# Quantification d'Incertitudes d'une chaîne de méta-modèles de la qualité de l'air à l'échelle urbaine

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With increased pollutant emissions and exposure worldwide, studies on air pollution and health effects have become increasingly common. However, urban scale models generally have high computational costs, and parameters (e.g. traffic demand and meteorological conditions) are often unknown at micro scales or dependent on sparse input data, leading to high uncertainties. Uncertainty quantification using assimilation of observational data can improve understanding and use of complex dispersion models. Model Order Reduction methods can render numerous simulations for uncertainty quantification, optimization, and exposure estimation feasible. Using our reduced-basis (RB) meta-model of a simulation chain at street resolution over Clermont-Ferrand, France, including operational models for traffic assignment, emissions, and atmospheric dispersion-reaction, we study the quantification and propagation of uncertainties by Monte Carlo methods.

We use two years of hourly observation data on traffic, pollutants, and meteorological conditions, and data on the urban geometry, traffic, vehicle fleet, and background surface emissions, provided by the city of Clermont-Ferrand and SME Numtech. The dynamic traffic model, solved on a network over $300km^2$, has been meta-modeled in [1]. After dimensional reduction of inputs by RB, the atmospheric dispersion model, covering a grid at 20m resolution over approximately $180km^2$, is replaced by a meta-model for $NO_2$ [2]. This meta-modeling technique has the advantage of relying on a RB which represents the dominant behaviors of the model solutions, but employs a relatively simple non-intrusive implementation at minimal computational cost. The full chain simulation requires nearly three hours, whereas our metamodel solves the entire chain in mere seconds.

Uncertainty in inputs throughout the simulation chain (e.g. traffic demand for the traffic model) can be represented by probability density functions, then propagated from the traffic and emissions models to the inputs of the dispersion model. Additional uncertainty is introduced due to the dimensional reduction necessary for computational costs and meta-modeling. We study the propagation of uncertainty in the complete chain, using Monte Carlo ensembles and probabilistic scores, comparing simulations to air quality and traffic observations. Our access to a particularly rich set of measurements on both traffic flow and pollutant concentration allows us to evaluate the accuracy of our uncertainty quantification using observational data. In particular this allows us to compute statistical scores on an ensemble for which we can describe its ability to represent observed uncertainty, and this at two levels of the modeling chain.

## Références

[1] R. Chen et al. "Metamodeling of a Dynamic Traffic Assignment Model at Metropolitan Scale". Submitted 2018.

[2] Hammond, J. K., et al. "Meta-Modeling of a Simulation Chain for Urban Air Quality." Advanced Modeling and Simulation in Engineering Sciences, vol. 7, no. 1, Sept. 2020, p. 37. BioMed Central, https ://doi.org/10.1186/s40323-020-00173-2.

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