recalibrated for processing of Volume 7 data, and the same calibration was also implemented for Volumes 8 and 9. The new calibration is based on a comparison with M-874 using absolute scans centered around the 1998 site visit. For this cross-calibration, the 1995 Optronic Laboratories calibration values for M-874 have been used (see 1997-1998 Operations Report). The procedure applied is explained in Section 4.2.1.5.

Lamp M-666 does not have a calibration from an independent standards laboratory and was not used for calibration of the SUV-100 spectroradiometer. The lamp, however, is an important backup in case one of the site standards failed.

Figure 5.3.1 shows a comparison of 200W006, 200W021, and M-763 with M-874 at the start of the season (1/15/99). All three lamps agree on the ±1.5% level. Figure 5.3.2 shows the comparison of the site standards at the end of season. The agreement is on the same level, confirming that all lamps did not drift during the season.

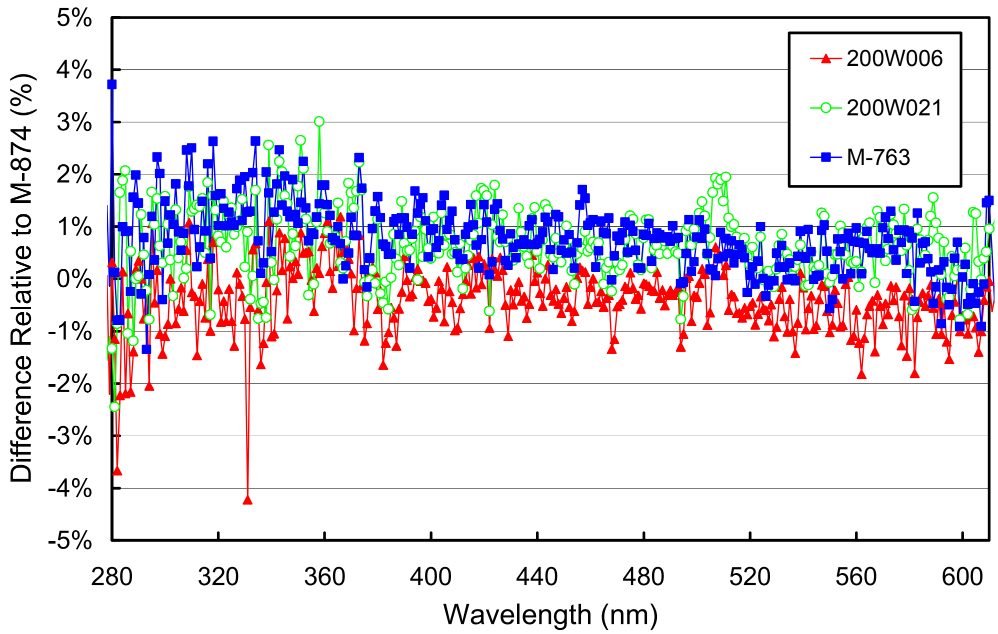

Figure 5.3.1. *Comparison of South Pole lamps 200W006, 200W021, and M-763 with the BSI traveling standard M-874 at the start of the season on 1/15/99.*

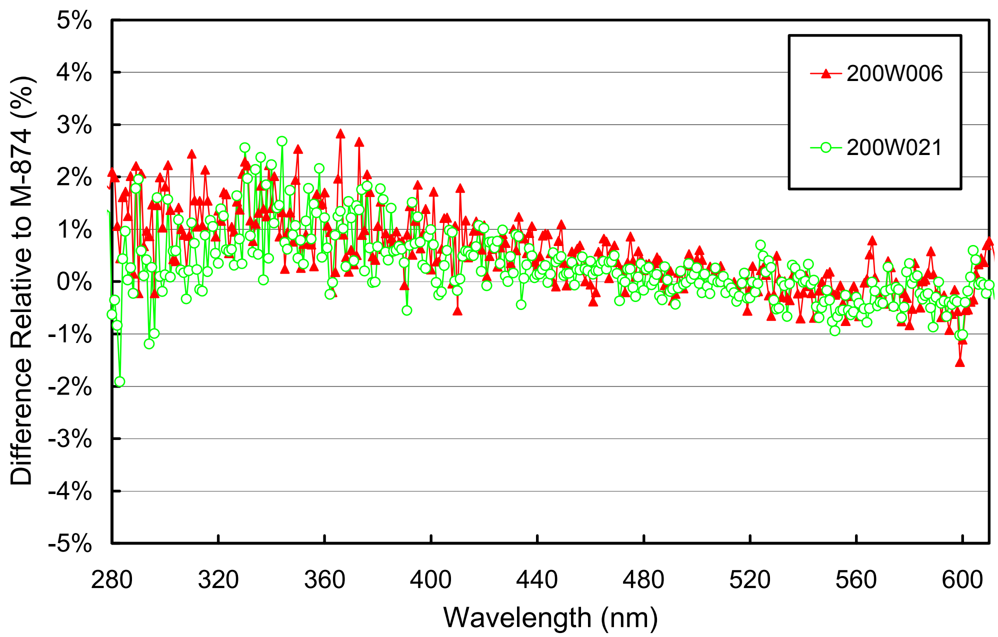

Figure 5.3.2. *Comparison of South Pole lamps 200W006, and 200W021 with the BSI traveling standard M-874 at the end of the season on 1/18/00.*

5.3.2. Instrument Stability

The stability of the spectroradiometer over time is primarily monitored with bi-weekly calibrations utilizing site irradiance standards, and daily response scans of the internal irradiance reference. The stability of the internal lamp is monitored with the TSI sensor, which is independent from possible monochromator and PMT drifts. When TSI measurements indicate that the internal lamp has drifted by more than 2%, a new irradiance is assigned to this lamp, based on the bi-weekly absolute calibrations (see Section 4.2.1.2).

By logging the PMT currents at several wavelengths during response scans, changes in the instrument responsivity can be detected. Figure 5.3.3 shows the changes in TSI readings and PMT currents at 300 and 400 nm, derived from the daily response scans of the South Pole 1999-2000 season.

The TSI measurements show that the internal lamp was stable to within ±1% during the whole season. The PMT currents at 300 and 400 nm indicate that the instrument was stable to within ±2.5%, except during two short periods during the polar night in July and August 2000.

Although the internal lamp was stable, calibrations with the 200-Watt site standards suggested that the accuracy of the instrument calibration can be increased by splitting the season in four periods, denoted Periods 1 to 4. The irradiance assigned to the internal lamp was calculated separately for all periods following the procedure described in Section 4.2.1.2. Figure 5.3.4 shows the ratios of the irradiance assigned to the internal lamp in the different periods. Changes between consecutive periods are less than 2%. Figure 5.3.5 presents the ratios of the standard deviations and average spectra, calculated from the individual spectra of each period. This ratio is useful for estimating the variability of the calibrations in each period. As can be seen, the variability is less than 1% in all periods, confirming the good stability of the calibrations.

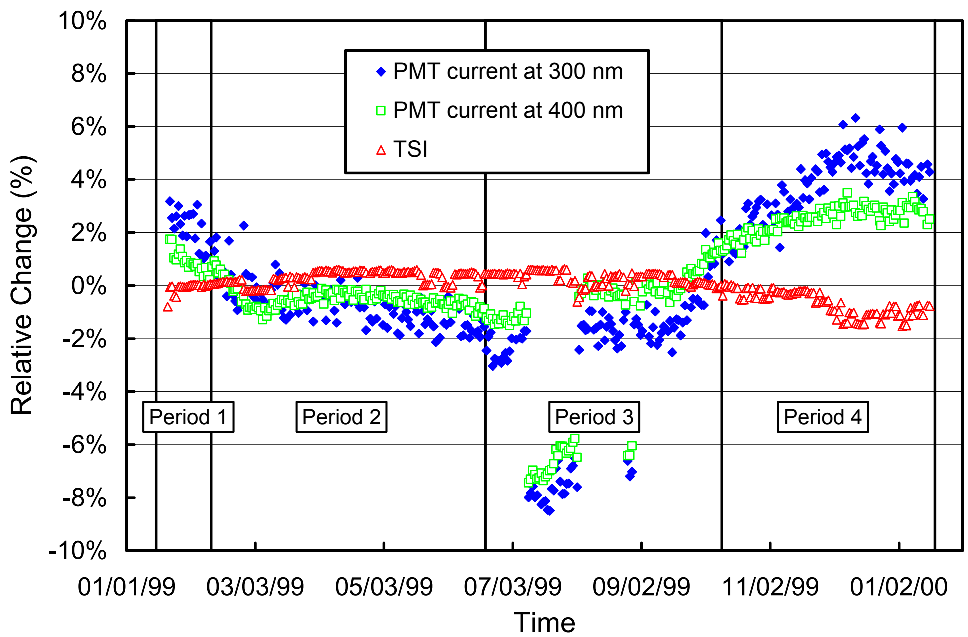

Figure 5.3.3. *Time-series of PMT current at 300 and 400 nm, and TSI signal during measurements of the internal irradiance standard performed during the South Pole 1999-2000 season. The data are normalized to the average of the whole period. The two low clusters of points in Period 3 were during the polar night.*

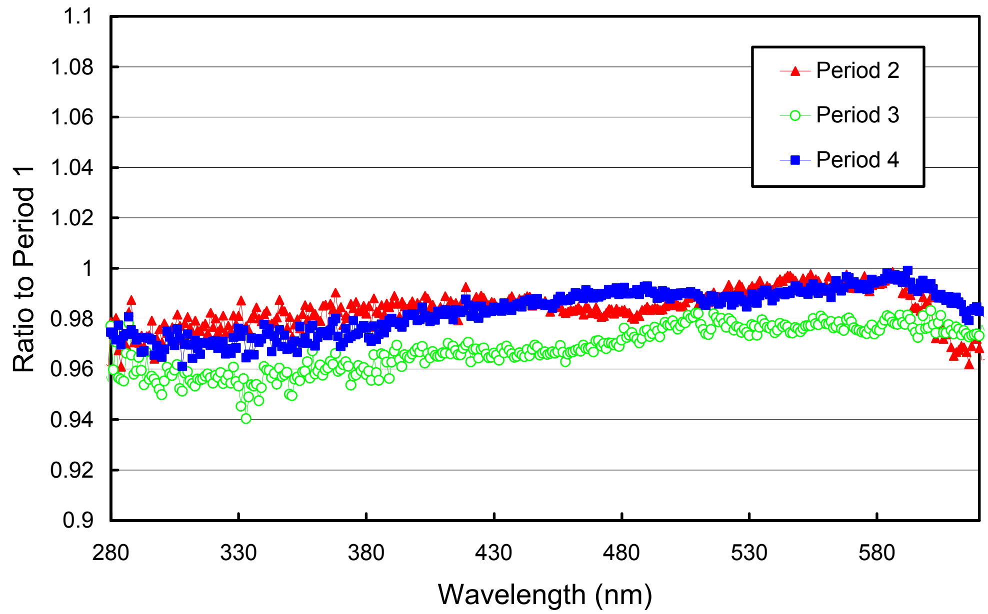

Figure 5.3.4. *Ratios of the irradiance assigned to the internal lamp in Periods 2 – 4, relative to Period 1.*

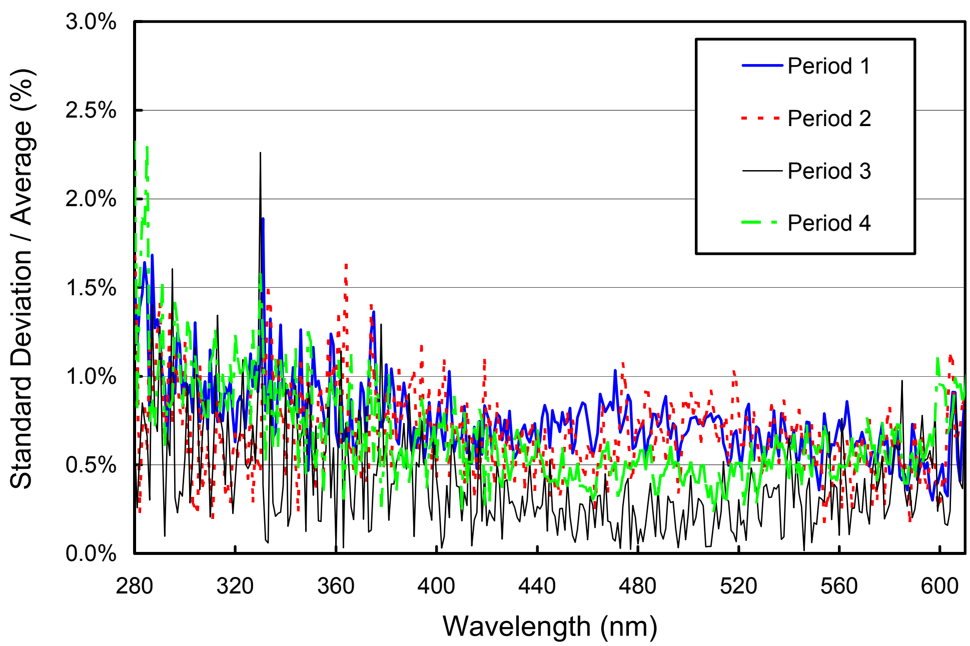

Figure 5.3.5. *Ratio of standard deviation and average calculated from the absolute calibration scans measured during the South Pole 1999-2000 season.*

5.3.3. 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. After this step, there may still be a deviation from the correct wavelength scale, but this bias should ideally be the same for all days. Figure 5.3.6 shows the differences in the wavelength offset of the 296.73 nm mercury line between two consecutive wavelength scans. In total, 219 scans were evaluated. For 94.5% of the days, the change in offset was smaller than ±0.035 nm and there were no days with shifts larger than ±0.07 nm.

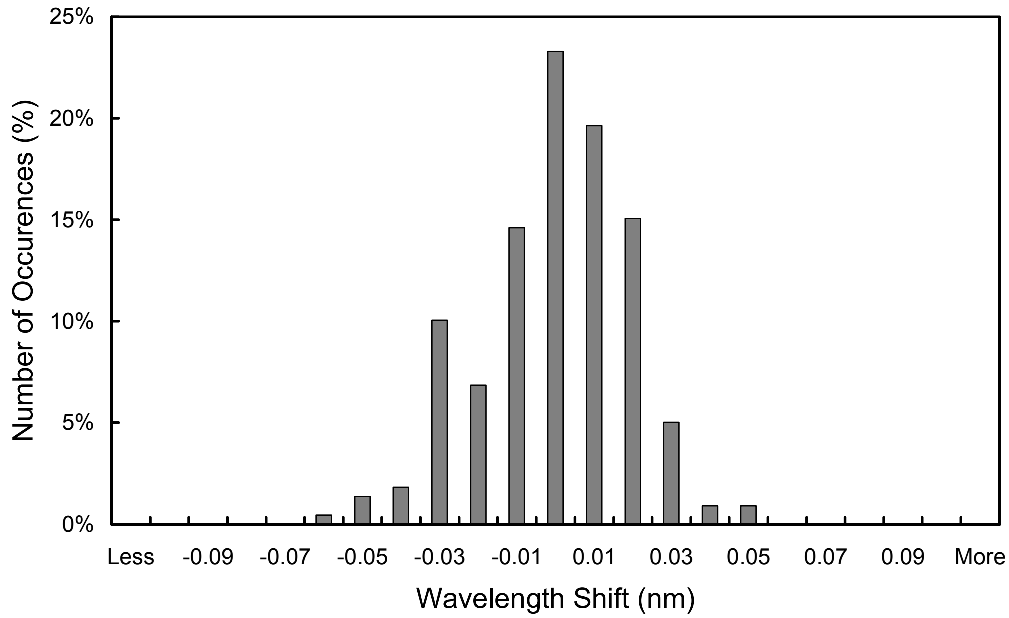

Figure 5.3.6. *Differences in the measured position of the 296.73 nm mercury line between consecutive wavelength scans. The x-labels give the center wavelength shift for each column. The 0-nm histogram column covers the range -0.005 to +0.005 nm. "Less" means shifts smaller than –0.105 nm; "more" means shifts larger than 0.105 nm.*

After the data was corrected for day-to-day wavelength fluctuations, the wavelength-dependent bias between this homogenized data set and the correct wavelength scale was determined with the Fraunhofer-correlation method, as described in Section 4.2.2.2. The thick lines in Figure 5.3.7 shows the resulting correction functions that were applied to the Volume 9 South Pole data. The function labeled "Fraunhofer Method Part 1" was applied between 1/20/99 and 12/4/99; the function labeled "Fraunhofer Method Part 2" was applied between 12/5/99 thru 1/16/00. Both functions depend on wavelength, which is caused by non-linearities in the monochromator drive. In order to demonstrate the difference between the result of the Fraunhofer-correlation method and the method that was historically applied, Figure 5.3.7 also includes the correction functions that were calculated with the "old" method, i.e., the functions are based on internal wavelength scans only. The average difference between both methods is 0.07 nm. As explained in Section 4.2.2, this bias is caused by the different light paths for internal wavelength scans and solar measurements.

After the data has been wavelength corrected using the shift-function described above, the wavelength accuracy was tested again with the Fraunhofer method. The results are shown in Figure 5.3.8 for four UV wavelengths. The residual shifts are generally smaller than ±0.05 nm. No data exist for few days shortly before and after polar night because irradiance levels are too small for achieving a good-quality correlation during this time. The actual wavelength uncertainty may be slightly larger due to wavelength fluctuations of about ±0.02 nm throughout a given day, and possible systematic errors of the Fraunhofer-correlation method (see Section 4.2.2.2).

Although data from the external mercury scans do not have a direct influence on the data products, they are an important part of instrument characterization. Figure 5.3.9 illustrates the difference between internal and external mercury scans collected during both site visits. The wavelength scale of the figure is the same as applied during solar measurements. The peaks of the external scans, which have the same light path as solar measurements, agree reasonably well with the nominal wavelength of 296.73 nm, whereas the peak of the internal scans is shifted about 0.14 nm to shorter wavelengths. External scans have a bandwidth of about 1.05 nm FWHM, whereas the bandwidth of the internal scan is only 0.78 nm. Since external scans have the same light path as solar measurements, they more realistically represent the monochromator bandpass relevant for solar scans.

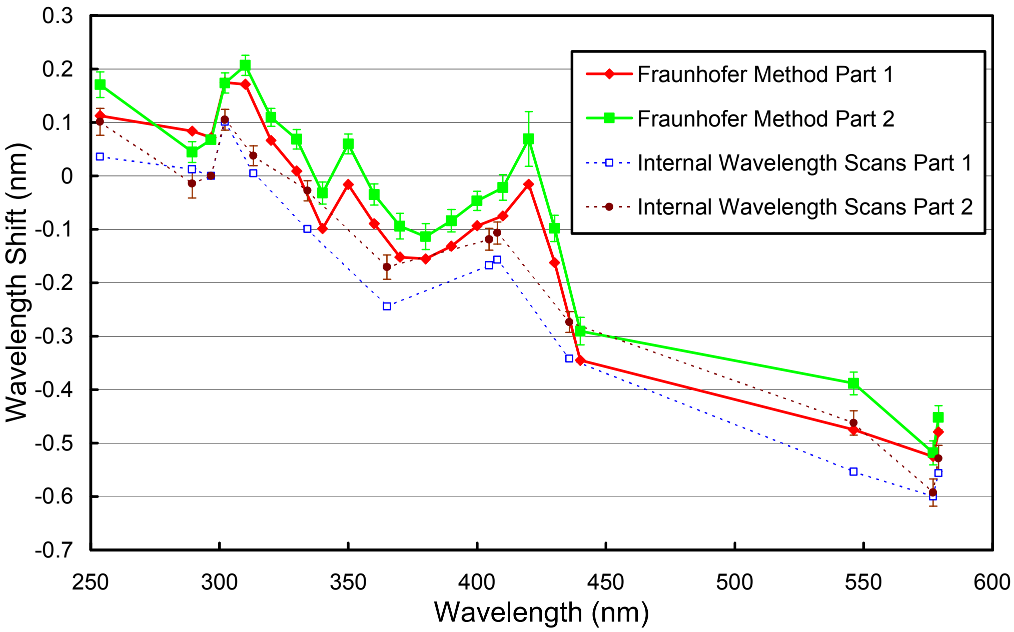

Figure 5.3.7. *Monochromator non-linearity for the South Pole 1999-2000 season. Thick lines: Correction functions calculated with the Fraunhofer-correlation method, applied to correct the South Pole Volume 9 data. Thin broken lines: Correction function calculated with the method that was historically applied. The offset difference between both methods is 0.07 nm. The error bars show the 1σ standard deviation of the wavelength shifts.*

5.3.4. Missing Data

A total of 17540 scans are part of the published South Pole Volume 9 dataset, which are 99% of all scans scheduled. Of the missing scans, 52, 225, and 189 were superseded by absolute, wavelength, and response scans, respectively. Since South Pole Station has 24 hours of sunlight per day during the austral summer, a loss of data scans cannot be avoided. For unknown reason, the system did not record a total of 56 scans on 12/10/99, 12/17/99, and 12/30/99. Due to service by the site operator, 15 scans were lost on 2/22/99. A total of 120 scans was found to be defective and therefore excluded from the dataset. Of these scans, 24 scans, measured at 06:00 and 06:15, were excluded in the period 2/9/99 – 2/21/99, when a mast of the ARO building was shading the SUV collector. The 05:30 and 05:45 scans recorded between 10/21/99 and 11/2/99 were excluded for the same reason. On 11/14/99 and 11/15/99, 62 scans were lost when the fuse of the PMT cooler power blew, which resulted in a temporary change in system responsivity. In total less than 1% of all scans were lost because of technical problems.

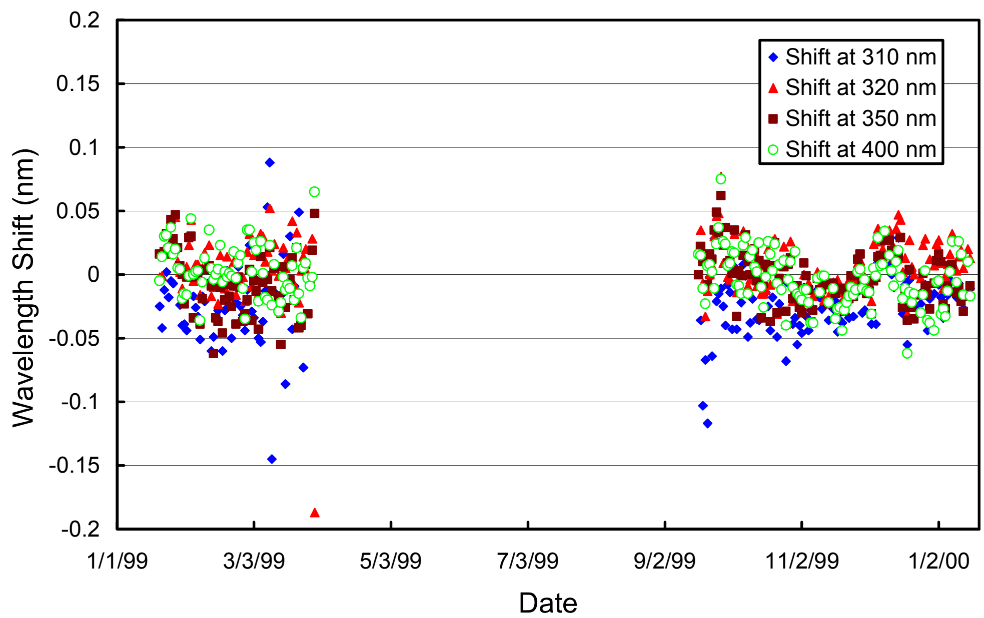

Figure 5.3.8. *Wavelength accuracy check of the final data at four wavelengths by means of Fraunhofer correlation. The noontime measurement has been evaluated for each day of the season. No data exist during polar night.*

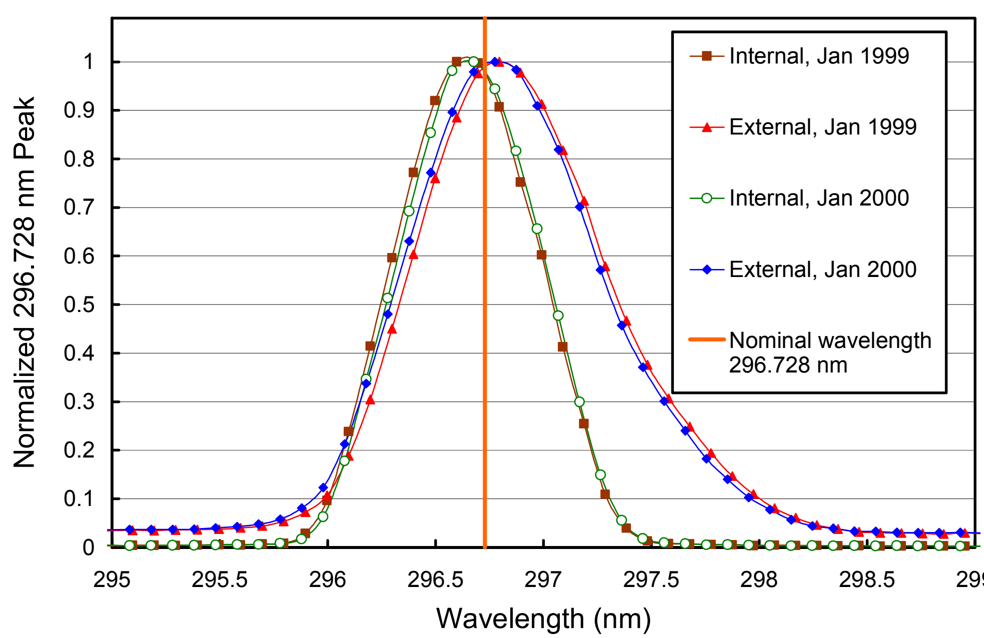

Figure 5.3.9. *The 296.73 mercury line as registered by the PMT from external and internal sources. The wavelength scale is the same as applied for solar measurements, i.e., it is based on a combination of internal scans and the Fraunhofer-correlation method.*