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, feedforward control using upwind inflow measurements, by laser (light detection and ranging) and ranging remote sensing instruments, has attracted an increasing interest during the last couple of years. So far, the reported inflow measurements have been along a few measurements directions, 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. In this work we 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 V112 turbine (59 m hub height and 35 m rotor diameter) located at Ejbyeøgre Enge in eastern Denmark. The new two-dimensional scanning device including two rotating prisms was integrated on top of a modified ZephIR 300 continuous-wave coherent Doppler lidar (CZTech/ZephIR) operating at a wavelength of 1.5 μm. The lidar was modified so that one of the two wedge-shaped optical prisms and the instantaneous accurate position of the spinner-mounted wind lidar measured by an integrated three-axis accelerometer.

The scanning strategy
The scanning speed is adjustable and it is possible to perform within any one second a complete two-dimensional scan pattern covering an equal spherical surface, the rotating coordinate frame of the spinner, bounded by the perimeter of a cone with its apex in the spinner-mounted lidar and with a full opening angle of 60°.

The actual absolute measurement positions were calculated from the reference position—defined as the two wedge-shaped optical prisms and the instantaneous accurate position of the spinner-mounted wind lidar measured by an integrated three-axis accelerometer. Additional measurements
Turbine parameters such as yaw direction, yaw misalignment and wind speed on top of the nacelle were logged as well as wind on the nearby mast. Rotor-sensing movements in the blades were acquired by an optical fiber-based strain measurement system. This data will be used in a future analysis to study the correlation between the spinning wind field and the load on the turbine.

Experimental, a proof-of-concept test with a blade mounted lidar was performed during the measurement campaign. This is reported in a separate EWEA 2013 contribution (Abstract ID 461).

References

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