Geophysical Research Abstracts
Vol. 18, EGU2016-9595, 2016
EGU General Assembly 2016

Multi-year simulations of air pollution in two cities

Katrin Zink, Antoine Berchet, Lukas Emmenegger, and Dominik Brunner
Empa, Swiss Federal Laboratories for Materials Science and Technology, Laboratory for Air Pollution/Environmental Technology, Duebendorf, Switzerland (dominik.brunner@empa.ch)

As more and more people are living in urban areas world wide, air quality monitoring and forecasting at the city scale becomes increasingly critical. Due to the proximity to sources and the complex, fine-scale structure of the flow and turbulence in the built environment, air pollutant concentrations vary strongly in cities both spatially and temporally. Studies assessing the effect of air pollution on human health would greatly benefit from accurate knowledge of individual exposure, but given the high variability of concentrations and the mobility of the population, this is a marvellous task requiring highly-resolved, city-wide information on air pollutant concentrations.
The Swiss Nano-Tera project OpenSense II addresses these issues using statistical and physical modeling of air pollution at very high resolution combined with long-term air pollution measurements and mobile networks of low-cost sensors. In the framework of this project, we have set up the nested meteorology and dispersion model system GRAMM/GRAL the cities of Lausanne and Zurich and improved several computational aspects of the system.
Using the mesoscale model GRAMM, we simulate the flow in a larger domain around the two cities at 100 m resolution taking the complex topography and influences of different land cover on surface-atmosphere exchange of heat and momentum into account. These flow fields serve as initial and boundary conditions for the nested model GRAL, which simulates the flow inside the city at building-resolving scale (5 m resolution) based on the Reynolds-Averaged-Navier-Stokes equations, and computes the transport and dispersion of air pollutants in a Lagrangian framework. For computational efficiency, both GRAMM and GRAL simulations are run for a fixed catalog of 1008 weather situations varying in terms of background wind speed, direction and stability. Hourly time-series of meteorology and air pollutants are constructed from these steady-state solutions by selecting, for each hour of the period of interest, the situation best matching the winds observed at weather stations within the GRAMM model domain.
Detailed emission inventories available for the two cities serve as inputs for the dispersion simulations. For Zurich, an extremely detailed inventory with 60 source categories for 9 air pollutants including line, point and area sources has been generated by the city authorities, allowing us to simulate the contribution of different sources separately. The annual emissions are scaled with temporal profiles of diurnal, day-of-week and seasonal variability taking local information (e.g. heating and traffic activity) into account whenever possible.
For the two cities, 10 years of NO_x and PM concentrations have been simulated with hourly temporal and 5 m spatial resolution. We demonstrate the good performance of the model system compared to regular air pollution observations, and its potential for quantifying trends in emissions and imissions and for accurately assessing human exposure at the city scale.