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Angular Response Characterisation of Broadband UVB Sensors with Artificial Sources

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Routine annual calibration of UVB sensors used for measurement of ultraviolet index (UVI) is necessary to ensure the accuracy of long term monitoring networks, which show increasing UVI levels caused by ozone depletion. This information is important in areas such as public health. A full description of the calibration process of such instruments is described elsewhere [1]. However, an area not well documented in the literature [2] is the cosine response dependence on the spectral distribution of the source used to perform the measurement. Though this spectral dependence may not be unexpected to some users of such instruments, for others it is something they need to be aware of.

This paper describes a study of spectral dependence of the cosine response of two different broadband UVB instruments: a Yankee Environmental Systems (YES) UVB 1 Pyranometer and an International Light (IL) 'SED240' detector with 'ACT5' and MSL custom fitted UG11 filters. Both instruments are designed to mimic the CIE Erythemal Response Function and hence measure UVI, with the former an example of a Robertson-Berger type instrument and the latter using interference filters to achieve the desired spectral response shape. Measurements were made using a Xenon-arc, Tungsten or Mercury source, either alone or in combination with WG280, WG305 or WG320 Schott glass cut-off filters.

Results clearly show that, in addition to the instrumental cosine response being far from ideal, there is also a spectral dependence. The IL instrument performed increasingly well with increased proportions of short wavelength radiation (less than 290 nm), whilst the YES UVB-1 sensor performed better with shorter wavelength radiation cut off. It is therefore important to determine which light source is most appropriate to use during cosine response characterisation. Measurements of the spectral distribution of each source and filter combination, integrated with the instrument spectral response functions, found the Xenon arc lamp in combination with WG320 filter to most closely match the equivalent integral performed with typical high and low solar zenith angle solar spectra.

The cause of these cosine response variations is likely due to the wavelength dependent variation in refraction angles of incident light from the various broadband sources. This introduces an additional uncertainty to the cosine response corrections applied during instrument calibration, as the artificial sources used will never perfectly match the solar spectrum, which indeed will vary dependent on solar zenith angle and ozone column depth. As cosine response can be the highest contributor to overall measurement uncertainty, accurate measurement is critical.

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[2]. J. J. Michalsky, L. C. Harrison, and W. E. Berkheiser, III, Solar Energy, Vol 54, No. 6, 1995, pp. 397-402.