



Investigations of Methane Emissions from the Munich Oktoberfest 2018

Jia Chen (1), Florian Dietrich (1), Hossein Maazallahi (2,4), Dominik Winkler (1), Andreas Forstmaier (1), Magdalena Hofmann (3), Hugo Denier van der Gon (4), and Thomas Röckmann (2)

(1) Environmental Sensing and Modeling, Technical University of Munich, Munich, Germany (jia.chen@tum.de), (2) Institute for Marine and Atmospheric Research, Utrecht University, Utrecht, The Netherlands, (3) Picarro B.V., 's-Hertogenbosch, The Netherlands, (4) Netherlands Organisation for Applied Scientific Research (TNO), Utrecht, The Netherlands

Oktoberfest, the world's largest Volksfest with over 6 million visitors, is held annually in Munich. In 2018, during the 16 days of the Oktoberfest, 7.5 million liters of beer were consumed, and the use of energy added up to 2.91 million kilowatt hours of electricity and 191,000 cubic meters of natural gas [1].

We have investigated the Munich Oktoberfest for two consecutive years. The measurements during our 2017 Munich city campaign indicated Oktoberfest as a possible significant source for methane [2]. Therefore, we have continued our investigation in 2018 focusing on Theresienwiese, where the Oktoberfest takes place. We used a combination of differential column measurements [3] and in-situ measurements. Two compact solar-tracking Fourier transform spectrometers (EM27/SUNs) measuring column concentrations of CO₂, CH₄ and CO were deployed upwind and downwind of the Theresienwiese, with a distance ranging from 500 m to 2,000 m. In addition, backpack measurements of CH₄ using a portable Picarro GasScouter G4302 were performed either by walking or by biking around the Theresienwiese, outside of the festival area.

The backpack measurements show enhancements up to several hundred ppb compared to background values and measurements performed after the Oktoberfest. The enhancements are mostly observed in the northern and north-western part of the Theresienwiese, where the measurement locations were closer to the beer tents. In addition, the enhancements are higher in the morning and late afternoon/evening, which indicates human emissions are not the only source, because the amount of visitors increases towards the evening. Other possible sources could be methane leaks in the natural gas pipeline system, incomplete combustion in the natural gas fired grills or emissions caused by the sewage system.

The differences in upwind and downwind column measurements are up to 2 ppb. By combining the backpack measurements with a Gaussian plume model, we have obtained a preliminary estimate of the methane emission from the Theresienwiese that agrees with our column results.

Further steps include model refinement and source attribution. The concentration hotspots will be compared with infrastructure maps to attribute the source type to those emitters. Furthermore, based on the results from 2017 and 2018, there could be other significant methane emitters during the Oktoberfest time period, which we will focus on in our future investigations.

[1] Portal München Betriebs-GmbH & Co. KG, "Die Wiesn-Bilanz 2018." <https://www.oktoberfest.de/de/article/Aktuell/Meldungen/Die+Wiesn-Bilanz+2018/5182/>. [Accessed: 08-Jan-2019].

[2] J. Chen et al., "Mesoscale Column Network for Assessing GHG and NO_x Emissions in Munich," in *Geophysical Research Abstracts*, 2018, vol. 20, pp. EGU2018-10192-2.

[3] J. Chen et al., "Differential column measurements using compact solar-tracking spectrometers," *Atmos. Chem. Phys.*, vol. 16, no. 13, pp. 8479–8498, Jul. 2016.