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Statistical postprocessing of turbulence resolving wind power forecasts

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Accurate short-term wind power forecasts are crucial for a reliable and efficient integration of wind energy in power systems and electricity markets. Commonly, forecasts for a couple of hours to days ahead are based on the output of numerical weather prediction models. With the advance of computing power the spatial and temporal resolution of these models have increased substantially in the past years and their gained ability to resolve smaller scale processes provides great potential for forecast improvements. However, high-resolution forecasts unfortunately often exhibit spatial and/or temporal displacement errors so that, when regarding measures such as mean absolute or squared errors, they often perform worse than smoother forecasts from lower-resolution models.

Recent computational advances have enabled the use of Large Eddy Simulation (LES) in the context of operational weather forecasting, yielding turbulence resolving weather forecasts with a resolution of 100 meter or finer. This study investigates how these ultra-high resolution forecasts can be used most efficiently for forecasting the 160 MW offshore wind farm Horns Rev I in Denmark. To this end, a set of day-ahead forecasts for Horns Rev 1 covering two years on a horizontal resolution of roughly 15 meter using ECMWF boundary data have been analyzed. In addition to spatially and temporally averaged fields of various meteorological parameters, unfiltered model output from single grid points on roughly 5 seconds resolution have been used.

It is shown that temporal and/or spatial smoothing of the forecasts clearly improves their skill, even though potentially valuable high-frequency information is lost. Therefore, a new statistical post-processing approach is proposed that is based on smoothing but additionally employs the distribution of the high-frequency signal around the smoothed forecast time series. The higher-frequency information clearly improves the forecasts and a comparison with ECMWF shows promising results.