



Traffico veicolare e PM10 in area veneziana

dal dettaglio emissivo al contributo alla concentrazione in atmosfera

S. Pillon¹, F. Dalan¹, F. Liguori¹, and G. Maffeis²

¹ ARPAV - Environmental Protection Agency of the Veneto Region, Via Lissa, 30171 Mestre (VE), Italy

[fliguori\(at\)arpa.veneto.it](mailto:fliguori(at)arpa.veneto.it)

² TerrAria s.r.l., Via Zarotto 6, 20124 Milano, Italy

[g.maffeis\(at\)terraria.com](mailto:g.maffeis(at)terraria.com)

Expert Panel EMISSIONI DA TRASPORTO STRADALE

Venezia, 16 Ottobre 2008

Aim

Investigate Particular Matter (PM10) source apportionment on the wide urban area of Venice and its mainland

Methodology

A multi-scenario approach applied on a CALMET-CAMx System

Nested grid structure to separate local contributions from those of middle and long range transports.

Background

Assessment of Model Uncertainty using measurements of PM10 and chemical speciation of filters

[Pillon et al., 2008](#)

HARMO 12 Conference

International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes
Cavtat, Croatia, October 6th-9th, 2008

Initial & Boundary Conditions

CHIMERE

PREVAIR, Laplace Institute, INERIS, LISA, C.N.R.S.

output of 0.5x0.5 degrees

Initial : 3D variable in space

Boundary: function of (z, t) for the four borders;

top: one constant value for each specie

Meteorology

CALMET (version 5.5)

temperature field, horizontal wind (u, v), vertical diffusivity

+

interpolation of radio-soundings data

pressure and water vapour concentration

CTM

CAMx (version 4.0)

CBIV

landuse and albedo: **CORINE LAND-COVER** (250m x 250m);

haze (**AErosol RObotic NETwork - NASA**);

ozone column (**TOMS - NASA**);

photolysis rate.

Gridded emissions

+

Mayor Point Source

Emission Inventory

Top-Down: CORINAIR National Inventory (APAT) for all sources

Bottom Up: source sectors 1, 3, 4, 6, 7, 8 (SNAP '97)



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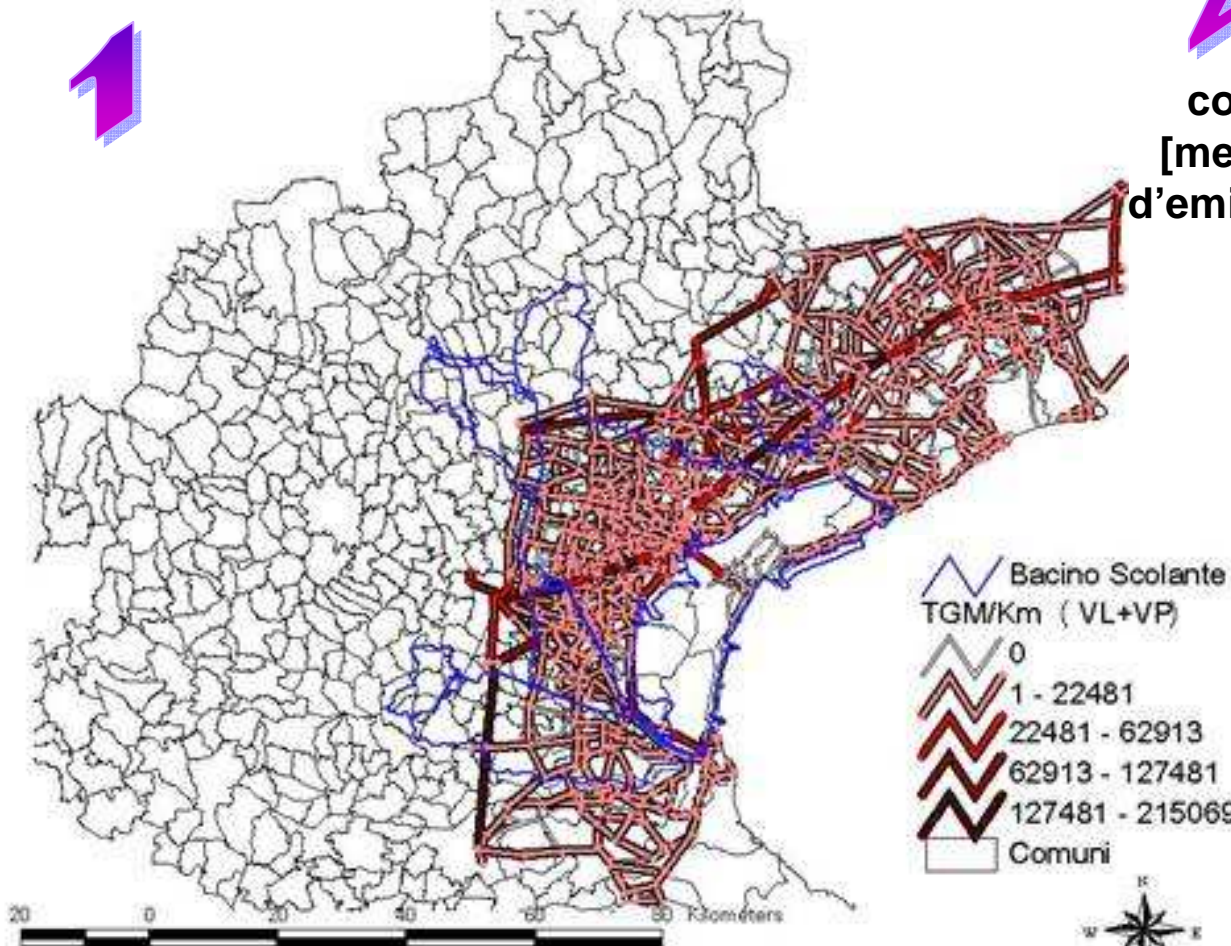
Processamento sorgenti stradali



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Traffico Giornaliero Medio (TGM)

1



2

Stima delle emissioni
arco per arco
 con codice di calcolo (ORAR, 2001)
 [metodologia COPERT III + fattori
 d'emissione per le polveri proposti
 dallo IIASA (IIASA, 2001)]

3

Suddivisione del grafo
 in celle di 1x1 km
 e somma delle emissioni
 degli archi ricadenti
 in ciascuna cella

Provincia di Venezia, output modello di traffico VISUM



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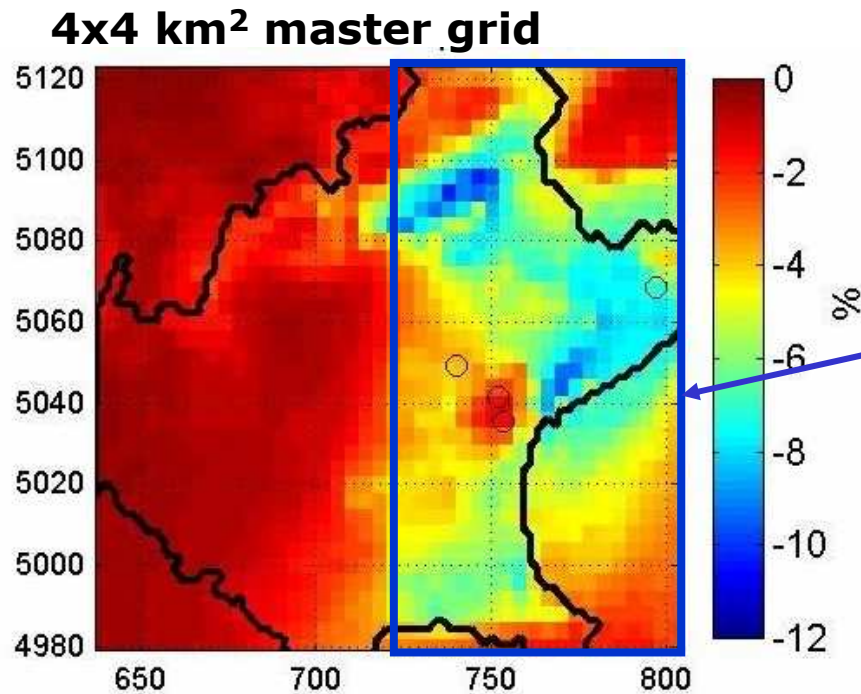
The Modelling Approach



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Estimation of different emission sectors contribution to PM10 concentrations through:

- scenarios runs with 50% emission reduction for each sector one by one
- calculation of the changes in pollutant concentrations resulting from the perturbations



50% reduction scenarios in order to minimize non-linear effect due to drastic changes in atmospheric composition and reactivity

1x1 km² nested grid

Reductions applied only on the nested grid in order to separate local contributions (generated in the nested area) from middle and long range pollution transports

“Brute-force” method, PSAT not available for CAMx ver. 4.0



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Check of the baseline scenario



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a 2 (winter) months run
daily concentrations and chemical speciation of PM₁₀
in 4 sites:

200x 168 km² master grid

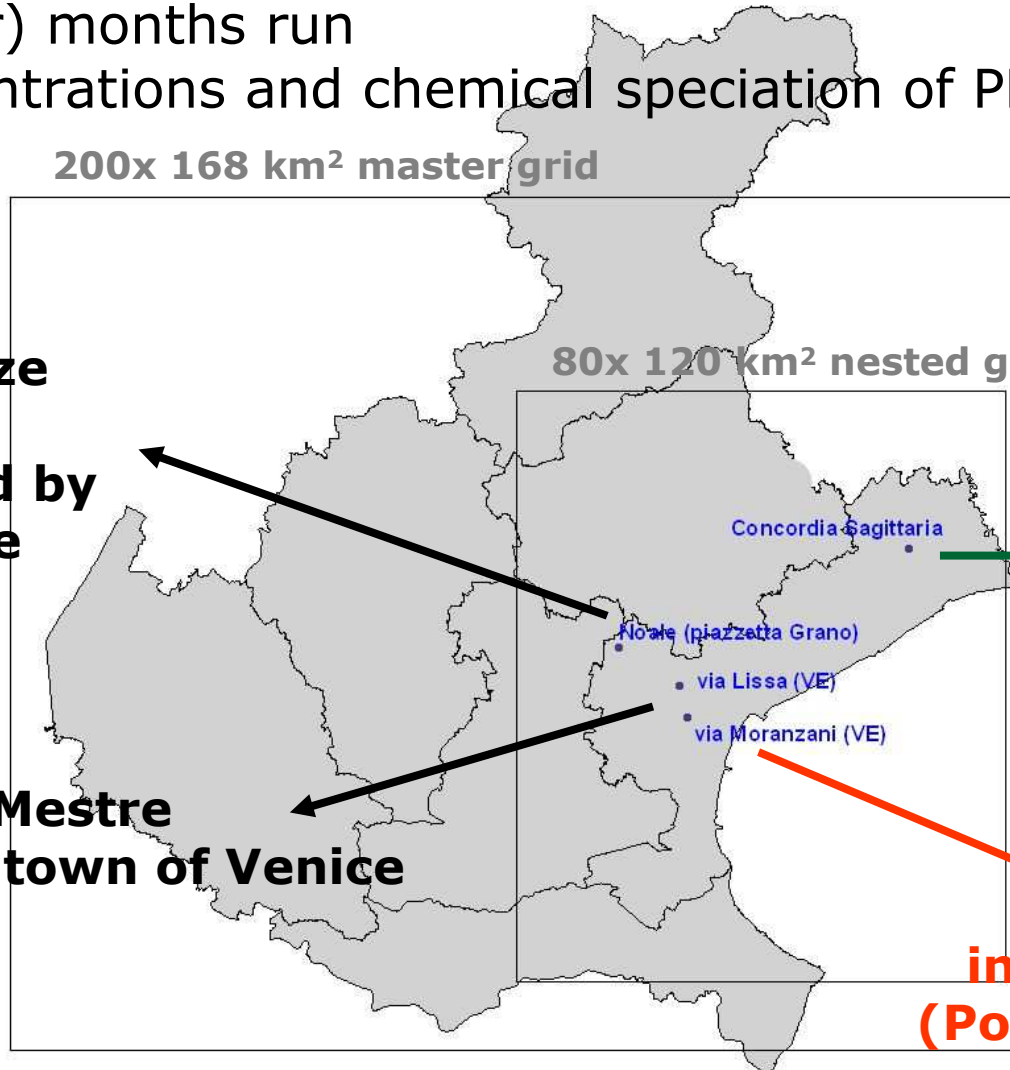
80x 120 km² nested grid

**a kerbside
in a mid-size
town
surrounded by
countryside**

**rural background
site**

**urban site in Mestre
the mainland town of Venice**

**industrial site
(Porto Marghera)**



Biancotto et al., 2007

Studio pilota sulla caratterizzazione del PM₁₀ in provincia di Venezia

www.arpa.veneto.it



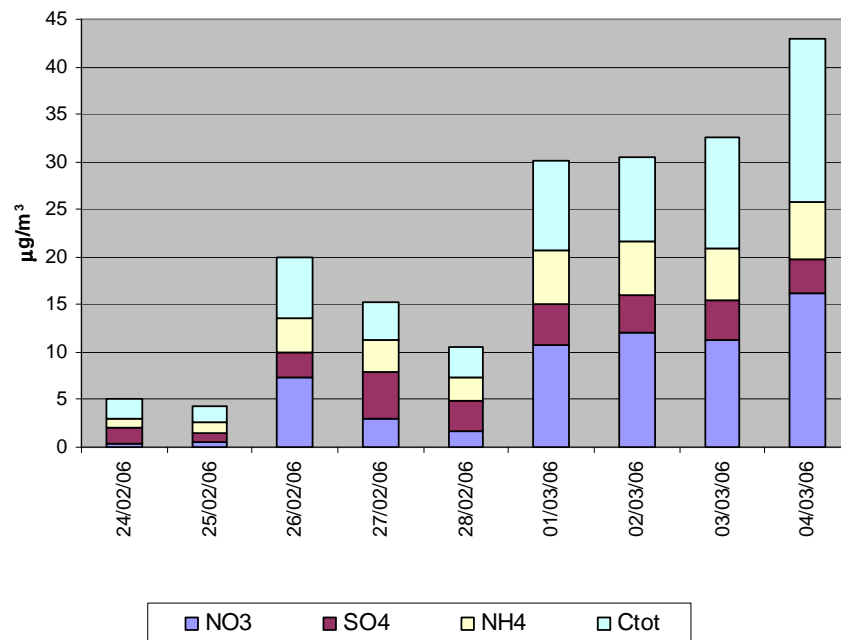
Check of the baseline scenario



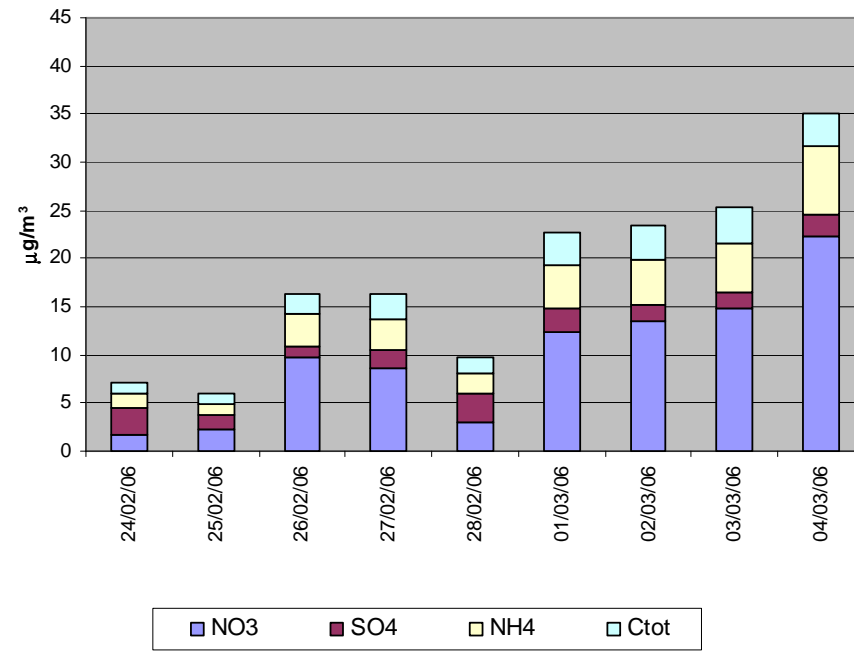
Daily measured and modelled PM10 components in the rural site from low PM10 pollution thanks to a thunderstorm to high PM10 build-up concentrations before next thunderstorm arrival.

The model reproduces the inorganic aerosols growth (only SO4 slightly underestimated), but cannot capture the growth of the total carbon component.

Rural site – inorganics observed



Rural site – inorganics modelled



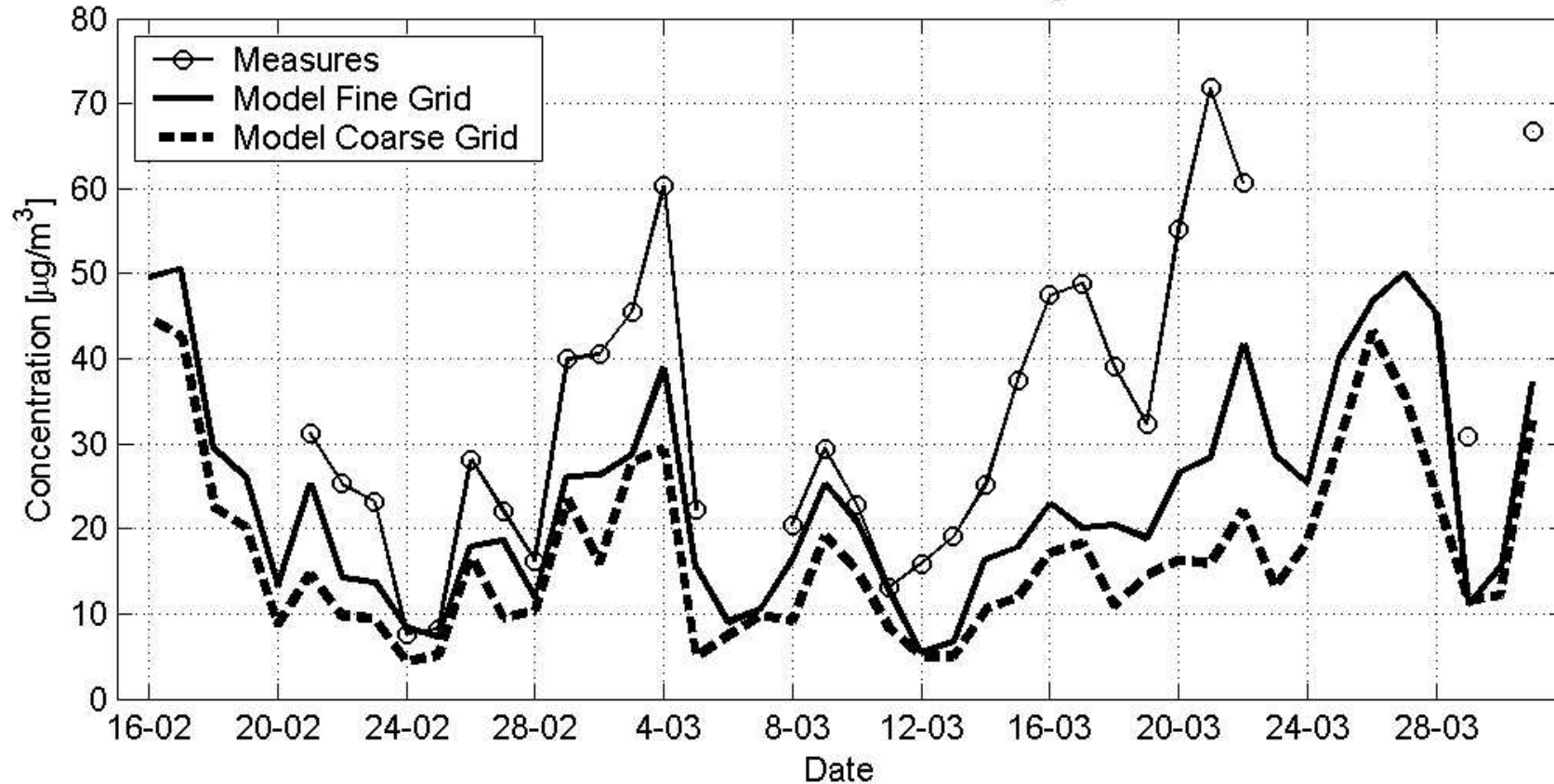
Only PM10 components presents both in measurements and in model outputs are shown.



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PM10 at rural site of Concordia Sagittaria



A fine resolution run (nest-grid output - 1x1 km² resolution) improves the model estimate compared to a coarse grid one (master grid output - 4x4 km² resolution).

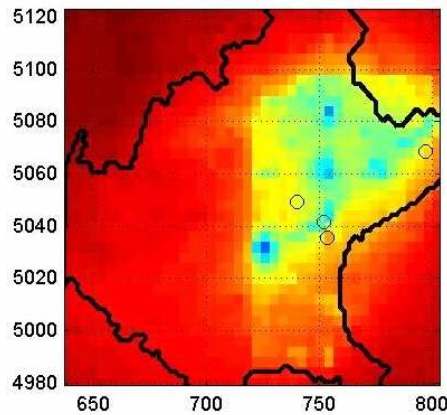


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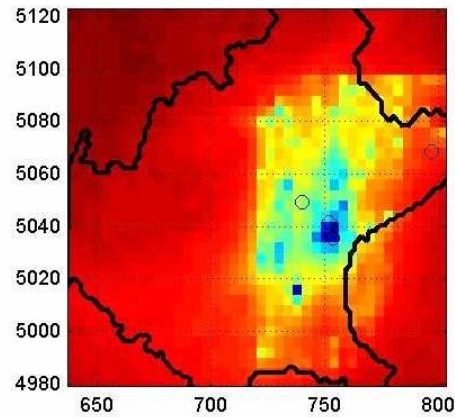
The Outcome 1/2



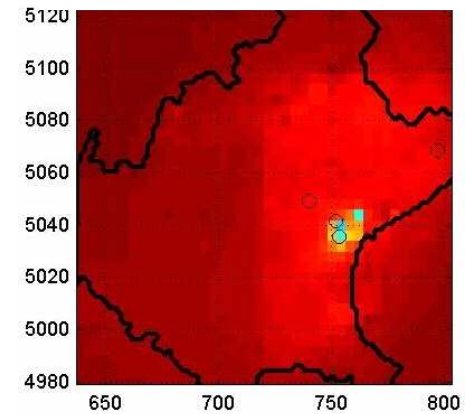
Road Transport



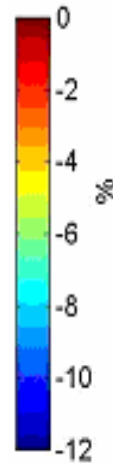
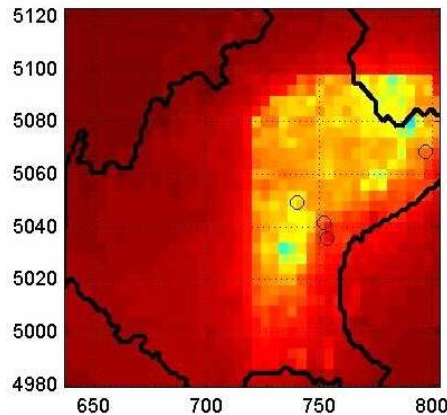
Industrial Plants



Other transports

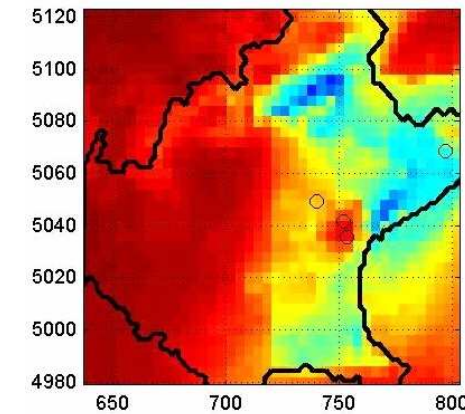


Domestic Heating



relative (%)
reductions of
average PM10
of the 2-months
period
for the 5
reduction
scenarios

Agriculture



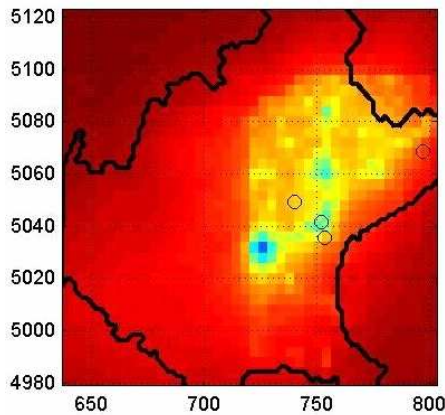


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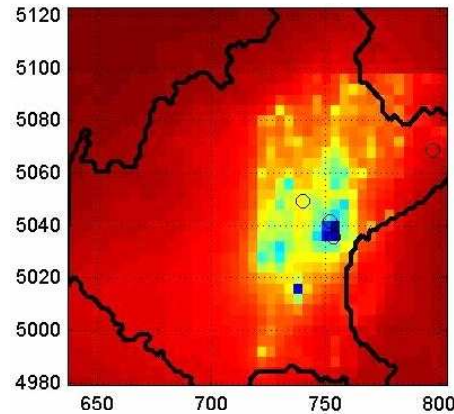
The Outcome 2/2



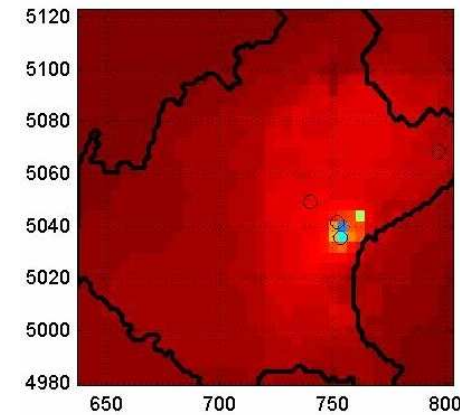
Road Transport



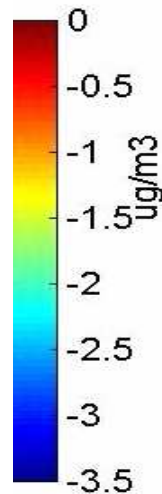
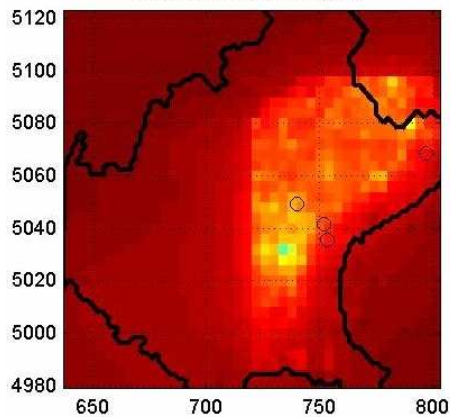
Industrial Plants



Other transports

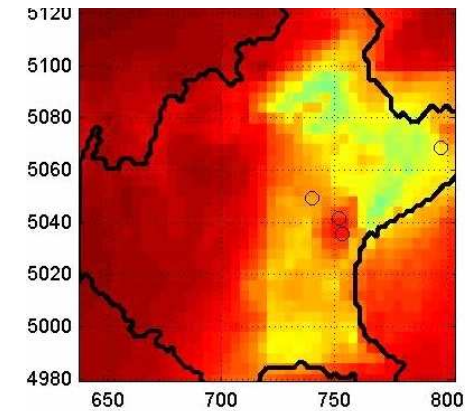


Domestic Heating



The reductions vary from a few tenths to a few units of $\mu\text{g}/\text{m}^3$ of PM10

Agriculture



The average PM10 level estimated by the model is around $17 \mu\text{g}/\text{m}^3$ at the rural site and between 27 and $31 \mu\text{g}/\text{m}^3$ in the other sites



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2 different results:



1. Estimation of **L**ocal **A**nthropogenic **E**mission **C**ontribution (LAEC) to PM10 concentrations

$$\text{LAEC} = 2 * \sum_i^5 \Delta \text{ sector}_i$$

Since:

- scenario reductions applied = 50% of the sector's emission
- 5 scenarios = include all anthropogenic sources

(in the hypothesis that the emission perturbations had not changed significantly the atmospheric composition and reactivity)

2. Source Apportionment (SA) of the different emission sectors to the locally produced PM10

(at least for the primary and the secondary inorganic PM10 components for which the modelling system shows an acceptable level of confidence)



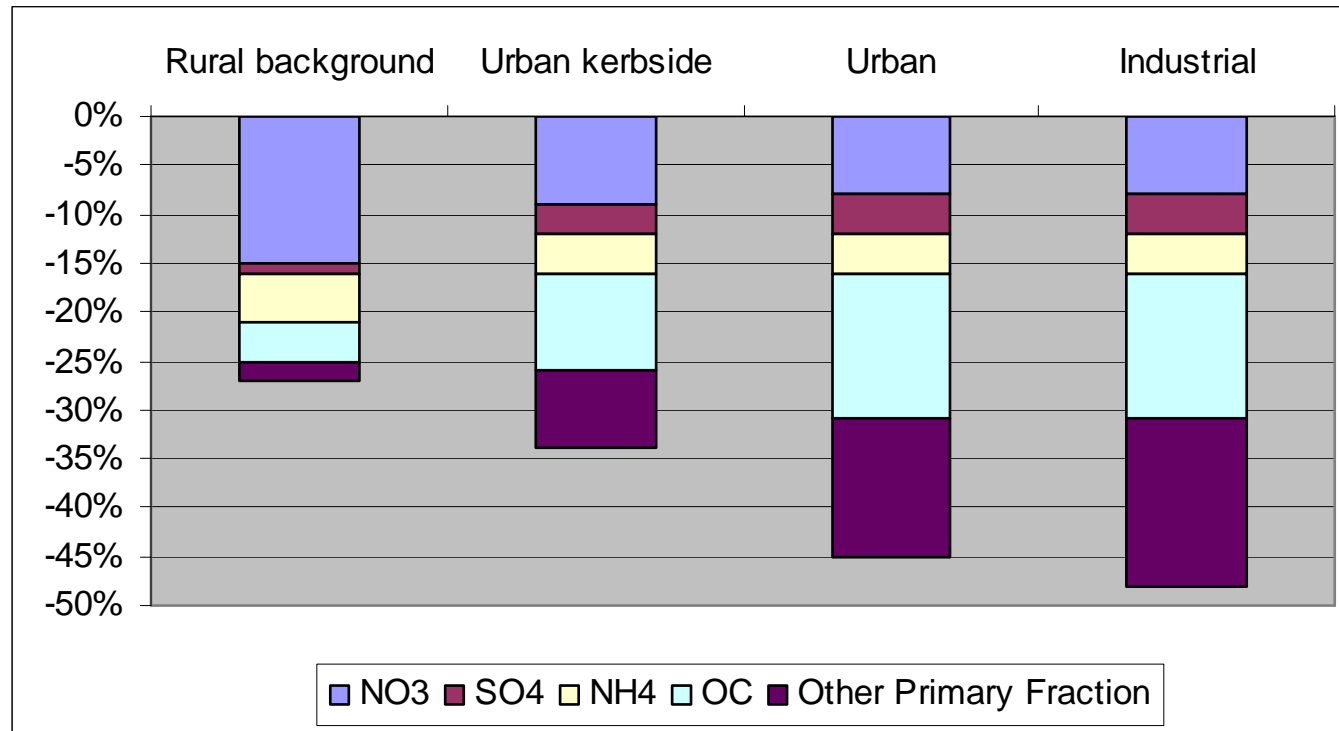
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First result



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Local emission contributions to PM10 concentrations,
divided in the different PM10 components,
for the 4 sites



The local contribution is minimum in the rural site (less then 30%)
and maximum in the industrial one (more then 45%)

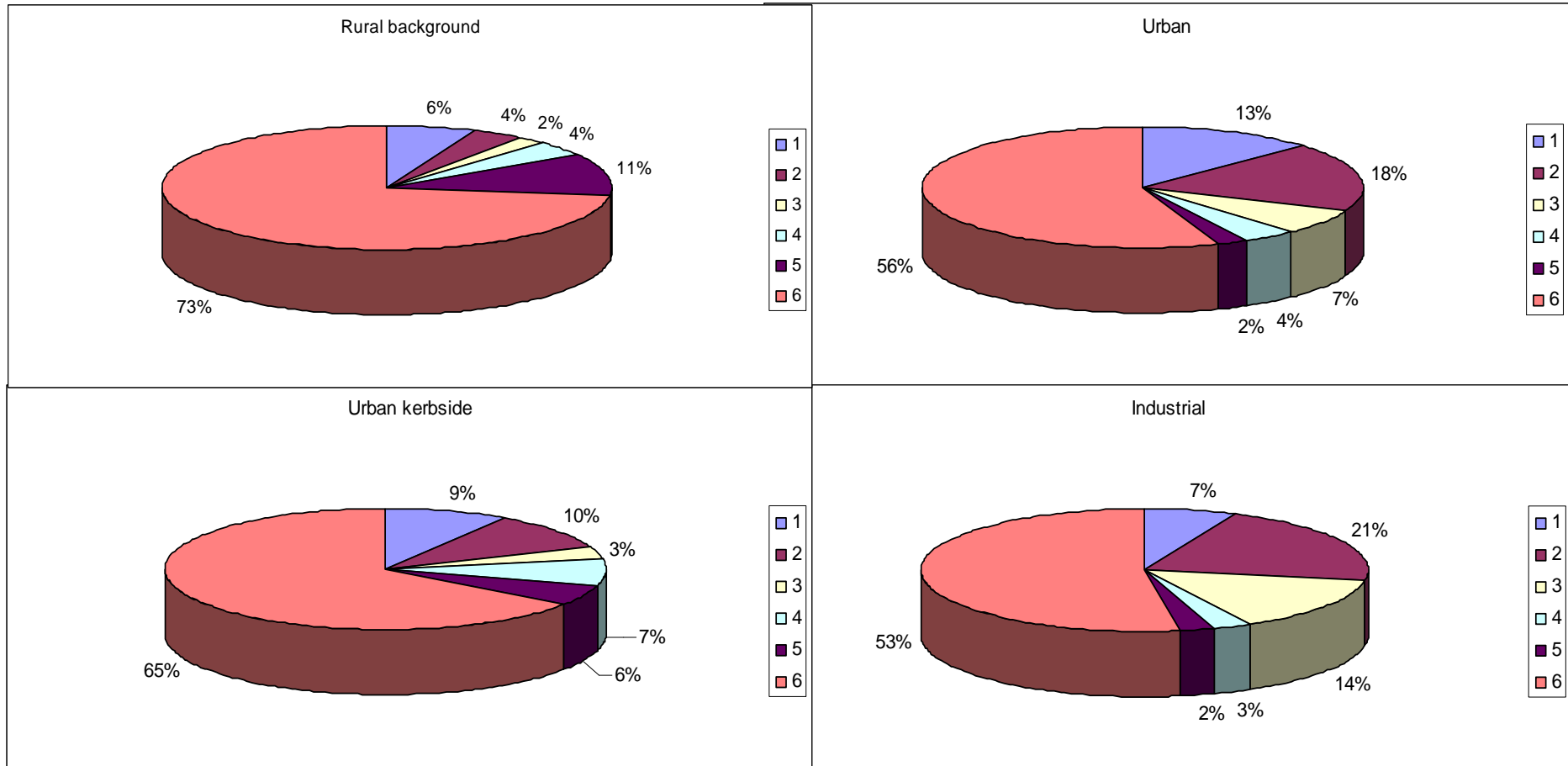
$$2 * \sum_i^5 \Delta \text{sector}_i / \text{PM10}_{\text{baseline}}$$



Second result



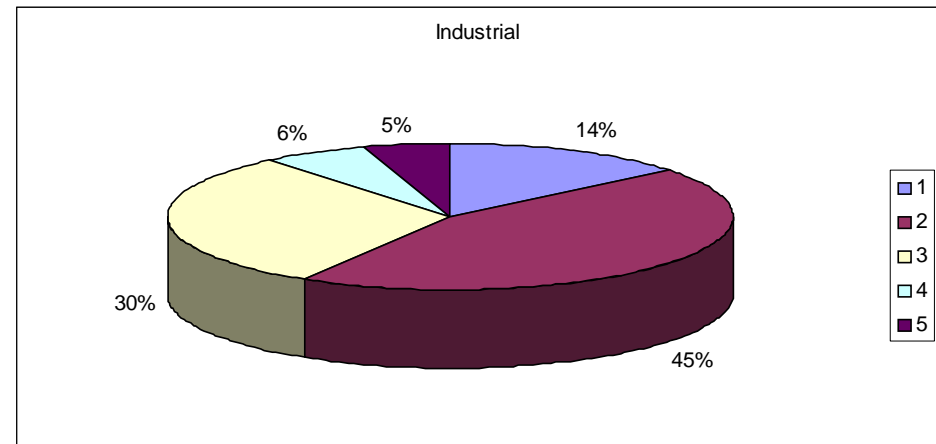
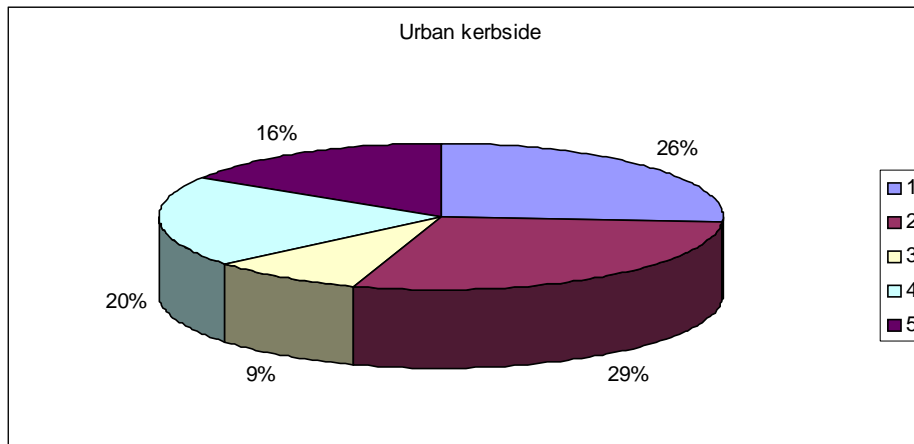
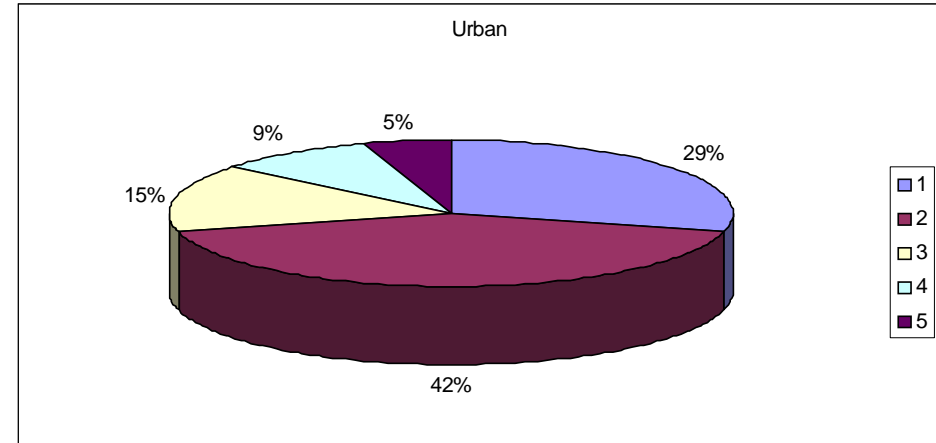
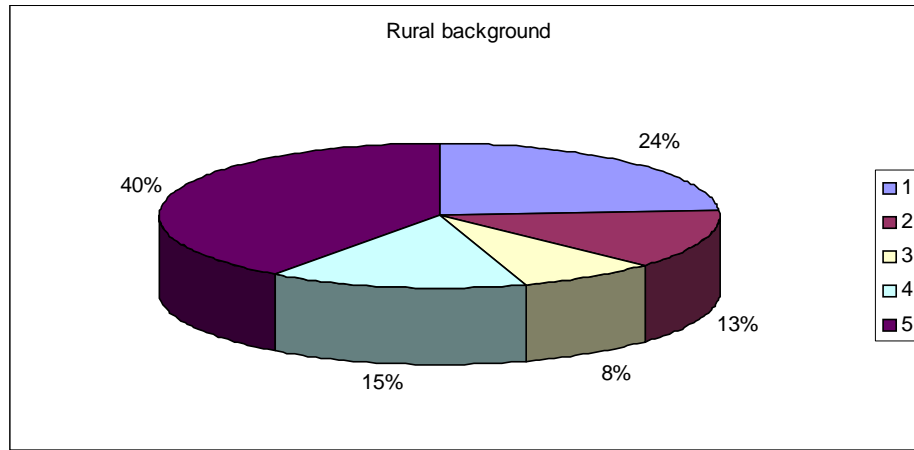
SA for total PM10 concentration levels



**1=Road Transports 2=Industrial Plants 3=Other Transports 4=Domestic Heating
5=Agriculture 6=Extra domain contributions**

The source apportionment depends on the location of the site

SA for locally produced PM10 concentrations



**1=Road Transports 2=Industrial Plants 3=Other Transports
4=Domestic Heating 5=Agriculture**

The source apportionment depends on the location of the site



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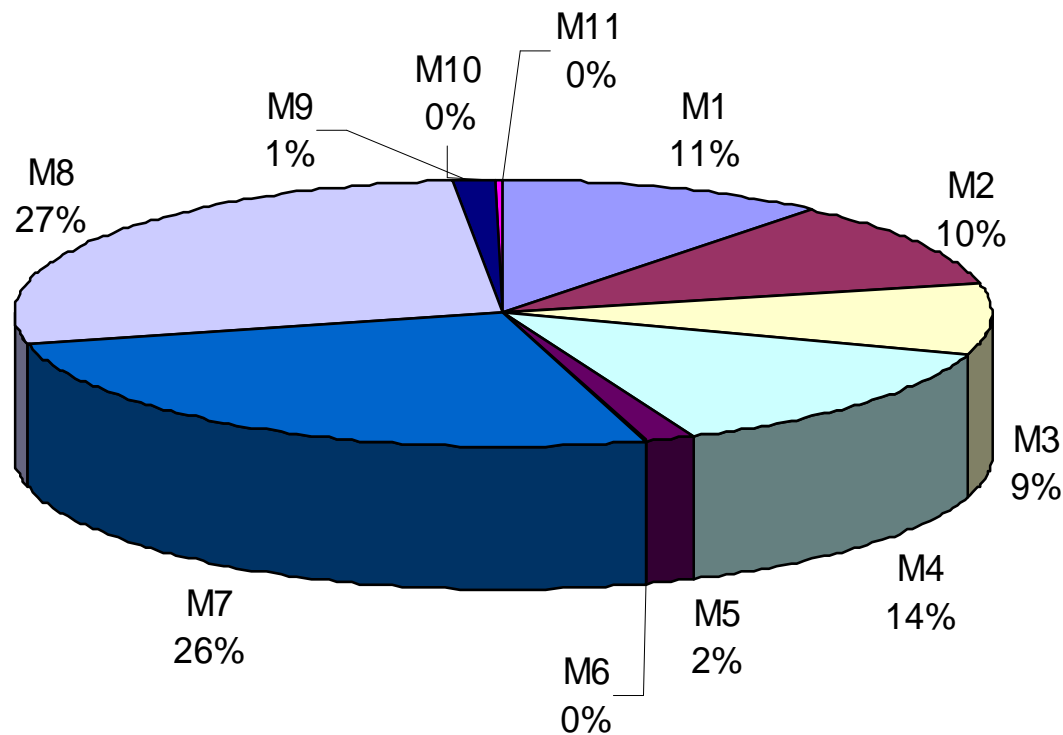
From emissions to concentrations



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Emissions

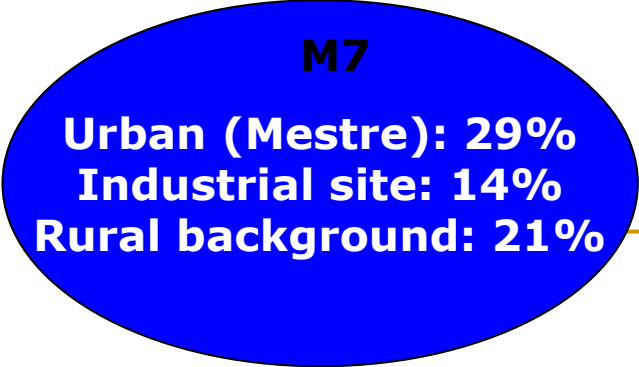
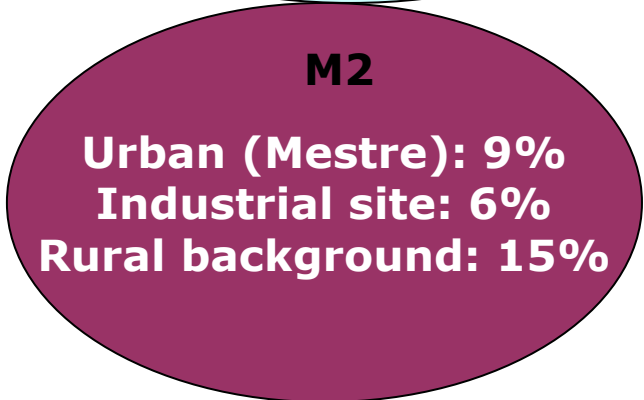
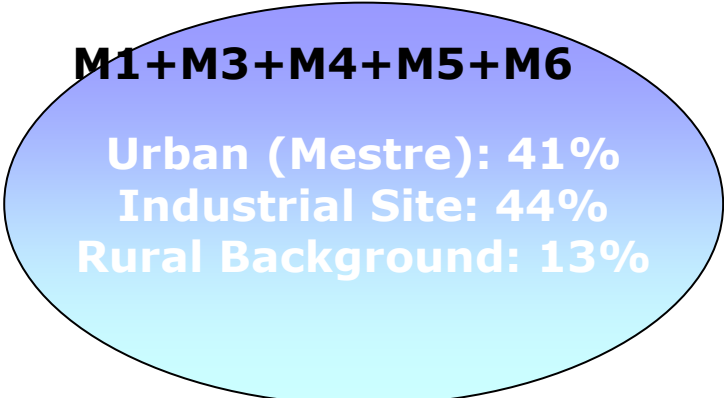
Integrated BU-TD PM10 ESTIMATION



M1+M3+M4+M5+M6 = 26%

Concentrations

M1+M3+M4+M5+M6



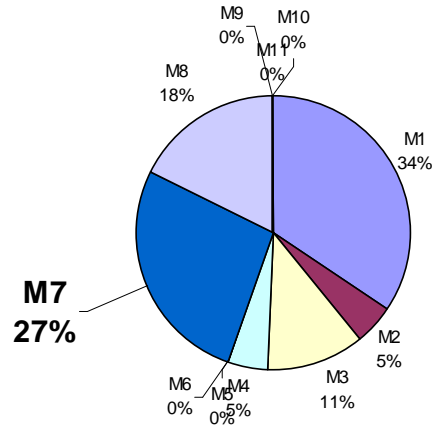


Integrated BU-TD Emission Inventory

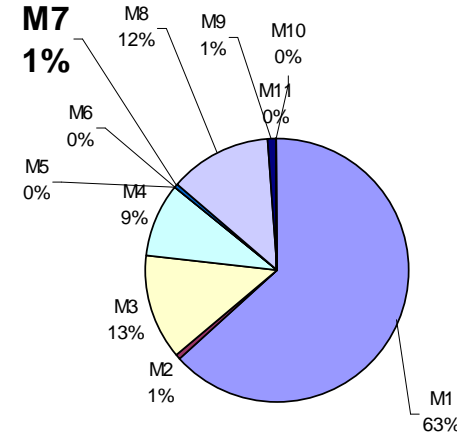


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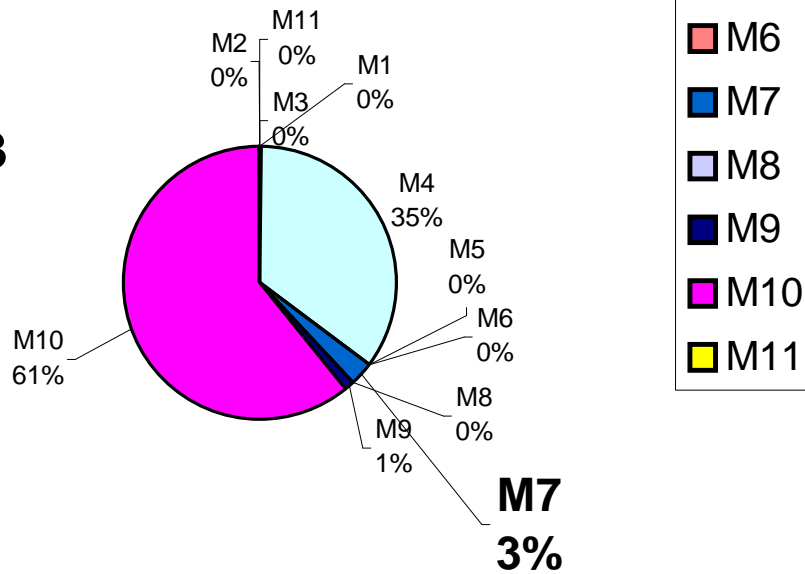
NOx



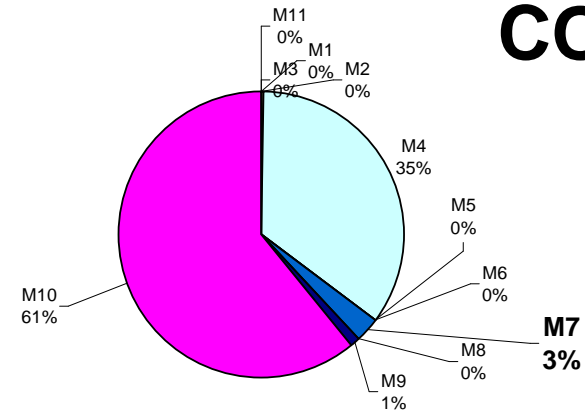
SOx



NH₃



COV





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Dalla "torta" delle emissioni (locali) a quella delle concentrazioni

PROVINCIA DI VENEZIA

PM10 totale: contributo emissivo percentuale diviso per macrosettore.

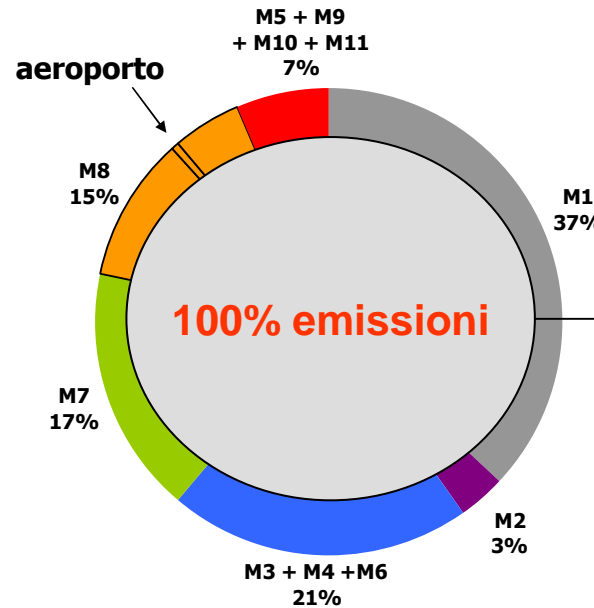
Aggiornamento Gennaio 2007
dell'incrocio top down – bottom up

PM10 totale = PM10 primario (circa 6%) +
PM10 secondario

PM10 secondario = somma pesata delle emissioni di
particolato a partire dai suoi precursori

Porto di Venezia: 10%

Aeroporto M.Polo: 0.5%



concentrazioni
45% Mestre
48% Zona
industriale
27% Concordia

- M01 Produzione di energia
- M02 Riscaldamento
- M03+M04+M06 Attività produttive
- M07 Traffico su strada
- M08 Traffico non su strada
- M05+M09 +M010+M011 Altro



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Dall'approccio parametrico ai risultati del modello fotochimico



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Emissioni

Concentrazioni

PROVINCIA DI VENEZIA

PM10 totale: contributo emissivo percentuale diviso per macrosettore.

Aggiornamento Gennaio 2007 dell'incrocio top down – bottom up

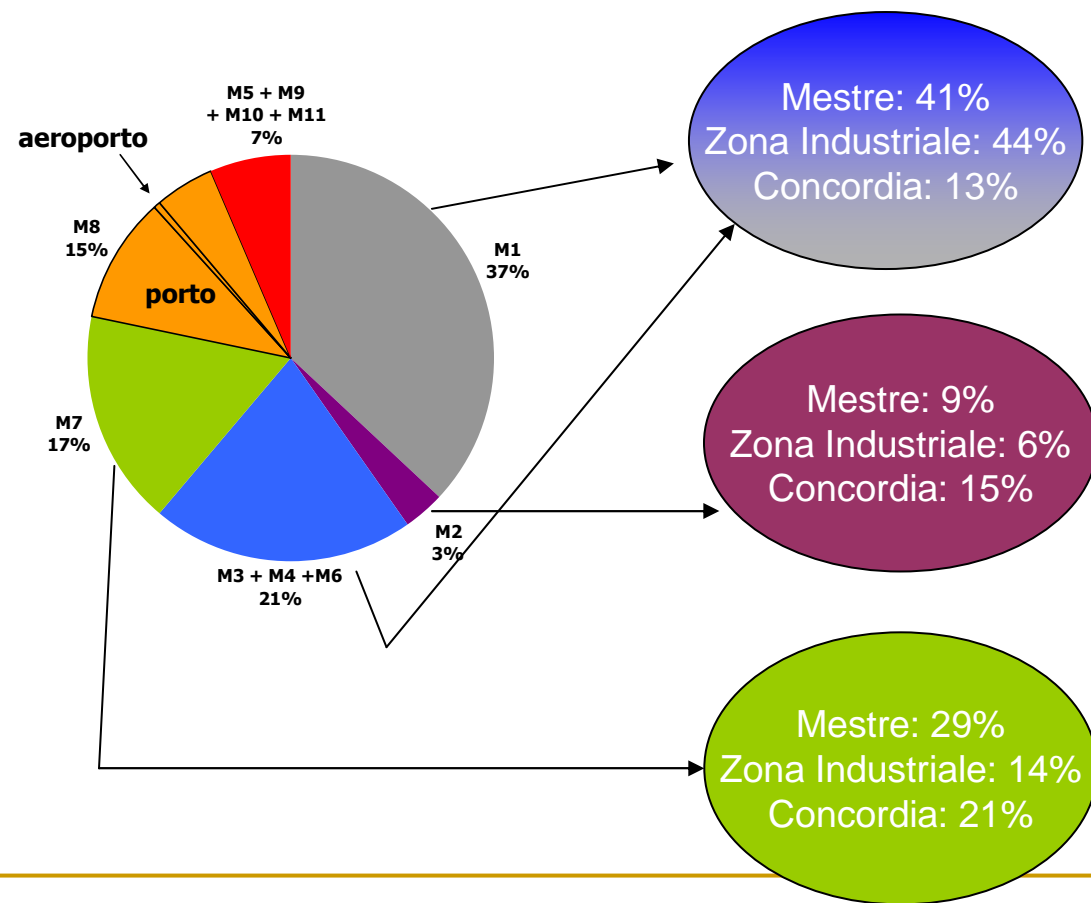
PM10 totale = PM10 primario (circa 6%) + PM10 secondario

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- M01 Produzione di energia
- M02 Riscaldamento
- M03+M04+M06 Attività produttive
- M07 Traffico su strada
- M08 Traffico non su strada
- M05+M09 +M010+M011 Altro



ORAR, 2006

Approccio parametrico per la definizione della densità emissiva di PM10 totale, utilizzato nell'ambito della **Zonizzazione della Regione Veneto**



Conclusions (of general interest)



- daily mean measures of PM10 concentrations are well reproduced by the modelling system for *clean* days, but model underestimates PM10 levels in the days with stagnant air conditions and the underestimation becomes stronger as the stagnant conditions persist;
 - secondary inorganic aerosol production proved to be well described by the model; organic aerosol is underestimated;
 - the changes in PM10 concentrations resulting from the emission source perturbations are always less severe than the source perturbation itself. Inorganic secondary components of the aerosol are more resilient than primary ones; however the reduction of the local anthropogenic primary aerosol is not sufficient to turn down significantly PM10 concentration levels.
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Conclusions

(of local interest)



- the average PM10 level estimated by the model is around 17 $\mu\text{g}/\text{m}^3$ at the rural site and between 27 and 31 $\mu\text{g}/\text{m}^3$ in the other sites. The average scenarios impact vary between few tenths to few units of micrograms per cubic metre;
 - the local emissions contribution to the PM10 varies between 30 and 50% (but the model captures only part of PM in the area under investigation, which, at worst, is about half of the measured value);
 - a Source Apportionment analysis has been performed by calculating the differences in concentrations of each scenario and the base case. The traffic emission contributes roughly 26-29% of the locally produced PM10 at kerbside or in a rural background site. Agriculture emission contributes 40% in a rural site and Industrial emissions accounts for 44% of the local portion of PM10 in an industrial site. These estimates do not account for the PM10 concentrations coming from outside the wide Venice area.
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