Geophysical Research Abstracts
Vol. 20, EGU2018-10192-2, 2018
EGU General Assembly 2018

Mesoscale Column Network for Assessing GHG and NO_x Emissions in Munich

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The majority of anthropogenic greenhouse gas (GHG) emissions originate from cities, therefore monitoring emissions in cities is essential to fight climate change. In addition to GHG, nitrogen oxides (NO_x) also play an important role in the urban climate. Recently, the exceeded limits for NO_x in many German and European cities have led to vigorous discussions on the ban of diesel vehicles in cities.

Munich has a population of about 1.5 million and the highest population density in Germany. Munich sets up an ambitious emission reduction goal to cut CO_2 emissions by 10% every 5 years and be carbon neutral by 2050. The reports of the city are based on software that employs a (non-measurement) bottom-up method. The natural gas pipeline system in Munich is from the 1960s, and power plants and heating plants are mostly natural-gas based. Both could be sources of unwanted CH_4 emissions that cannot be detected using the bottom-up method. In addition, Oktoberfest, the world's largest Volksfest, is held annually in Munich. There haven't been any GHG/NO_x measurements for Oktoberfest reported so far.

In Sept./Oct. 2017, we deployed six solar-tracking spectrometers (EM27/SUN) measuring column-averaged concentrations of CO_2 and CH_4 based on the differential column measurements principle [1, 2]. Five stations were placed at the city edges to capture the inflow/outflow column amounts at arbitrary wind conditions. Additionally, one inner-city station that has already been successfully operating for 1.5 years [3], served as downwind site for half a city and upwind site for the other half. It allows for better partitioning of the city emissions. Four of the spectrometers were also utilized to monitor the column-averaged concentrations of CO, which will benefit source identification and apportionment. Further, we deployed two MAX-DOAS for mapping the NO_x concentrations in a mobile setup on several days and capturing the differential column concentrations in a stationary setup for the rest of the campaign.

Initial analyses indicate Oktoberfest as a possible significant source for CO_2, CH_4 and CO. Column enhancements of CO_2, CH_4, and CO during the Oktoberfest were around 6 ppm, 22 ppb, and 12 ppb, respectively. The enhancements before and after were significantly smaller. In addition, we detected a transient of a high CO plume (up to 20 ppb column enhancement) passing the city on 8 Sept. 2017, observed from all CO stations. We have combined these data with HYSPLIT-STILT and WRF-STILT models to retrieve city and local emissions. This investigation is part of an joint effort to investigate city GHG emissions funded by US Environmental Defense Fund.

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