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Observing the fine structure of the lower atmospheric boundary layer with a scanning profiling system

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In August 2006, the field experiment LIBRETTO (LIndenBerg REacTive Trace gas prOfiles) was carried out in cooperation with the German Meteorological Service (DWD) at the field site of the Richard Aßmann Observatory in Lindenberg. A prominent feature of this site is a 99 m mast where profiles of air temperature, relative humidity, wind speed and direction are measured. The mast is equipped with an elevator, usually used for service and maintenance. On this elevator, sensors for trace gases (CO_2, H_2O, O_3), air temperature and relative humidity have been installed. During the experiment, the elevator system was run continuously, providing scanned profiles of trace gas concentrations through the lowest 99 m of the atmospheric boundary layer (ABL) approx. every 10 minutes. A set of trace gas sensors for CO_2, H_2O and O_3 was constantly operated in 99 m height to provide an upper reference for the elevator measurements. At the lower end of the elevator profile, trace gas reference measurements comprised CO_2, H_2O, O_3 and additionally NO and NO_2.

The correlation between mast and elevator system of the air temperature time series over the entire experiment is high at all standard mast levels (z = 10, 20, 40, 60, 80, 98 m), being not less than R^2 = 0.98. This indicates the ability of the elevator system to correctly resolve the spatiotemporal evolution of air temperature at all heights and thus the mean state of the atmospheric boundary layer.

The high spatial resolution of the elevator system provides a much more detailed insight into the fine structure of the ABL and its temporal evolution. The advantage of a high spatial resolution of a scanning profiling system compared to gradient measurements at six fixed levels depends on the state of the ABL, mainly its state of stability.

These dependencies will be highlighted based on profiles of meteorological and chemical quantities.

The combination of spatially highly resolved trace gas profiles in conjunction with observed changes of trace gas levels close to ground and at 99 m will be used to describe the temporal evolution of the nocturnal boundary layer and to quantify the magnitude of its internal inhomogeneity.