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Determination of wind velocity components and its characteristics in the wake of a full scale wind turbine using short-range ground-based synchronized WindScanners

Hasan Yazicioglu, Nikolas Angelou, and Torben Mikkelsen
Danish Technical University, Wind Energy, Roskilde, Denmark (tomi@dtu.dk)

Detailed 3D wind velocity deficit structures have been measured in the wake behind a full-scale horizontal axis wind turbine using lidar remotes sensing based synchronized WindScanners. Three ground-based synchronized WindScanners were installed around a HAWT Nordtank test turbine (550 kW, 40-m Ø) located at the Risø campus of the Danish Technical University (DTU).
The ground based short-range WindScanners are light detection and ranging (lidar) remote sensing instruments, synchronized and trajectory coordinated, capable of measuring the 3D wind characteristics, both in the induction and in the wake zone flows of the wind turbines (Windscanners.eu).
The experimental setup allowed the monitoring of both zones, depending to the yaw direction of the wind turbine. The data presented in this study were acquired during a day when both the direction of the wind and the wind turbine yaw were almost aligned to the axis of the two scanning patterns. This way the analysis of the wake characteristics and the corresponding wind speed deficit on downstream positions, was possible.
The short-range WindScanners swept synchronously the downstream area up to 1.5D with its three line-of-sights on horizontal and vertical planes, in alternate 30-min periods. The successive measurement allowed us to reconstruct the wind vector field in discrete points in the two measurement planes.
The acquired high-resolution data set revealed the 3D wind components and their characteristics within the wind turbine wake. This study represents a new baseline reference for further wake flow analysis and measurements and observed characteristics that will contribute to the further evaluation and improvement of CFD-based modelling.
The wake measurements rook place during the 2015 UniTTE (Unified testing procedures for wind turbines through inflow characterization using nacelle lidars).