

# Service tool: urban mapping and deterministic modelling

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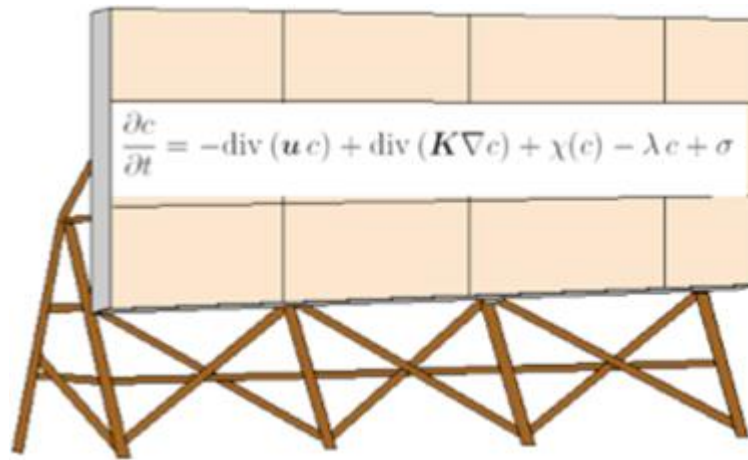
# Context

- High concentrations for several pollutants in urban areas: NO<sub>2</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>
- Need a better characterisation of composition & properties of particles, in particular
  - Black carbon (BC) concentrations
  - UFP concentrations, characterized by the particle number PN
- High spatial heterogeneities observed for NO<sub>2</sub>, BC and PN
- Maps are required at spatial scales below 100 m, at the minimum, to be able to differentiate the street from the urban background concentrations.
- Hourly time resolution is desirable.

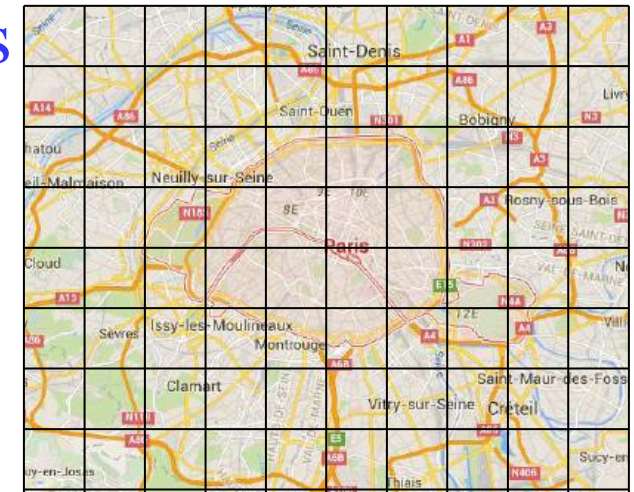
# Regional modelling

Chemistry-transport models (CTM) solve the mass conservation equation on a 3D mesh with spatial resolution down to 1 km x 1 km.

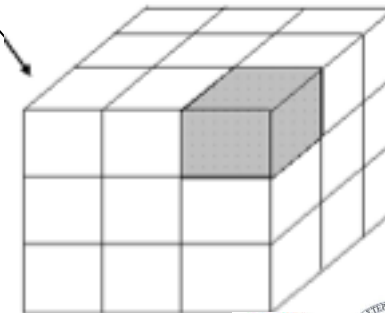
=> Background urban concentrations



2D view



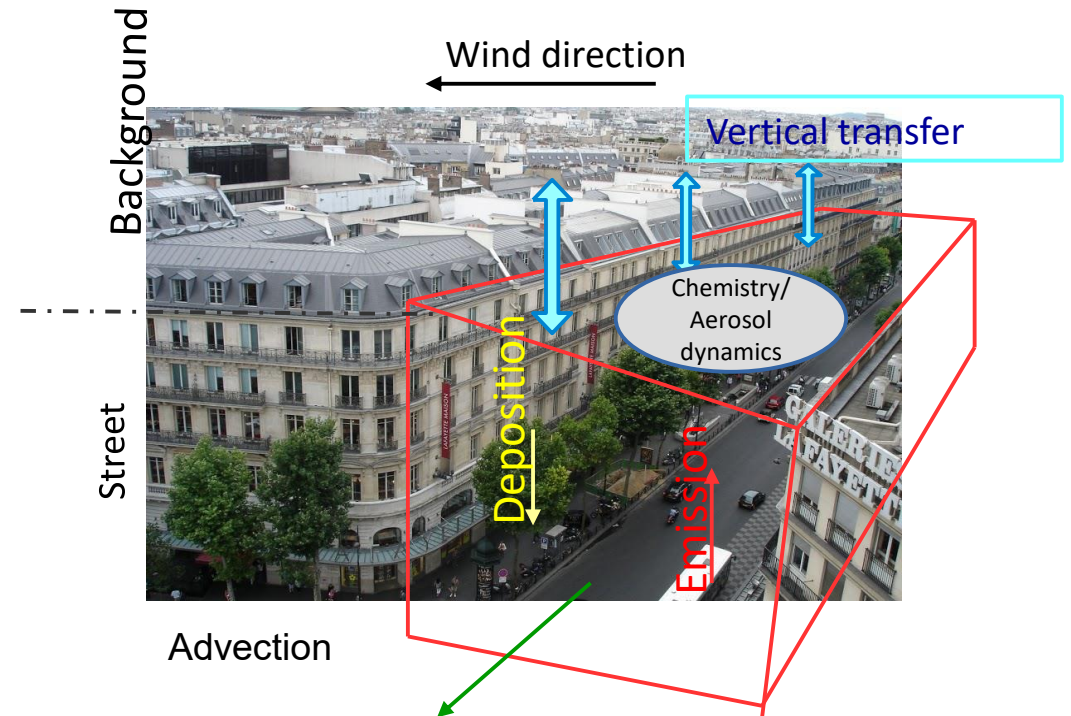
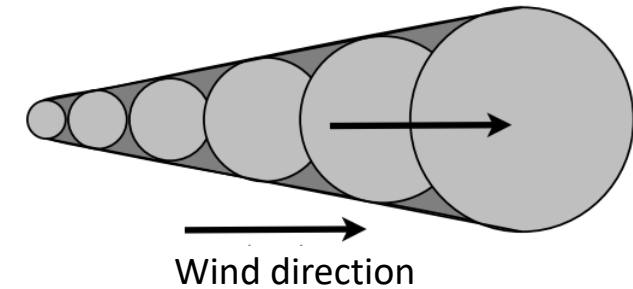
3D



May not resolve spatial heterogeneities of NO<sub>2</sub>, BC and PN

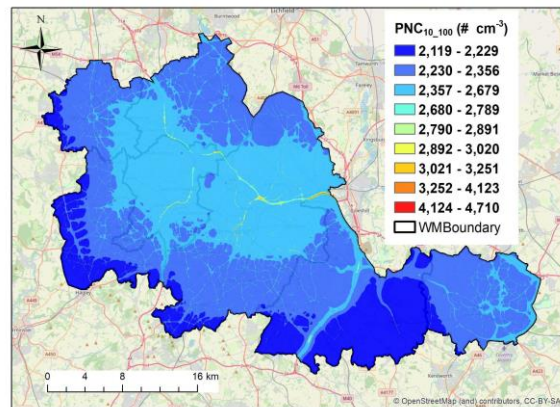
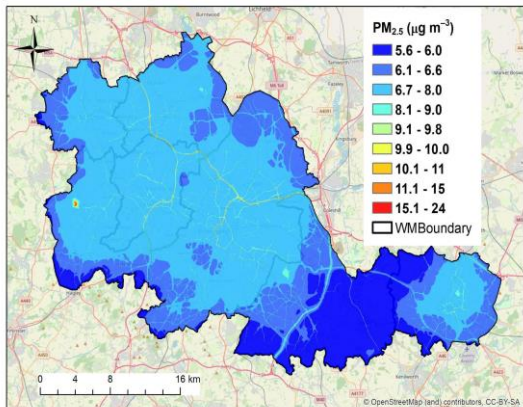
# Urban modelling

- For modelling over a whole city, two model types for local modelling:
  - Gaussian based model
  - Street-network model
- Other model types exist (e.g. computational fluid dynamics) but difficult to apply over a whole city

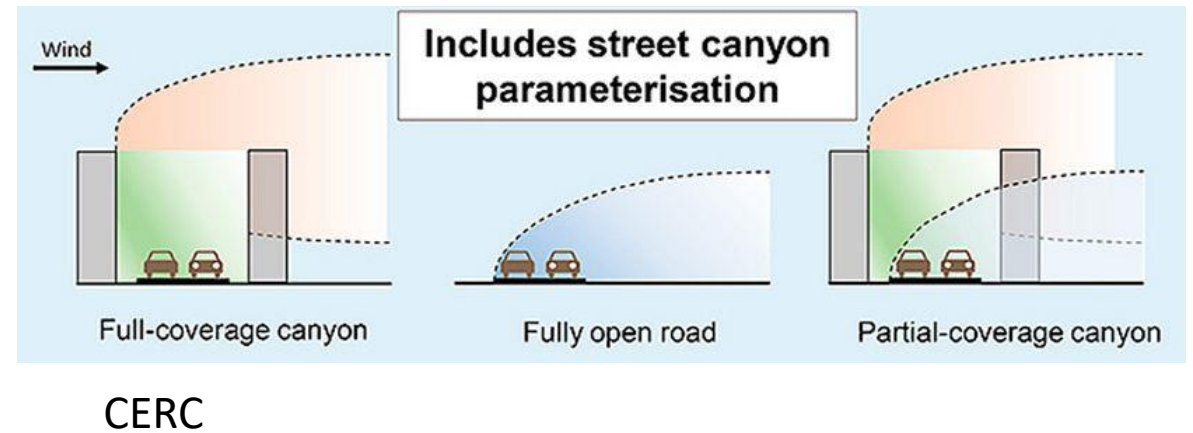


# Methodology

- Three methodologies of different complexity
  - **The Gaussian-based model ADMS-Urban** (urban background observation coupled to Gaussian-based model) =>  $\text{NO}_2$ ,  $\text{PM}_{2.5}$  and PN



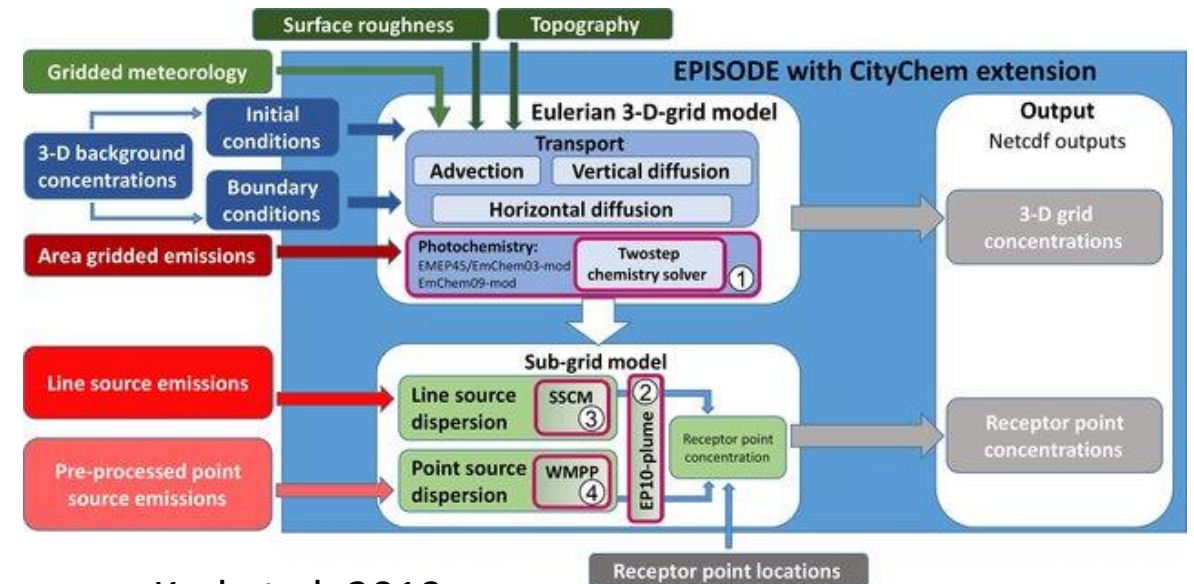
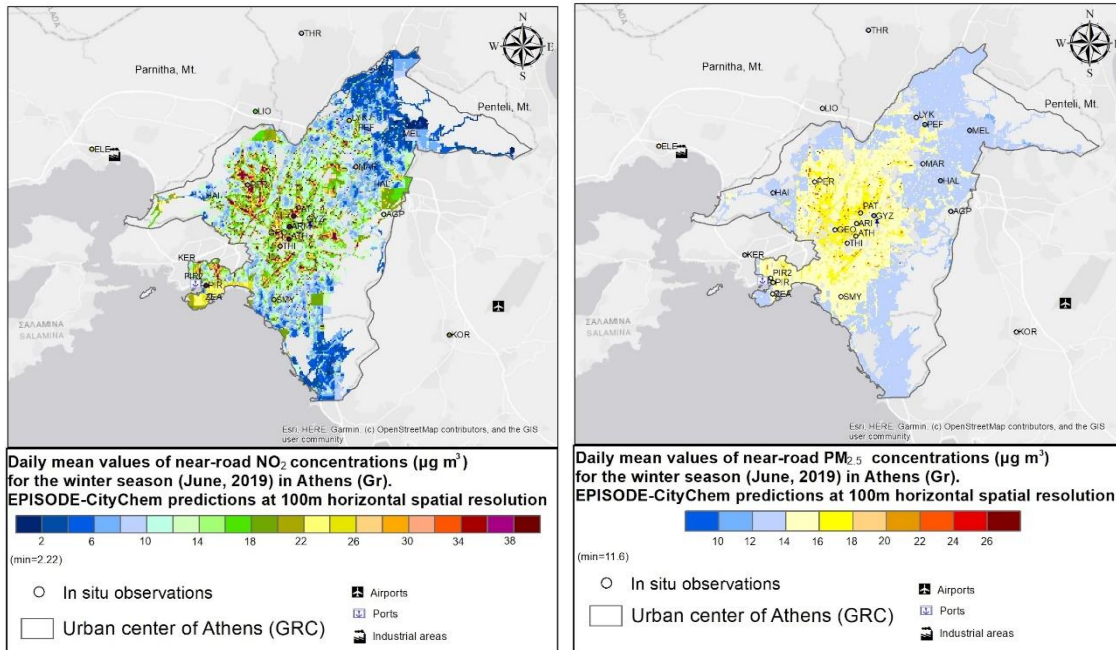
$\text{PM}_{2.5}$  and PN concentrations in summer 2019



CERC

# Methodology

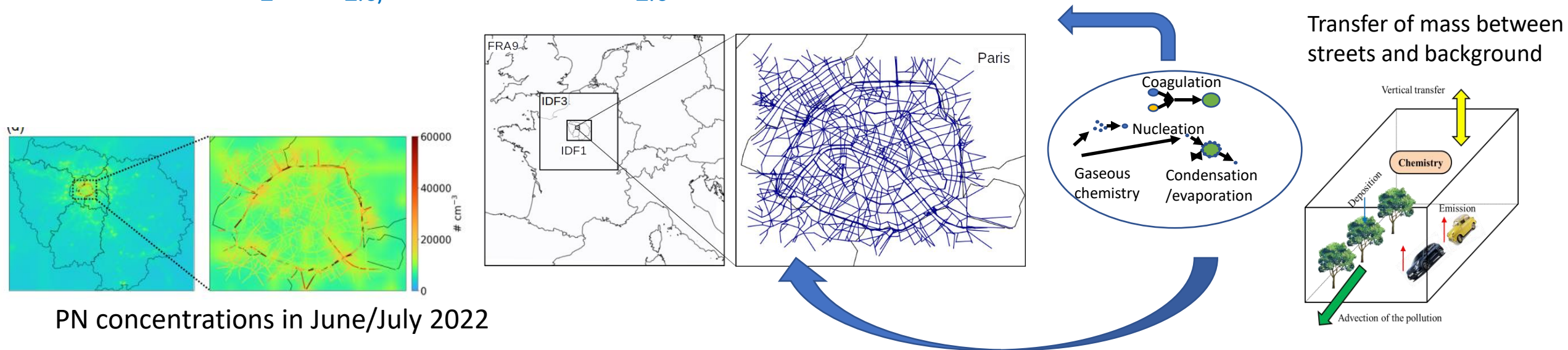
- Three methodologies of different complexity
  - **The multi-scale hybrid model Episode-CityChem** (3-D Eulerian CTM grid model with sub-grid Gaussian dispersion) =>  $\text{NO}_2$ ,  $\text{PM}_{2.5}$



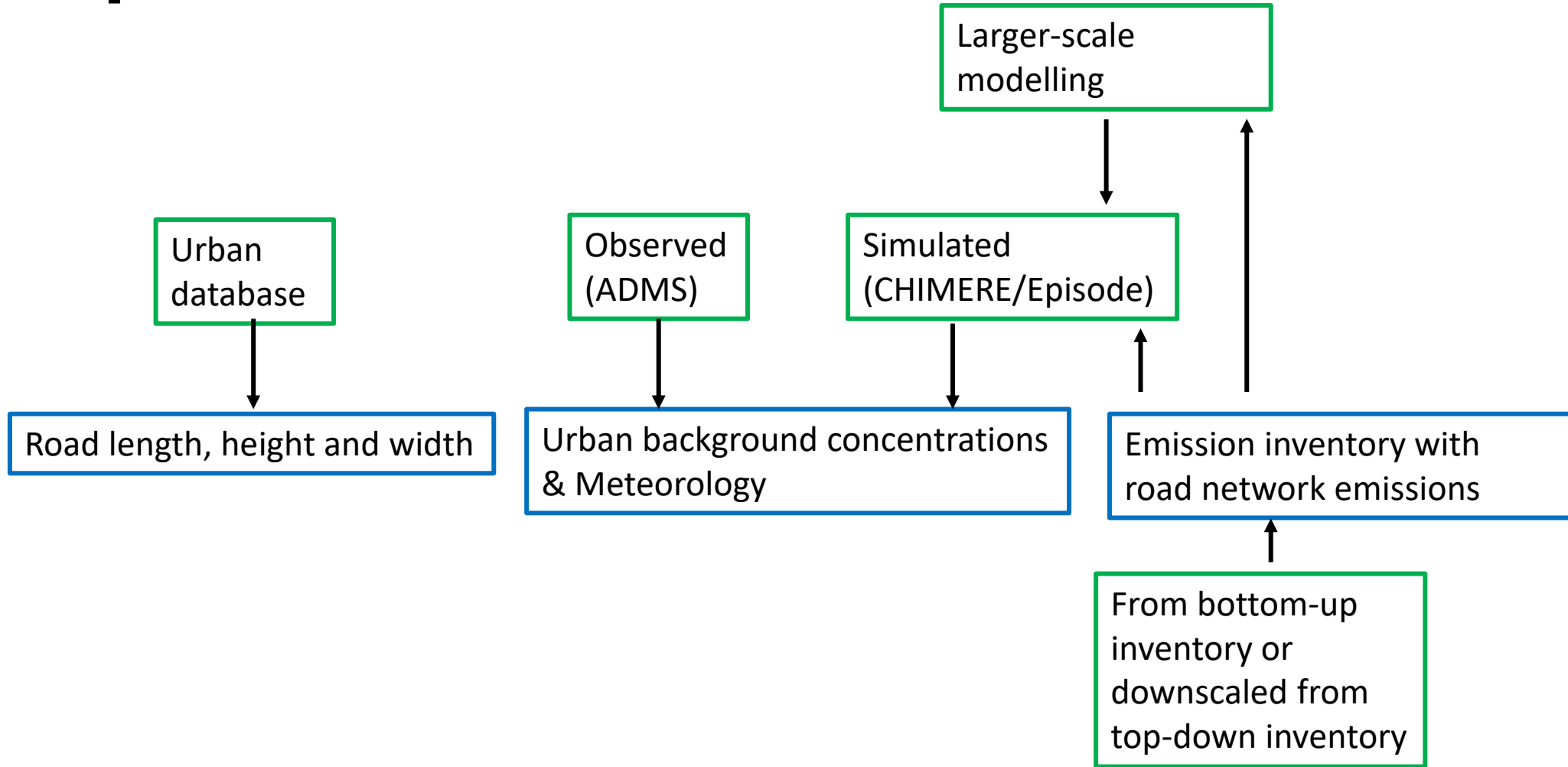
Karl et al. 2019

# Methodology

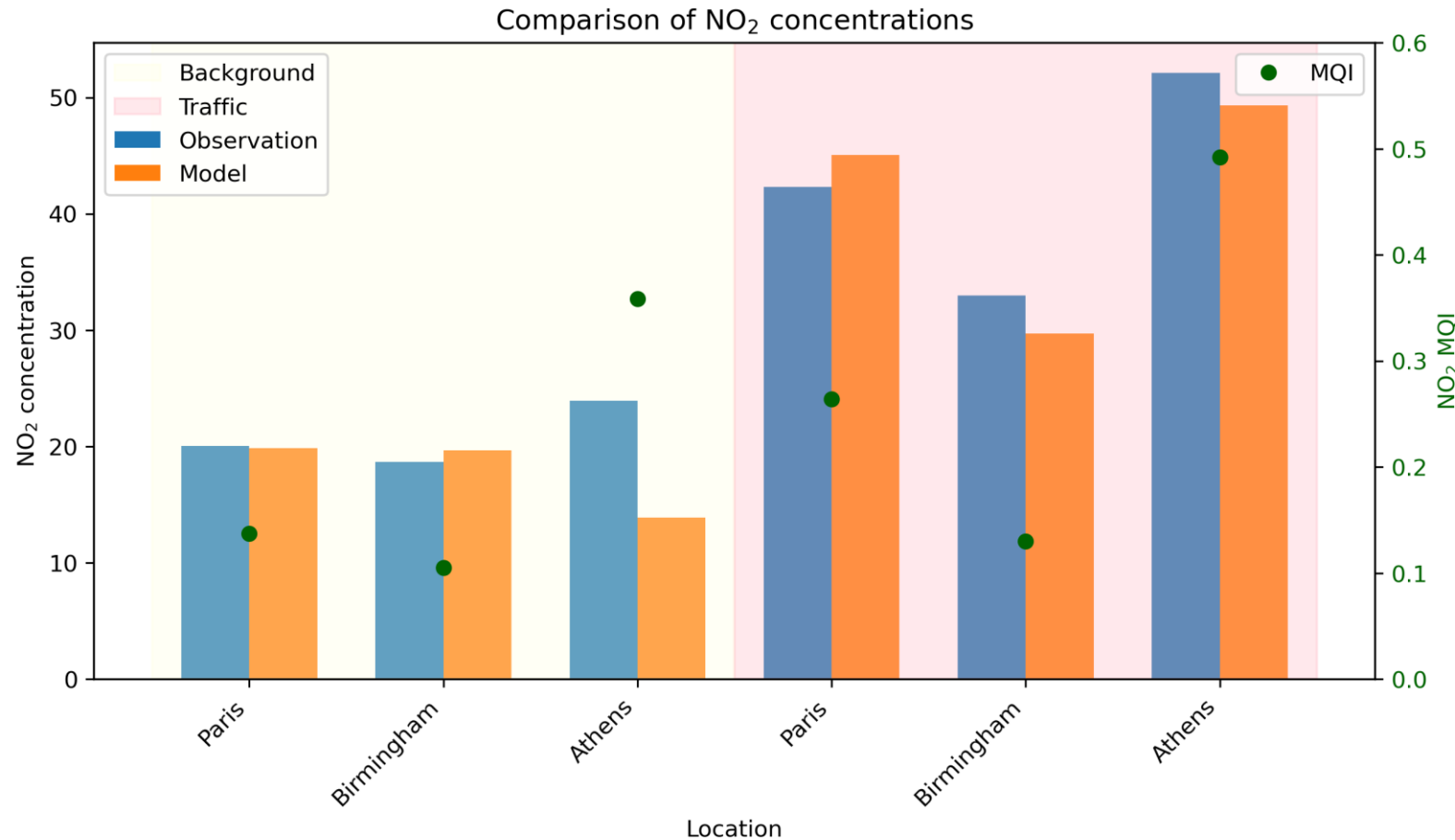
- Three methodologies of different complexity
  - **The multi-scale eulerian model CHIMERE/MUNICH/SSH-aerosol** (3D Eulerian CTM with sub-grid Eulerian dispersion and chemistry/aerosol dynamic at all scales) =>  $\text{NO}_2$ ,  $\text{PM}_{2.5}$ , BC, PN and  $\text{PM}_{2.5}$  detailed composition



# Input data



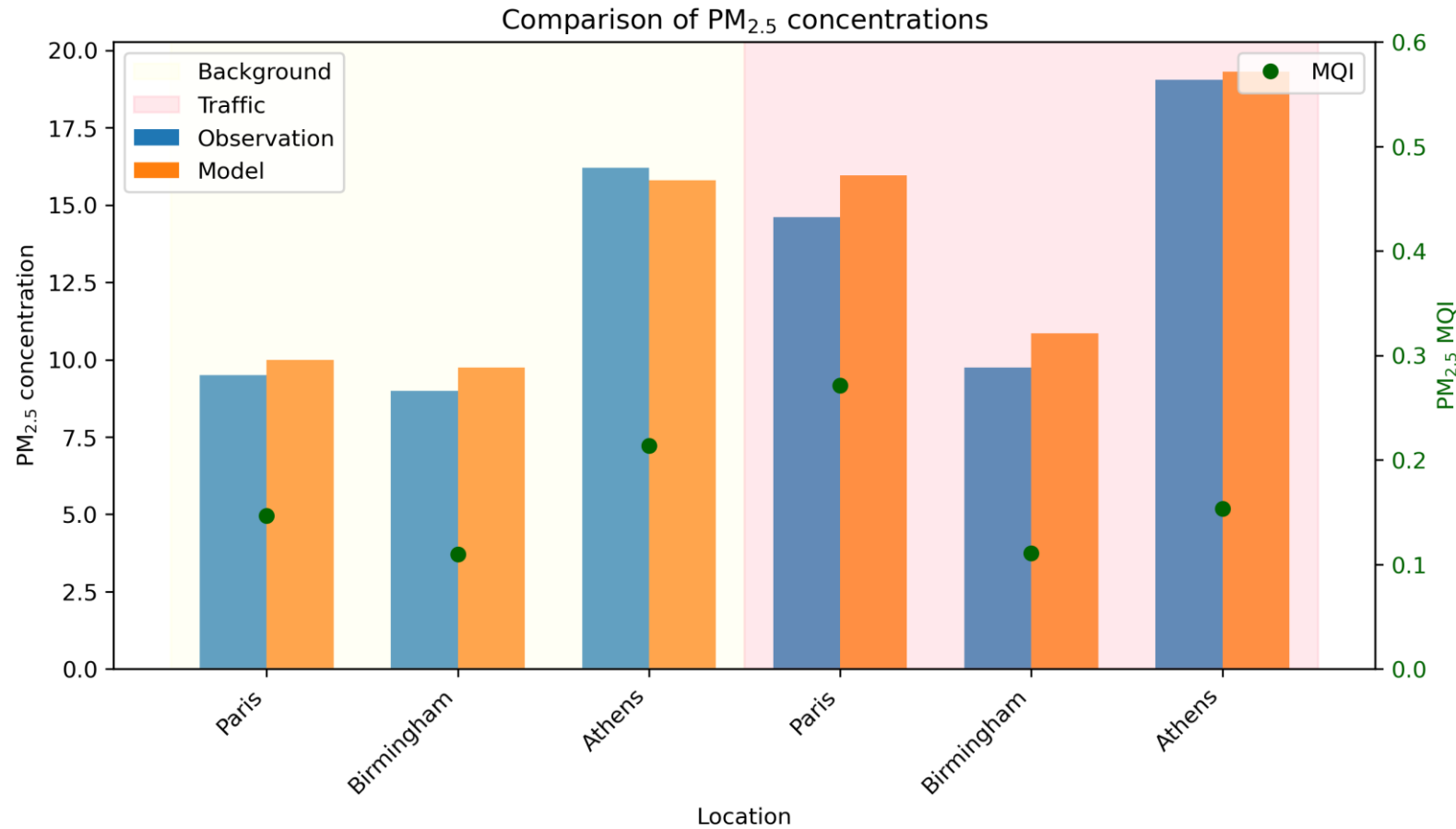
# Model evaluation



MQI: Modelling Quality Indicator  
< 1 => Good modelling quality

Average over 1 summer and 1  
winter periods

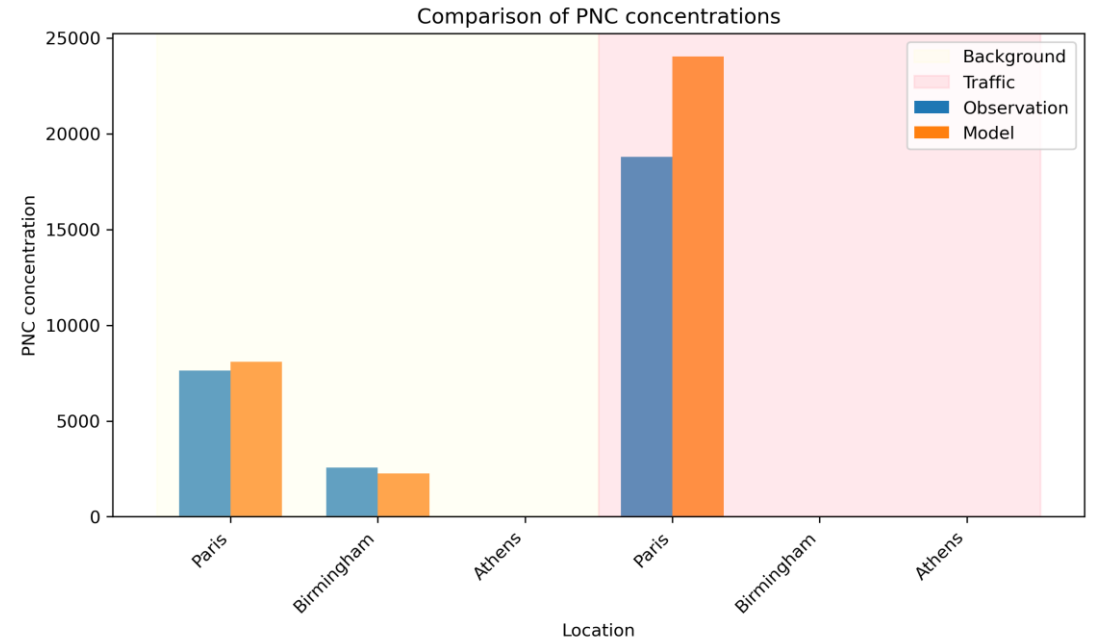
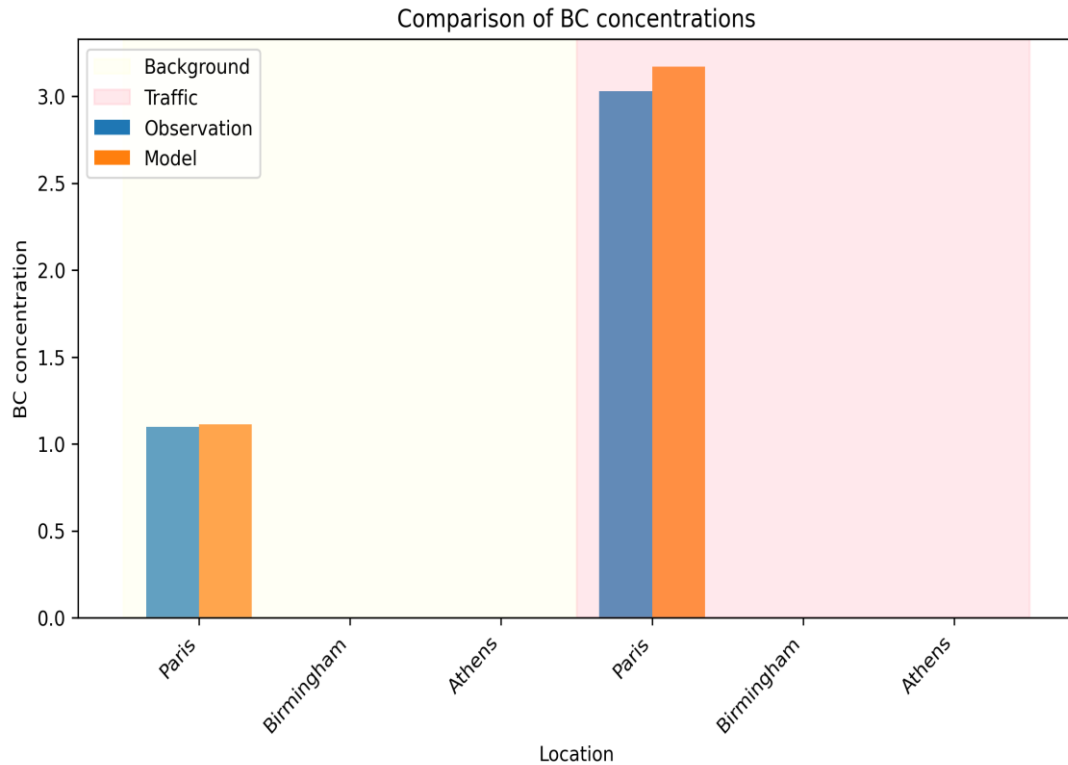
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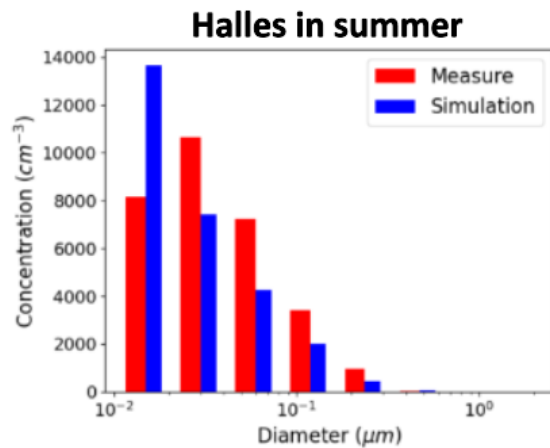
# Model evaluation



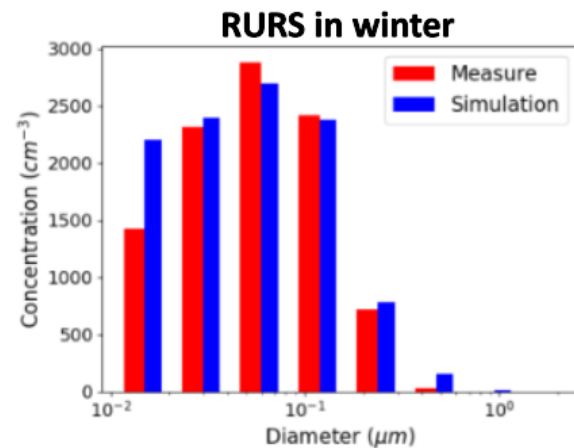
Average over 1 summer and 1 winter period, except for PNC traffic (1 summer period only)

# Model evaluation

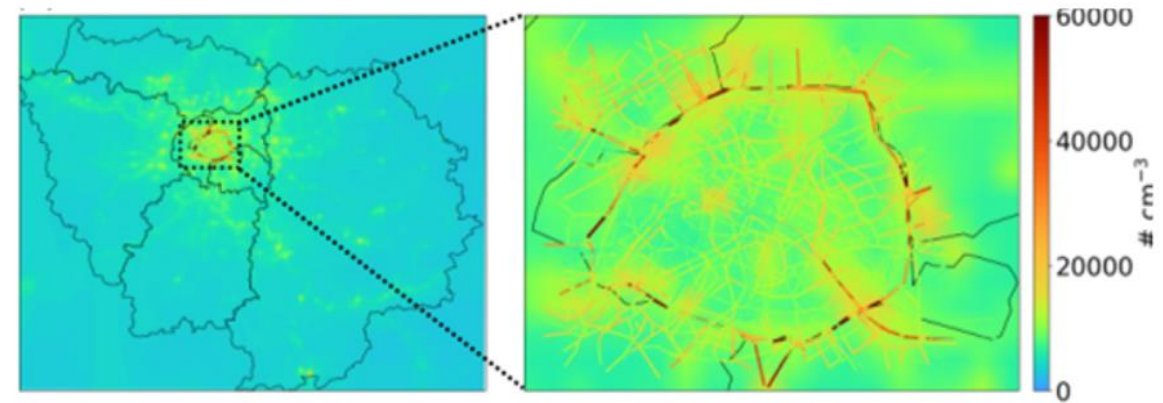
Further to PNC, evaluation of the modelling of the size distribution for the models representing aerosol dynamics (CHIMERE/MUNICH)



Paris City Center  
(urban background)



Rural station



# Stage of recommendation

- Urban deterministic models may be used to represent concentrations in the urban background and down to the street scales in cities.
- Urban variabilities of NO<sub>2</sub>, BC, PN are particularly large.
- Spatial variability down to 100 m x 100 m or down to the level of the street segment may be represented, and concentrations may be output hourly or daily, as necessary.
- These models require an emission inventory, which can be downscaled from a top-down inventory or correspond to a bottom-up one, and the average characteristics of each main street (height, length and width).
- For model evaluation, it is advised to evaluate the models at different types of fixed stations characteristic of urban areas (traffic, urban background, suburban background) for the different modelled pollutants.
- Need more observations at traffic stations