EMS Annual Meeting Abstracts
Vol. 8, EMS2011-656-1, 2011
11th EMS / 10th ECAM

Forecasting the weather
- ensemble techniques
in probabilistic weather prediction

Investigation on wind turbine wakes: wind tunnel tests and field measurements with Lidars

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The survey of the interaction between atmospheric boundary layer and wind farms is of utmost importance for optimization of wind turbine power production and for the design of wind farm layout. In this work wind tunnel tests of wind turbine models were carried out in order to relate wake flow features to the wind turbine performance; particular attention is paid to the variation of the wake flow and of turbulence with different incoming boundary layers. The wake flow of a wind turbine is characterized by a strong velocity defect in proximity of the hub, which is found to be related to the wind turbine performance. Furthermore, the downstream distance of the wake recovery is found to affect the efficiency of wind turbines placed downstream and to be strongly dependent on the background turbulence level; in other words, an increased turbulence level typically anticipates the wake recovering. A helicoidal vortex system generated from the tip of the blades is clearly detected; however, these vortices diffuse rapidly by moving downstream of a distance about two blade diameters. An increased turbulence level is typically detected downstream of each wind turbine for heights comparable to the top-tip of the blades; this flow feature produces increased fatigue loads on the wind turbines, which could represent a significant hazard for real wind turbines. Subsequently, aligned and staggered wind farm layouts were studied by varying streamwise and transverse distances between wind turbines. Preliminary field measurements of a real wind turbine are also presented. The synergic analysis of wind tunnel and field measurements allows a deeper characterization of wind turbine performance.