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A method to estimate erythemal UV from total solar irradiance measurements based on 9 years of 1-minute data at Lauder, New Zealand

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The radiative effect of clouds on the incident surface solar radiation highly depends on the spectral band of the solar spectrum that is considered. In particular, cloud effects are known to be different for the broadband erythemal ultraviolet (hereafter, UVE) irradiance and the total global solar irradiance (GR) due to the much more important molecular (Rayleigh) scattering on the UV than on the visible and near infrared wavelengths. In this work we investigate these differences by analysing 9 years (2000-2008) of 1-minute UVE and GR measured at Lauder (45.04S, 169.68E, 370m asl), New Zealand. Clear sky models for UVE (hereafter UVEc) and GR (GRc) are considered and their performances are tested (total ozone and aerosol optical depth measurements were available and used as inputs to UVEc).

Effective cloud transmissivity, also known as cloud modification factor (CMF) is calculated as the ratio between the 1-minute measurements and the clear sky estimation from modelling, both for UVE (CMF_UVE) and GR (CMF_GR). The two CMF are then compared; for this comparison, Total Sky Imager (TSI) estimations of sky cover (CF) and sunny or not condition (SUN) were also available. The analyses are undertaken as a function of solar zenith angle (SZA), CF and SUN. Differences between CMF_UVE and CMF_GR are maximum for intermediate values of the latter. For example, when CMF_GR = 0.3, it turns out that average CMF_UVE is in the range 0.4-0.6, and when CMF_GR = 0.6, average CMF_UVE is in the range 0.65-0.85. The higher values in the range correspond always to the greater SZA. In addition, largest discrepancies between CMF_GR and CMF_UVE are seen for large CF conditions.

From this, a methodology to calculate CMF_UVE as a function of CMF_GR and SZA is proposed and validated using 2 years of independent data (2009-2010). The agreement between estimated and measured UVE is remarkably good: absolute differences are less than 0.5 UVI units (being the greatest at lower SZA), and relative differences are less than 5% (the greatest at higher SZA).