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Investigation of the flow in complex terrain with regard to wind-energy research using the small remotely piloted aircraft MASC

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Wind energy is of primary importance for renewable electricity generation and large investments are being made in the field. In southern Germany the best potential sites for wind energy are in complex terrain, where inhomogeneities in the boundary layer, such as thermals and transient structures are induced.
In a joint effort by several research groups of the WindForS (www.windfors.de) competence cluster, the flow over an escarpment on the Swabian Alb is currently investigated in detail. For the prevailing wind direction at our test site, upstream of the potential site for turbines, the flow passes an escarpment, causing acceleration, shear and inclination. A variety of instruments is installed, including several wind LiDAR and a 100 m meteorological tower equipped with IEC-Standard analogue instruments and sonic anemometers. The Environmental Physics working group of the University of Tübingen is collecting airborne in-situ measurements with multiple remotely piloted aircraft on several days of intensive measurements. The instrumentation includes several fast thermometers ($\approx$ 30Hz), a capacitive humidity sensor ($\approx$3Hz), a five-hole flow probe ($\approx$30Hz), an inertial measurement unit (IMU) and GNSS for position and velocity above ground. The goal is to study the airflow in different regimes of thermal stability, different wind speeds and wind directions, as well as different seasons with varying land-use and thus surface roughness, in this complex terrain. Flight patterns with MASC (Multipurpose Airborne Sensor Carrier) are horizontal straight parallel level flights (so-called legs) stacked in 25 m steps between 75-300 m AGL. These flight legs are used to calculate turbulence statistics and turbulent transport, spectra, mean values but also the influence of surface heterogeneity and orography (complex terrain) on the atmosphere. Results of several days of measurements will be presented and compared to the other measurement systems on site and the CFD simulation.