EMS Annual Meeting Abstracts
Vol. 9, EMS2012-244, 2012
12th EMS / 9th ECAC

Wind Tunnel tests and multiple-LiDAR measurements of Wind Turbine Wakes

G. V. Iungo and F. Porté-Agel
EPFL, ENAC, WIRE, Switzerland

Wind energy is growing in popularity and is becoming one of the most profitable sources of renewable energy, thus more efficient and optimized wind energy systems are needed. In this study a wind tunnel investigation is presented, which was carried out by using hot-wire anemometry and multi-hole pressure probes, in order to analyse the development of wind turbine wakes and the evolution of turbulence statistics by moving downstream. The effect of different incoming wind profiles and different turbulence levels were tested. The distance of recovery of the wakes and turbulence dissipation, thus the performance of downstream turbines within a wind farm, are found to be strongly dependent on the characteristics of the incoming wind. An increased turbulence level is typically detected downstream of each wind turbine for heights comparable to the top-tip of the blades, which could represent increased fatigue loads on the following wind turbines. Dynamics of wake vorticity structures are surveyed, in particular the hub vortex, i.e. an axial vortex observed in the near wake, is found to be characterised by a single helix instability. Besides wind tunnel tests, wind measurements of the wake flow produced from real wind turbines are performed with three wind LIDARs. Bi-dimensional scans are performed in order to analyse the wind field in proximity of the wake, like wake size, magnitude of the velocity defect and wake turbulence with different atmospheric boundary layer conditions. Furthermore, simultaneous measurements with two or three LIDARs allow the reconstruction of multi-component velocity field.