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Aerosol forecast and its effect on surface solar radiation

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Aerosols affect surface solar radiation (SSR) by modifying cloud properties. For solar energy applications, either for photovoltaics (PV) or concentrating solar power (CSP) systems, understanding of spatio-temporal variability of aerosol is essential for short-term forecasts of solar radiation.

This study aims to quantify interday variability of the commonly used proxy for optical properties of aerosols - aerosol optical depth (AOD) at the wavelength of 500 nm and to assess the deviation in direct normal irradiance (DNI) and in global horizontal irradiance (GHI) caused by AOD variation using radiative transfer modeling.

The following AOD data are used: AOD forecasts for the next day from the Copernicus Atmosphere Monitoring Service (CAMS); ground-based AOD measurements from the Aerosol Robotic Network (AERONET); ModIs/Terra high spatial resolution data set (MIDAS) which is based on satellite retrievals. We select locations with different aerosol types around the globe based on AERONET stations, where at each site more than 1500 daily values for consecutive days from 2010 to 2020 are available. We adopt the persistence approach using AOD data from AERONET and MIDAS and compare them with CAMS forecasts. The AOD data from AERONET serve as ground truth for validation. Under cloudless conditions, AOD variability informs the deviation of DNI and GHI forecasts from the observation. Furthermore, we attempt a worldwide clustering of aerosol types based on chemical modeling. Interday AOD variability is high in megacities with high aerosol load and in the proximity of highly variable aerosol sources such as desert dust and biomass burning (fires).

This work should deepen our knowledge of spatio-temporal variability of aerosol in the context of AOD and SSR prediction, thus contributing to the quality and reliability of solar resource assessment.