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COCAP - A compact carbon dioxide analyser for airborne platforms

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Airborne platforms are a valuable tool for atmospheric trace gas measurements due to their capability of movement in three dimensions, covering spatial scales from metres to thousands of kilometres. Although crewed research aircraft are flexible in payload and range, their use is limited by high initial and operating costs. Small unmanned aerial vehicles (UAV) have the potential for substantial cost reduction, but require lightweight, miniaturized and energy-efficient scientific equipment.

We are developing a COmpact Carbon dioxide analyser for Airborne Platforms (COCAP). It contains a non-dispersive infrared CO_2sensor with a nominal full scale of 3000 μmol/mol. Sampled air is dried with magnesium perchlorate before it enters the sensor. This enables measurement of the dry air mole fraction of CO_2, as recommended by the World Meteorological Organization. During post-processing, the CO_2 measurement is corrected for temperature and pressure variations in the gas line. Allan variance analysis shows that we achieve a precision of better than 0.4 μmol/mol for 10 s averaging time. We plan to monitor the analyser's stability during flight by measuring reference air from a miniature gas tank in regular intervals.

Besides CO_2, COCAP measures relative humidity, temperature and pressure of ambient air. An on-board GPS receiver delivers accurate timestamps and allows georeferencing. Data is both stored on a microSD card and simultaneously transferred over a wireless serial interface to a ground station for real-time review. The target weight for COCAP is less than 1 kg.

We deploy COCAP on a commercially available fixed-wing UAV (Bormatec Explorer) with a wingspan of 2.2 metres. The UAV has high payload capacity (2.5 kg) as well as sufficient space in the fuselage (80x80x600 mm^3). It is built from a shock-resistant foam material, which allows quick repair of minor damages in the field. In case of severe damage spare parts are readily available. Calculations suggest that the UAV can reach a maximum altitude of 2000 metres.

COCAP will aid in interpreting ground-based trace gas measurements by profiling the lower troposphere. In addition, transport modelling around measurement sites can be improved by assimilating the profiles-derived mixed layer height. Furthermore, COCAP is a promising tool for the identification of CO_2 point sources, e.g. leaking carbon storage sites.