

The ATMONSYS lidar system for boundary layer observations: Experiences and first results from two field-campaigns

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The planetary boundary layer (PBL) is the connecting interface between the earth's surface and the free troposphere. Its dynamics are therefore of high importance for multiple reasons. One of them is that the majority of tropospheric humidity, aerosols, trace gases and sensible heat is defined by emission from the earth's surface. Thus, land-atmosphere feedback processes lead to direct interactions between ground emissions and the atmospheric composition. As another reason, the PBL determines the turbulent propagation of those measures into higher altitudes and finally the free troposphere. Therefore, essential weather and climate processes strongly depend on the permeability of the PBL. In order to study the effects of heterogeneous terrain on the PBL's thermodynamic structure and improve long-term weather forecasts, dense measurements are needed.

With the aim of observing the PBL's thermodynamic state in its full extent, multiple sensors have to be combined to get a comprehensive picture of all relevant changes in the dynamics and composition of the PBL.

With the atmospheric monitoring system (ATMONSYS) lidar container, we developed a mobile, ground-based system for observations throughout the entire PBL and beyond. Three different techniques are implemented for capturing the following measures:

- Temperature columns with a 355 nm Rotational Raman lidar.
- Aerosol backscatter coefficients with a 532 nm elastic backscatter lidar.
- Water vapor concentrations with a differential absorption lidar working at around 817 nm.

Depending on the measure, the temporal resolutions span from 10-300 s with vertical resolutions of 7.5-100 m. Due to its high resolutions, this lidar system can play an important role in PBL monitoring. So far, the system was put into practice during two major field-campaigns. The Chequamegon Heterogeneous Ecosystem Energy-balance Study Enabled by a High-density Extensive Array of Detectors (CHEESEHEAD) campaign 2019 focused on the determination of energy fluxes in the heterogeneous terrain of northern Wisconsin. In 2021, we could participate in the Field Experiment on submesoscale spatio-temporal variability in Lindenberg (FESSTVaL), focusing on convection processes during summer. Both campaigns consisted of multiple sensors, which additionally allowed us to validate the data quality of our newly developed system.

Within this contribution, we present for the first time the technical concept behind the ATMONSYS lidar with the lessons learned from two campaigns. In addition, we give insights into the first results of our measurements and show system comparisons from the different field campaigns.