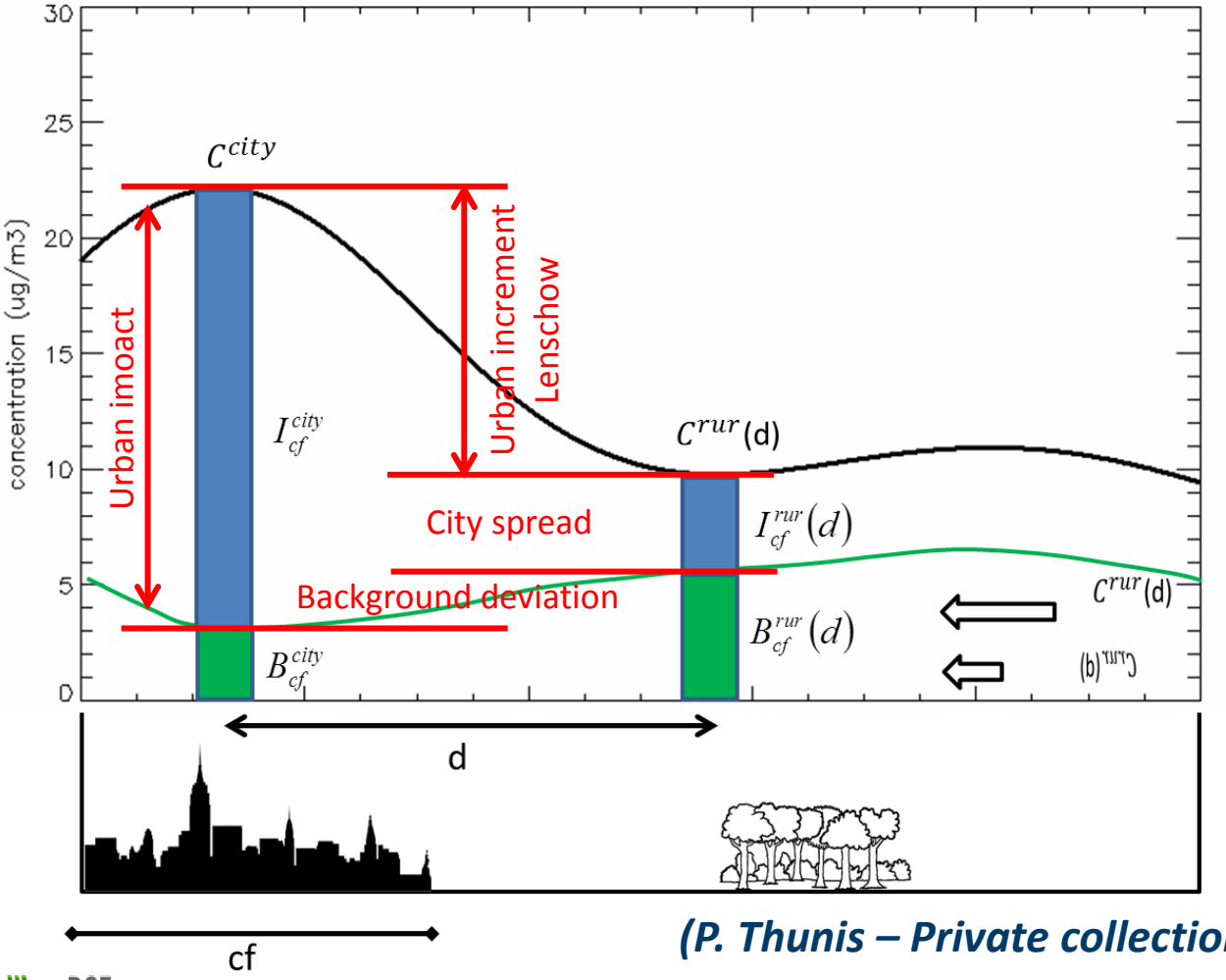
Spatial source apportionment

Is there any methodology available?

Spatial source apportionment

Incremental approach



$$C^{city} = B_{cf}^{city} + I_{cf}^{city}$$

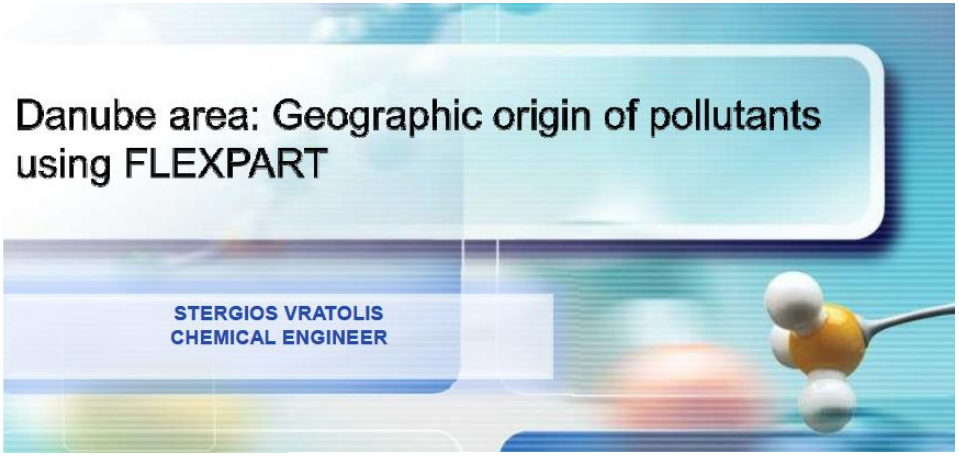
$$C^{rur}(d) = B_{cf}^{rur}(d) + I_{cf}^{rur}(d)$$

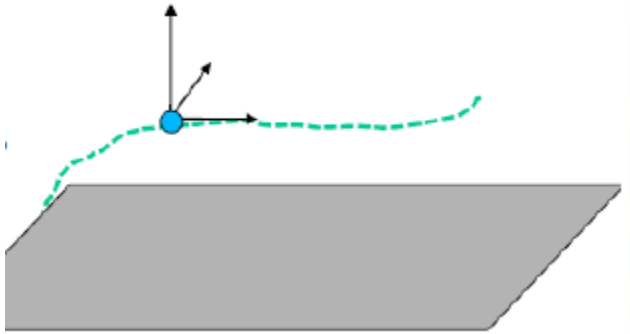
$$I_{cf}^{city} = \left[C^{city} - C^{rur}(d)\right] + I_{cf}^{rur}(d) + \left[B_{cf}^{rur}(d) - B_{cf}^{city}\right]$$

(P. Thunis – Private collection)

Spatial source apportionment
using Receptor Models coupled with Lagrangian models

ANALYSIS OF SOURCE BACKWARD TRAJECTORIES





$$\frac{\partial c_i}{\partial t} + u_x\frac{\partial c_i}{\partial x} + u_y\frac{\partial c_i}{\partial y} + u_z\frac{\partial c_i}{\partial z} = \frac{\partial}{\partial x}\left(K_{xx}\frac{\partial c_i}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_{yy}\frac{\partial c_i}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_{zz}\frac{\partial c_i}{\partial z}\right) + R_i(c_1, c_2 \cdots, c_n) + E_i(x,y,z,t) - S_i(x,y,z,t)$$

Divergence of the advected flux

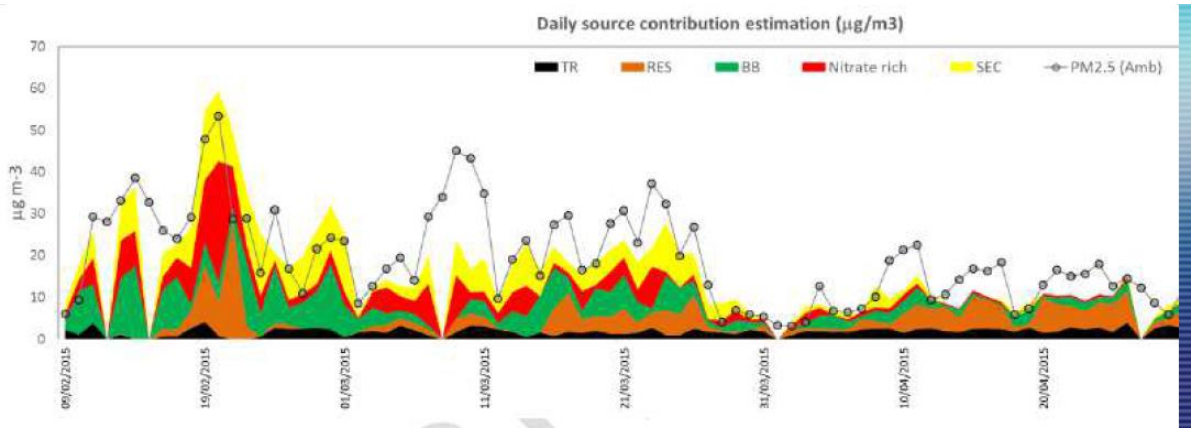
Divergence of the turbulent fluxes

Chemical reactions

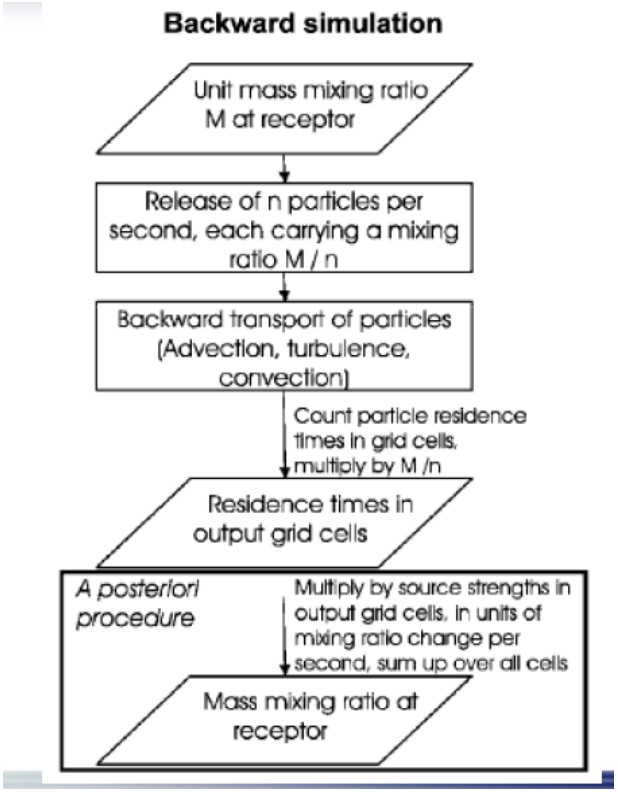
Emissions

Sinks

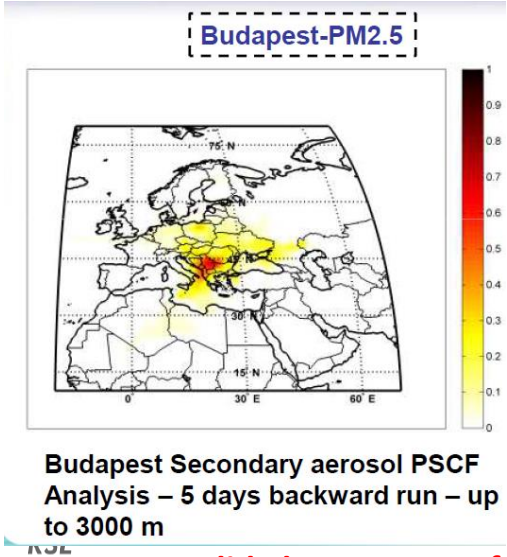
1st Receptor Model



2nd Lagrangian model

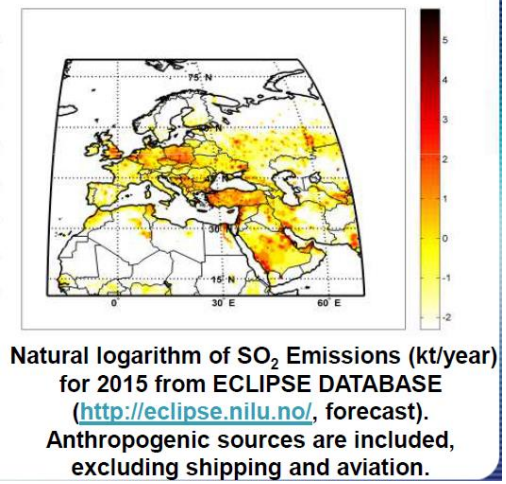


3rd Potential Source Contribution Function (PSCF)



Budapest Secondary aerosol PSCF Analysis – 5 days backward run – up to 3000 m

4th Emission overalapping



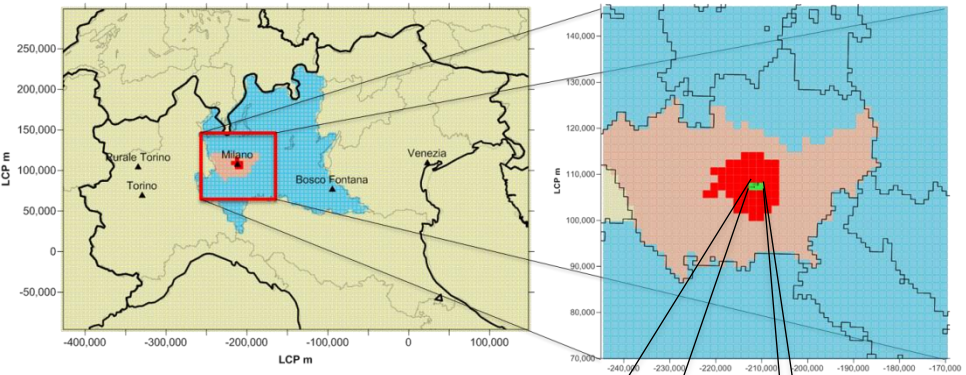
Natural logarithm of SO_2 Emissions (kt/year) for 2015 from ECLIPSE DATABASE (http://eclipse.nilu.no/, forecast). Anthropogenic sources are included, excluding shipping and aviation.

Slide by courtesy of S. Vratolis

Spatial source apportionment with…. *Source Oriented Models*

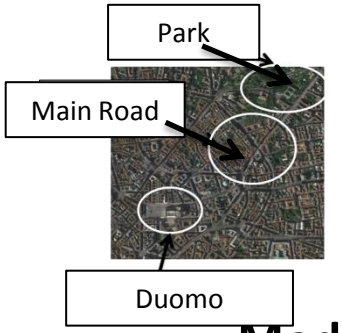
A case study for the Milan urban area

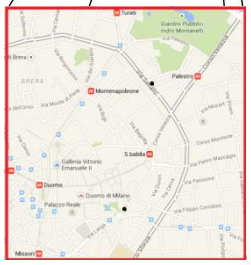
Nicola Pepe, Guido Pirovano, Alessandra Balzarini, Maurizio Riva, Anna Toppetti



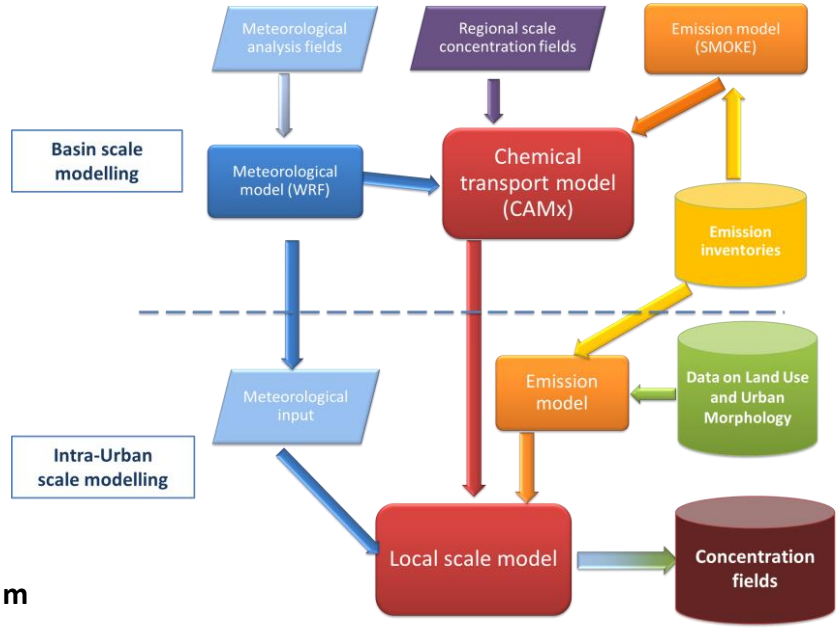
Resolution = 5 km

Resolution = 1,7 km





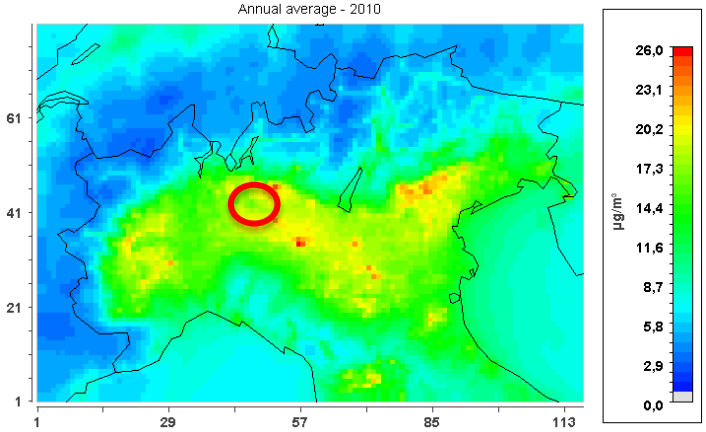
Resolution = 20 m

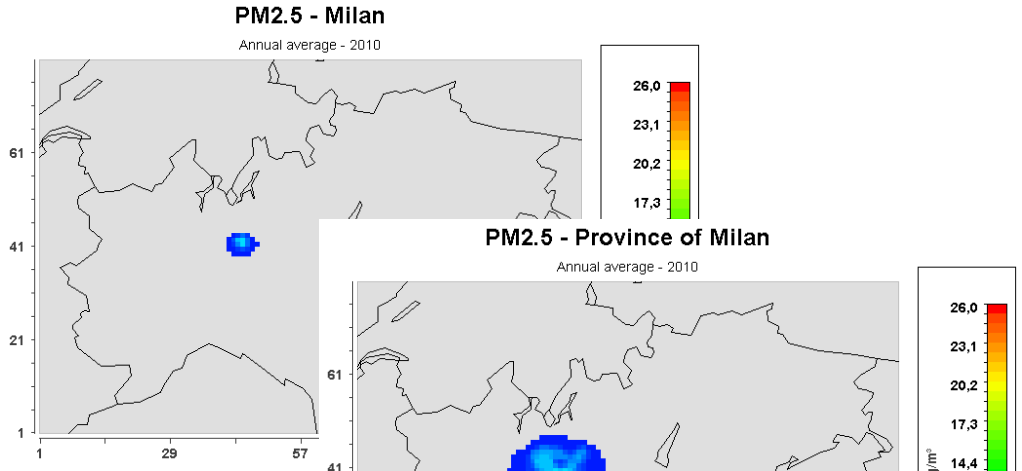


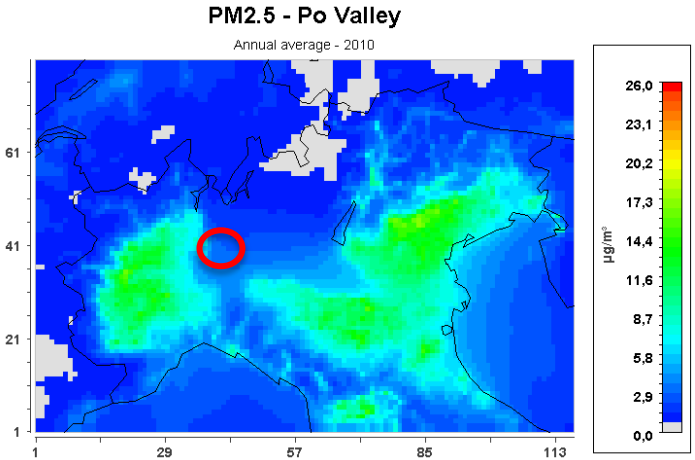
Model domain – Po Valley, Milan urban area, Milan city centre

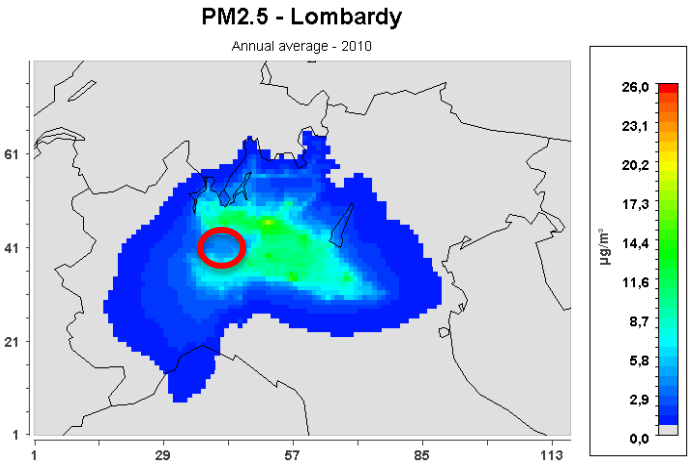
(following Lenschow definitions, but not Lenschow approach)

Spatial source apportionment with…. *Source Oriented Models*





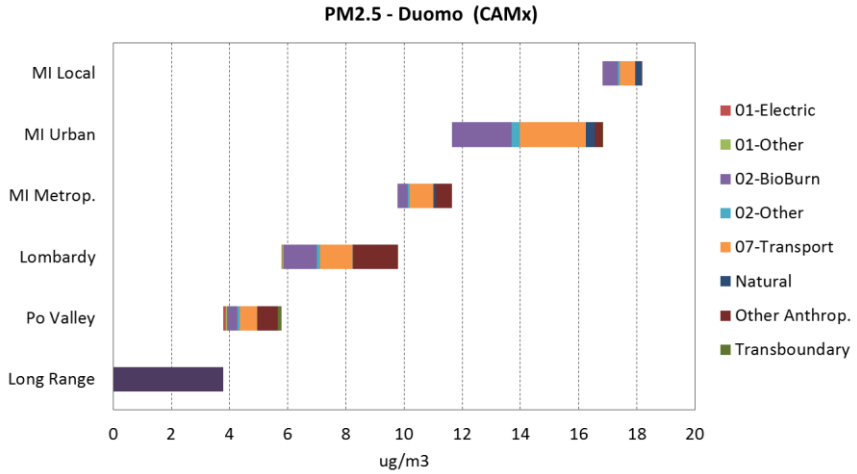


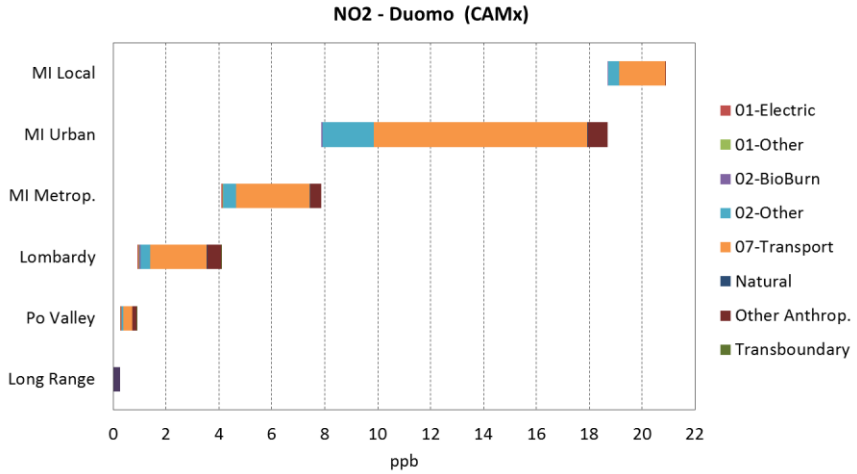


$PM_{2.5}$ yearly mean – Source regions contribution – Grid analysis

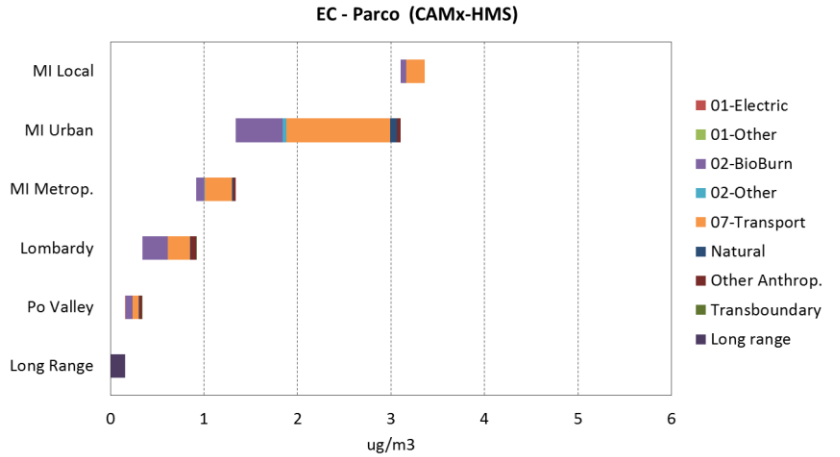
Spatial source apportionment with…. *Source Oriented Models*

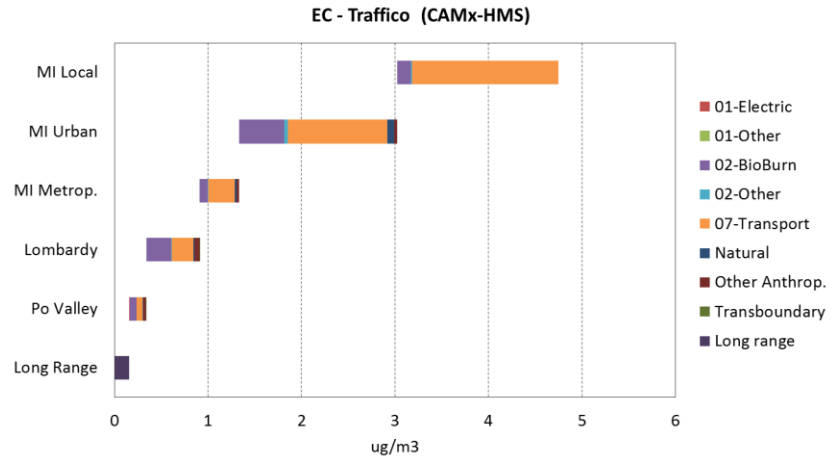
Mesoscale modelling





Meso + Local scale modelling





Yearly mean – Source regions/categories contribution – Receptor analysis

Discussion

1) Do we need Spatial Source Apportionment (SSA)?

2) To do what?

- To investigate the role of *source regions* and not only *source categories?*
- To support planning (with clear recommendations)?
- To support e-reporting?

3) Can we identify any "best practice" to perform SSA?

- What are limits and strengths of RMs and SMs?
- Can we compare/combine them?
- What about validation of SSA results?

4) Do we need an intercomparison exercise for SSA methods?

- Goals? (comparing different models/methods, testing Lenschow approach,..)
- How to design it? (Area and period of study, observations, input dataset,…)
- Which kind of models? (RMs, CTMs, LSMs,…)
- Time scheduling?
- *Volunteers…?*

5) If there is a Spatial Source Apportionment… will there be also a Spatial Source Allocation?