Remote Sensing of Atmosphere-Land Surface Interactions in the Convective Boundary-Layer

In this study observations of the Jülich ObservatorY for Cloud Evolution (JOYCE) are used to identify spatial and temporal patterns of surface-atmosphere exchange. The JOYCE site is equipped with a range of state-of-the-art ground-based remote sensing techniques and provides temporal and spatial highly-resolved measurements, as well as long-term observations. The constantly growing multi-year data set at JOYCE offers detailed insight into the diurnal and seasonal boundary-layer development concerning turbulence, clouds and winds. Studying the mixing processes and their evolution in the lower atmosphere is essential in order to understand the coupling between near surface turbulence and cloud formation.

A classification method based on Doppler wind lidar data is able to provide information on the turbulent regions in the boundary-layer and objectively assigns a source for the mixing with a high temporal resolution. In this method, a combination of several lidar quantities (attenuated backscatter coefficient, vertical velocity skewness, dissipation rate of turbulent kinetic energy, vector wind shear, horizontal winds) is used to discriminate between surface and cloud driven turbulence.

The first statistical analysis of the turbulent classes clearly showed seasonal variations in the diurnal cycle and a relation of turbulent mixing to nocturnal low-level jets. Due to the emerging Doppler wind lidar networks, the robust method is intended to be applied at various sites in different climatic regimes, including maritime and high latitude regions to distinguish between processes that are site specific and generally valid.

Furthermore, the classification is used to select specific conditions for the evaluation of interaction processes between near surface turbulence and vegetation properties. In these predominantly convective cases, the land surface heterogeneity is assessed by exploiting the high performance aircraft supported spectrometer HyPlant measuring sun-induced refection and chlorophyll fluorescence, as well as time series of eddy-covariance stations and a land use classification. Following this, the derived spatial variability of the surface fluxes is connected to measurements of a scanning microwave radiometer providing horizontal water vapor gradients. In this way, influences of the orography and vegetation can be identified.