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WRF advection and diffusion of MSG cloud estimates for short-term solar radiation forecasting

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Accurate short-term (i.e. up to 6 hours ahead) solar radiation forecasts are a crucial element for solar energy grid integration and for an efficient solar plant management. Currently, Cloud Motion Vector (CMV) derived from Meteosat Second Generation (MSG) images are the reference methodology. Nonetheless, reliability of these forecasts quickly deteriorates with the forecasting horizon; due to the lack of atmospheric dynamic information. In this respect, Numerical Weather Prediction (NWP) models are more suitable. Nevertheless, the accuracy of the cloudiness forecast provided by these models at the high spatial resolution (few kilometers) needed in solar energy applications is far from optimal. In this work, a new method for short-term solar radiation forecasting, that combines satellite and NWP forecasting methodologies, is presented and evaluated. The method consists of three steps. Firstly, cloud index maps are retrieved from MSG images using the Heliosat-II algorithm. Then, these maps are inserted in WRF model as a tracer in the vertical level of the model where the clouds are located. In this study, these heights are provided by a ceilometer. Finally, WRF model is used to advect and diffuse the cloud index. GHI and DNI forecast are derived from the forecasted cloud index using a clear-sky solar radiation model. The performance of this method was assessed using solar radiation observations collected at the University of Jaen (Spain). The data set comprises 25 days, containing all types of sky conditions. 6 hour forecast, with a 15 minutes time step, were obtained and tested against forecasts derived from smart persistence, a CMV method and the WRF model. Results showed that the proposed model provided significantly more accurate DNI forecasts than the other model. Particularly, the skill against persistence is about 20% in terms of RMSE. On the other hand, the WRF model is very competitive at GHI forecasts.