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New Concepts for Studying Land-Surface-Atmosphere Feedback Based on a new Lidar Synergy and Grey Zone Simulations

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Improved understanding and simulations of land-surface-atmosphere feedback processes are essential for predicting extreme weather events and the changes of the water cycle in the era of climate change. This requires observations of the surface energy balance closure and of the structure of the atmospheric boundary layer simultaneously. In this presentation, a new strategy is introduced for studying land-surface exchange and entrainment processes in the convective boundary layer (CBL) over complex terrain combining a new generation of remote sensing and model systems.
The sensor synergy consists of combination of scanning Doppler lidar (DL), water-vapor differential absorption lidar (WVDIAL), and temperature rotational Raman lidar (TRRL) systems, which are capable of measuring 2D fields of surface and entrainment fluxes, supported by surface in-situ measurements. It is demonstrated that the WVDIAL and the TRRL have currently worldwide the highest resolution and accuracy of water-vapor and temperature profiling using remote sensing systems during daytime.
Based on recent and upcoming field efforts, particularly the Surface Atmospheric Boundary Layer Exchange (SABLE) campaign in August 2014, it is shown that with these active remote sensing systems, both sensible and latent heat flux profiles in the convective boundary layer can be measured, what is to our knowledge for the first time. Furthermore, by a sophisticated combination of surface scans, surface momentum, heat, and latent heat fluxes can be determined.
These observations will be complemented with a hierarchy of simulations based on the WRF-NOAH-MP-HYDRO model system, which includes new dynamic parameterizations for crop roots and leaf areas as well as a consistent simulation of the water cycle through all compartments of the soil-vegetation-atmosphere continuum. For comparisons with field data, the model system is operated with a rapid update cycle using 3D variational data assimilation (3DVAR). Model simulations for selected golden days of field campaigns are performed down to the grey zone with a series of grid increments of 3 km – 1 km – 300 m – 100 m so that model runs with different physics as well as with and without parameterizations of turbulence are possible. By detailed comparisons of these model simulations with in-situ network and scanning lidar observations a better understanding of soil-vegetation-atmosphere feedback will become possible under different forcing and soil moisture regimes. First results are presented at the conference.