Application-oriented classification of lidar profilers - or: Introducing lidars to power performance

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Citation (APA):
Commercially available lidars have reached a level of accuracy where they can be considered as serious alternative to standard cup anemometers. A standardized application to power performance testing, however, requires a traceable classification scheme that allows for a complete evaluation of the uncertainty of the measurement. With an application-oriented classification concept, we propose a generic procedure that is to be adjusted to upcoming revisions of the standards for power performance testing. Our work is part of the UpWind project (WP 6) and discussed in IEC MT12-1 currently revising the IEC 61400-12-1 standard for power performance testing.

Relevance:
Commercially available lidar profilers have reached a level of accuracy where they can be considered as serious alternative to standard cup anemometers - especially with significant advantages in large heights or in areas where it is difficult and costly to set up a meteorological mast. A further benefit is that lidars can measure wind speeds and wind directions simultaneously at different height levels, why they are particularly suited for considerations of vertical wind shear.

Following these considerations, it is an obvious procedure to introduce lidars to resource assessment and power performance testing. A standardized application, however, requires a traceable classification scheme that allows for a complete evaluation of the uncertainty of the measurement. With an application-oriented classification concept, we propose a generic procedure that is to be adjusted to upcoming revisions of the standards for power performance testing.

Approach:
Lidar accuracy is evaluated in terms of traceability to cup anemometer measurements at different height levels. In a verification measurement, both the agreement between lidar and reference mean wind speeds at the same height (giving a gain error) and the accuracy of the sensing height of the lidar (giving the estimate for a possible altitude error) are tested. For this, we apply one- and two-parametric regression analyses, as described elsewhere. The classification concept comprises as first step a generalized system classification, evaluating verification measurements with respect to peculiar dependencies on secondary parameters, then the accuracy test for each individual instrument, resulting possibly in a calibration of the tested instrument, and as last step the application-oriented classification of the instrument, for that the results of the individual verification measurement are evaluated with respect to clearly defined criteria. In this way, traceability is transferred from the reference sensor to the tested lidar, and a respective lidar uncertainty can be deduced accordingly.

Results:
We present the results for several tested commercial lidars that were evaluated with respect to this classification concept. In particular, it is discussed how the concept is adjusted to different approaches of power performance testing, including the consideration of a rotor-averaged wind speed derived from measurements at different height levels.

Conclusions / Innovation:
Our work forms a crucial step for a standardized application of lidar profilers in power performance testing and resource assessment. It prepares the ground for the introduction of lidars as efficient and in many cases cost effective alternative to cup anemometers in standard applications.