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Solar UV irradiance calculations with the use of satellite-based cloud, ozone and aerosol retrievals

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Surface spectral UV estimates from the Ozone Monitoring Instrument (OMI) satellite sensor continue the long-term Total Ozone Mapping Spectrometer (TOMS) and provide daily irradiances in a global scale for 305nm, 310nm, 324nm and 380nm. Several studies showed that OMI overestimates UV irradiances especially on sites with high aerosol load. Correction procedures were proposed that partly correct this effect when compared with ground- based (GB) spectral measurements from reliable UV spectroradiometers.
In this study we have tried to investigate the possibility to use a synergy of available ozone column, aerosol and cloud optical properties' data from the MODerate resolution Imaging Spectroradiometer (MODIS) sensors on Terra and Aqua, and OMI that are used as input parameters in a radiative transfer model (RTM) with the purpose to retrieve spectral UV irradiances. In order to compare our retrievals, we have used spectral irradiance UV measurements for the years 2005 and 2006 from various European sites that contribute their measurements in the European UV Database.
For aerosol and cloud inputs used for the RTM calculations, several options were included in order to validate the results and explore the possibility of using such a new approach for calculating UV irradiances worldwide. Such aerosol inputs were based on: MODIS Level 3 and Level 2 data. For example aerosol inputs included various parameters with spatial resolutions of 1 by 1 degree (L3), 50 X 50 Km, 10 X 10 Km,(L2) and the approach of the Multi-sensor Aerosol Products Sampling System (MAPSS). Also CIMEL (AERONET) data, when existing, were used in order to explore possible spatial variability aerosol effects. In the case of clouds both OMI and MODIS cloud fraction and cloud optical depth data have been used, again, exploring spatial effects using different approaches with the L2 and L3 MODIS data.
Differences of the various RTM outputs were compared with the GB UV station data. For investigating the effect of aerosol inputs on the RTM, we included only cloudless sky data, while all sky data were used for the effect of clouds. The ratios of OMI / GB and RTMs /GB were investigated as a function of wavelength, cloud optical depth, cloud fraction, different spatial approaches of aerosol optical depth and solar zenith angle.
In general, the use of the RTM in all sky and clear sky data showed differences up to 10% compared with the GB stations. Using L2 (50X50 Km) and L3 aerosol data, results showed differences less than 5% compared with the case of using GB aerosol inputs. In this approach standard deviations of L3 data were approximately double, depending on each site's aerosol spatial variability. Despite differences observed on the cloud fractions that have been derived by MODIS and OMI at each site, results for different spatial resolutions showed that different RTM input approaches agree quite well with the GB UV data. OMI/GB comparisons showed, the previously observed, overestimation that can partly solved for cloudless skies with aerosol post-correction OMI approach. This have to be improved and used also for cloudy conditions with additional correction assumptions, in order to improve the OMI UV retrievals.