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Sensitivity of a radiative transfer model to the uncertainty in the aerosol optical depth used as input

Roberto Román, Julia Bilbao, Argimiro de Miguel, and Ana Pérez-Burgos

VALLADOLID UNIVERSITY, SPAIN., Applied Physics Department, Science Faculty, Valladolid, Spain (juliab@fa1.uva.es, 34983 423013)

The radiative transfer models can be used to obtain solar radiative quantities in the Earth surface as the erythemal ultraviolet (UVER) irradiance, which is the spectral irradiance weighted with the erythemal (sunburn) action spectrum, and the total shortwave irradiance (SW; 305-2,8000 nm). Aerosol and atmospheric properties are necessary as inputs in the model in order to calculate the UVER and SW irradiances under cloudless conditions, however the uncertainty in these inputs causes another uncertainty in the simulations. The objective of this work is to quantify the uncertainty in UVER and SW simulations generated by the aerosol optical depth (AOD) uncertainty.

The data from different satellite retrievals were downloaded at nine Spanish places located in the Iberian Peninsula: Total ozone column from different databases, spectral surface albedo and water vapour column from MODIS instrument, AOD at 443 nm and Angström Exponent (between 443 nm and 670 nm) from MISR instrument onboard Terra satellite, single scattering albedo from OMI instrument onboard Aura satellite. The obtained AOD at 443 nm data from MISR were compared with AERONET measurements in six Spanish sites finding an uncertainty in the AOD from MISR of 0.074.

In this work the radiative transfer model UVSPEC/Libradtran (1.7 version) was used to obtain the SW and UVER irradiance under cloudless conditions for each month and for different solar zenith angles (SZA) in the nine mentioned locations. The inputs used for these simulations were monthly climatology tables obtained with the available data in each location. Once obtained the UVER and SW simulations, they were repeated twice but changing the AOD monthly values by the same AOD plus/minus its uncertainty. The maximum difference between the irradiance run with AOD and the irradiance run with AOD plus/minus its uncertainty was calculated for each month, SZA, and location. This difference was considered as the uncertainty on the model caused by the AOD uncertainty.

The uncertainty in the simulated global SW and UVER varies with the location, but the behaviour is similar: high uncertainty in specific months. The averages of the uncertainty at the nine locations were calculated. Uncertainty in the global SW is lower than 5% for SZA values lower than 70º, and the uncertainty in global UVER is between 2 and 6%. The uncertainty in the direct and diffuse components is higher than in the global case for both SW and UVER irradiances, but a balance between the changes with AOD in direct and diffuse components provide a lower uncertainty in global SW and UVER irradiance.

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