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A study of the subgrid scale variability due to heterogeneous surface emissions in air-quality modelling: a quantification based on a statistical approach.

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A persisting challenge with regards to small scale air-quality modelling is to assess health impacts and population exposure studies. Both aspects demand a high resolution of modelled output concentrations that can not be provided by mesoscale chemistry transport models (CTMs)(maximum horizontal resolution of 1km). One of the principal limitations to the increase of models resolution is the uncertainty associated to the input meteorological and emissions fluxes data. Emissions, especially in the context of an urban environment, are highly heterogeneous both spatially and temporally and the increase in their resolution risks to increase models uncertainty. The built of the emissions inventories commonly used in CTMs is based on the knowledge of the mean annual flux over large areas at which higher resolution information (activity sectors, land-use and temporal profiles) is applied a posteriori in order to represent a realistic variability of the emissions patterns. Nevertheless, the accuracy of model results does not increase linearly with resolution. Small scale errors are accumulated as the resolution becomes too high adding noise to models calculation. Based on this assumption we suggest that spatial scales lower than 1km (horizontal resolution) can not be treated in a deterministic way in air-quality models. Any available information concerning smaller scales should be taken into account as a subgrid scale feature and be represented statistically in model parametrizations.

In this context we present a study based on CHIMERE CTM simulations where the subgrid scale heterogeneity of the emitted species was taken into account following a statistical approach. At a common CTM calculation, all information concerning subgrid scale heterogeneous emissions is simultaneously lost once the species are released and diluted at the volume of the cell. Here we retrieve this information by combining the fluxes emitted by the different activity sectors with the land-use data providing the fraction of each grid-cell occupied by the corresponding sector. In practice we divided the grid-cells at the first model's vertical layer at sub-surfaces corresponding to the different activity sectors encountered inside the cell. At each model's time step a different calculation of the species concentration is integrated over each sub-surface. The different resulting concentrations represent different members of the distribution of the mean output value at the subgrid scale. The standard deviation of these components expresses the subgrid variability of model's mean output concentrations.