Lidar measurements characterizing the thermodynamic and dynamic structure of the boundary layer up to the turbulence scale

Andreas Behrendt¹, Diego Lange¹, Florian Späth¹, Shravan Kumar Muppa², Simon Metzendorf³, Christoph Senff³, and Volker Wulfmeyer¹

¹University of Hohenheim, Inst. for Physics and Meteorology, Stuttgart, Germany (andreas.behrendt@uni-hohenheim.de)
²University of Bayreuth, Bayreuth, Germany
³NOAA Earth System Research Laboratory/Chemical Sciences Division, Boulder, CO, USA

One weakness of today's weather and climate models is the inaccurate representation and parameterization of the boundary layer processes and land-atmosphere (L-A) feedback. In order to investigate these processes, scanning lidar systems allow the observation not only of wind with Doppler lidar but also of humidity and temperature. It is expected that advances in the understanding of LA feedback and boundary-layer exchange will significantly contribute to better simulations of clouds and precipitation on all temporal and spatial scales.

In this contribution, we present recent thermodynamic measurements in the surface layer, atmospheric boundary layer and free troposphere with very high resolution achieved during several field campaigns like the Land-Atmosphere Feedback Experiment (LAFE) in 2017, ScaleX in 2019, EUREC4A in 2020, and at the Land-Atmosphere Feedback Observatory (LAFO) in 2020.

University of Hohenheim (UHOH) operates besides two scanning Doppler lidars (HALO Photonics StreamlineXR), three lidars for thermodynamic profiling which have been developed within the last 15 years by the Institute of Physics and Meteorology itself. These are two scanning lidar systems which are semi-automated and a fully-automated vertical pointing lidar system.

The water vapor differential absorption lidar (DIAL) of UHOH is a mobile system with a laser power of up to 10 W at 818 nm with a pulse repetition rate of 300 Hz. The receiver consists of an 80-cm telescope. The raw resolution of the atmospheric backscatter signals is 15 m and single shot. The resolution of the data product, the water vapor number density or absolute humidity, is typically 1 to 10 s and 40 to 200 m.

The UHOH Rotational Raman Lidar measures temperature and water vapor mixing ratio. Also this system is mobile. So far, we used as transmitter a flash-lamp-pumped Nd:YAG laser with 12 W at 355 nm at 50 Hz. This laser is currently being exchanged against a similar laser with 20 W at the same pulse repetition frequency. The light backscattered from the atmosphere is received with a 40 cm telescope. Four channels detect the elastic backscatter signal, two rotational Raman signals, and the water vapor Raman signal. The signal intensities are detected in analog and photon counting mode with raw resolutions of 7.5 m and 10 s. Typical resolutions of the data products are
100 m and 10 s.

A compact and automated further development of this system, ARTHUS for Atmospheric Raman Temperature and Humidity Sounder, uses already this powerful diode-pumped laser transmitter (20 W at 355 nm, 200 Hz).

Measurement examples of all instruments will be presented and an outlook to future developments will be discussed.

**How to cite:** Behrendt, A., Lange, D., Späth, F., Muppa, S. K., Metzendorf, S., Senff, C., and Wulfmeyer, V.: Lidar measurements characterizing the thermodynamic and dynamic structure of the boundary layer up to the turbulence scale, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-7191, https://doi.org/10.5194/egusphere-egu2020-7191, 2020