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Estimating different UV indices in southern Spain using a NILU-UV multichannel instrument

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The high interest in accurately measuring the solar ultraviolet radiation that reaches the earth's surface and, particularly, its biological effects have recently extended the use of UV multichannel radiometers. Within this framework, the NILU-UV instrument was developed by the Norwegian Institute for Air Research and it has presently become an instrument of reference. It is a moderate-bandwith instrument with five UV narrow-band (10nm FWHM) channels centered at 305, 312, 320, 340 and 380 nm, and a sixth broad channel for the measurement of the photosynthetically active radiation.

This multifilter radiometer provides estimations of several relevant UV integrals such as the erythematically weighted irradiance defined by McKinlay and Diffey in 1987, UV-A (320-400 nm) and UV-B (280-320 nm) irradiances. These indices are computed as linear combinations of signals recorded at different channels by means of calibration coefficients provided by the manufacturer.

The present study focuses on assessing the reliability of the mentioned estimations by its comparison with independent measurements. Such reference data are provided by the Brewer MKIII #150 spectrophotometer belonging to the "Instituto Nacional de Técnica Aeroespacial" (INTA). This instrument measures spectral UV irradiances from 290 to 363 nm by steps of 0.5 nm. Additionally, a new approach based on multiple regression is proposed and compared to the reference values. In this case, the 75% of data (6362) were randomly selected for the fitting and the remaining 25% (2121) for the validation. Only cases corresponding to solar zenith angle lower than 70º have been considered.

Both radiometers were co-located at the terrace of the Atmospheric Sounding Station "El Arenosillo" (31.10ºN, 6.73ºW) of INTA, Spain. The period of study comprises the whole year 2008, guaranteeing a wide variety of atmospheric conditions.

The comparison shows a notably poor agreement between the manufacturer estimation and the reference measurements for UVI (MBE=19.1%, MABE=19.4%) and UV-B (MBE=51.8%, MABE=51.8%). The results for UV-A are significantly better (MBE=0.2%, MABE=5.4%). Our proposed approach remarkably improves the agreement with Brewer measurements for the three indices: UVI (MBE=0.2%, MABE=5.1%), UV-B (MBE=-0.3%, MABE=4.1%), and UV-A (MBE=0.03%, MABE=3.8%).

This study emphasizes the suitability of multichannel radiometers for the estimation of relevant UV integrals. It also highlights the need for a previous accurate calibration consisting in a laboratory characterization of the each channel (relative spectral response and angular response) and absolute calibration based in outdoors intercomparison against a well calibrated spectroradiometer.