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Source apportionment with a hybrid modelling system: application to the Milan metropolitan area

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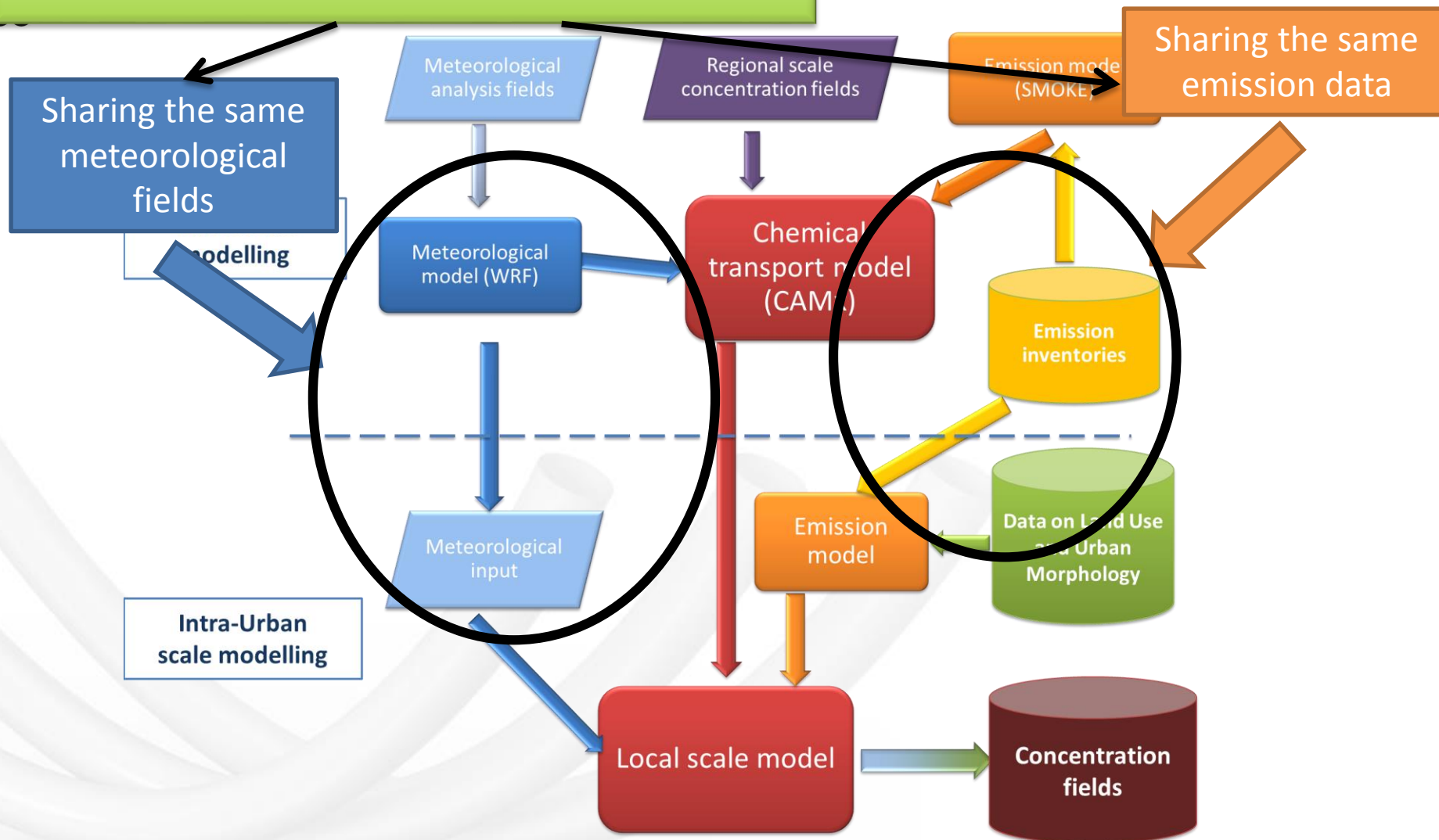
Goals and contents

Developing and applying a hybrid modelling system to reconstruct air quality and source contributions in an urban area

1. Hybrid Modelling System (HMS) and Case study
2. Source apportionment
3. Evaluation of obtained results
4. Conclusions



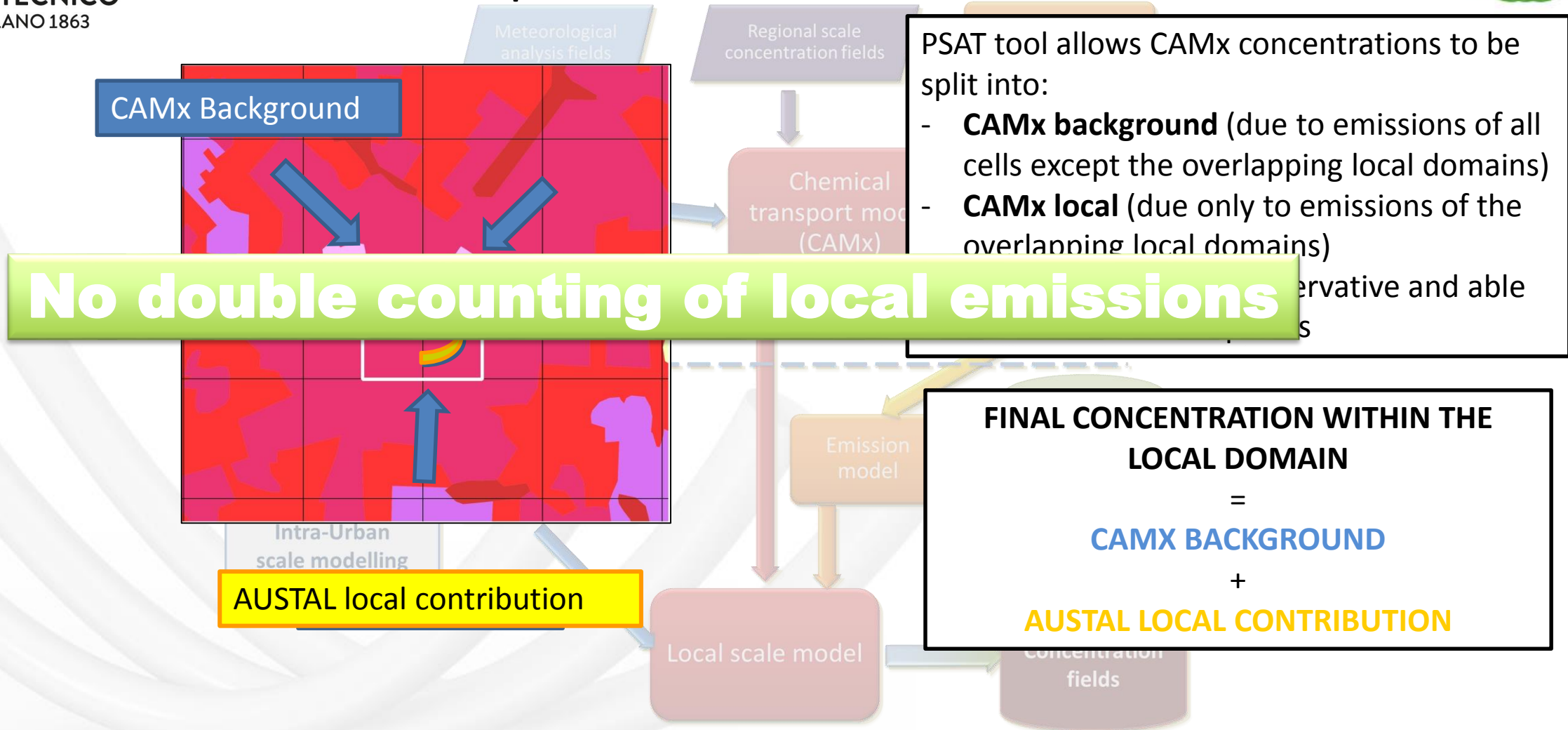
KEY FEATURES





CAMx/AUSTAL- Hybrid modelling system

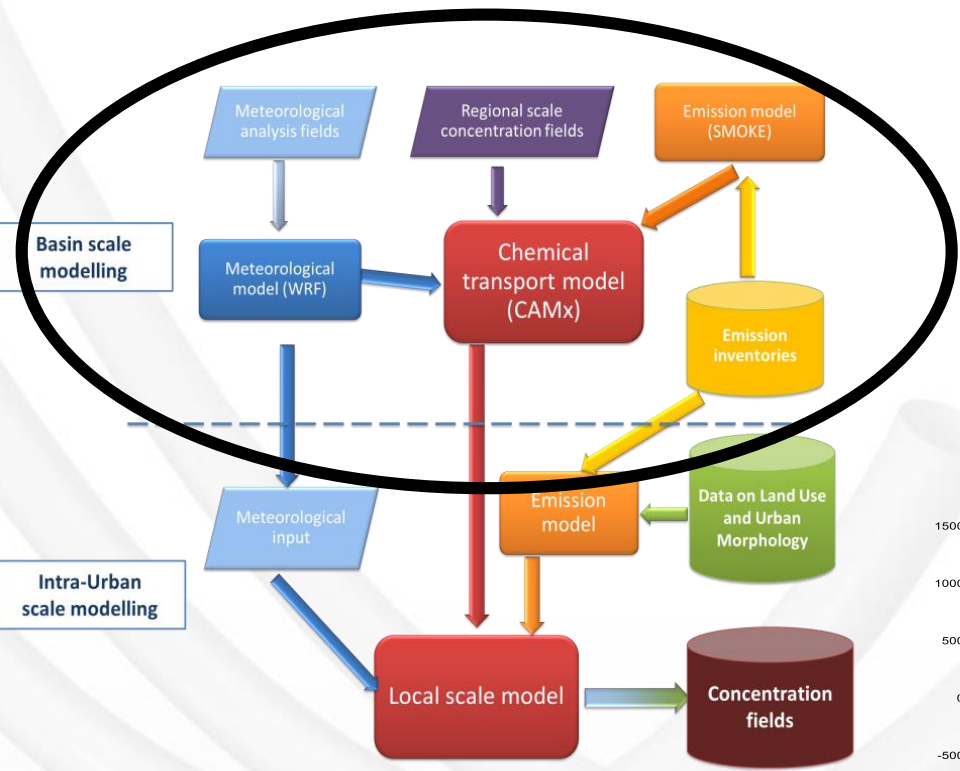
Computation of the final concentration





Modelling system and case study

CAMx



Meteorological fields

WRF v.3.4.1 – 4 domains

Europe (45 km) + **Italy** (15 km)

Po Valley (POV) (5 km) + **Milan urban area (MIL)** (1.7 km)

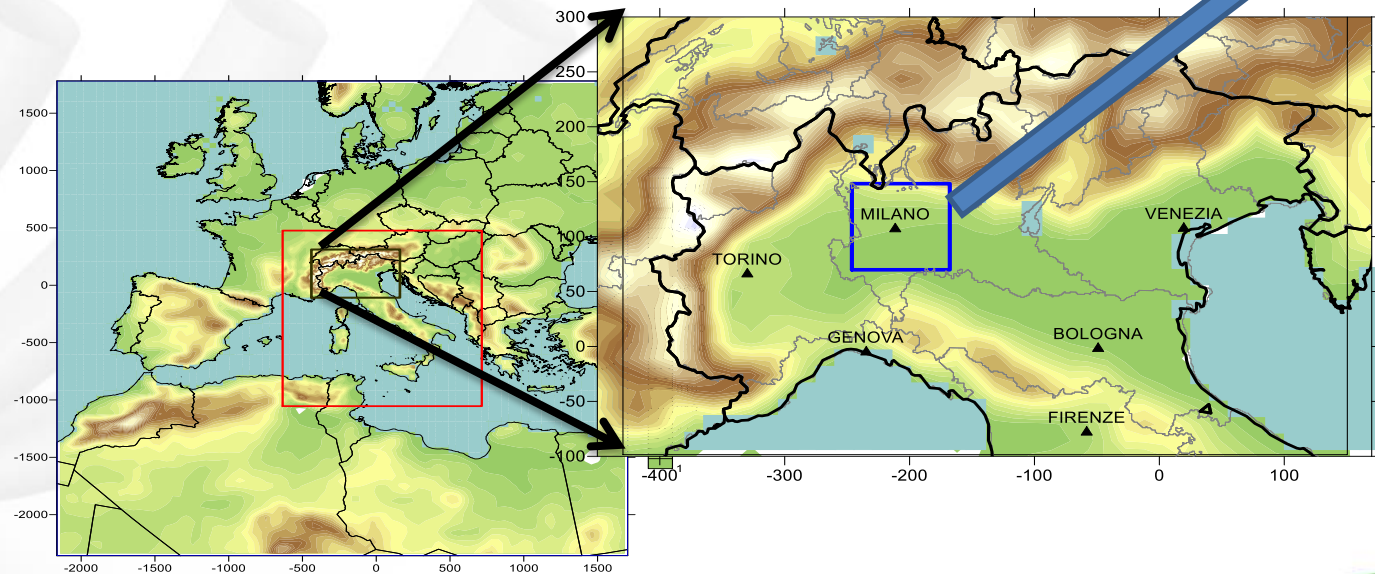
ECMWF – Analysis fields

Emissions

Regional inventories for Lombardia, Piemonte, Veneto and Emilia Romagna

ISPRA and EMEP 2010 for other areas

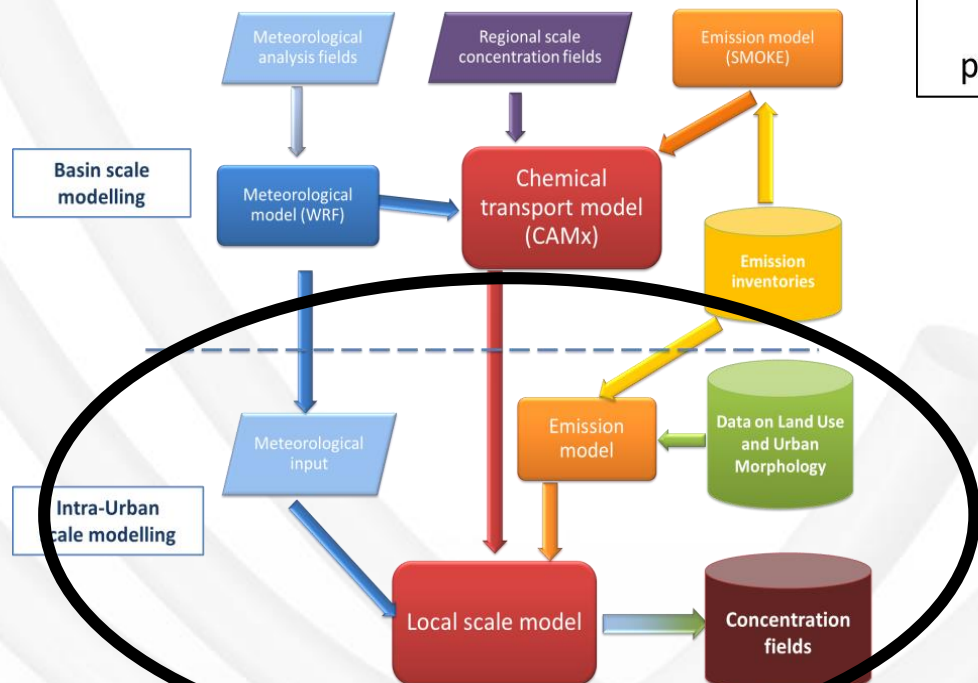
Period: year 2010



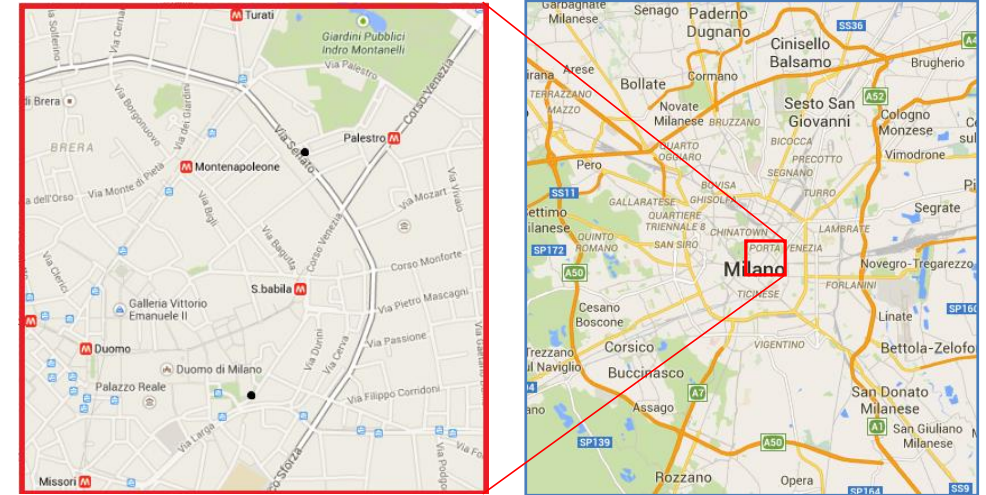
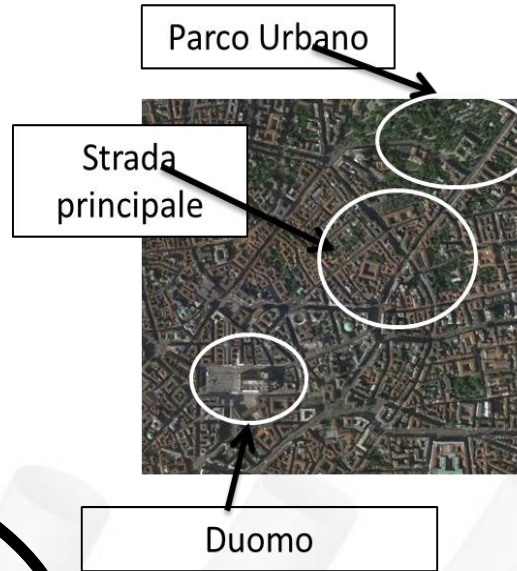


Modelling system and case study

Pepe et al., Atmospheric Environment 141 (2016) 297-311



AUSTAL



Domain

(1,6 x 1,6) km² resolution 20 m (80 x 80 cells) – corresponding to 1 CAMx cell

Meteorological input

- TALDIA with LMO, wind speed and direction from WRF

Emissions

Domestic heating (point sources) and road transport (linear sources)

Buildings

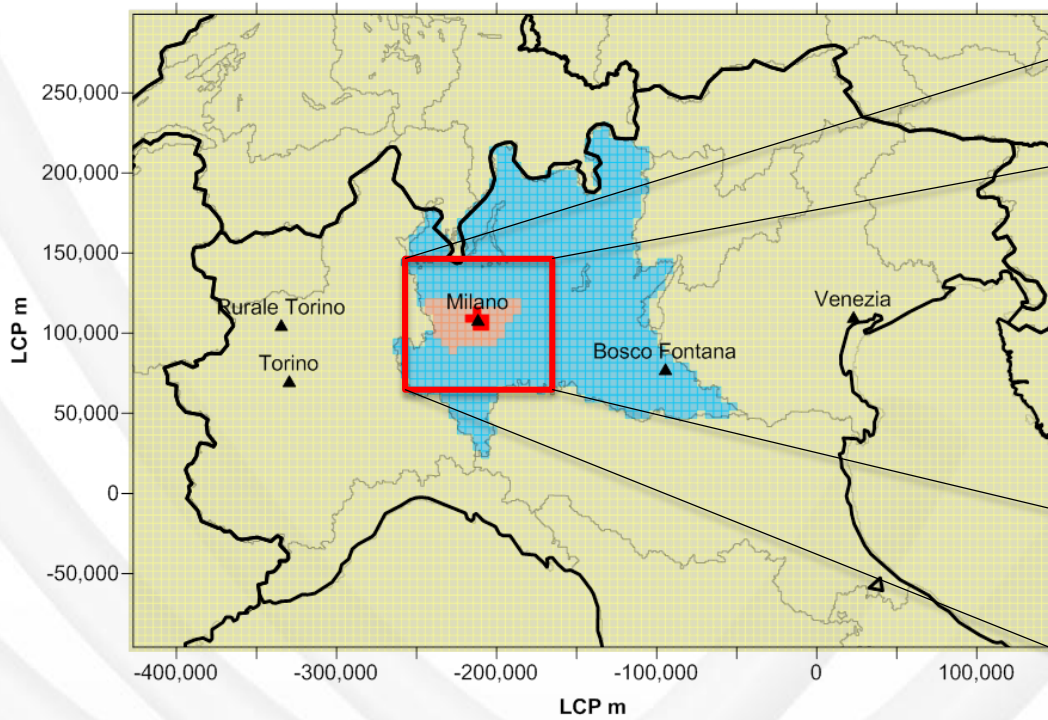
2604 cells (6400 totals) represent buildings. Land use database = ATLAS EUROPE

Roads

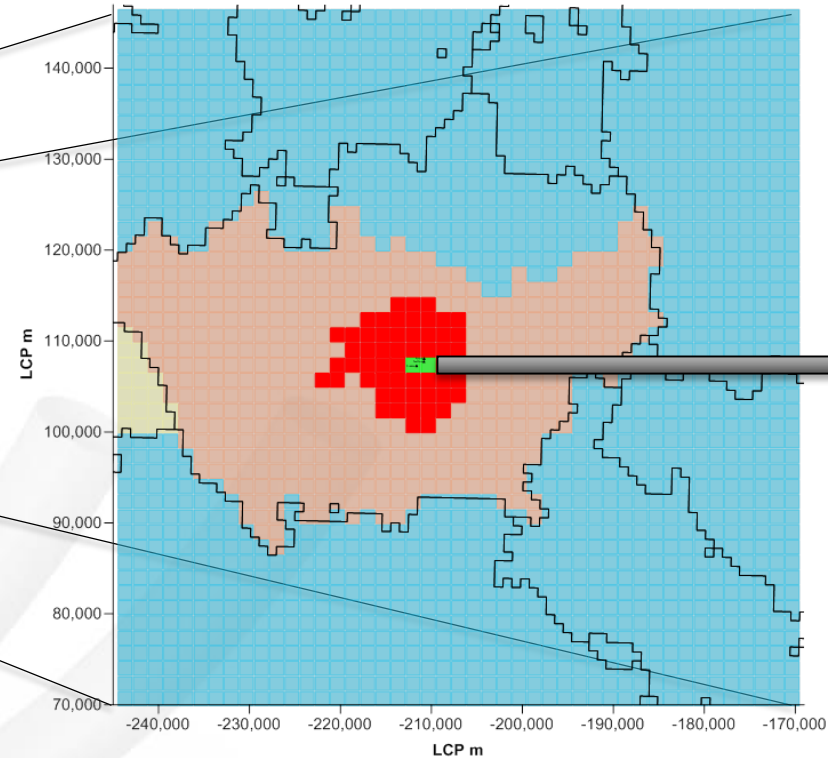
545 road arcs, each with a specific emission



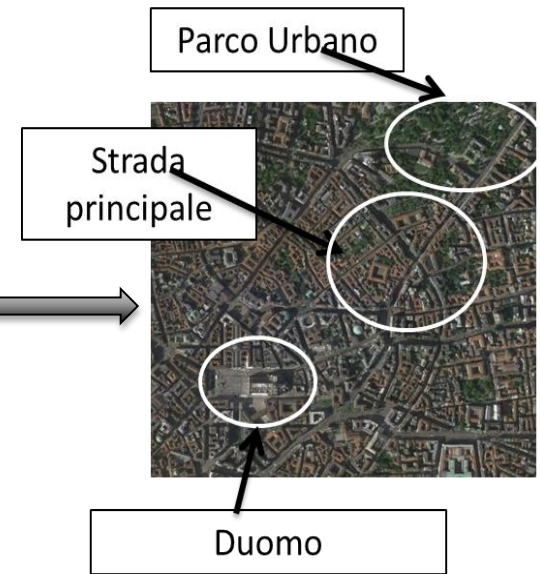
Emission regions «tagging»



Resolution = 5 km



Resolution = 1,7 km



Resolution = 20 m



Emission categories

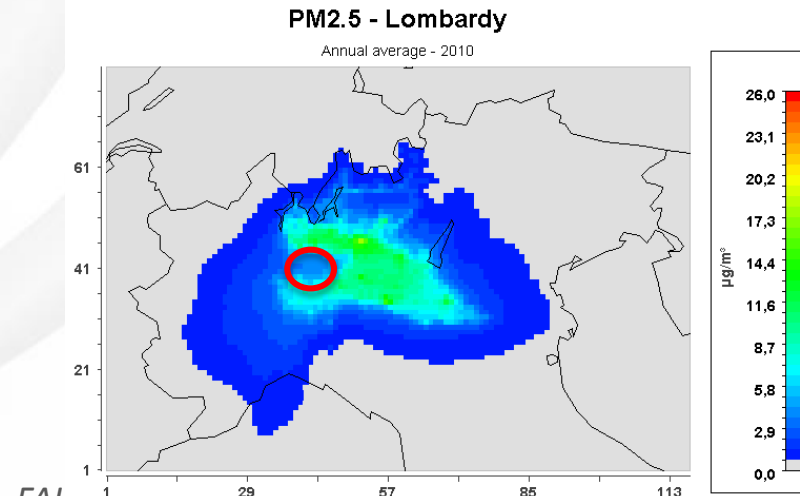
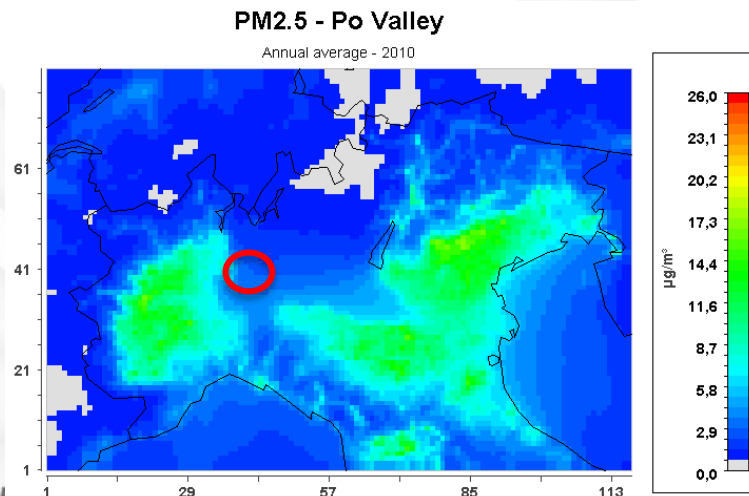
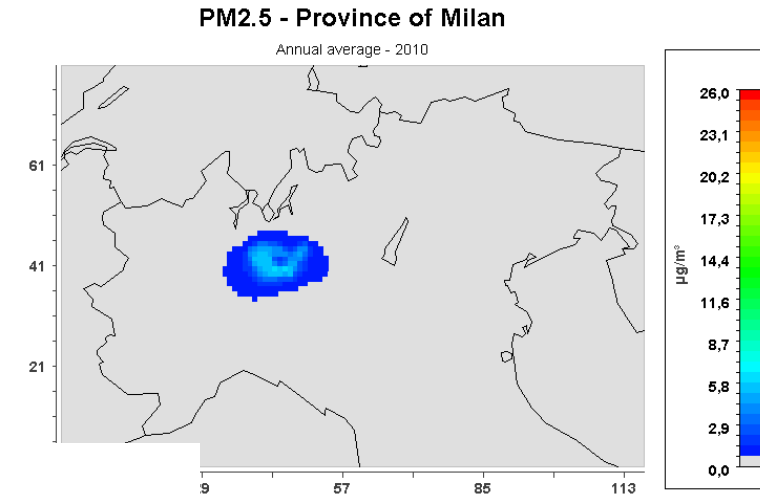
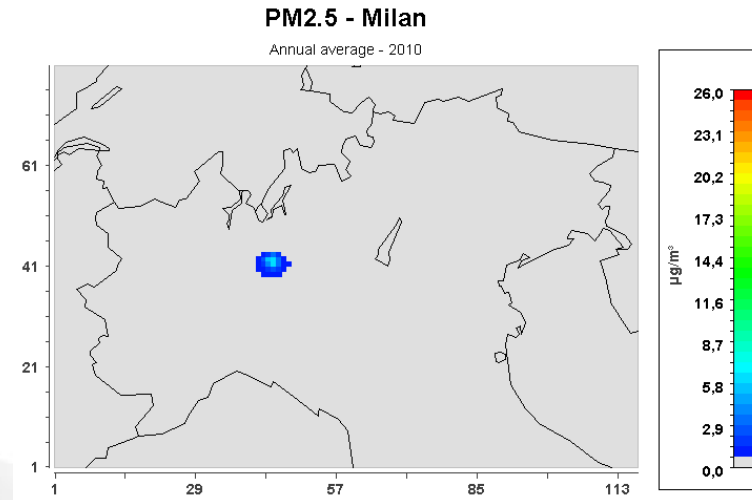
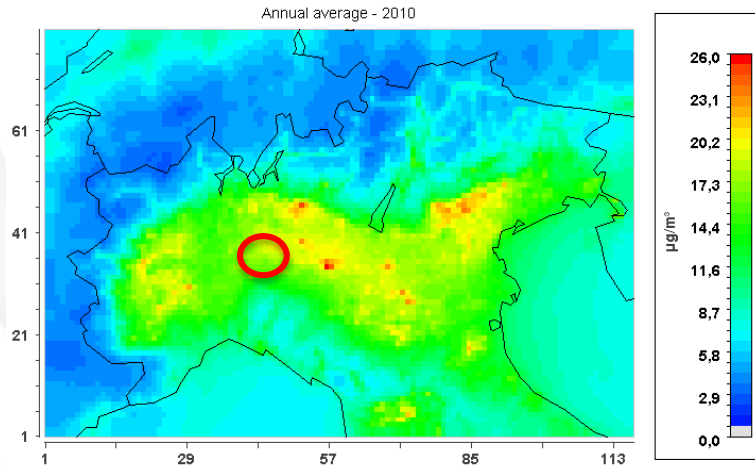
01 ELE	Electrical power plants
01 OTH	Other power plants
02 BIO	Biomass burning for residential and commercial heating
02 OTH	Other residential and commercial heating
07 AUT	Road transport – Private cars
07 LEG	Road transport – Light duty vehicles
07 PES	Road transport – Heavy duty vehicles
07 MOT	Road transport – two wheels
11 NAT	Natural sources
EMEP	Transboundary sources
OTHER	Other sources: Industry, Agriculture , solvents, off-road transport





CAMx - Po valley

PM_{2.5} – Annual mean – geographical source apportionment



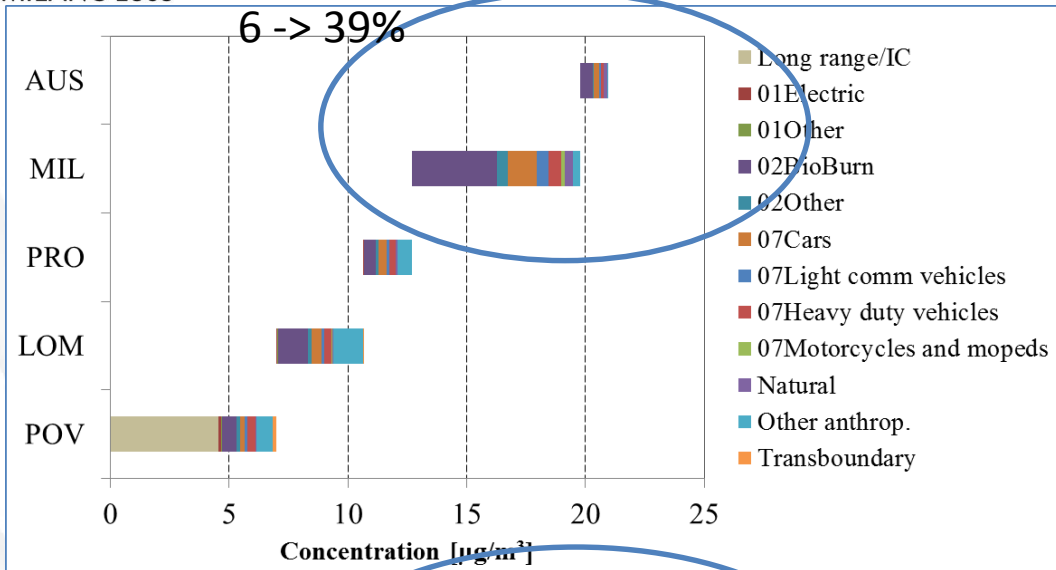


HMS - receptor analysis - PM_{2.5}

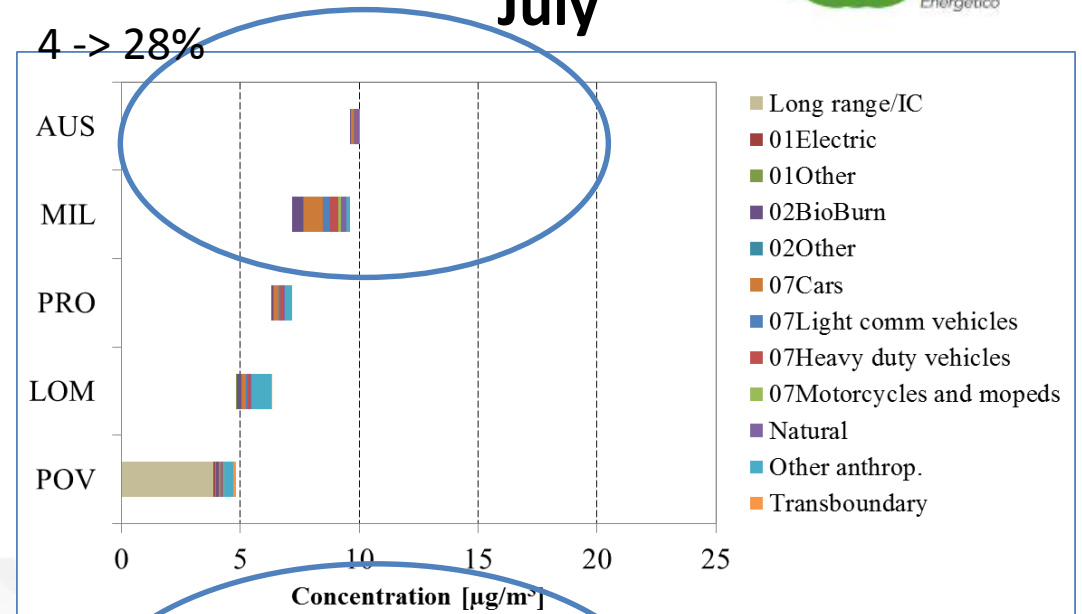


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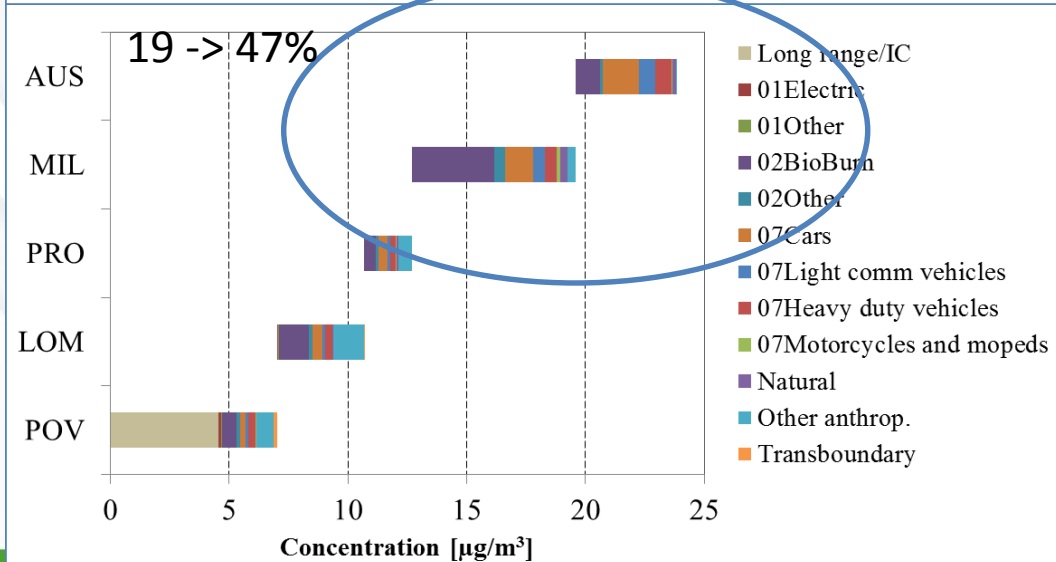
March



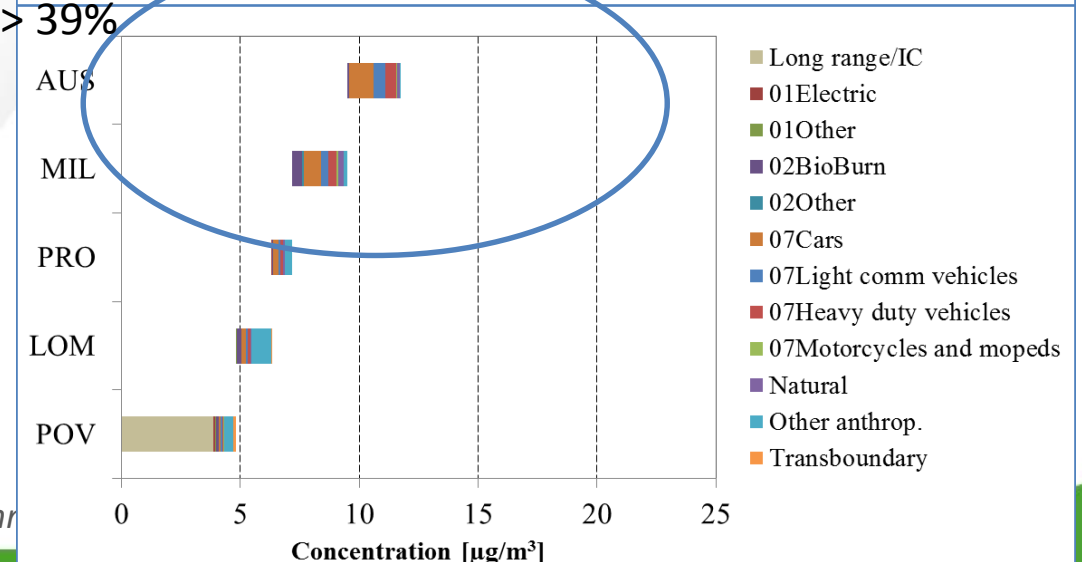
July



Park



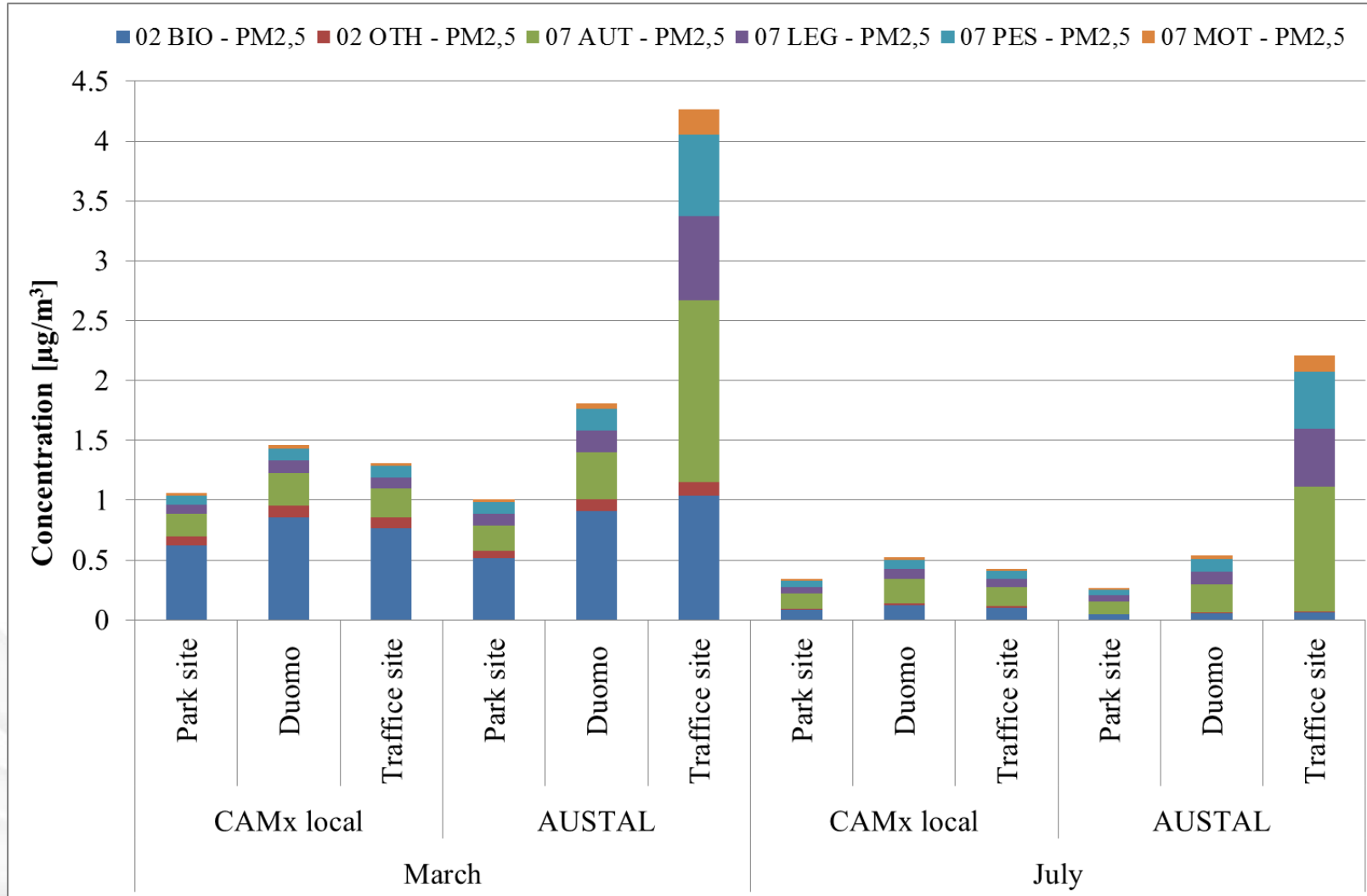
20 -> 39%



Traffic

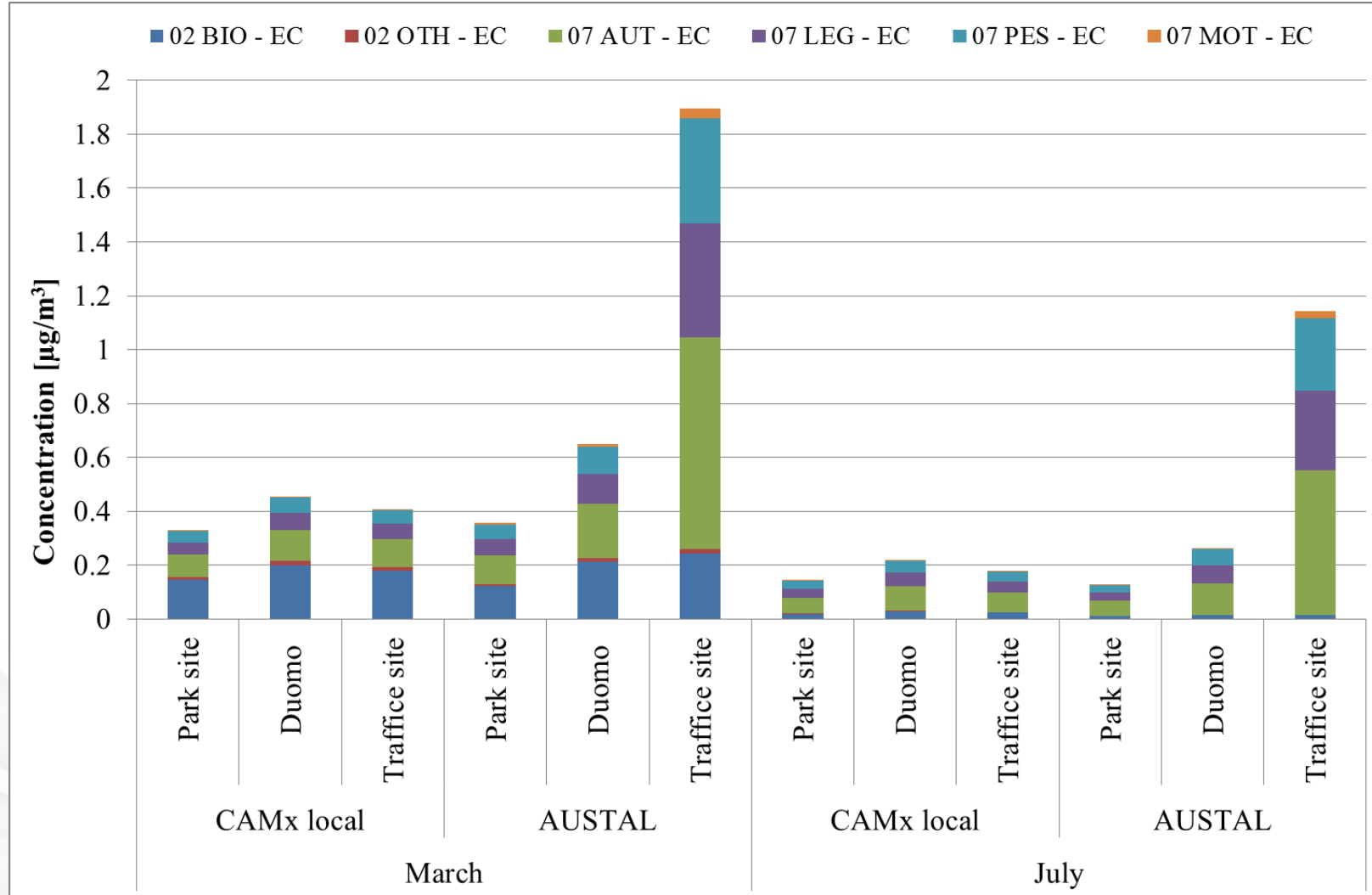


HMS - Receptor analysis - PM_{2.5}





HMS - Receptor analysis - EC

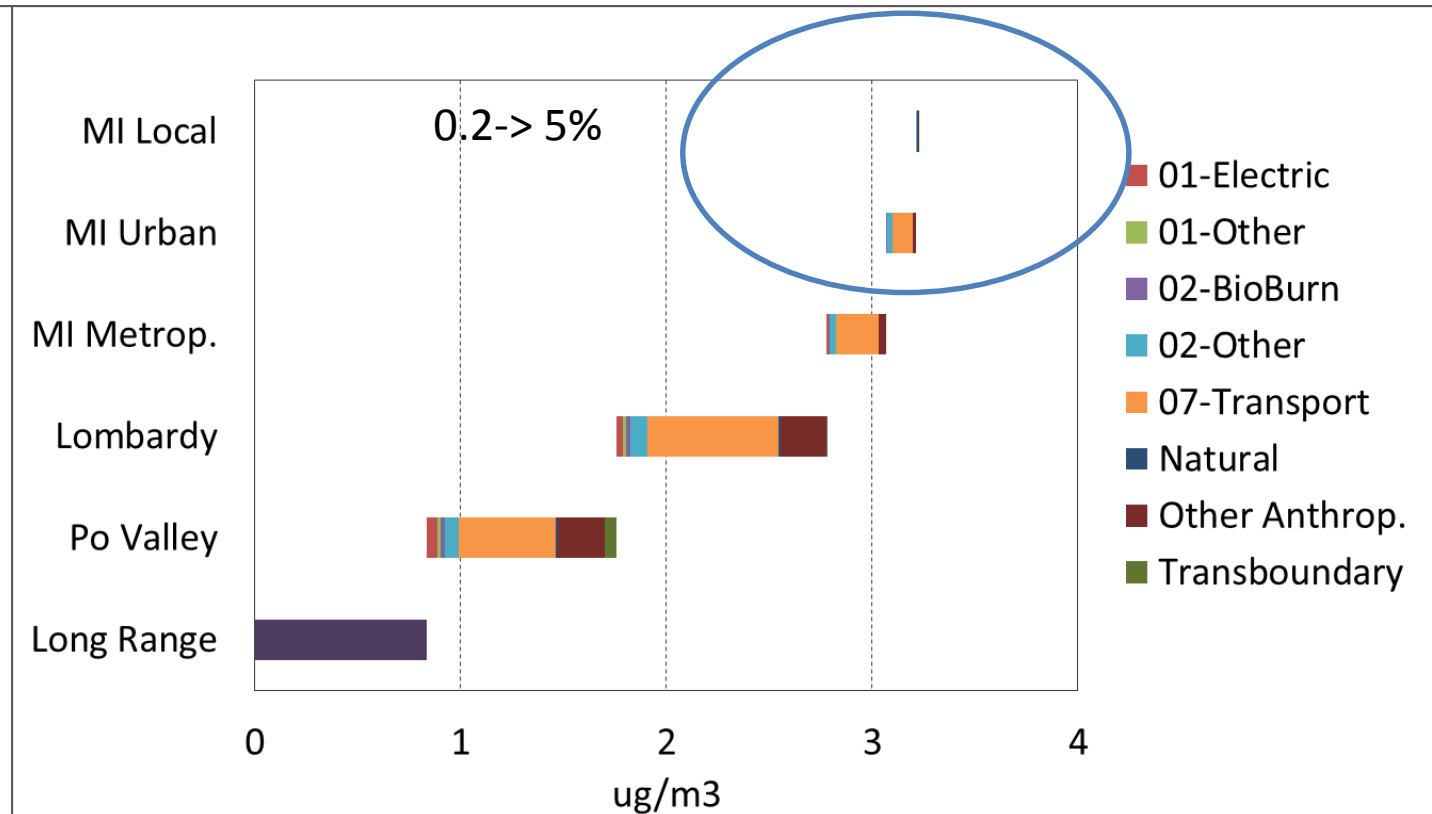
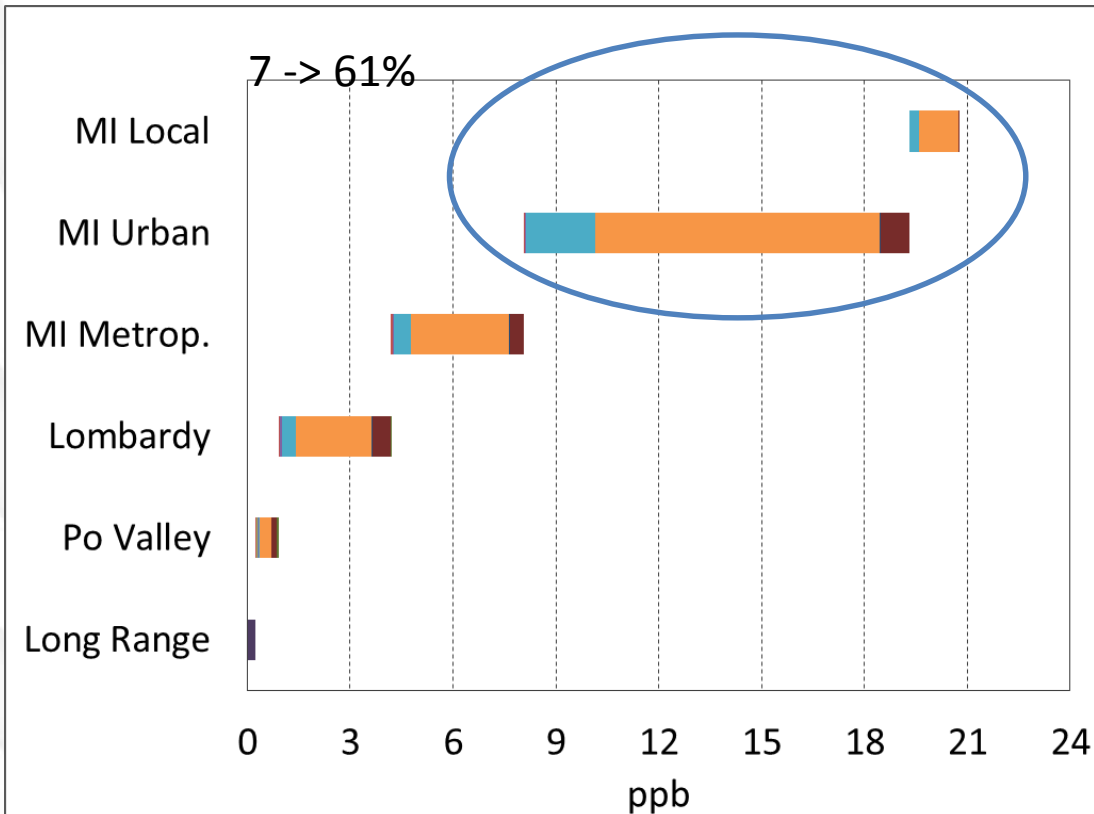




CAMx - Receptor analysis - NO₂ e NO₃⁼

NO₂

NO₃⁼



Yearly mean

CAMx vs AIRUSE (qualitative comparison)



Sources	AIRUSE+ (2013)		This work (2010)	
	Concentration ($\mu\text{g}/\text{m}^3$)	%	Concentration ($\mu\text{g}/\text{m}^3$)	%
Vehicle Exhaust (VEX)	1.8	6 %	3.6	19 %
Vehicle non-exhaust (NEX)	2.5	8 %		
Biomass burning (BB)	5.1	17 %	4.3	23 %
Salt (SEA)	0.4	1 %	0.2	1 %
Industrial (IND)	1.4	5 %	not tracked	
Mineral (MIN)	1.5	5%	not tracked	
Secondary nitrate (SNI)	8.9	30%	8.7	46 %
Secondary sulfate (SSO)	5.6	19%		
Not apportioned	2.6	9 %	-	
Total	29.8		18.7	

Pepe et al, 2018. Atmospheric Environment (submitted)

Conclusions



Particulate Matter is a **multiscale** and **multisource** problem

Road Transport, Biomass Burning and Agriculture are the main sources of **Particulate Matter**

The **local context** can introduce detectable **spatial variability** in the spatial concentration pattern but providing a **minor** contribute to the total concentration

HMS reproduces with reasonable results both primary, secondary PM and precursors

The **comparison** with **AIRUSE** results provided a **qualitative evaluation** of HMS results for $PM_{2.5}$

Further developements of HMS (on-line treatment of line sources)

Better harmonization of bottom up and top down approaches for emission reconstruction



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THANKS FOR YOUR ATTENTION!

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