Full two-dimensional rotor plane inflow measurements by a spinner-integrated wind lidar

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Introduction
Wind turbine blade reduction and power performance optimization via advanced control strategies are active areas in the wind energy community. In particular, feed-forward control using upstream inflow measurements by laser-doppler anemometry and range-gating remote sensing instruments has attracted an increasing interest during the last couple of years. So far, the reported inflow measurements have been from a few measurement points or at most on a circle in front of the turbine, which is not optimal in a complex inflow such as in the wakes of other turbines. Here, the present novel full two-dimensional radial inflow remote measurements.

The field campaign 2012
During the summer of 2012, a proof-of-concept field campaign was established. A two-dimensional upward scanning wind lidar was mounted in the rotating spinner of an operating Vestas V100 turbine (59 m hub height and 83 m rotor diameter) located at Tjejnæborg Einge in western Denmark. The new two-dimensional scanning device including two rotating prisms was integrated on top of a modified Zephyr 300 continuous-wave coherent Doppler lidar (ContravesZephyr) operating at a wavelength of 1.5 μm. The lidar was modified to show three deflecting Doppler spectrom at a rate selectable up to about 500 measurements per second. This ensured short enough transversal sampling volumes when the prisms were rotating at maximum speed.

The scanning strategy
The scanning speed is adjustable and it is possible to generate wake inflow using one second a complete two-dimensional scan pattern covering an upwind spherical surface. The rotating configuration being in step with the scanning lidar, which is the principle of the presented novel full two-dimensional radial inflow remote measurements.

The inflow scanned at night on a spherical surface at a measurement distance of 100 m during periods of 10 seconds without any influence from wakes from nearby turbines. The line-of-sights eight measurements have been converted to axial (along the rotation axis of the wind turbine rotor) wind speeds corresponding to the measured projection along the line-of-sight of the lidar.

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Stable atmosphere without wake influence

Unstable atmosphere with wake influence

References

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