Characterization of a tree wake using three short-range WindScanners

Angelou, Nikolas; Dellwik, Ebba; Mann, Jakob

Publication date:
2018

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

Link back to DTU Orbit

Citation (APA):
Characterization of a tree wake using three short-range WindScanners

N. Angelou¹, E. Dellwik¹ and J. Mann¹

¹Wind Energy Department, Technical University of Denmark
Contact: nang@dtu.dk

Motivation
A project called Single Tree was initiated in the Wind Energy Department of the Technical University of Denmark (DTU), with the objective to characterize the flow around a solitary tree.

The presence of solitary trees in a flat terrain introduce heterogeneities, which modify the characteristics of the wind. The wind-trees interaction is a topic of study in applied research areas, like wind energy, where the estimation of wind resources and associated turbulence levels is necessary to describe accurately the wind conditions over an area. In the case of rough landscapes typical uncertainties in the estimation of the terrain roughness can result to 10% uncertainty in the annual energy production estimate [1].

Method
For the needs of this study a European Oak tree (Quercus robur), located on the shore of the Roskilde fjord in Denmark, was selected. Such a tree is commonly found in forests or solitarily in urban and rural environments in temperate regions. Using a commercial terrestrial laser scanner, the dimensions and the detailed geometry of the tree were measured and two meteorological masts equipped with multiple in-situ sonic anemometers were used to provide reference measurements of the wind conditions. The wind flow characteristic was performed using three short-range WindScanners [2][4].

Remote sensing instrument (Short-range WindScanner)
A short-range WindScanner consists of a Doppler wind lidar and an optical scanner head. The lidar is a continuous-wave, monostatic, infrared Doppler lidar, capable to measure both the amplitude and sign of the projection of the wind vector to its line-of-sight [3]. The transmitted light is steered in the atmosphere using a scanner head that deflects the lidar’s line-of-sight using two independently rotating wedge-shaped prisms, each with a deflection angle of 30°. Through the implementation of the aforementioned configuration the short-range WindScanner can scan a volume defined within a cone with an aperture angle of 120°.

Conclusions
The acquired data reveal the details of a tree wake dimensions, quantify the corresponding wind deficit and provide an insight on the characteristics of the flow around the tree. These observations contribute to the understanding of the wind-trees interaction and furthermore shall be used for the validation of fluid dynamics numerical models.

References

Acknowledgement
The authors would like to acknowledge the Independent Research Fund Denmark, for the financial support via The Single Tree Experiment, Grant No.611100121B.