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Turbulence in wind turbine wakes under different atmospheric conditions from static and scanning Doppler LiDARs

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Wake characteristics are of great importance for wind park performances and turbine loads. Wind tunnel experiments helped to validate wake model simulations under neutral atmospheric conditions. However, recent studies show strongest wake characteristics and power losses in stable atmospheric conditions. Considering all three occurring atmospheric conditions this study presents a turbulence analysis of wind turbine wake flows measured by static and scanning Doppler LiDARs at the coast of the Netherlands. We use data collected by three Windcubes v1, a scanning Windcube 100S and sonic anemometers during the Wind Turbine Wake Experiment – Wieringermeer (WINTWEX-W). Turbulence parameters such as Turbulence Intensity (TI) and turbulent kinetic energy (TKE) are retrieved from the collected raw data. Results show highest turbulence on the flanks of the wake where strong wind shear dominates. On average the spatial turbulence distribution becomes more homogeneous with conical areas of enhanced TI. Highest turbulence and strongest wind deficits occur during stable weather conditions. Despite the ongoing research on the reliability of turbulence retrievals of Doppler LiDAR data, the results are consistent with sonic anemometer measurements and show promising opportunities for a qualitative study of wake characteristics such as wake strength and wake peak frequencies.