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Towards monitoring localized CO_2 emissions from space: co-located regional CO_2 and NO_2 enhancements observed by the OCO-2 and S5P satellites

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Carbon dioxide (CO_2) is the most important anthropogenic greenhouse gas. Measuring and monitoring its emissions at adequate spatial resolution and temporal sampling from space has become an important objective of (potential) future satellite missions such as the planned European anthropogenic CO_2 monitoring mission or NASA's GeoCarb mission.

CO_2 is long lived and well mixed in the atmosphere. Globally, its natural gross fluxes are much larger than anthropogenic emissions. Consequently, the detection and analysis of the plumes from individual point sources from the active or passive remote sensing measurements of the CO_2 column-average dry-air mole fraction (XCO_2) is challenging.

In populated and industrialized areas, the largest fraction of the emissions of NO_x (the sum of nitrogen monoxide, NO and nitrogen dioxide, NO_2) and thus NO_2 originates from the co-emission with CO_2 during the combustion of fossil fuels, e.g., by power plants, traffic, and domestic heating. NO_2 has a short lifetime in the order of hours, so that its vertical column densities often exceed background levels by orders of magnitude near sources. This makes it a suitable tracer of recently emitted CO_2, i.e. close to the source before the CO_2 plumes blend into background concentrations.

In this presentation we use NO_2 measurements made by the S5P satellite to help to locate the anthropogenic CO_2 plumes in co-located XCO_2 measurements of the OCO-2 satellite, close to sources. Due to OCO-2's narrow swath, it usually measures only a cross section of the plume. For various case studies, we estimate the cross sectional CO_2 flux utilizing ECMWF ERA5 wind information and discuss the results and potential source attributions by taking into account the extended NO_2 plume structures observable in S5P's wide swath. We compare the estimated fluxes with the EDGAR, ODIAC and GFED emission data bases.