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Multicopter RPAS as a tool for ABL investigations

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Fixed wing Remotely Piloted Aerial Systems (RPAS), e.g. SUMO from University of Bergen or MASC from Eberhard Karls University of Tübingen, have become a common tool for ABL investigations during the past decade. Using rotary wing RPAS has several advantages for data acquisition in the lowest ABL, but due to downwash effects, their use for sampling the air is not obvious. In the recent years, we have developed a multicopter RPAS including a meteorological sensor package suitable for ABL investigations from ground level up to a few hundred meters agl. It has been shown in several campaigns that the results reproduce the data from classical tools, e.g. tethered balloon and masts, nicely.

Multicopter RPAS are used for ABL investigation since 2011 by University of Applied Sciences Ostwestfalen-Lippe and it has been demonstrated that they are capable of sampling meteorological and air chemical parameters from close to the ground up to several hundred meters above ground level if operated in a suitable way. Our multicopter RPAS use four propellers driven by electrically powered motors. The total power consumption is about 150-250 W for normal flight patterns and moderate wind conditions. Depending on the capacity of the battery and the system setup, flight times of more than 45 min are possible (up to 30 min at -30 °C). The autopilot allows any desired flight patterns. Most campaign flights actually are vertical profiles or horizontal or vertical survey patterns within light of sight. The autopilot receives data from a GPS module, magnetic, inertial and pressure sensors and computes control data for the motors based on this input. The flights are planned using a ground control station software and digital maps and the flight planning includes the setup of several safety features in case of system failures. A safety pilot supervises the flight, a ground control station (GCS) operator monitors the system status based on data sent by the autopilot and a 2.4 GHz telemetry link. In case of a failure, either the safety pilot or the GCS operator can take over the control of the RPAS. Night time operation of the RPAS is made possible due to suitable illumination which allows the identification of the multicopter's orientation, if required.

The standard meteorological sensor package includes fast temperature (thermocouple type) and humidity sensors, a sensor for the surface temperature and optionally a wind sensor. The meteorological sensor package can be replaced by an air chemistry package (CO_2, CH4, optical particle counter) or visual sensors (VIS, IR, thermo cam).

We will show results from comparison flights and of two recent campaigns (PABLS15 and Weser15) and how the multicopter RPAS provides complementing data. The PABLS15 campaign in July 2015 was dedicated to the dinocturnal cycle of the stable atmospheric boundary layer (ABL) in the Pannonian plane near Szeged (Hungary), close to the Serbian border. In August 2015, the Weser15 campaign was dedicated to the investigation of the small scale thermal signal of the German river Weser, approx. 60 km from Hannover, Paderborn and Kassel.