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Total Column Greenhouse Gas Monitoring in Central Munich: Automation and Measurements

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It is challenging to use in-situ surface measurements of CO_2 and CH_4 to derive emission fluxes in urban regions. Surface concentrations typically have high variance due to the influence of nearby sources, and they are strongly modulated by mesoscale transport phenomena that are difficult to simulate in atmospheric models.

The integrated amount of a tracer through the whole atmosphere is a direct measure of the mass loading of the atmosphere given by emissions. Column measurements are insensitive to vertical redistribution of tracer mass, e.g. due to growth of the planetary boundary layer, and are also less influenced by nearby point sources, whose emissions are concentrated in a thin layer near the surface. Column observations are more compatible with the scale of atmospheric models and hence provide stronger constraints for inverse modeling.

In Munich we are aiming at establishing a regional sensor network with differential column measurements, i.e. total column measurements of CO_2 and CH_4 inside and outside of the city. The inner-city station is equipped with a compact solar-tracking Fourier transform spectrometer (Bruker EM27/SUN) in the campus of Technische Universität München, and our measurements started in Aug. 2015. The measurements over seasons will be shown, as well as preliminary emission studies using these observations.

To deploy the compact spectrometers for stationary monitoring of the urban emissions, an automatic protection and control system is mandatory and a challenging task. It will allow solar measurements whenever the sun is out and reliable protection of the instrument when it starts to rain. We have developed a simplified and highly reliable concept for the enclosure, aiming for a fully automated data collection station without the need of local human interactions.

Furthermore, we are validating and combining the OCO-2 satellite-based measurements with our ground-based measurements. For this purpose, we have developed a software tool that permits spatial, temporal and quality data filtering and selection from the OCO-2 database. We observed inconsistencies between nadir and glint measurements nearby Munich on consecutive days with similar weather conditions in August 2015. To visualize our regional sensor network, we have developed software to generate KML-Files, which enables us to display and browse the results of our measurement site, OCO-2 measurements as well as future satellite tracks.