Category: 5

Calibration procedures for nacelle-mounted profiling lidars

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1. Introduction

1.1 Use of profiling lidars for power performance assessment

It is now commonly accepted that ground-based profiling LIDARs can improve power performance assessment by measuring simultaneously at different heights [1]. On the other hand, even though they are unable to measure the wind shear, two-beam nacelle lidars studies show promising capabilities to assess power performance [2] and avoid the erection of expensive meteorology masts, especially offshore. A new generation of commercially developed profiling nacelle lidars combine the benefits of both.

Fig. 1 Left: “Demonstrator” (credits: ECN / XEMC Darwind / Avent Lidar Technology)

Right: ZephIR Dual Mode (credits: ZephIR lidar)

1.2 The need for calibration procedures

The fundamental reason for developing calibration procedures is to assign uncertainties to the measured parameters. Calibration procedures for two-beam pulsed lidars have been published in [3]. We have developed new procedures for profiling nacelle lidars (both pulsed and continuous wave).

In this paper, we will present the procedures used for the calibration of newly developed nacelle-based profiling lidars and the results obtained.

2. Calibration procedures principles

The outputs of a profiling lidar are usually reconstructed parameters (e.g. horizontal wind speed), mathematically derived from a number of measurements of radial wind speed (RWS) at different heights. The new procedures are based on individual RWS calibration. Uncertainties are then derived by combining the RWS uncertainties through the reconstruction algorithms. This method is referred as “white box” in contrast with a “black box” calibration (direct comparison of the reconstructed outputs to a reference instrument).

The question of uncertainties for complex wind characteristics derived from profiling nacelle-based lidars (shear, veer, turbulence intensity) can be addressed much more comprehensively using the white rather than the black box method.

3. Results

Two profiling nacelle lidars, an Avent Lidar Demonstrator and a ZephiR DM have been calibrated at DTU's test site for large wind turbines, Høvsøre. They have been placed on the ground, their geometry measured (e.g. cone or opening angles), and their internal inclinometers calibrated. The line of sight (LOS) direction is derived using a sonic anemometer retrieving the wind direction. The RWS along the LOS have been compared to the measurements from a cup anemometer top-mounted on a mast. Finally, uncertainties of the LOS speed calibration have been determined as well as those of the reconstructed parameters.

4. References

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