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Forecasting of solar irradiance at Reunion Island using numerical weather prediction models

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Diverse stakeholders of the photovoltaic (PV) power value chain require more accurate forecasts of global horizontal irradiance (GHI) in order to optimally exploit the solar power potential and guarantee grid stability. This especially accounts for non-interconnected areas with a high potential for PV such as the French overseas territory of Reunion Island located in the Indian Ocean (21°S, 55°E), where 100% of renewables in the energy mix by 2030 are aimed for. Pronounced tropical convection often causes a high variability and limited predictability of GHI on Reunion Island, especially in austral summer.
In contrast to global circulation models (GCMs), limited-area numerical weather prediction (NWP) models (LAMs) allow to resolve cloud and radiation processes in the order of kilometres and minutes. One important factor that impacts the accuracy at which NWP models forecast GHI is the accuracy of the initial conditions.
The assimilation of multi-phase cloud water path (CWP) Meteosat-8 retrievals using the Weather Research and Forecasting (WRF) LAM and an ensemble Kalman Filter has proven to improve initial conditions in terms of clouds and short-term (6-24 hours) forecasts of GHI for Reunion Island. Building on these efforts, in this study we evaluate the improvement achieved using this WRF-based data assimilation (DA) method in comparison to other operational LAMs and GCMs, namely the LAM AROME, and the GCMs ARPEGE, GFS, ICON and IFS.
A period of several weeks in austral summer 2017/18 and ground-based irradiance observations at 12 sites on Reunion Island are considered for the GHI forecast assessment. Compared to GFS and IFS, the GCMs that provide the boundary conditions for WRF and AROME respectively, downscaling to higher resolutions using the LAMs leads to improved GHI forecasts compared to the performance of the respective GCM. In the case of WRF, the forecasts are further improved by applying CWP DA.
Among the considered models, the best results are achieved by the models WRF and AROME with an average RMSE of about 270 W/m^2 and a MAE of about 205 W/m^2.
In summary, this work quantifies the benefits and the potential of satellite DA with LAMs for GHI forecasts in a Tropical environment.