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High-resolution air pollution modeling for urban environments in support of dense multi-platform networks

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As the fraction of people living in urban areas is rapidly increasing worldwide, the impact of air quality on human health in cities is a growing concern not only in developing countries but also in Europe despite the achievements of European air quality legislation. One obstacle to the quantitative assessment of the connections between health and air quality is the very high temporal and spatial variability of air pollutant concentrations within cities. Yet, an important issue for obtaining accurate and spatially highly resolved air pollution data is the trade-off between the high costs of accurate air pollution sensors and the number of such devices required for succinctly monitoring a given geographical area.

The OpenSense 2 project aims at establishing air quality data at very high temporal and spatial resolution in the cities of Lausanne and Zurich in Switzerland in order to provide reliable information for epidemiologic studies and for the design of air pollution controls and urban planning. Towards this goal, observations from both stationary reference monitoring stations and low-cost mobile sensors (including sensing platforms anchored on public transport vehicles) are combined with high-resolution air quality modeling throughout the two cities.

As a first step, we simulate the 3-dimensional, high-resolution dispersion and distribution of key pollutants using the GRAMM/GRAL modeling system. The GRAMM meteorological meso-scale model calculates wind fields at 100 m resolution accounting for the complex topography and land use within and around the two cities. GRAMM outputs are then used to drive the building-resolving dispersion model GRAL at 5-10m resolution. Further key inputs for GRAL are high resolution emission inventories and the 3-D building structure which are available for both cities.

Here, in order to evaluate the ability of the GRAMM/GRAL modeling system to reproduce air pollutant distributions within the two cities of Lausanne and Zurich, we analyze time series and spatial gradients from OpenSense2 in-situ observations and GRAMM/GRAL outputs and evaluate the influence of typical weather situations on the local air quality.