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Numerical simulations of thermally driven slope winds

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Most severe events of atmospheric pollution occur under weak synoptic systems when circulation is mainly driven by local forcing. The aim of this study is to investigate the diurnal and nocturnal evolution of the atmospheric boundary layer over a slope under simplified idealized boundary conditions. The three dimensional non-hydrostatic mesoscale model WRF (Weather Research and Forecast) is used at very high horizontal and vertical resolution to perform large eddy simulations of typical structures of such convective flows. A 1.5 order TKE turbulence closure is adopted to model the sub-grid scale fluxes. To reproduce the diurnal-nocturnal cycle we impose a sinusoidal law for the bottom heat flux with a 24 hours period and various amplitudes. The domain is symmetric, having an infinitely long straight valley in the y direction; for the x direction we assume periodic lateral boundary conditions. The first set of simulations was performed with a uniform grid spacing of 50X50X50 m. Since the depth of the katabatic flow is limited to 10-40 m, we introduced a vertically stretched grid in order to obtain a finer mesh near the ground, avoiding an increase of the total grid points and hence containing computational demand. Results show that at this resolution the model is able to correctly reproduce local circulation dynamics driven by thermal forcing even at slight terrain variations. Moreover the diurnal growth of the convective boundary layer leading to the onset of the anabatic wind as well as the formation of the so called ’cold pool’ in the valley in the night time are evidenced.