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An integrated analysis of wind turbine wakes at Perdigao based on three Doppler lidar datasets

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During the intensive period (May-June 2017) of the Perdigao experiment, three sets of Doppler lidars were operated, at least in part, to scan the wake of the wind turbine. The lidars were focused on tracking the wake as it propagated downwind from the southwest ridge. DTU used a dual Doppler lidar system scanning in an almost horizontal plane at turbine hub height from the northeast ridge. CU operated a single scanning lidar in the valley bottom approximately 1 km northeast of the WT conducting multiple arc scans every 10-minutes (arcs at varying elevations scanning over azimuth angles of; 209 to 241 degrees from N, and elevation angles of 7-23 degrees (both centered on the WT)). Three lidars were operated by DLR with a main focus on the wake propagation in the valley. Two of those lidars are placed in-plane with the WT for the main wind direction, one in the valley and one on the distant mountain ridge, performing continuous, coplanar dual-Doppler range height indicator (RHI) measurements of the valley flow and WT wake. The third DLR lidar is placed on the SW ridge, cutting the WT wake at multiple distances downstream with RHI scans to track its lateral position. Integrating data resulting from these scanning Doppler lidars the WT wake can be characterized in 3-D at relatively high temporal resolution permitting quantitative analyses of the temporal and spatial characteristics of the wake. Here we report on development of the analysis framework designed to permit integration of data time series from the different instruments, quantification of the uncertainty in wake characterization arising from the operation of different types of lidars and their scanning geometry during the campaign, and provide illustrative examples of wake behavior and characteristics (e.g. asymmetry, centerline deficit) based on case studies collected under different atmospheric stability.