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Using MACC-derived products to predict clear-sky irradiance at surface

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The MACC project (Monitoring Atmosphere Composition and Climate) has issued a wealth of results on aerosol properties, and total column content in water vapor and ozone. The modeling of the changes in time of these properties and constituents is of utmost importance for an accurate modeling of the changes in solar irradiance received at ground under clear skies.
A new clear-sky model called McClear was developed to better exploit the MACC outcomes. It aims at producing direct and diffuse components of the radiation with an accuracy close to that of the libRadtran radiative transfer model and computational speed approximately 5000 times greater. The abaci, or look-up tables, approach combined with interpolation functions is adopted here.
The abaci contain the clearness index (ratio of irradiance at ground to irradiance at top-of-atmosphere) for global radiation and its direct component for null ground albedo, and the atmosphere spherical albedo for three values of ground albedo: 0, 0.1, and 0.9, for selected values of the inputs to McClear describing the optical state of the atmosphere and ground albedo. The clearness indices and atmospheric spherical albedos are obtained by running libRadtran for these values called node points.
An optimization was made for the selection of the node points and design of interpolation functions between node points with the following constraints: i) decrease as much as possible the number of node points, in order to have abaci as small as possible, ii) select / design interpolation functions as fast as possible, and iii) interpolated values must be close to the libRadran results with the following constraints derived from WMO (2008): the bias shall be less than 3 W/m^2 and 95% of the differences should be less than 20 W/m^2. The last constraint on the difference with libRadtran was checked for each input separately as well as combination of all inputs using all node points and interpolation functions.
McClear has been run with inputs from MACC and MODIS ground albedo and its results were compared to measurements made in several stations within the Baseline Surface Radiation Network in various climates. Analysis of the discrepancies permits to better understand the model and its performance, to understand its advantages comparing to the existing ESRA model and to identify its defaults for future improvements.
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