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SHORT ABSTRACT

Abstract title: Development of a New Lagrangian Air Pollution Model for Denmark

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Abstract text *(maximum 350 words.)*

The *Urban Background Model Lagrange* (UBML) is a 3D air pollution model being developed at the Department of Environmental Science, Aarhus University, to more accurately predict the local scale concentration of air pollutants in Denmark. We presuppose that UBML will perform better than its predecessor *Urban Background Model* (UBM, www.au.dk/UBM) when validated against measurements from the Danish monitoring network since it applies much more comprehensive and realistic descriptions of the atmosphere.

The Lagrangian nature of UBML makes it possible to more accurately describe atmospheric transport and dispersion close to emission sources. The transport and dispersion are modelled by computing particle trajectories, governed by the local mean wind and a random motion, mimicking dispersion, described by *Lagrangian stochastic* (LS) schemes. These particles (representing ensembles of fluid particles) are released from point, line, and area emission sources. Since the particle trajectories are computed independently, the model is in principle ideal to parallelize. Based on a larger literature review, a set of LS schemes has been implemented in UBML alongside various parameterizations of the *planetary boundary layer* (PBL); most importantly the turbulent velocity variance, the local decorrelation timescale, and the PBL height. For the input data, existing UBM modules have been extended for loading and transforming 3D meteorology data from the *Weather Research and Forecasting* (WRF) model and 3D chemical boundary conditions from the *Danish Eulerian Hemisphere Model* (DEHM).

Numerical tests have been conducted to test and verify the implementation of the different modules of UBML. Further, the model has been validated against measurements for different chemical species (including NO_x, CO, $PM_{2.5}$, and PM_{10}) to investigate the performance of the model when applying different combinations of LS schemes and PBL parameterizations. Preliminary results show that the model performs well with respect to measurements, and also performs as well or even better than UBM. Additional work will have to be carried out, including the development of deposition and chemistry schemes, to improve the performance of the model further. Expectantly, UBML can be integrated into the DEHM/UBM/AirGIS modelling system (www.au.dk/AirGIS) to significantly improve human air pollution exposure modelling to further advance health impact assessments.

Motivation*

The overall motivation behind the development of UBML is to help advance methodologies for human air pollution exposure modelling. The ambition is to obtain a deeper insight into different PBL parameterizations and dispersion schemes applied by the larger community by implementing these in UBML, and then validating the model against the vast amount of measurement data from the Danish monitoring network. Additionally, analyses of how to handle common numerical challenges related to air pollution modelling in general, and Lagrangian modelling in particular, have the potential to shed light upon problems faced by other modellers in the field. Having a reliable modelling system is paramount in the combined effort to understand the complex phenomenon of pollutant exposure and health impact assessment, and, ultimately, we hope that UBML will be able to significantly contribute to this joined task.