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Quantification of CO_2 and CH_4 megacity emissions using portable solar absorption spectrometers

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Urban areas already contribute to over 50% of the global population, additionally the percentage of the worldwide population living in Metropolitan areas is continuously growing. Thus, a precise knowledge of urban greenhouse gas (GHG) emissions is of utmost importance. Whereas, however, GHG emissions on a nationwide to continental scale can be relatively precisely estimated using satellite observations (and fossil fuel consumption statistics), reliable estimations for local to regional scale emissions pose a bigger problem due to lack of timely and spatially high resolved satellite data and possible biases of passive spectroscopic nadir observations (e.g. enhanced aerosol scattering in a city plume). Furthermore, emission inventories on the city scale might be missing contributions (e.g. methane leakage from gas pipes).

Here, newly developed mobile low resolution Fourier Transform spectrometers (Bruker EM27/SUN) are utilized to quantify small scale emissions. This novel technique was successfully tested before by KIT and partners during campaigns in Berlin, Paris and Colorado for detecting emissions from various sources.

We present results from a campaign carried out in February – April 2016 in the Tokyo bay area, one of the biggest Metropolitan areas worldwide. We positioned two EM27/SUN spectrometers on the outer perimeter of Tokyo along the prevailing wind axis upwind and downwind of the city source. Before and after the campaign, calibration measurements were performed in Tsukuba with a collocated high resolution FTIR spectrometer from the Total Carbon Column Observing Network (TCCON).

During the campaign the observed XCO_2 and XCH_4 values vary significantly. Additionally, intraday variations are observed at both sites. Furthermore, an enhancement due to the Tokyo area GHG emissions is clearly visible for both XCO_2 and XCH_4. The observed signals are significantly higher compared to prior campaigns targeting other major cities. We perform a rough estimate of the source strength. Finally, a comparison with an observation from the OCO-2 satellite is shown.