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Evaluating the Performance of WRF-Solar Model for 72-Hour Ahead Global Horizontal Irradiance Forecasting in West Africa: A Case Study of Ghana

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Accurate forecasting of solar irradiance is crucial for the integration of solar energy into the power grid, power system planning, and the operation of solar power plants. The Weather Research and Forecasting (WRF) model, with its solar radiation (WRF-Solar) extension, has been used to forecast solar irradiance in various regions worldwide. However, the application of the WRF-Solar model for global horizontal irradiance (GHI) forecasting in West Africa, specifically in Ghana, has not been studied. This study aims to evaluate the performance of the WRF-Solar model for GHI forecasting in Ghana, focusing on 3 health centers (Kologo, Kumasi and Akwatia) for the year 2021. We applied a two one-way nested domain (D1=15 km and D2=3 km) to investigate the ability of the WRF solar model to forecast GHI up to 72 hours in advance under different atmospheric conditions. The initial and lateral boundary conditions were taken from the ECMWF operational forecasts. In addition, the optical aerosol depth (AOD) data at 550 nm from the Copernicus Atmosphere Monitoring Service (CAMS) were considered. The study uses statistical metrics such as mean bias error (MBE), root mean square error (RMSE), to evaluate the performance of the WRF-Solar model with the observational data obtained from automatic weather stations in the three health centers in Ghana. The results of this study will contribute to the understanding of the capabilities and limitations of the WRF-Solar model for forecasting GHI in West Africa, particularly in Ghana, and provide valuable information for stakeholders involved in solar energy generation and grid integration towards optimized management of in the region.
Keywords: WRF-Solar; Global horizontal irradiance; Forecasting; West Africa; Ghana