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Measurements of the Latent heat flux profile in the Convective Boundary Layer using Ground based Lidar systems during Land Atmosphere Feedback Experiment 2017

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Abstract
The transport of water vapour in the atmospheric boundary layer plays a major role in various atmospheric phenomena such as clouds, thunderstorms, and radiation. Turbulent processes in the convective boundary layer (CBL) are responsible for the transport of these important scalars. It is very challenging to measure profiles of turbulent higher-order moments (HOMs) and fluxes throughout the CBL because it requires high spatial and temporal resolutions. Robust methods have been developed to correct the turbulence measurements for lidar instrumental noise. Recently, a new generation of Doppler, Raman, and differential absorption lidar systems has been developed to provide wind, temperature, and water-vapour profiles with the required temporal and spatial resolutions. Such a combination of water vapour differential differential absorption lidar (DIAL) and a Doppler lidar (DL) were used simultaneously for profiling the convective boundary layer thermodynamic structure over the Atmospheric Radiation Measurement Southern Great Plains site during August 2017. These measurements were combined by the means of eddy correlation technique to obtain the latent heat flux (LHF) profile in the CBL. Several days of data were investigated under different back ground conditions such as clear sky and cumulus topped boundary layers. Latent heat flux was derived upto the cloud bottom height under cloudy conditions. A decrease in the LHF profile was found towards the top of the CBL in dry atmospheric conditions on 04 August 2017. On this day, only a maximum of 250 W.m-2 was found in the middle of the CBL and decreased to zero at the CBL top. Contributions from the surface latent heat flux was found to be more when soil moisture was found to be high after a rain event. LHF peaked up to a maximum of 400 W.m-2 in the middle of the CBL for this case on 23 August 2017. These flux profiles can be used for the evaluation of large eddy simulation outputs which are crucial for the development of various turbulence parameterization schemes used in numerical weather prediction models. Furthermore, these schemes are also important for the proper simulation of cloud and rain events in the regional weather models.