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On the induced uncertainties in direct normal irradiance calculations under cloud-free conditions due to aerosol optical depth from MACC re-analysis data

Vassileios Salamalikis (1), Blanc Philippe (2), and Andreas Kazantzidis (1)

(1) Laboratory of Atmospheric Physics, Physics Department, University of Patras, Greece (akaza@upatras.gr), (2) MINES ParisTech, Center Observation, Impact, Energie, Sophia Antipolis Cedex, France

Clear sky Surface Solar Irradiance (SSI) is of great importance, notably for the Direct Normal Irradiance (DNI) dedicated to development of Concentrated Solar Technologies (CST). In this study, the aerosol optical depth (AOD) estimation obtained through the Monitoring Atmospheric Composition and Climate (MACC) re-analysis project are validated with ground-based measurements of aerosol properties from the worldwide Aerosol Robotic NETwork (AERONET). Indeed, AODs from AERONET at 550 nm and 1240 nm are compared against the 3h resolution AOD estimation from MACC. In terms of Root Mean Square Error (RMSE), low values (<10%) are obtained for Europe and Eastern Asia but for several stations in central Africa the RMSE for 1240 nm is very high. High predictive power of MACC is linked to areas with low error estimations but in specific regions inAmerica, very low and even negative correlation values are observed, indicating, at these locations, the weakness of the MACC model to describe the AOD variability.

Then, the model McClear of surface solar irradiance under clear sky condition based on the radiative transfer model libRadtran has been used for the estimation of the induced uncertainties observed in the AOD from MACC in the prediction of the corresponding DNI. Low errors in the DNI predictions are revealed in several large areas providing an overestimation/underestimation of the DNI close to 5% for the Mean Bias Error (MBE) and less than 15% for the RMSE. Of course, for locations where MACC fails to reproduce the variability of the AOD measured by the corresponding AERONET stations, the RMSE can be greater than 20% while the high absolute MBE values ($\pm$15%) are observed.