Geophysical Research Abstracts
Vol. 19, EGU2017-15731, 2017
EGU General Assembly 2017

Effects of Land Surface Heterogeneity on Simulated Boundary-Layer Structures from the LES to the Mesoscale

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Land heterogeneity influences the atmospheric boundary layer (ABL) structure including organized (secondary) circulations which feed back on land-atmosphere exchange fluxes. Especially the latter effects cannot be incorporated explicitly in regional and climate models due to their coarse computational spatial grids, but must be parameterized. Current parameterizations lead, however, to uncertainties in modeled surface fluxes and boundary layer evolution, which feed back to cloud initiation and precipitation.

This study analyzes the impact of different horizontal grid resolutions on the simulated boundary layer structures in terms of stability, height and induced secondary circulations. The ICON-LES (Icosahedral Nonhydrostatic in LES mode) developed by the MPI-M and the German weather service (DWD) and conducted within the framework of HD(CP)^2 is used. ICON is dynamically downscaled through multiple scales of 20 km, 7 km, 2.8 km, 625 m, 312 m, and 156 m grid spacing for several days over Germany and partial neighboring countries for different synoptic conditions. We examined the entropy spectrum of the land surface heterogeneity at these grid resolutions for several locations close to measurement sites, such as Lindenberg, Jülich, Cabauw and Melpitz, and studied its influence on the surface fluxes and the evolution of the boundary layer profiles.