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Investigation of Humidity Structures from the Land-Surface to the Lower Troposphere Using a Scanning DIAL

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The exchange of momentum, energy, and water between the atmosphere and the land-surface as well as related feedback processes are relevant for the development of the planetary boundary layer (PBL). One weakness of today's weather and climate models is the inaccurate representation and parameterization of these processes. In order to investigate these processes, the Land-Atmosphere Feedback Experiment (LAFE) was organized at the Atmospheric Radiation Measurements (ARM) Program Southern Great Plains site in Oklahoma, USA, in August 2017. Among standard in-situ instruments, a novel scanning lidar synergy was deployed. The target variables were wind velocity, humidity, and temperature observed from the land-surface through the PBL up to the lower troposphere. With specific coordinated scans not only vertical profiles above one point were captured but also 2-dimensional fields of wind, humidity and temperature. By combining their profiles, further quantities like surface sensible and latent heat fluxes can be derived and turbulent to mesoscale structures were detected. The collected data set will allow detailed studies of land-atmosphere feedback processes as well as comparisons with model output.

In this contribution we will focus on the results of our 3-D scanning water vapor differential absorption lidar (DIAL). During usual intensive observations periods, a scan pattern with consecutive low elevations and full RHI scans was applied. The low elevation RHIs reached from the land-surface to an elevation angle of 7° and were performed with a scan speed of $1°s^{-1}$ for 50 min while during the remaining 10 min of an hour full RHIs from the land-surface to the vertical with $1°s^{-1}$ were performed. In addition, special observation periods for vertical steering measurements were conducted as well. First results are presented at the conference revealing complex 2-D structures of the surface layer water-vapor field with strong vertical coherence throughout the PBL. These results may question the applicability of Monin-Obukhov similarity theory in heterogeneous terrain.