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Guidelines for monitoring solar UV irradiance using array spectroradiometers

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One activity within the European Metrology Research Project Traceability for surface spectral solar ultraviolet radiation is to develop guidelines for routine spectral solar UV measurements using array spectroradiometers. These cost-effective instruments have the advantage of allowing fast measurement sequences to monitor the high variability of solar radiation due to moving clouds. From the spectra any desired biologically weighted doses can be derived by post-processing, i.e. applying the action spectrum for erythema or for vitamin D synthesis. Therefore, the array spectroradiometers have the potential to replace filter radiometers currently used in UV monitoring networks.

In addition to existing general guidelines for instruments to measure solar ultraviolet radiation (published by the World Meteorological Organisation) further new techniques (e.g. for wavelength calibration or stray light determination and correction) will be investigated within the actual research project. The outcome of these investigations will provide a valuable input to the guidelines.

Key features needing to be considered are the dynamic range of the analog-to-digital converter of the array spectroradiometer used for the determination of accurate weighted doses under all atmospheric conditions and the necessity for temperature stabilization and for automated dark signal measurements.

In order to homogenise routine operation of these instruments, it is further important to follow strict procedures for the characterisation, operation and post-processing:

The most important characteristics of an array spectroradiometer, which have to be determined prior to the set-up of an instrument for solar UV measurements, are wavelength calibration, slit function, stray light properties, spectral structure of the dark signal, linearity, noise equivalent irradiance and spectral responsivity.

For routine operation, the integration time for each measurement should be optimized to utilise the full dynamic range of the instrument. Thus, a sequence of dark measurement, test measurement and final measurement is necessary. The number of repetitions should be adjusted according to the required statistical uncertainty component and to the available time between two measurements. The raw data should be saved together with information about date and time of the start of the measurement, integration time, number of repetitions, dark signal, instrument temperature, place of measurement and instrument identification.

Post-processing includes consideration of nonlinearity, dark signal with its spectral structure, integration time, stray light correction, spectral response function and weighting function.