

## Long-term characterization of the boundary-layer for studying land-surface atmosphere interactions

Boundary-layer turbulence and interaction processes between the surface and lower atmosphere are essential for wind energy applications, air quality assessment and improving the representation in weather and climate models. Since 2011 the Jülich Observatory for Cloud Evolution (JOYCE), which is embedded in a rural environment with heterogeneous land use and topography, is equipped with a wide range of continuously measuring ground-based remote sensing and in-situ instruments providing detailed insight into patterns of the cloudy boundary-layer and surface conditions.

A method based on Doppler lidar data showed the potential of classifying the main sources of turbulence into a set of boundary layer types with sufficient temporal and spatial resolution in an emerging Doppler lidar network. The classification is applied to over six years of observations at JOYCE and used for evaluating the diurnal and seasonal cycles, as well as selecting specific atmospheric conditions to further analyze land-surface atmosphere interactions.

Nocturnal low level jets are a frequently occurring phenomenon and showed significant amount of turbulence below the jet nose and an accumulation of atmospheric gases near the surface. Using high resolution large-eddy simulations (LES) the presence of an orographic flow depending on the wind direction causing a high variability of the vertical velocity is found in the model but also in the long-term measurements of the Doppler lidar.

The hemispheric scans of a microwave radiometer allow for an identification and quantification of horizontal gradients in integrated water vapor (IWV) and liquid water path (LWP) measurements. During clear sky and convective situations the scans provide information on the spatial distribution of IWV, which can be linked to near-surface fluxes and the topography depending on the time of the day and the synoptic weather type. As a verification of the spatial variability, additional satellite derived products of IWV and maps of hyper-spectral reflectance and fluorescence obtained from an airborne high-resolution imaging spectrometer are evaluated. With a connection to the LWP variability, the study aims towards a better understanding of the water cycle processes ranging from vegetation transpiration to the development of clouds.