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Characterization of a tree wake using three short-range WindScanners

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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 characterization was performed using three short-range WindScanners [2][4].

3D wake measurements of a tree
An example of a 10-min mean wake of the tree is presented, based on the radial wind speed measurements acquired from one of the short-range WindScanners. The wake has been measured during a period when the wind was flowing from a direction that approximately aligned to the normal axis of the scanning plane (y-axis). A maximum deficit of 63% between the upwind and downwind speed is observed.

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.

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References