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Towards an integrated study of urban CO_2 emissions

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High-resolution monitoring is the basis for CO_2 emissions tracking and attribution in urban areas. This work is an important step towards an integrated urban CO_2 emissions monitoring system. Three middle-cost nondispersive infrared (NDIR) sensors of 500€ to 3000€ are characterised. Furthermore, CO_2 emissions of large, regional point sources are simulated to analyse their effect on these sensors' signals.

The three sensors are Vaisala GMP343, Senseair HPP3 and SmartGas FlowEvo CO_2. Their analysis and characterisation is achieved by co-locating them with a Picarro G2401 cavity ringdown spectrometer for 40 days. Co-locating different middle-cost sensors is novel and enables a direct performance comparison. While the HPP3 is the only one to reach a 1 min mean standard deviation under 1 ppm, the GMP343 is the most linear and stable with a drift of $0.03(2) \times 10^{-1}$ ppm per day and the SmartGas sensor provides the best price-to-performance ratio. For all sensors, precisions (the 1 min mean error's lower bound) of under 0.8 ppm are determined. In general, temperature stabilisation turns out to be one of the most promising avenues of performance improvement for all sensors.

The sensors' in-situ measurements are combined with meso-scale meteorological simulations for the Rhine-Neckar region using the Weather Research and Forecasting model (WRF). In two case-studies, simulated excess CO_2 due to large, regional point sources and measured CO_2 concentration are compared. Both simulations show qualitative agreement with the measurements. The differences between measurements and simulation, however, highlight aspects to be refined. These include increasing the horizontal and vertical resolution of the simulation domain as well improving as the parametrisation of the planetary and urban boundary layer.