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The effect of including mesoscale phenomena in Large Eddy Simulations of convective boundary layers

J.G. Pedersen, M. Kelly, and S.-E. Gryning

Department of Wind Energy, Risø Campus, DTU, Roskilde, Denmark (jegp@dtu.dk)

By use of measurements of the wind profile up to 1400 m carried out by a new ground-based wind lidar, the ability of Large Eddy Simulation (LES) to predict the wind profile in the entire boundary layer is studied.
Increased computer power has made it possible to run LESs of realistic atmospheric boundary layer flows within reasonable computation times. Prediction of wind speeds to estimate power production is one potential application. The size of the computational domain will, however, in most cases be limited to a few kilometers in each direction due to the inherent requirement of high spatial resolution. This raises the question of how to handle the influence of weather phenomena acting on scales larger than the computational domain.
We have performed two case studies in which we compare wind profiles from LESs of daytime convective boundary layers to measured wind profiles. One set of measurements is from the National Test Site for wind turbines at Høvsøre (Denmark), and the other is from a site in Hamburg (Germany). In both cases wind lidar measurements are available up to approximately 1400 m above ground level. Tower based measurements are available up to 160 m at Høvsøre and up to 250 m at the Hamburg site. In the Hamburg case we also use radio soundings.
Simulations with different types of forcing are performed to study the influence of mesoscale phenomena. We show that to get fair agreement between simulated and measured wind profiles, the simulated flow has to be driven by a both time and height dependent geostrophic wind. In the Hamburg case, we also show that large scale advection of warm air has a significant impact on the wind profile.