Technical University of Denmark

Recent Achievements with Ground-Based Remote Sensing for PBL Research

Mikkelsen, Torben Krogh; Mann, Jakob; Courtney, Michael; Sjöholm, Mikael; Angelou, Nikolas; Gryning, Sven-Erik; Batchvarova, Ekaterina; Pena Diaz, Alfredo; Gurpinar, Ali

Publication date:
2011

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

RECENT ACHIEVEMENTS WITH GROUND-BASED REMOTE SENSING FOR PBL RESEARCH

Torben Mikkelsen; Jakob Mann; Mike Courtney; Mikael Sjöholm; Nikolas Angelou, Sven-Erik Gryning, Ekaterina Batchvarova; Alfredo Peña Diaz; Ali Gurpinar.

Wind Energy Division

Risø National Laboratory for Sustainable Energy, Technical University of Denmark

Frederiksborgvej 399 DK- 4000 Roskilde, Denmark

Corresponding Author Torben Mikkelsen tomi@risoe.dtu.dk

Abstract: (<300 words)

Recent progress within ground-based remote sensing for planetary boundary layer research is presented, in particular regarding wind measurements. Dissemination of remote sensing equipment has been spurred recently mainly due to technological achievements in combination with an increased demand for wind energy resource assessment studies for wind energy.

Today, the hub heights on 5 MW wind turbines is above 100 meters and rotor planes exhibits diameters above 120 meters, and blade tips reaches to almost 200 meters height. The wind speed profiles over the rotor planes are consequently no longer representatively measured by a single cup anemometer placed on a met-mast at hub height, but call for multi-height wind speed and shear measurement strategies over the entire height-range between 50-200 meters aloft. Traditional met-towers reaching this height are expensive and cumbersome to move and call for reliable and easy deployable and transportable remote sensing equipment.

Within PBL research the boundary-layer wind profiles at these heights are also no longer fully scalable by standard Monin-Obukhov similarity scaling but becomes at height progressively influenced by the effective effective mixing height and mesoscale non-baroclinic effects.

During the last decade, significant developments with both sound based SODAR and laser based LIDAR wind remote sensing equipment have been address and to obtain wind profiles at greater heights.

Recently, hundreds of newly designed ground based SODARS and hundreds of both pulsed and continuous wave wind lidars, including some aerosol lidars and ceilometers have been deployed worldwide to measure the wind resources and to understand PBL wind profiles.

During the talk, progress and achievements with today's remote sensing profilers, both sodars and lidars, will be shown:

First we address our own developments of SODAR based remote sensing, where both monostatic and bi-static SODAR configurations have been investigated for wind profiles assessment studies with in the lower PBL.

Recent developments with commercial available ground- based LIDAR based wind profilers will also be addressed, listing our experiences and the key features of both continuous wave (cw) and pulsed coherent detection based systems.

A case study addressing on-going developments and field studies with the aim to integrate horizontal wind lidars into the control systems of operation wind turbines will demonstrated, it's a lidar based forecasting system under development for enhancing yaw and pitch control on operating wind turbines.

Two standard commercially available Leosphere/WLS70 wind profiler were installed during 2010/2011 at our reference test site (Høvsøre) in Denmark. Measurement of the PBL wind speed and direction profiles, including turbulence have with these remote sensing profilers been obtained to heights up to 1.5 km above the ground. Depending on atmospheric stability, the measured profiles exhibit evidence of both classical convective scaling during daytime convective conditions and evidence of nocturnal jets at night time.

Finally, a short presentation will be given about our on-going work with both a short range (10 -200 m) and long-range (100 - 5000m) 3D scanning wind lidar systems presently under development at Risø DTU for detailed surface and boundary layer research, for more details see www.windscanner.dk .