Large eddy simulation of the onset of the sea breeze

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There are many numerical studies of the sea breeze, both in real and idealized conditions; for the most part the latter are two-dimensional simulations since the idealized sea-breeze circulation takes place in a vertical plane orthogonal to the coastline. Of course in reality, the sea-breeze circulation is much more complex because it can be modified by the synoptic flow, coastline curvature, coastal orography, Coriolis effects, turbulence, cloud cover, etc. In the present work, we take a step towards greater realism by using a Large Eddy Simulation (LES) model capable of simulating boundary-layer-scale three-dimensional turbulence along with the mesoscale sea-breeze circulation. The basic experimental design considers a rotating, uniformly stratified, resting atmosphere which is suddenly heated at the surface over the land” half of the domain. In order to focus on the simplest nontrivial problem, the diurnal cycle, effects of moisture, interactions with large-scale winds and coastline curvature were all neglected in this study. The assumption of a straight coastline allows us to compute the small-scale turbulent eddies together with the mesoscale sea breeze with a grid spacing of 100 m in a rectangular domain extending 100 km in the cross-coast direction, but only 5 km in the along-coast direction, since one can assume periodic conditions in the along-coast direction (the vertical domain size is 4 km.). Through dimensional analysis of the simulation results, we were able to identify the length and velocity scales characterizing the simulated sea-breeze motions as functions of the externally specified parameters.