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Capabilities of Scanning Lidar Systems to Observe Surface Layer Profiles of Humidity, Temperature and Wind

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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, scanning lidar systems allow the observation of surface layer profiles of humidity, temperature and wind velocity. In August 2017, the Land-Atmosphere Feedback Experiment (LAFE) was organized at the Atmospheric Radiation Measurements (ARM) Program Southern Great Plains site in Oklahoma, USA, with the deployment of a novel scanning lidar synergy.A combination of a differential absorption lidar, Raman lidars, and Doppler lidars was used to measure humidity, temperature, and the horizontal wind velocity from the land-surface through the boundary layer 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 sensible and latent surface 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 present first results of the 3-D scanning water vapor differential absorption lidar (DIAL), of the scanning temperature Raman lidar (TRRL), and of scanning Doppler lidars (DL) revealing complex 2-D structures of the surface layer and throughout the ABL. Additionally, an estimation of fluxes can be obtained by using the combination of the quantities humidity, temperature and wind velocity. These results may question the applicability of Monin-Obukhov similarity theory in heterogeneous terrain.