On the use of remote sensing measurements for very short-term forecasting of offshore wind power

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Summary
Very short-term forecasts of wind speed and power are normally built on statistical methods, due to the computational cost of running Numerical Weather Prediction (NWP) models. This work focuses on the use of wind measurements from remote sensing systems such as lidars and radars to derive very short-term forecasts of offshore wind power. Wind speed and direction observations upstream of a wind farm can be advected to forecast the wind speed and power in a very short-term horizon of five minutes, outperforming the forecasting benchmark persistence.

1. Introduction

The increasing integration of offshore wind power into the grid brings new challenges for ensuring grid stability and power quality. Due to the intermittent nature of wind, accurate very short-term predictions are required. Classical methods use time series analysis to derive forecasts of wind in a very short-term horizon, here defined as less than 30 minutes. Due to the computational cost of NWP models, the only available alternative to statistical models are remote sensing observations. Over the last two decades much interest has been put on using remote sensing technologies such as lidars and radars for multiple wind energy applications: wake analysis, resource assessment or wind turbine control. Lidars and radar systems can measure wind speeds and directions up to 30 km and have been proven to be relevant for forecasting ([1] and [2]).

2. Wind speed advection-based technique

We propose a wind speed forecasting technique assuming the advection of wind field vectors observed from PPI (plane position indicator) scans of remote sensing devices. Based on the available data from two measurement campaigns with scanning lidars [1], respectively radar [2], a very short-term horizon of five minutes is evaluated. First, data from near-coastal flow measurements based on scanning lidars is used to derive wind speed predictions. The correction of the advected wind speed for local effects like orography, roughness and height is modelled based on lidar measurements. Secondly, data from a dual-Doppler (DD) radar measurement campaign around an offshore wind farm is used to derive deterministic and probabilistic forecasts of wind power. Only free-flow wind turbines are considered. Forecasts of wind speed are derived by advecting wind field vectors upstream from the wind turbines with their local trajectories. A power curve built on DD measurements and SCADA data is used to derive the power forecasts.

3. Conclusions

A high correlation between the predicted and observed wind speeds and power is found for the two cases. Results from deterministic and probabilistic experiments (see Fig.1) outperform the benchmark persistence.

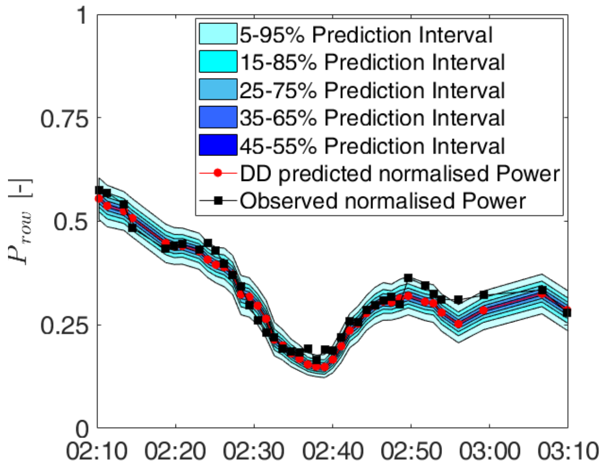

Fig. 1: Probabilistic forecast of wind power using remote sensing observations from a Dual-Doppler radar [2]

4. References

[1] Valldecabres L, Peña A, et al. Very short-term forecast of near-coastal flow using scanning lidars, Wind Energ. Sci. Discuss., 2017.
[2] Valldecabres L, Nygaard NG, von Bremen L, Kühn M. Very short-term probabilistic forecasting of wind power based on dual-Doppler radar measurements in the North Sea, TORQUE 2018, in press.