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Requirements for the UV dosimetry of humans

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Ultraviolet radiation (UV) from the sun causes a considerable global disease burden, including acute and chronic health effects on the skin, eyes and immune system. It is crucial for humans to prevent over-exposure to UV radiation. On the other hand, UV is essential for the production of
vitamin D in the human body. Emerging evidence suggests an association between vitamin D levels and risk indicators relating to some cancers, cardiovascular disease and multiple sclerosis among others, along with the established link with musculoskeletal health. Therefore, there is a need for studies into the required UV dose for maintaining optimal levels of vitamin D, whereas avoiding the damaging effects of over-exposure. The ambient UV dose rate (incident irradiance on a horizontal, unshaded surface weighted with the action spectrum of a determined biologic response) and ambient UV dose (integrating the dose rate over the time the surface is exposed) can be obtained by spectroradiometers, broad-band and narrow-band radiometers. The quantitation of human UV exposure is a more complex issue as it is related to the dose received by differently oriented surfaces in different settings and posture.

The physical requirements for estimating the exposure is given including a mathematical definition of the term weighted exposure are shown in the presentation. Moreover the performance of state-of-the-art dosimeters is investigated. Historically, the most widely used types are based on changes in the optical properties of certain materials after exposure to UV radiation. More recently, electronic ultraviolet dosimeters using wide band-gap photodiode sensors have been developed.

Doses of erythemally weighted irradiances derived from polysulphone (PS) and electronic ultraviolet (EUV) dosimeters have been compared with measurements obtained using a reference
Spectroradiometer used in the context of the Network for the Detection of Atmospheric Change. PS dosimeters showed mean absolute deviations of 26% with a maximum deviation of 44%, the calibrated EUV dosimeters showed mean absolute deviations of 15% (maximum 33%) around noon during several test days in the northern hemisphere autumn. In the case of EUV dosimeters,
measurements with various cut-off filters showed that part of the deviation from the CIE erythema action spectrum was due to a small, but significant sensitivity to visible radiation that varies between devices and which may be avoided by careful preselection. Usually the method of calibrating UV sensors by direct comparison to a reference instrument leads to reliable results.
However, in some circumstances the quality of measurements made with simple sensors may be over-estimated. In the extreme case, a simple pyranometer can be used as a UV instrument,
providing acceptable results for cloudless skies, but very poor results under cloudy conditions. It is concluded that while UV dosimeters are useful for their design purpose, namely to estimate personal UV exposures, they should not be regarded as an inexpensive replacement for meteorological grade instruments.