Geophysical Research Abstracts,
Vol. 11, EGU2009-7118, 2009
EGU General Assembly 2009

Uncertainty characterization and quantification in air pollution models. Application to the ADMS-Urban model.

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Evaluation of human exposure to atmospheric pollution usually requires the knowledge of pollutants concentrations in ambient air. In the framework of PAISA project, which studies the influence of socio-economical status on relationships between air pollution and short term health effects, the concentrations of gas and particle pollutants are computed over Strasbourg with the ADMS-Urban model. As for any modeling result, simulated concentrations come with uncertainties which have to be characterized and quantified.

There are several sources of uncertainties related to input data and parameters, i.e. fields used to execute the model like meteorological fields, boundary conditions and emissions, related to the model formulation because of incomplete or inaccurate treatment of dynamical and chemical processes, and inherent to the stochastic behavior of atmosphere and human activities [1].

Our aim is here to assess the uncertainties of the simulated concentrations with respect to input data and model parameters. In this scope the first step consisted in bringing out the input data and model parameters that contribute most effectively to space and time variability of predicted concentrations.
Concentrations of several pollutants were simulated for two months in winter 2004 and two months in summer 2004 over five areas of Strasbourg. The sensitivity analysis shows the dominating influence of boundary conditions and emissions. Among model parameters, the roughness and Monin-Obukhov lengths appear to have non neglectable local effects. Dry deposition is also an important dynamic process.

The second step of the characterization and quantification of uncertainties consists in attributing a probability distribution to each input data and model parameter and in propagating the joint distribution of all data and parameters into the model so as to associate a probability distribution to the modeled concentrations.
Several analytical and numerical methods exist to perform an uncertainty analysis. We chose the Monte Carlo method which has already been applied to atmospheric dispersion models [2, 3, 4]. The main advantage of this method is to be insensitive to the number of perturbed parameters but its drawbacks are its computation cost and its slow convergence. In order to speed up this one we used the method of antithetic variable which takes adavantage of the symmetry of probability laws. The air quality model simulations were carried out by the Association for study and watching of Atmospheric Pollution in Alsace (ASPA). The output concentrations distributions can then be updated with a Bayesian method.

This work is part of an INERIS Research project also aiming at assessing the uncertainty of the CHIMERE dispersion model used in the PrevÁir forecasting platform (www.prevair.org) in order to deliver more accurate predictions.

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