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Heat and moisture budgets from airborne measurements and high resolution model simulations

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High resolution simulations with the mesoscale model FOOT3DK were performed to measure heat and moisture budgets of the boundary layer under convective weather conditions. The large-scale atmospheric forcing is provided by COSMO-DE model simulations. The model budgets are validated against energy budgets obtained by airborne measurements over heterogeneous terrain in Western Germany in April and August 2009. Following the conservation equations, the time rate-of-change, the vertical divergence, and the horizontal advection for an atmospheric column of air are estimated. Due to the small spatial extent of the flight pattern, the advection term is assessed indirectly as a residuum.

Results show that the model is able to simulate the general features of the boundary layer such as humidity, temperature and wind profiles adequately. Concerning the temporal evolution, results are inconsistent: while the time trend of specific humidity exhibits some deficiencies, the trend of potential temperature is matched accurately. Furthermore, the simulated turbulent surface fluxes of sensible and latent heat are comparable to the measured fluxes, leading to similar values of the vertical divergence. However, a slight overestimation of latent heat fluxes (+ 7 %) and a moderate underestimation of sensible heat fluxes (- 19 %) are found. The analysis of different horizontal model resolutions exhibits improved turbulent surface fluxes with increased resolution, which can be attributed to a reduction of the aggregation effect. Furthermore, effects of scale interaction could be identified. While time trends and advection are controlled by mesoscale forcing, the turbulent surface fluxes are mainly influenced by microscale processes.