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Atmospheric Urban Dispersion and Inverse Modelling for the Determination of Accidental Sources

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The ongoing deployment of dense monitoring networks, made easier by the miniaturisation of sensor devices and the improvement in the communication between those sensors and a control center, allows to obtain a nearly real-time information about air pollution in urban areas. Numerical models can also be used to describe air quality, and data assimilation methods can be developed to combine the information from both the observations and the numerical model. In the particular event of an accidental or terrorist release of a pollutant, inverse modeling techniques can help reconstruct the source term and retrieve the precise location and magnitude of the source(s).
In this work, we have implemented different inverse modelling techniques and applied them in the context of the Mock Urban Setting Test (MUST) field experiment, which consisted in several well-documented releases of a passive tracer in an artificial urban area modelled by an array of shipping containers set up in the Great Basin desert in Utah. For the simulations, we have used the open source Computational Fluid Dynamics (CFD) model Code_Saturne, developed by EDF R&D and CEREA, to simulate the flow field and dispersion including the effects of the buildings.
Inverse modelling techniques can be divided in two categories: the parametric ones, where the source term to retrieve is a priori parametrised in order to simplify the computations, and the non-parametric ones which deal with more general sources but can be costly. We implemented methods from both categories to compare their general behaviour in different situations. The use of a CFD model is also resource-demanding, but it is necessary to fully take into account the complex geometry of any urban area. To highlight this, we also used a simpler, Gaussian model to compare the efficiency and the precision of the inverse modelling methods with both models.