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Direct normal irradiance forecasting at dust sites based on aerosol data assimilation

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The optimal operation of concentrating solar thermal power plants (CSP) or concentrating photovoltaic plants (CPV) requires precise forecasts of direct normal irradiance (DNI). Aerosols have a strong impact on DNI. High aerosol loads may cause a reduction of DNI of up to 20-30% under clear-sky conditions. Thus, an accurate representation of the aerosol optical depth (AOD) is crucial for reliable DNI forecasts. Concentrating solar power plants are often located in desert/arid regions where dust events are likely to occur. For those locations with strong aerosol or especially dust sources in the vicinity, using only large scale, low resolution aerosol information from satellites might not be sufficient. Ground-based measurements of particulate matter (PM10 and PM2.5) provide additional, more precise, local information. On the other hand, sparsely populated desert areas are only poorly equipped with in-situ measurement devices. Thus, data assimilation seeks to make optimal use of all available observations.
Within the EU FP7 project DNICast, assimilation based simulations are performed using the EURopean pollution Dispersion-Inverse Model (EURAD-IM) including a 3D/4D- Var data assimilation scheme and sophisticated aerosol dynamics and aerosol chemistry schemes. The setup includes all aerosol related observation streams along with routine data assimilation plus available on-site data and will provide assimilation based short term forecasts of AOD at selected test sites. The system is embedded in the European Earth observation system MACC (now: CAMS) and benefits from near-real time in situ and space borne measurements. The system is coupled to the WRF model to provide radiation forecasts based on aerosol information from the EURAD-IM data assimilation scheme. We will present simulation results for CSP sites on the Iberian Peninsula evaluating the gain of information obtained by data assimilation to capture small-scale dust events and large scale Saharan dust events, which both cause sharp decreases in CSP power production. The simulation results are validated using ground-based AOD measurement data from the AERONET measurement network, as well as radiation observations.