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Development of a solar energy forecasting system for two real solar plants based on WRF Solar with aerosol input and a solar plant model

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Regional meteorological models are becoming a generalized tool for solar energy production forecasting, due to their capacity to simulate different types of cloud formations and their interaction with solar radiation. The greater demand for reliable forecasting tools in the energy industry is the motivation for the development of an integrated system that combines the Weather Research and Forecasting atmospheric model package designed to fulfill the needs of solar energy applications (WRF-Solar), with the solaR power plant model. This study focuses on the use and validation of this coupled tool in forecasting the energy production for two real solar plants, one in Spain and another in India. A period of one year for the Spanish emplacement and nine months for the Indian site are simulated with a daily operational forecasting set-up. Aerosol data from the Copernicus Atmosphere Monitoring Service (CAMS) are considered in the calculations, a new capability in WRF-Solar. Power predictions are obtained and compared with real data from the inverters of both plants provided by the operating company.

The results show that WRF-Solar obtains accurate forecasts of global, direct, and diffuse radiation and of the ambient temperature that solaR uses as input to predict the energy production of the solar plants. The normalized Mean Annual Errors (NMAE) is 5.18% in the Spanish and 5.59% in the Indian plant for the first day of predictions, demonstrating a reliable performance of the forecasting system in different climate locations. The skill scores for the second day of prediction are also promising, with practically the same errors as the previous day (5.19% and 6.17 for Spain and India respectively). By comparing the model predictions, with and without AOD input during the dustiest days in the Spanish site, the importance of the aerosol effect inclusion is demonstrated with an improvement up to 10% in the energy forecast. These results demonstrate the system's potential both for solar plant operation and energy market applications.