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A sensitivity study of mesoscale wind profile simulations to PBL parameterization

F. Durante (1), T. de Paus (2), J. Beran (3), B. Lange (3), M. Strack (1)

(1) German Wind Energy Institute, Wilhelmshaven, Germany (2) CNR, Roma, Italy (3) ForWind, Center for Wind Energy Research, Oldenburg, Germany

(f.durante@gast.dewi.de / Fax:+49(0)44214808-43 / Phone: +49(0)4421/4808-776)

Accurate modelling and forecast of the vertical profile of the surface wind speed is important for meteorological, oceanographic and climate modelling and also crucial for a number of applications, e.g. storm prediction, wind power utilization, etc. A large number of meteorological models and parameterizations of the planetary boundary layer (PBL) is available for this.

In this study, the mesoscale model MM5 is used to simulate wind regimes at five different locations both over land and over sea surface.

The main goal is to analyze the performance of different PBL scheme presently implemented in the MM5 model in predicting the vertical wind profile and the temporal variation of the wind speed in the lower boundary layer.

In order to verify the response of the PBL parameterization, a set of simulations have been performed with three different PBL schemes (Blackadar, ETA-MY and MRF). The model set up and data providing initial and boundary conditions were kept unchanged when possible.

Three sets of simulations have been conducted over land for the sites of Cabauw (The Netherlands), Wilhelmshaven (Germany) and Karlsruhe (Germany). Two sets of offshore simulations have been performed over the North Sea and results are compared with observations measured at the stations FINO1 and Horns-Rev.

Special attention was payed to simulate periods with different atmospheric stability conditions to test the sensitivity of the considered PBL schemes to changes in the thermal stratification.

It was found that the PBL parameterization plays a crucial role in mesoscale simulation and has a large influence on the simulated wind speed within the lower part of the PBL.

Results suggest that, among the considered PBL schemes, the ETA-Mellor-Yamada scheme shows the best agreement with the observations.