Long-term calibration of a New Zealand erythemal sensor network

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Abstract

New Zealand's clear skies and hence high solar ultraviolet (UV) radiation have prompted a public education and warning programme on the dangers of UV exposure. Part of this programme was the establishment since 1989 of a network consisting of six erythemal radiometers located mainly in centres of high population density and the use of measurement data in radio broadcasts of the UV index, derived from these measurements (Ryan et al 1996). The Measurement Standards Laboratory of New Zealand (MSL) has been responsible for the annual calibration of these radiometers since the network's inception and in this paper we will present the changes in spectral responsivity performance of four of these radiometers up until the present time (Bittar and Hamlin, 1991).
The six radiometers in the set are manufactured by International Light Inc. They consist of a vacuum photodiode (SED 240), a thin film filter (ACTS270) and a ground fused silica cosine diffuser (type W). The output current is measured using a current to voltage converter circuit and a data collection system.

The calibration is a two step process. Firstly, the relative spectral response shape of the radiometer is measured; this shape is then scaled to values of absolute spectral irradiance responsivity by measuring the radiometer's response to a calibrated spectral irradiance standard. Prior to 1997 the reference detector used to determine the relative spectral response shape was a Rhodamine B fluorescence quantum counter (Melhiush, 1972), since then a calibrated silicon photodiode has been used. A change in traceability also occurred in 2002 when our set of primary spectral irradiance reference lamps became traceable to the NIST detector based irradiance scale (Yoon et al, 2002). The relative expanded uncertainty in the more recent calibrations is no greater than 5 % from 310 nm to 330 nm, this being the region of significant interest for solar erythema.

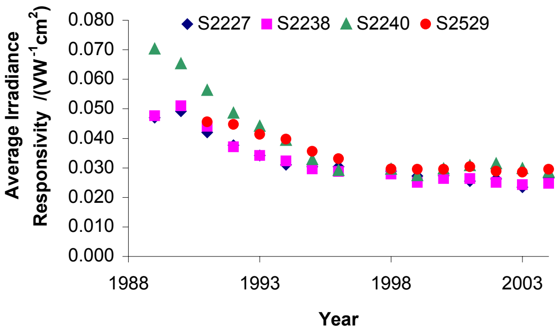

Figure 1. Average irradiance responsivity from 280 nm to 330 nm for each year of calibration for four of the six radiometers. As can be seen there is a reduction in the responsivity over this period the rate of which has recently decreased. In addition, there is agreement between the calibrations using the Rhodamine B and silicon photodiode reference sensors (1996 to 1998).

All radiometers in the set have drifted between calibrations as can be seen in Figure 1. As a performance check the transmittance of the filters in some of the radiometers has also been measured annually (Figure 2.) and the above drifts in response are mainly ascribed to changes in the transmittance of the filters. In some cases the annual changes in response are greater than the level of uncertainty in the calibration and the presence of continued drift highlights the need for regular calibration of this network of radiometers.

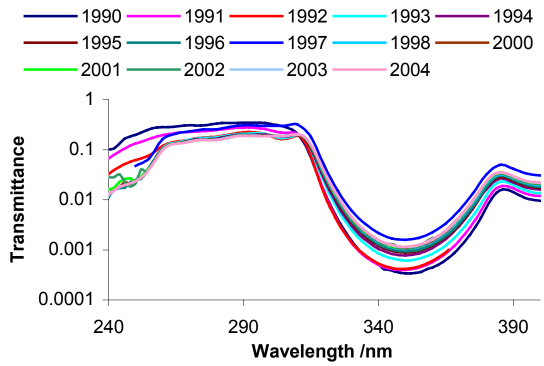

Figure 2. Spectra of filter transmittance for radiometer S2238 from 1990 to 2004. With the transmittance displayed on a logarithmic scale the change in the transmittance slope between 320 nm and 340 nm is more easily seen.

References

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