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High-resolution simulations of surface energy fluxes during the LITFASS-2003 experiment

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Land surface heterogeneity effects on the sub-grid scale of climate and numerical weather prediction models are of vital interest for the energy and mass exchange between the surface and the atmospheric boundary layer. High-resolution numerical model simulations can be used to quantify these effects, and are a tool to obtain area-averaged surface fluxes over heterogeneous land surfaces. The paper presents high-resolution non-hydrostatic model simulations for the LITFASS area near Berlin during the LITFASS-2003 experiment. Model simulations were carried out using the non-hydrostatic model FOOT3DK of the University of Köln with resolutions of 1 km and 250 m. The LITFASS-2003 experimental data set is used for an intercomparison. The screen level quantities show a good quality for the simulated temperature, humidity and wind speed and direction. Averaged over the four weeks experimental period, simulated surface energy fluxes at land stations shows a small bias for the turbulent heat fluxes and an underestimation of the net radiation caused by excessive cloudiness in the simulations. For eight selected days with low cloud amounts, the net radiation bias is close to zero, but the sensible heat flux shows a strong positive bias. Large differences are found for latent heat fluxes over a lake, which are partly due to local effects in the measurements, but the main problem seems to be the overestimation of the turbulent exchange under stable conditions in the daytime internal boundary layer over the lake. In the area average over the LITFASS area of 20x20km^2, again a strong positive bias of 70 W/m^2 for the sensible heat is present. For the dry soil conditions during June 2003, the SVAT model of FOOT3DK is sensitive to variations in the soil type and its hydrological properties. An additional problem is that the supply of ground water to the lowest soil layer is not accounted for.