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Large-eddy simulation modeling of the unstable boundary layer over sea

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The diurnal atmospheric boundary layer evolution observed during an experimental campaign realized on the island of Anholt in the Kattegat sea (Sempreviva and Gryning, 2000) is studied numerically using a Large-Eddy Simulation (LES) model. This is a modified version of the Moeng's model (Moeng, 1984), since it includes the virtual potential temperature integration and an improved eddy viscosity closure near the ground (Sullivan et al., 1994). The model is initialized with mean wind, temperature and humidity vertical profiles based on data from early in the morning of June 16,1992. Simulations for this case study are performed with two forcings: matching the time evolution of the surface heat and humidity fluxes in one case, and matching the temperature and humidity measured at the sea level in the other case. Results from the model are compared with data from the experimental campaign. LES mean profiles are in good agreement with the experimental ones for the first fours hours of the day, when the ABL is dominated by convection. Mean profiles of temperature and humidity indeed show a well-defined mixed layer up to 1-2 km of height. However, the simulated results and the observations present differences for the afternoon, when the ABL suddenly collapses and strong temperature and humidity inversions appear at about 400 m above sea level. An explanation for this difference can be found performing a synoptic analysis of the meteorological conditions of the day under investigation. Turbulent statistics is also studied to characterize ABL evolution.