Geophysical Research Abstracts
Vol. 18, EGU2016-7390, 2016
EGU General Assembly 2016

Multi-scale modeling of urban air pollution: development of a Street-in-Grid model

Youngseob Kim (1), You Wu (2), Christian Seigneur (1), and Yelva Roustan (1)

(1) CEREA, Joint Laboratory École des Ponts ParisTech / EDF R&D, Université Paris-Est, Champs-sur-Marne, 77455, France (kimy@cerea.enpc.fr), (2) EDF R&D China, Beijing, 100005, China

A new multi-scale model of urban air pollution is presented. This model combines a chemical-transport model (CTM) that includes a comprehensive treatment of atmospheric chemistry and transport at spatial scales greater than 1 km and a street-network model that describes the atmospheric concentrations of pollutants in an urban street network.

The street-network model is based on the general formulation of the SIRANE model and consists of two main components: a street-canyon component and a street-intersection component. The street-canyon component calculates the mass transfer velocity at the top of the street canyon (roof top) and the mean wind velocity within the street canyon. The estimation of the mass transfer velocity depends on the intensity of the standard deviation of the vertical velocity at roof top. The effect of various formulations of this mass transfer velocity on the pollutant transport at roof-top level is examined. The street-intersection component calculates the mass transfer from a given street to other streets across the intersection. These mass transfer rates among the streets are calculated using the mean wind velocity calculated for each street and are balanced so that the total incoming flow rate is equal to the total outgoing flow rate from the intersection including the flow between the intersection and the overlying atmosphere at roof top.

In the default option, the Leighton photostationary cycle among ozone (O_3) and nitrogen oxides (NO and NO_2) is used to represent the chemical reactions within the street network. However, the influence of volatile organic compounds (VOC) on the pollutant concentrations increases when the nitrogen oxides (NO_x) concentrations are low. To account for the possible VOC influence on street-canyon chemistry, the CB05 chemical kinetic mechanism, which includes 35 VOC model species, is implemented in this street-network model. A sensitivity study is conducted to assess the uncertainties associated with the use of the Leighton cycle chemistry.

The street-network model is coupled to the CTM Polair3D of the Polyphemus air quality modeling platform to constitute a Street-in-Grid (SinG) model. The street-network model is used to simulate the concentrations of the chemical species in the lowest layer in the urban area and the simulation for the upper layers is then performed by Polair3D. Interactions between the street-network model and the host CTM occur at roof-top and depend on the vertical mass transfer described above.

The SinG model is used to simulate the concentrations of gas-phase pollutants (O_3 and NO_x) in a Paris suburb. The emission data for each street that are needed for the street-network model were obtained from a dynamic traffic model. Topographic data, such as street length/width and building height, were obtained from a geographic database (BD TOPO). Simulated concentrations are compared to concentrations measured at two monitoring stations that were located on each side of a large avenue.