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Scanning lidars for atmospheric boundary-layer research

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DTU Wind Energy has developed a technology for co-located and synchronized wind measurements using remote-sensing wind lidars (WindScanner). After years of development, this technology is now operational. We demonstrate results from two of the first experiments in which this technology represents the back-bone instrumentation: a near-shore offshore experiment and an experiment over patchy forested terrain.

The coastal experiment took place during winter 2015-2016 and combined lidars and mesoscale models to find the most cost-efficient way of estimating near-shore wind resources on the west coast of Denmark. On the land side, the terrain is undulating and there is a steep cliff at the shore. The experiment represented a first attempt to remotely measure the gradient in the coastal wind speed. It was used simultaneously with measurements from vertically profiling lidars, a meteorological mast and an offshore buoy.

A dual wind lidar set-up used two synchronized lidars that were separated horizontally but focused at the same point and moved that point over a scanning pattern from 5 km offshore to 4 km inland. In addition, a single lidar set-up reconstructed the wind speed based on scanning a 60 degree sector in three horizontal planes. The measurements from both the single and dual lidar setups showed a height-dependent coastal gradient in mean wind speed. At the coastline, an acceleration related to the orography was observed.

The forest experiment started in March 2016 in Northern Denmark. In this experiment, the dual wind lidar setup was mounted on two balconies at 50 m height in tall towers located 4 km apart. The land use is a mixture of agricultural and forested areas in relatively flat terrain. To interpret the scanned wind fields over the heterogeneous land surface, detailed information on the terrain and vegetation characteristics are needed. We use aerial lidar scans of the surface to create maps relevant for interpreting the wind fields and use them in relation to WindScanner data in this first analysis from the experiment.