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Simulating the dispersion of NO_x and CO_2 in the city of Zurich at building resolving scale

Dominik Brunner, Antoine Berchet, Lukas Emmenegger, Stephan Henne, and Michael Müller

Empa, Swiss Federal Laboratories for Materials Science and Technology, Laboratory for Air Pollution/Environmental Technology, Duebendorf, Switzerland (dominik.brunner@empa.ch)

Cities are emission hotspots for both greenhouse gases and air pollutants. They contribute about 70% of global greenhouse gas emissions and are home to a growing number of people potentially suffering from poor air quality in the urban environment. High-resolution atmospheric transport modelling of greenhouse gases and air pollutants at the city scale has, therefore, several important applications such as air pollutant exposure assessment, air quality forecasting, or urban planning and management. When combined with observations, it also has the potential to quantify emissions and monitor their long-term trends, which is the main motivation for the deployment of urban greenhouse gas monitoring networks.

We have developed a comprehensive atmospheric modeling model system for the city of Zurich, Switzerland (∼600,000 inhabitants including suburbs), which is composed of the mesoscale model GRAMM simulating the flow in a larger domain around Zurich at 100 m resolution, and the nested high-resolution model GRAL simulating the flow and air pollutant dispersion in the city at building resolving (5-10 m) scale. Based on an extremely detailed emission inventory provided by the municipality of Zurich, we have simulated two years of hourly NO_x and CO_2 concentration fields across the entire city. Here, we present a detailed evaluation of the simulations against a comprehensive network of continuous monitoring sites and passive samplers for NO_x and analyze the sensitivity of the results to the temporal variability of the emissions. Furthermore, we present first simulations of CO_2 and investigate the challenges associated with CO_2 sources not covered by the inventory such as human respiration and exchange fluxes with urban vegetation.