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Vertical profiling of the atmosphere using drone-borne dropsonde

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Accurate and high-resolution profile observations of the atmosphere are required for assimilation and initiation of numerical weather prediction models and validation of satellite observations. Currently radiosounding is one of the most accurate method for this providing in-situ observations throughout the atmosphere. Radiosounding, however, is financially expensive and often temporally limited to 2-4 measurements per day. Here we present a new type of measurement platform for the vertical profiling. An octocopter with a Vaisala RD41-dropsonde was used for temperature and humidity measurements. A custom-build ground station allowed autonomous operation of the drone. The project aims investigating the reliability of drone-borne sensor deployment for the vertical profiling.

In order to characterize effects of the measurement platform, the measurement results from ascending and descending legs were compared against each other and against reference observations collected with radiosondes. Then, the effects of heat conduction from the drone itself and solar radiation on the dropsonde were characterized. The effect of solar radiation was characterized based on current understanding of the heat balance of the sensor. Finally, the drone-borne observations were analyzed statistically accompanied by individual case studies. The statistical analysis revealed distinct outliers in the measurements. These outliers were analyzed individually to find out situations when the measurement setup may fail.

The results show a warm bias in temperature and a dry bias in humidity during the ascending leg. Difference in temperature between the two flight legs was on average 0.26°C and the standard deviation 0.22°C. For humidity the average difference was -1.4% and the standard deviation 2.2%. Comparison against radiosonde for temperature measurements showed an average difference of 0.42°C with 0.25°C standard deviation in the ascend leg and 0.19°C average difference with 0.23°C standard deviation in the descend leg. Average difference of relative humidity was -1.9% with 2.6% standard deviation during the ascend leg and -0.3% with 2.4% standard deviation during the descend leg.