Geophysical Research Abstracts
Vol. 20, EGU2018-4561, 2018
EGU General Assembly 2018

Multi-Doppler lidar measurements of a wind turbine wake with adaptive scanning trajectories

Norman Wildmann (1), Nikola Vasiljevic (2), and Thomas Gerz (1)

(1) German Aerospace Center (DLR e.V.), Institute of Atmospheric Physics, Wessling, Germany (norman.wildmann@dlr.de), (2) DTU Wind Energy,Roskilde, Denmark

In the context of the Perdigão 2017 experiment, the German Aerospace Center (DLR) deployed three long-range scanning Doppler lidar systems with the dedicated purpose of investigating the wake of the single wind turbine at the experimental site. The main scanning scenario that was pursued during the six weeks of intensive operation was a combination of dual-Doppler RHI scans in-line with the wind turbine in main wind direction and an RHI scan at a slanted angle, cutting the wake at one to five rotor diameters downstream. In addition to this scenario, a novel method was established to investigate wake properties with ground-based lidars, independent of the wind direction. For this method, the three lidars which were space- and time-synchronized using the Windscanner software developed by the Danish Technical University (DTU), were programmed to measure with crossing beams at ten single points from one to ten rotor diameters downstream the wind turbine. Every half hour, the measurement points were adapted to the current wind direction to obtain a high availability of wake measurements in changing wind conditions. Depending on the combination of azimuth and elevation angles, linearly independent measurements of radial velocity at the beam intersection points allow the calculation of the two-dimensional or even three-dimensional wind vector.
Two approaches to estimate the prevailing wind direction were tested throughout the campaign: In the first approach, VAD scans of one of the lidars were used to calculate a five-minute average of wind speed and wind direction every half hour, whereas later in the experiment, five-minute averages of sonic anemometer measurements of a meteorological mast close to the wind turbine became available in real-time and were used for the scanning adjustment.
Results of wind speed deficit and wake center location estimation are presented for two measurement days with varying westerly winds. The new method allowed to obtain good wake measurements over the whole measurement period, where a static scanning setup would only have captured a fraction of the wake occurrences. The results show that state-of-the-art engineering models for wakes underestimate the actual wind speed deficit in all cases and the propagation of the wake is far from linear in the complex flow at the Perdigão site.