Targeted airborne Doppler lidar observations in the vicinity of convective systems

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Airborne Doppler lidar measurements present a valuable tool for meteorological research, as they allow targeted and spatially resolved observations of atmospheric flow phenomena with high resolution.

In recent years, a new airborne Doppler lidar system has been developed by the Karlsruhe Institute of Technology (KIT) in collaboration with the TU Braunschweig for use on-board the German Dornier 128-6 research aircraft. The system consists of a Lockheed Martin WindTracer WTX Doppler lidar and a dedicated 2-axis scanner developed for the aircraft by Arges GmbH. Compared to existing airborne Doppler lidars, the new system offers higher spatial resolution and more flexibility for targeted measurements, in part because of the low airspeed of the Dornier 128-6 carrier aircraft and the capability to operate in uncontrolled airspace.

In the summer of 2021, the Swabian MOSES (Modular Observation Solutions for Earth Systems) field campaign was carried out under the leadership of the Institute for Meteorology and Climate Research (IMK-TRO) of KIT in southwestern Germany, in which 10 German scientific institutions participated. The first measurements with the new airborne lidar system were conducted within the measurement campaign, which focuses on the frequent initiation and development of deep convective systems between the Black Forest and the Swabian Jura in southwestern Germany.

This contribution presents results obtained by combining airborne and ground-based lidar measurements. The observations enabled by the measurement concept provide insight into flow processes in the thunderstorm environment. After an overview of the measurements performed, the achieved measurement quality of the airborne Doppler lidar will be validated. The comparison with measurements of ground-based Doppler lidar at three locations shows a good agreement. It is shown that the high-resolution airborne Doppler lidar measurements are capable of providing unique insights into the flow dynamics on the meso-scale. The influence of orography on flow is clearly detectable, with both local valley circulation and mountain lee effects observed. The combination of airborne and ground-based Doppler lidar measurements also allows us to assess the representativeness of the ground-based measurements. Further combination with radar observations provides context for the thunderstorm activity associated with the flow field. Thus, the combination of targeted airborne Doppler lidar measurements with ground-based remote sensing networks proves to be a suitable and promising technique to gain new insights into flow phenomena in the vicinity of thunderstorms. Finally, the further potential of Doppler lidar measurements is discussed and possible future activities are pointed out.