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Large-eddy simulation of neutral atmospheric boundary layer

A. Hansen, J. Mann, J. Johansen, N. N. Sørensen
Risø national lab., P.O.Box 49, DK4000-Roskilde,

The wind properties throughout the atmospheric boundary layer (ABL) are important in many applications. For wind engineers to accurately determine loads on wind-turbines, site-specific wind information is crucial. Design fatigue loading of wind turbines is traditionally determined from aero-elastic simulations, where a structural model is exposed to a synthetic generated wind field. Wind-turbines are often placed in complex terrain, which is beyond the capabilities of most wind field generators.

To generate a turbulent wind field containing realistic coherent structures, we use Large-Eddy-Simulation (LES). The approach adopted solves the Reynolds Averaged Navier-Stokes equations (RANS) close to the ground, where LES is too costly, and switches to LES away from the wall. To smoothen the transition between the two methods a stochastic backscatter model is adopted [1].

Results of the naturally stratified ABL are presented, with focus on wind over rough and flat terrain. Mean velocity profiles follow closely the well known logarithmic law-of-the-wall in the surface layer. Additionally, profiles of mean velocity and momentum fluxes are shown up through the entire boundary layer. Flow over the relatively low Askervein hill located at the Hebrides is presented and results compare well with field experiments done in 1983 (P. Taylor and H. Teunissen).

References

[1] A. Hansen, N. Sørensen, J. Mann, and J. Johansen. Hybrid rans/les of neutral atmospheric boundary layer: Simple terrain. *iTi Conference on Turbulence, Bad Zwischenahn, Germany*, 25th-28th of September 2005. Submitted.