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## Urban methane emission estimate using measurements obtained by MUCCnet (Munich Urban Carbon Column network)

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In 2019, we established the Munich Urban Carbon Column network (MUCCnet) [1] that measures the column-averaged concentration gradients of CO<sub>2</sub>, CH<sub>4</sub> and CO using the differential column methodology (DCM, [2]). The network consists of five ground-based FTIR spectrometers (EM27/SUN from Bruker [3]), which are deployed both on the outskirts of Munich and in the city center. The distance between each outer spectrometer and the center station is approximately 10 km. Each spectrometer is protected by one of our fully automated enclosure systems [4], allowing us to run the network permanently. In addition, data are available from three one-month measurement campaigns in Munich between 2017 and 2019, each using five to six spectrometers.

To quantify urban methane emissions, we developed a Bayesian inverse modeling approach that was tested first in Indianapolis using campaign data from 2016 [5]. After adapting the modeling framework to the Munich case, we are able to use the large amount of data gathered by MUCCnet to quantify the methane emissions of the third largest city in Germany in detail. The framework takes the spatially resolved emission inventory TNO-GHGco (1 km x 1 km) as a prior estimate and refines it through the Bayesian inversion of the EM27/SUN observations. Our long-term dataset and continuous operation will provide new insights into Munich's urban carbon cycle and will allow us to evaluate climate protection measures in the future.

Thanks to the automation, we were also able to continue the measurements during the COVID-19 lockdowns in Germany, resulting in a unique dataset that allows us to verify and improve our model.

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