Greenhouse Gas Emissions from Major Population Centers in Europe and Asia: Aircraft-borne CH4 in-situ observations during the EMeRGe field missions.

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Abstract:

Major Population Centers (MPCs) accommodate more than half of the world population but cover only 2% of the terrestrial Earth’s surface. Thus industry, energy usage, air pollution, and enhanced greenhouse gas emissions agglomerate in narrow areas. About one third of global anthropogenic methane (CH$_4$) originates from urban agglomerations, i.e. from pipeline leaks, landfills, and sewage treatment plants. Emission inventories significantly underestimate these emissions by 7-15%. However, a more accurate quantification is needed to develop efficient mitigation strategies for reducing CH$_4$.

We report on aircraft-borne CH$_4$ in-situ measurements during EMeRGe, investigating the Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales. Mission flights were carried out with the German research aircraft HALO over Europe (July 2017 from Germany) and Asia (March-April 2018 from Taiwan) probing pollution plumes of various MPCs mainly at altitudes below 3 km.

Individual CH$_4$ footprints are identified and the increase in CH$_4$ mixing ratio is quantified by using in-situ measurements downwind of selected urban hotspots to better understand the regional impact of urban CH$_4$ emissions. In addition to CH$_4$ further trace gases (e.g. CO$_2$, NOx, CO, O$_3$) are analyzed to identify different potential anthropogenic and natural emission sources. The probed air masses are traced back to their possible emission source area using numerical models.

In-situ observations during EMeRGe-Europe show that CH$_4$ enhancements are most distinctive in the boundary layer, with highest mixing ratios encountered in the Po Valley, London and BeNeLux (up to 2.4 ppm). First analysis indicates that a clear apportionment to individual CH$_4$ sources is hampered by the agglomeration of heavy industry and small cities surrounding MPCs. Sampled emissions from Asian MPCs show similar maximum CH$_4$ concentrations (e.g. Tainan, Manila, Yangtze Delta; up to 2.1 ppm) but in general higher background values at low altitudes compared to Europe.