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The Land Atmosphere Feedback Observatory (LAFO): A novel sensor network to improve weather forecasting and climate models

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The land-atmosphere system consists of the soil, vegetation, and atmosphere including the influence of human activities. The energy and water transport processes in this system as well as their related feedback processes determine the structure and the diurnal cycle of the atmospheric boundary layer (ABL), which is the layer between the land surface and the free troposphere. One weakness of today's weather and climate models is the inaccurate representation and parameterization of the boundary layer processes such as land-atmosphere (L-A) feedback. (Santanello et al. 2018). For instance, corresponding observations are necessary to improve parameterizations of dynamic vegetation models, Monin-Obukhov similarity theory (MOST), and atmospheric turbulence. It is expected that advances in these areas will significantly contribute to better simulations of clouds and precipitation on all temporal and spatial scales.

The Land Atmosphere Feedback Observatory (LAFO) at the University of Hohenheim in Stuttgart (Germany) brings together an ensemble of established and newly developed sensors with unequaled spatial and temporal resolution to get new insight in L-A processes in the soil-plant-atmosphere continuum (Wulfmeyer et al. 2018). An extended set of soil physical, plant dynamic and meteorological variables throughout the planetary boundary layer (PBL) are measured focusing on evapotranspiration and turbulent exchange processes.

The LAFO sensor synergy consists of three key components. 1) 3D scanning lidar systems: A water vapor differential absorption lidar (WVDIAL) and a temperature rotational Raman lidar (TRRL), both developed at the Institute of Physics and Meteorology are deployed in combination with Doppler lidars (DL). The WVDIAL and the TRRL provide water vapor and temperature remote sensing data with very high resolution up to the turbulent scale (Behrendt et al. 2015, Wulfmeyer et al. 2015, Muppa et al. 2016, Späth et al. 2016). Currently, they are worldwide unique. Horizontal wind profiles and turbulent wind fluctuations are measured with DLs. 2) A soil water and soil temperature network has been set up in the study area. It has been combined with eddy-covariance stations (Imukova et al. 2016). 3) Devices for vegetation characterization based on an innovative sensor-setup, for example, the "BreedVision" phenotyping platform (Busemeyer et al. 2013) based on an innovative sensor-setup providing an extensive set of sensor-data for field phenotyping and feature prediction.

In this contribution, we demonstrate the new sensor synergy and how these observations are used to study and to improve parameterizations of L-A feedback focusing on MOST and atmospheric turbulence.