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Improvement of a low-cost CO2 commercial NDIR sensor for UAV atmospheric profiling applications

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Unmanned Aerial Vehicles (UAVs) have the potential to fill in gaps in greenhouse gases (GHG) observations by providing high-resolution vertical profiling, horizontal mapping of fluxes and 3D measurements close to the ground. UAVs can ultimately allow better characterizing the spatial distribution of various GHG sources and sinks. To achieve these goals, important efforts are currently put towards the development of compact, lightweight, low powered and highly accurate GHG sensors on UAVs.

This study aims to develop and validate a UAV-CO_2 sensor system to map specific source emissions close to the ground. The CO_2 sensor used here is the High-Performance Platform (HPP 3.2, SenseAir AB) of a total weight 1058g including battery. Prior to its integration in the UAV, the CO_2 sensor accuracy and linearity tests were performed in the laboratory. Allan Deviation showed the sensor precision to be within ±1ppm at 1 Hz. Corrections due to temperature and pressure changes were performed using specific formulas obtained from chamber experiments. Field (manned aircraft) tests were performed, where the P/T correction equations were evaluated for two CO_2 sensors which were compared against an airborne reference instrument (Picarro G2401-m). After laboratory tests and field deployment, the HPP CO_2 sensor was integrated into a small fixed-wing UAV with a wingspan of 1.83m and customized avionics and payload developed by the Unmanned Systems Research Laboratory of the Cyprus Institute performed successful atmospheric profiling below/above the boundary layer, at an agricultural site in Cyprus. This HPP CO_2 sensor is also to be integrated in a quad-copter for vertical take-off landing (VTOL) in urban environments to execute intensive (every 20-min) atmospheric profiling (0-1km altitude) over the city of Nicosia (Cyprus). These flights provide us with useful insights into the CO_2 vertical distribution within the planetary boundary layer (and above) for different (remote/urban) regions in Cyprus.