Difference Between Version 0 and Version 2 Data, Barrow

Figure 1 shows the ratio of Version 2 and Version 0 data as a function of time for nine different spectral integrals and dose rates $E_W(t)$, defined as:

$$E_W(t) = \int_{\lambda_L}^{\lambda_H} E(\lambda,t)\ W(\lambda)\ d\lambda \tag{1}$$

where $E(\lambda,t)$ is spectral irradiance at wavelength λ and time *t* and

$W(\lambda)$ is a weighting function (or action spectrum), describing the wavelength dependence of radiation on biological matter.

Spectral integrals were calculated by setting $W(\lambda)=1$ for the wavelength ranges 298.507 – 303.03 nm, 303.03 – 307.692 nm, 307.692 – 312.5 nm, 337.5 – 342.5 nm, 290 – 315 nm (UV-B), 360 – 400 nm, and 400 – 600 nm. Dose rates were calculated for two weighting functions, namely the action spectrum for sunburn (erythema) [*McKinlay and Diffey*, 1987] and the action spectrum for DNA damage [*Setlow*, 1974]. Shaded bands in Figure 1 indicate data of different volumes. All time series display discontinuities at volume boundaries, as instrument maintenance performed between volumes affected the system's characteristics such as cosine error and monochromator wavelength mapping. Volume 5 has been split into Volume 5A (1/27/94-6/9/94) and Volume 5B (6/12/94-10/25/95). The cosine error associated with data of the two volumes is different due to exchange of the system's monochromator during instrument service in June 1994. Similarly, Volume 6 was split into Volume 6A (10/28/95-6/5/96) and Volume 6B (6/10/96-10/20/97). During system service in June 1996, a different system control software was installed. Data files produced by the original and new software have different formats. The ratio of Version 0 and Version 2 during the period when the original software was installed exhibits a large scatter for reasons explained below.

Systematic differences between Version 0 and Version 2 are mostly caused by wavelength error and cosine error corrections. Below 310 nm, the wavelength error correction is an important factor due to the large increase of spectral irradiance in the ozone cut-off region of the solar spectrum. Differences in the 300 – 310 nm interval range between –2% and +22%. In this interval, the contribution of radiation from the solar beam contributes less than 35% to global irradiance at Barrow. The cosine error correction is dominated by the correction factor for diffuse skies, which is smaller than 1.042 for all years and independent of solar zenith angle (SZA).

Above 310 nm, the effect of wavelength errors is small and the difference of the two versions is mostly due to the cosine error correction. Differences between Version 0 and 2 peak at SZAs between 65° and 80°, depending on the spectral band. At very large SZAs, differences become again smaller due to the diminished contribution from the direct beam to global irradiance. When the Sun is below the horizon, differences are caused by the constant correction factor for diffuse skies.

The change in the dominance of wavelength error and cosine error correction can be visualized by comparing the first five plots of Figure 1, which are arranged in the order of increasing wavelength.

The first plot compares Version 0 and Version 2 for the integral 298.507 – 303.03 nm. The wavelength calibration of Version 0 data of Volumes 1 – 6 was based on scans of a mercury discharge lamp, which is internal to the instrument. Measurements of this lamp have a different light path than measurements of solar radiation through the instrument's cosine collector [*Booth et al*., 2000]. The path-difference resulted in a wavelength error of approximately 0.1 nm in calibrated solar data. The difference of 0-22% between Version 0 and Version 2 data seen in the first plot of Figure 1 for the period of Volumes 1 – 6 is predominantly caused by the Version 2 correction of the wavelength bias that affected Version 0 data. For Volumes 7 – 14, the difference of the two datasets is smaller and varies between 0% and about +5% with the exception of data from April 9, 1999, when the difference exceeded 20%. The reason of the large difference on this day is unknown but it is likely rooted in Version 0 data. Volume 7 was the first volume where the wavelength correction of Version 0 data was based on a Fraunhofer line correlation procedure [*Booth et al*., 2000] rather than scans of the internal mercury lamp.

The effect of the wavelength error correction is considerably smaller for the 303.03 – 307.692 nm integral (second plot in Figure 1) and the 307.692 – 312.5 nm integral (third plot). The effect of the cosine error shows a steady increase from plot to plot and is most pronounced for the 400 – 600 nm integral (5th plot). Here, differences between Version 0 and Version 2 can reach 20%, and peak at SZAs of about 80°. For SZAs smaller than 50°, 60° and 70°, differences are less than 7%, 9% and 15%, respectively. Ratios of Version 2 and Version 0 data show different patterns for different years. The instrument's cosine collector was changed in December 1993 and November 2000. Different collectors have different cosine error and this causes discontinuities in the ratio of the two data versions. During the first half of 1994, a different monochromator was in place, which lead to a distinctly different pattern in the difference of the two versions. Due to an insufficient number of clear-sky spectra, coefficients for the cosine and Wood's anomaly corrections [*Bernhard et al*., 2004] could not be established with confidence for this short period. Hence, the cosine error correction applied during the first half of 1994 has a relatively large uncertainty. See document Uncertainty.pdf for more explanation.

The ratio of Version 2 and Version 0 data for UV-B radiation (6 th plot of Figure 1), exhibits large scatter for Volumes 1 – 6A. Every SUV-100 spectrum is a composite spectrum of three raw-spectra that are measured consecutively in different, but overlapping, wavelength intervals [*Booth et al*., 2000]. For Volumes 1 – 6A, a different system control software was used and raw data sampled with this software have different wavelength ranges than data of later volumes. Version 0 raw-spectra sampled up 6/5/96 were stitched together in a different way than Version 2 spectra. The increased noise is an artifact of the different sampling schemes and the fact that Version 0 and Version 2 spectra in the wavelength intervals 335-345 nm and 395-405 nm were measured at slightly (i.e. minutes) different times.

For DNA-damaging irradiance (7 th plot of Figure 1), the difference of both versions varies between 0% and approximately +10%, depending on volume. Early volumes display a larger scatter due to the different sampling schemes. The cosine error correction is dominated by the diffuse correction for all volumes.

Differences for the 360 – 400 nm integral (8th plot of Figure 1) vary between –5% and +11%. Also this integral is affected by the different sampling schemes of Version 0 and 2.

For erythemal irradiance (last plot of Figure 1), the difference of both versions is less than 10%. The effect of the cosine error is slightly larger as in the case of DNA-damaging irradiance, since erythemal irradiance is weighted more toward longer wavelengths compared to DNA-damaging irradiance.

References

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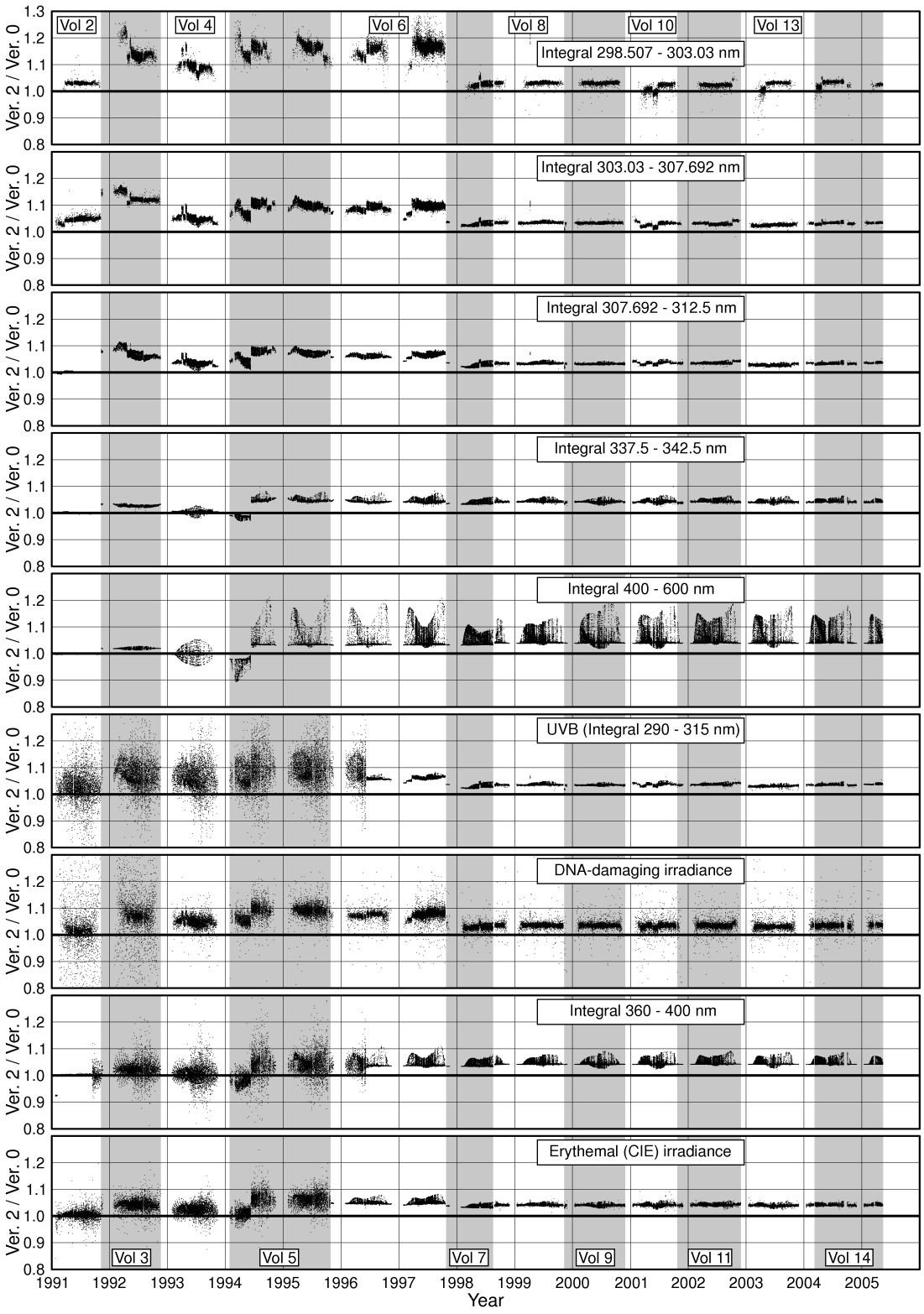

Figure 1. Ratio of Version 2 to Version 0 for the integrals 298.507 – 303.03 nm, 303.03 – 307.692 nm, 307.692 – 312.5 nm, 337.5 – 342.5 nm, 400 – 600 nm, 290 – 315 nm, and 360 – 400 nm; as well as DNA damaging and erythemal irradiance. Different shading marks data of different Volumes as indicated at the top and bottom of the graph.