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Relating small-scale emission and concentration variability in air quality models

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Air quality models are used to estimate the impact of air pollution on human health or vegetation, and to evaluate air pollution abatement strategies. Such models usually can give only one value of concentration for every grid cell. However, in particular for human exposure studies, information on the variability of the concentration is needed. Such variability can come from several sources, among others turbulence, and spatial heterogeneity of emissions.

Sources of emission have a wide range of size and shape. However, due to their complexity, air quality models do not allow for a realistic spatial representation of the sources. They use two dimensional emission fields allocated to a mesh with regular or non-regular rectangular grid cells. Therefore, the emissions from the source, or part of a source, located in a particular grid-cell are attributed to this cell. The amount of emission is distributed over it, and transformed into a mean exhalation rate or mean flux. Not only surface heterogeneity is lost, but also it will not be accounted for in the upper atmospheric levels.

We proposed a novel approach to the problem. This approach is based on the assumption that average emission acts as a source term of average concentration, while emission fluctuations are a source for the concentration variance. An error bar can then be associated to a simulated concentration. By implementing it into a mesoscale model, we tested it successfully against large-eddy simulation data, and applied it to the Lombardia region (Italy).