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Very short term wind power forecasting using shore-based scanning lidar observations over the Danish North Sea

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Abstract

As the share of variable generation wind power plants increase within electrical grids, we discover a rising need for the improvement of energy forecasts with which to schedule and regulate transmission systems. Forecasts on very short time scales (here defined as 15 minutes and less) are largely statistical and physical approaches which rarely outperform simple persistence (reference) models, (C. Monteiro et al, 2009). Errors in predicted vs. actual energy generation, along with failures to correctly forecast the arrival and magnitude of ramp events, contribute a significant uncertainty to the real-time operation of balancing markets and operator level windfarm control.

Long range scanning lidars such as the DTU WindScanner (WindCube 200S) have a maximum acquisition range of 12km using a pulse repitition frequency of 10kHz, (Vasiljević, 2014). The usage of scanning lidar data as input for short term wind power forecasts was suggested in (Frehlich, 2013) and is evaluated in this study using experimental data covering four months of measurements in the North Sea coastal zone of western Denmark. A total of three WindScanners were deployed within the RUNE campaign. Two units in dual Doppler mode performed complex scans at 50, 100 and 150m ASL following a transect line extending 3km inland to 5km offshore. A third device executed 60 degree sector scans which were post-processed into horizontal wind speed and direction values. Further, a network of calibrated, ground based profiling lidars provide wind profiles with varying observation heights covering 30 to 1000m. These profiles are used to benchmark the obtained scanning lidar forecasts, and are transformed into "virtual turbines" where comparisons can be made within the energy production domain.

Results and observations from the adjusted wind field advection method are presented, along with comparisons to baseline persistence models. Further, ramp events are captured and examined for suitability in improving predictions over very short time scales using the scanning lidar systems.

Keywords: Very short term wind power forecasting, gust and ramp prediction, scanning lidar, advection of coastal winds