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PV and wind power simulation with ERA5 and ERA5-land – a multi-country analysis

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Climate data sets are widely used for renewable power simulation. While previous generations of global reanalysis data including MERRA-2 and ERA-Interim have been widely assessed for their suitability to simulate variable renewable power systems, more recent datasets such as ERA5 and ERA5-Land lack validation, particularly in regions outside of Europe.

Here, we assess the accuracy and bias of wind power simulation using ERA5 wind speeds in Brazil and New Zealand as well as solar photovoltaic power simulation accuracy using ERA5-Land solar radiation and temperature data in Chile. We compare the performance of ERA5 and ERA5-Land to MERRA-2 based renewable power generation. The reference data sets are capacity factors derived from data measured at individual installations in each country and the performance indicators include the pearson's correlation coefficient, mean bias error (MBE) and root mean square error (RMSE). For wind power simulation, we also assess a bias correction method using the Global Wind Atlas.

Since models applying the resulting datasets are based on different spatial and temporal scales, we also aim at finding a relation between the spatial and temporal resolution and simulation quality. We assess the simulation results applying spatial aggregation ranging from individual installations to the country level and temporal aggregation varying from hours to months. This aids to evaluate the reliability of the simulated renewable power generation time series on various spatiotemporal scales for future simulation efforts.

Overall, we find that both datasets, ERA5 and ERA5-Land, perform well in wind and solar photovoltaic power simulations. For wind power simulation, ERA5 shows improved performance compared to MERRA-2 based wind power simulation, while for solar photovoltaic the improvements of ERA5-Land compared to MERRA-2 are minor. Correlation of wind power generation is around 0.8 without correction and MBEs around -0.1. Mean bias correction with the Global Wind Atlas does not consistently improve simulation results. For the solar photovoltaic power simulation, we find correlations above 0.75, while the MBE is between -0.05 and 0.1.