## Difference Between Version 0 and Version 2 Data

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:

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

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.

The difference between Version 0 and Version 2 is 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 + 13%. In this interval, the contribution of radiation from the solar beam contributes less than 25% to global irradiance at McMurdo. The cosine error correction is therefore dominated by the correction factor for diffuse skies, which is smaller than 1.073 for all years, and independent of SZA.

Above 310 nm, the effect of wavelength errors is small and the difference of the two versions is almost entirely due to the cosine error correction. Differences between Version 0 and 2 peak at SZAs between 72° and 84°, depending on the spectral band. At very larger 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 is based on a scan 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], resulting in a wavelength error of approximately 0.1 nm when using scans of the internal lamp for the calibration of solar data. The difference of 0-20% between Version 0 and Version 2 data seen in the first plot of Figure 1 for Volumes 1-6 is therefore mostly caused by the Version 2 correction of the wavelength bias that was affecting Version 0 data.

For Volumes 7-13, the difference of the two datasets is comparatively small and varies between –5% and +7%. Volume 7 was the first volume of Version 0 where the wavelength correction was based on a Fraunhofer line correlation [*Booth et al*., 2000] procedure rather than scans of the internal mercury lamp.

Errors in measured irradiance due to wavelength shifts also depend on SZA and total ozone, since both parameters influence the slope of the solar spectrum in the ozone cut-off region [*Bernhard and Seckmeyer*, 1999]. This explains why the ratio Version 2 / Version 0 of a given volume is not completely constant.

The effect of the wavelength error correction is much 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 (5$^{th}$ plot). Here, differences between Version 0 and Version 2 can be as high as 30%, and peak at SZAs between 78° and 84°. For SZAs smaller than 65°, 70° and 75°, differences are less than 10%, 15% and 20%, respectively. Ratios of Version 2 and Version 0 data show a different pattern before and after February 2000, when the instrument's collector was modified. For example, before February 2000, differences between the two versions may either be positive or negative. After February 2000, Version 2 data are consistently higher. Replacement of the instrument's relay lens at the beginning of Volume 12 lead to larger cosine errors. This explains the step in the ratio of the two Versions between Volume 11 and 12 (The new relay lens lead to a higher throughput of the system, which partly compensates the loss in throughput caused by the collector modification in February 2000).

The difference between Version 0 and Version 2 for UV-B radiation (6th plot of Figure 1), exhibits large scatter for Volumes 1-6, although average differences are similar to those of the 307.692 – 312.5 nm integral. 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 2-6, Version 0 and Version 2 composite spectra were stitched together in a different way, and the increased noise is an artifact of the different sampling schemes.

For DNA-damaging irradiance (7th plot of Figure S7), the difference of both versions varies between –2% and +13%, depending on volume. Volumes 1-3 display larger scatter, which is rooted in the Version 0 data set. The other volumes show little intra-volume variation. The cosine error correction is dominated by the diffuse correction for all volumes.

Differences for the 360 – 400 nm integral (8$^{th}$ plot of Figure 1) vary between –10% and +12%, and their pattern resembles that of the 400 – 600 nm integral.

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.

## References

G. Bernhard and G. Seckmeyer (1999), Uncertainty of measurements of spectral solar UV irradiance, *J. Geophys. Res*., *104*(D12), 14,321-14,345.

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.

Booth, C.R., G.H. Bernhard, J.C. Ehramjian, L.W. Cabasug, V.V. Quang, and S.A. Lynch (2000), *NSF Polar Programs UV Spectroradiometer Network 1997-1998 Operations Report*, 233 pp., Biospherical Instruments Inc., San Diego.

McKinlay, A.F. and B.L. Diffey (Eds.) (1987), A reference action spectrum for ultraviolet induced erythema in human skin, in: *Commission International de l'Éclairage (CIE)*, *Research Note*, *6*(1), 17-22.

Setlow, R.B., The wavelength in sunlight effective in producing skin cancer: a theoretical analysis, *Proc. Natl. Acad. Sci. U.S.A., 71*(9), 3363-3366, 1974.

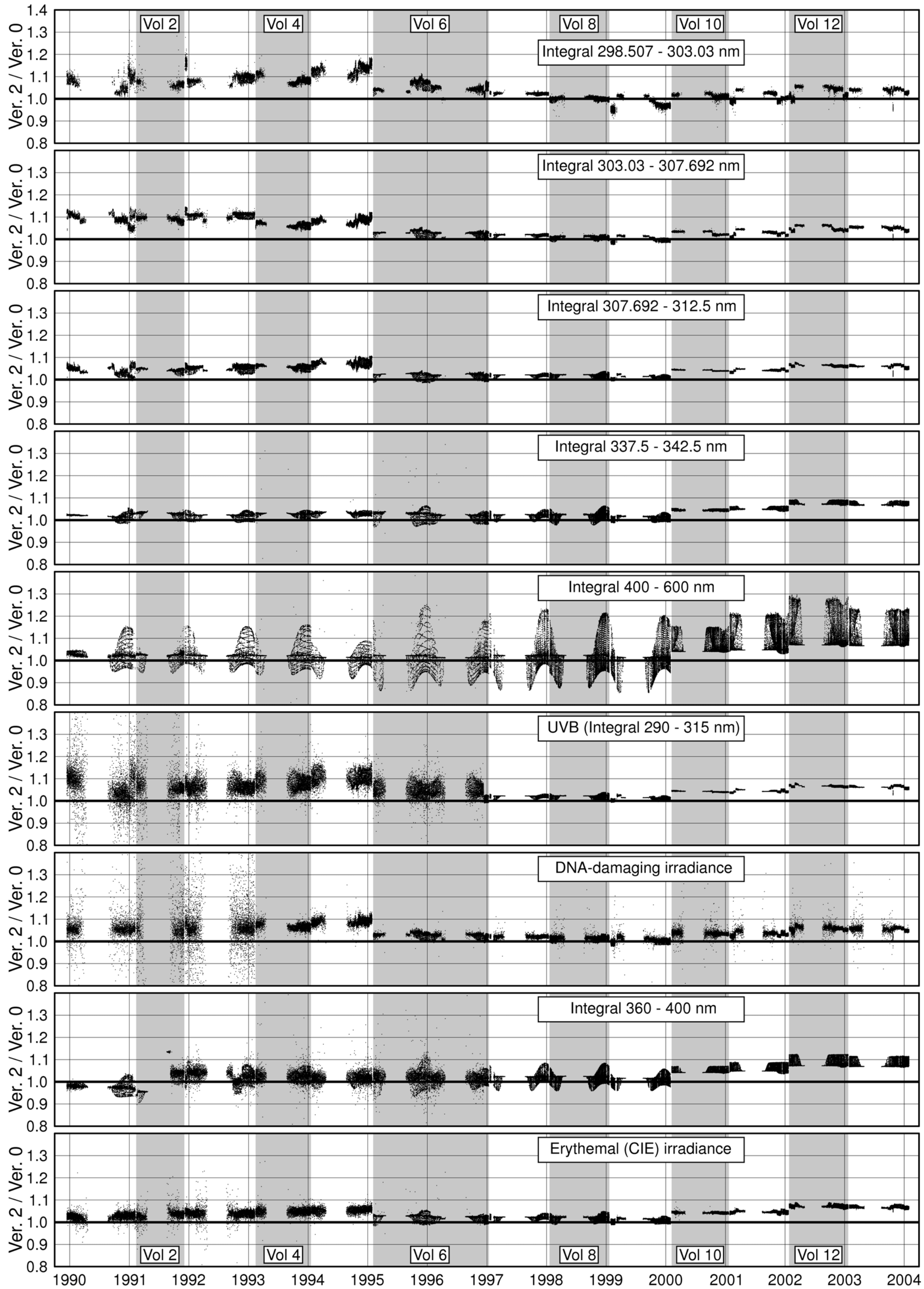


**Figure 1.** Ratio of Version 2 to Version 0 for the integrals 298.507 – 303.03 nm, 303.03 – 307.692 nm, 307.692 – 312.5 nm, 337.5 – 342.5 nm, 400 – 600 nm, 290 – 315 nm, and 360 – 400 nm; as well as DNA damaging and erythemal irradiance. Gray shading marks data that are part of even numbered Volumes as indicated on the top and bottom of the graph.