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Development of a short-term irradiance prediction system using post-processing tools on WRF-ARW meteorological forecasts in Spain

A. Rincón (1,2), O. Jorba (1), J.M. Baldasano (1,2)

(1) Barcelona Supercomputing Center, Earth Sciences, Spain (angel.rincon@bsc.es), (2) Environmental Modelling Laboratory, Technical University of Catalonia, Barcelona, Spain

The increased contribution of solar energy in power generation sources requires an accurate estimation of surface solar irradiance conditioned by geographical, temporal and meteorological conditions. The knowledge of the variability of these factors is essential to estimate the expected energy production and therefore help stabilizing the electricity grid and increase the reliability of available solar energy. The use of numerical meteorological models in combination with statistical post-processing tools may have the potential to satisfy the requirements for short-term forecasting of solar irradiance for up to several days ahead and its application in solar devices.

In this contribution, we present an assessment of a short-term irradiance prediction system based on the WRF-ARW mesoscale meteorological model (Skamarock et al., 2005) and several post-processing tools in order to improve the overall skills of the system in an annual simulation of the year 2004 in Spain. The WRF-ARW model is applied with 4 km x 4 km horizontal resolution and 38 vertical layers over the Iberian Peninsula. The hourly model irradiance is evaluated against more than 90 surface stations. The stations are used to assess the temporal and spatial fluctuations and trends of the system evaluating three different post-processes: Model Output Statistics technique (MOS; Glahn and Lowry, 1972), Recursive statistical method (REC; Boi, 2004) and Kalman Filter Predictor (KFP, Bozic, 1994; Roeger et al., 2003).

A first evaluation of the system without post-processing tools shows an overestimation of the surface irradiance, due to the lack of atmospheric absorbers attenuation different than clouds not included in the meteorological model. This produces an annual BIAS of 16 W m^{-2} h^{-1}, annual RMSE of 106 W m^{-2} h^{-1} and annual NMAE of 42%. The largest errors are observed in spring and summer, reaching RMSE of 350 W m^{-2} h^{-1}. Results using Kalman Filter Predictor show a reduction of 8% of RMSE, 83% of BIAS, and NMAE decreases down to 32%. The REC method shows a reduction of 6% of RMSE, 79% of BIAS, and NMAE decreases down to 28%. When comparing stations at different altitudes, the overestimation is enhanced at coastal stations (less than 200m) up to 900 W m^{-2} h^{-1}. The results allow us to analyze strengths and drawbacks of the irradiance prediction system and its application in the estimation of energy production from photovoltaic system cells.

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