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Large-eddy simulations of the convective atmospheric boundary layer over heterogeneous land surfaces

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The parameterization of the atmospheric boundary layer is crucial for accurate numerical weather predictions. Over heterogeneous terrain, several open challenges remain regarding the growth of internal boundary layers, the determination of mixing layer heights and the spatial distribution of heat and momentum fluxes.

The large-eddy simulation (LES) code we apply is based on the very robust Lagrangian scale-dependent dynamic subgrid-scale model. The flow is driven by a mean pressure gradient expressed in terms of horizontal geostrophic winds. The code is pseudo-spectral with spectral decomposition in the horizontal dimensions. Land surface heterogeneities take the form of distributed patches of surface temperature and momentum roughness derived from surface observations and land use analysis. Although recent developments in the code have enabled the simulation of the complete diurnal cycle, the focus here is restricted to convective conditions.

Data from LITFASS-2003 (standing for Lindenberg Inhomogeneous Terrain Fluxes between Atmosphere and Surface: a long-term Study) are utilized to validate the simulation results. The LES domain covers a 99-m meteorological tower with turbulent measurements and a few surface micrometeorological stations. We investigate the presence of large-scale turbulent structures that are typical for daytime conditions with a particular interest in the blending height.