Geophysical Research Abstracts
Vol. 15, EGU2013-8645, 2013
EGU General Assembly 2013

The ground heat flux simulated by the COSMO land surface scheme TERRA

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Land surface processes have a significant impact on near-surface atmospheric phenomena. They determine, among others, near-surface sensible and latent heat fluxes and the radiation budget, and thus influence atmosphere and land characteristics, such as temperature and humidity, the structure of the planetary boundary layer, and even cloud formation processes. It is therefore important to simulate the land surface processes in atmospheric models as realistically as possible.

Verifications have shown that the ground heat flux computed by the land surface scheme TERRA of the COSMO atmospheric model is systematically overestimated under dry conditions. Since this flux is part of the surface energy balance it affects the other components like the turbulent heat fluxes and the surface temperature. This means, an overestimation of the ground heat flux during daytime leads to an underestimation of the other surface fluxes and a reduced surface warming. During afternoon and night this behaviour is reversed.

Data from the Meteorological Observatory Lindenberg of the German Weather Service were used to analyse this model behaviour. In sensitivity experiments with the soil model TERRA it turned out that the simulated ground heat flux is particularly influenced by the shading effect of the incoming solar radiation due to the vegetation cover, but also by the thermal conductivity of the soil and its dependence on the soil moisture. Two formulations for the dependence of the thermal conductivity on soil moisture, following Johansen (1975) and McCumber and Pielke (1981), were tested in TERRA. It turned out that Johansen (1975) gives good results, while McCumber and Pielke (1981) overestimates the effect.