# An integrated road traffic-emissions-CTM model chain to assess urban air quality at the street level for the Paris region

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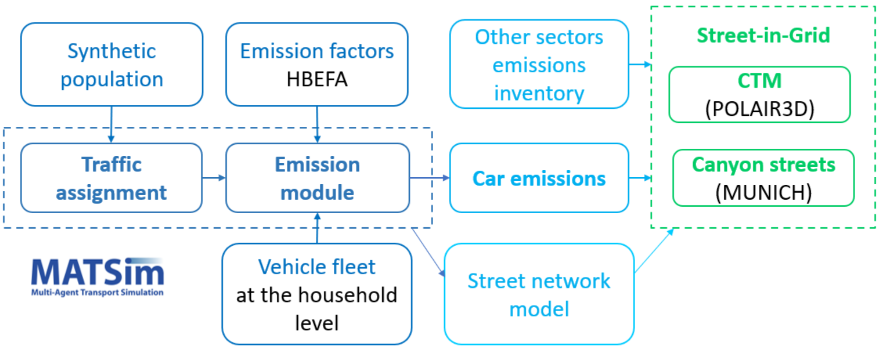
In the context of increasing urbanization, air quality assessment is essential for urban planning and transportation policies. Road traffic accounted for 47% of NOx emissions in Europe in 2018 (Air quality in Europe - 2020 report 2020). In order to assess the effect of public transport policies on air quality and exposure, integrated mobility – emissions – air quality modelling chains have recently been developed (Gurram, Stuart, and Pinjari 2019; Vallamsundar et al. 2016). However, the uncertainties associated with these modelling chains remain little studied. This study aims (a) to develop modelling chain for air quality assessment at the street level using an agent-based approach based on a traffic assignment model, an emissions model, and an air quality model, and (b) to perform a sensitivity analysis on the calculation of air pollutants concentrations. The newly developed modelling chain will also allow for future studies to evaluate air pollution exposure for the simulated population.

We developed a mobility-emissions–air quality modelling chain (Figure 1). Mobility and road traffic were simulated using the travel demand agent-based model MATSim. We then generated a synthetic car fleet associated with the population using a car ownership model with a pollutant emission-related car typology. We then use the outputs of the dynamic traffic assignment to estimate private car emissions at the street and vehicle level, considering its fuel type and Euro standard. We complete these emissions with the emissions inventories of other sectors from Airparif. Road traffic emissions were assigned to canyon streets, in which air quality was simulated using the MUNICH street model (Kim et al. 2022). Urban background concentrations were simulated using the Polair3D Eulerian chemical transport model (CTM). This framework enables a comprehensive chemical and transport simulation of multiple pollutants, including secondary aerosols, at the street level.

*Figure 1. An integrated modelling framework for ambient air pollution modelling*




In order to study the modelling chain sensitivity, we compare concentrations when using a disaggregate vehicle fleet versus an average vehicle in the emissions model. Another sensitivity test compares the use of the background CTM model alone (Polair3D) and the combined CTM and street air quality model (Street-in-Grid).

Regarding the disaggregated vehicle fleet model, comparing the performance of the AI models, the number of cars per household was predicted with 76.6% accuracy, 58.7% for fuel type, and 28.2% for emission standards. This model provides inputs for the agent-based mobility model to compute traffic-related daily emission profiles based on a synthetic population and synthetic vehicle fleet. The synthetic population of eqasim (Hörl and Balac 2021) was enriched with socioeconomic and mobility explanatory variables for the car ownership model, such as household and housing types or the presence of parking in the workplace. The emissions of passenger cars were then modelled based on the HBEFA emission factors depending on the Euro standard and fuel type of each car.

Additionally, a model was developed to generate a street network in which streets are defined by the built environment as it constrains pollutant transport. Based on OpenStreetMap's road network, we created a street graph with geographical information by merging roads within the same street, and then added properties to street links, including width and mean height. Road traffic emissions were then distributed on the street network. Finally, these emissions will be used as inputs in MUNICH and POLAIR3D for air quality modelling in the Paris region for 2014.

This sensitivity analysis will highlight the concentration uncertainty resulting from averaging vehicular emissions, along with the uncertainty related to the use of background pollution concentrations instead of street pollution levels. By combining individual travel patterns and street-level pollution concentrations from this modelling framework, future research will focus on the assessment of personal exposure to air pollution in the region's population.

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**Keywords:** urban air quality, vehicle emissions, spatial resolution, integrated environmental modelling, sensitivity analysis

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