Geophysical Research Abstracts, Vol. 8, 02594, 2006
SRef-ID: 1607-7962/gra/EGU06-A-02594

Simulations of the structure of the boundary layer over heterogeneous land surface using high-resolution mesoscale and LES models and comparisons with measurements for the LITFASS-2003 experiment

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The atmospheric boundary layer (ABL) structure for the LITFASS-2003 experiment was simulated using a suite of models including the regional climate model REMO (18 km grid), the Lokal-Modell (7 and 1 km grid), the FOOT3DK model (1 km and 250 m grid), and a LES model. Model simulations are compared to observations of vertical profiles from radiosondes, tower and lidar measurements, and airborne measurements of the Helipod system. Two case studies are presented, which allow the comparison of the ABL over specific surface types, and a statistical comparison is performed for the whole LITFASS-2003 period.

The first case study on 30 May 2003 represents a convective boundary layer (CBL) with strong entrainment conditions and weak winds. The entrainment flux of sensible heat is largest for the LES model and decreases with decreasing resolution for the FOOT3DK simulations. The entrainment zone is completely missing in the Lokal-Modell simulations. The second case study on 7 June 2003 also represents a CBL situation, but the entrainment is weak. In addition, both cases are quite different with respect to the nature of the land surface heterogeneity. While the land use contrast is dominating for the first case, the surface heterogeneity is strongly influenced by a very

heterogeneous pattern of soil moisture in the second case. The high-resolution simulations are able to resolve the ABL structure associated with these heterogeneities, and the comparison with Helipod data yields good agreement for most quantities. Largest differences are found for the latent heat flux profile, while simulated and measured sensible heat flux profiles are in good agreement. With the exception of the LES model, all models seem to underestimate the sensible heat entrainment fluxes, which partly explains the tendency of all models being too cold and too wet in the ABL. The largest errors are found for REMO and the operational version of the Lokal-Modell, which both largely overestimate the evaporation and ABL moisture due to inaccurate soil moisture initialisation.