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Overview on the use of Doppler lidars for boundary layer wind and turbulence measurements at DTU Wind Energy 2009 - 2019.

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At the turn of the Millennium optical fibre-technology based wind lidars became available for ground-based remote sensing of wind. Today, wind lidars have revolutionized our ability to accurately measure wind and turbulence quantities in the atmospheric boundary layer.

In the 90'ties and before, the meteorology section at Risø National Laboratory – now DTU Wind Energy - dealt primarily with met-mast based micrometeorological measurements of flow and turbulence over homogeneous and modest complex terrain, wind loads on buildings and later also around wind turbines. In the 90'ties wind energy related meteorology research took off. This created an urgent need for precise and detailed wind and turbulence measurements at heights that could not easily be reached by meteorological towers as the wind turbines continued to grow and their blade tips started to soar above 200 meters height.

In the 00'ties the DTU wind energy Department engaged with leading European research labs to operationally deploy the first telecom component based wind lidars for wind energy research.

Today the Department operates scanning wind lidars integrated within the department own-developed 3D wind lidar scanning systems (windscanner.eu). The WindScanners combine multiple synchronized and trajectory-coordinated 3D scanning wind lidar systems. WindScanner operate short-range (300 meter range) continuous-wave scanning lidars, as well long-range WindScanners, with measurement ranges up to 10 km.
The talk will review this development by showing examples from our many wind lidar based boundary layer wind and turbulence investigations performed at DTU Wind Energy during the past decade.

For instance, one study have revealed a systematic difference in the daily variation of the wind speed at typical wind turbine heights (100-200 m) off and on shore. The Weibull shape parameter has been experimentally investigated as function of height and strength of the daily variations in the vertical wind profile. Onshore, it exhibits a maximum value at the so-called reversal height. Offshore, however, the wind profiles did not exhibit distinct maxima's; hence offshore, no reversal height seems to exist.

Furthermore, in addition to wind sheer, wind lidars are also excellent instruments for measurements of wind veer aloft due to the Ekman spiral and baroclinity. Non-homogeneity in wind is especially pronounced in coastal areas, a preferred location for wind turbines.

Measurements of wind and turbulence fields are key for research in wind turbine load and fatigue studies. Therefore wind scanning has also been used for measurements of 3D coherent structures. 3D turbulence has also been investigated experimentally with the department's 3D scanning wind lidars developed and operated by the department (www.windscanner.eu).

Today DTU Wind energy department continuously engage with lidar measurements of boundary layer wind profiles, with flow over complex terrain, with experimental studies of coastal wind fields, and with turbulence and coherence studies around bridges.