Field test of an all-semiconductor laser-based coherent continuous-wave Doppler lidar for wind energy applications

Sjöholm, Mikael; Dellwik, Ebba; Hu, Qi; Mann, Jakob; Pedersen, Christian; Rodrigo, Peter John

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

ISARS2014 28-31 Jan 17th International Symposium for the Advancement of Boundary-Layer Remote Sensing | Auckland, NZ

FIELD TEST OF AN ALL-SEMICONDUCTOR LASER-BASED COHERENT CONTINUOUS-WAVE DOPPLER LIDAR FOR WIND ENERGY APPLICATIONS

M. Sjöholm[1], E. Dellwik[1], Q. Hu[2], J. Mann[1], C. Pedersen[2], and P. J. Rodrigo[2]

[1]Department of Wind Energy, Technical University of Denmark, Roskilde, Denmark

[2]Department of Photonics Engineering, Technical University of Denmark, Roskilde, Denmark

misj@dtu.dk

ABSTRACT

The wind energy industry is gaining interest in prevision of the rotor inflow for turbine control. The potential benefits are increased power production due to better alignment of the rotor to the mean wind direction as well as prolonged lifetime of the turbine due to load reductions. Several lidar-based instruments for wind turbine mounting are now commercially available. However, they suffer from high price and bulkiness. Therefore, the Technical University of Denmark has, in collaboration with the Danish company Windar Photonics A/S, developed a compact and low-cost lidar called WindEye based on a mass-produced all-semiconductor laser. The instrument is a coherent continuous-wave lidar with two fixed-focus telescopes for launching laser beams in two different directions. The alternation between the telescopes is achieved by a novel switching technique without any moving parts. Here, we report results from comparison campaigns with ultrasonic anemometer (METEK USA-1, Germany) measurements at a distance of about 80 meters from the lidar instrument. The influence of the finite spatial sampling volume at this range on the measured wind spectra is demonstrated. The sampling volume in the latest version of the instrument has been narrowed due to an improved telescope design and the signal quality has improved. Good reliability is essential for the anticipated applications for wind turbines. Thus, the lidar has been tested over extended periods in various meteorological conditions and the influence on the lidar signal strength from external atmospheric parameters such as relative humidity and concentrations of atmospheric particles is discussed. This novel lidar instrument design seems to offer a promising low-cost alternative for prevision remote sensing of wind turbine inflow.

Keywords: all-semiconductor laser, coherent Doppler lidar, wind turbine control, volume averaging