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Greenhouse Gas Emission Estimate Using a Fully-automated Permanent Sensor Network in Munich

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To effectively mitigate climate change, it is indispensable to know the locations of the emission sources and their respective emission strength. As the majority of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and carbon monoxide (CO) are generated in cities, our focus lies in the emission determination of urban areas. For this reason, we established a fully-automated sensor network in Munich, Germany to permanently measure GHGs.

Our permanent network is based on the differential column measurement principle [1] and measures the city emissions using five FTIR spectrometer systems (EM27/SUN from Bruker [2]). For these spectrometers we built a self-developed enclosure system and equipped them with several sensors (e.g. computer vision based solar radiation sensor) to measure the column-averaged concentrations of CO_2, CH_4 and CO in a fully-automated way. The difference between the column amounts inside and outside of the city reflects the pollutants abundance generated in the city. Four stations are placed at the city outskirts to capture the inflow/outflow column amounts in arbitrary wind conditions. One inner-city station, which has already been operating successfully since 2016 [3], is serving as a permanent downwind site for half of the city.

With the help of atmospheric transport models, combined with a Bayesian inverse modelling approach, those concentration differences are transferred into spatially resolved emission estimates of the city. After testing the network in two campaigns (2017 and 2018), the network is finally long-term operating since summer 2019 and continuously measures the GHG concentrations in Munich. We will show both the hardware achievements and first measurement and emission results after ten month of operation.

[1] Chen et al.: Differential column measurements using compact solar-tracking spectrometers. Atmos. Chem. Phys., 16: 8479–8498, 2016.

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[3] Heinle and Chen: Automated Enclosure and Protection System for Compact Solar-Tracking Spectrometers, Atmos. Meas. Tech., 11, 2173-2185, 2018