The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
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Workshop on Aerosol Impact in the Environment: from Air Pollution to Climate Change

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Basics of mitigation strategy on aerosol problem: from facts to acts

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Settore Tecnico Scientifico
CRMA - Centro Regionale di Modellistica Ambientale

From facts to Acts

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Palmanova - Italy

Presentation Outline

- Historical introduction
- DPSIR approach
- Role of numerical modelling
- Non technical measurements
- Examples and conclusions

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Historical introduction

61th A.D. Pliny the Elder (natural philosopher): air over Rome was barely breathable, this because of the emissions of its chimneys and stacks, releasing a lot of vapours and soot.

Well before the industrial revolutions (first -1770- and second -1850-), pollution episodes are mentioned in written texts. These pollution episodes (followed by complaints) were mainly related to factories (e.g., foundries) or fishes smoking activities

These episodes lead to local riots between foundries workers and farmers, whose crops suffered from factories emissions

Historical introduction

Social tensions in the neighbourhood of foundries bring to the introduction of the first known "end-of-pipe" emission control system: the dust chamber (~1550)

Pollution episodes and local complaints grew in number and intensity with the invention of steam engine (1769). This force the updating and enlargement of trade regulations

In 1810 France approved a formal act containing a list of roughly 60 production plants that need a formal approval (the "grand-mother" of IPPC EU directive!)

In 1823 France required a formal approval for the installation and use of steam engines. Germany did the same roughly around 1845

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Historical introduction

In these years (1840-1870), the first systematic researches on the reason of pollution and of its impacts on crops were performed (Stoeckhardt in Germany and Smith in England)

These works highlighted the relevance of sulphur oxide emissions as well as of dust emissions and of the heavy metals it contained. In these years, the expression "acid rain" comes to light...

These works suggested both mitigation and adaptation strategies (nothing new beneath the sun) as well as the need for technical formation (schools of furnacemen appeared in these years)

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Historical introduction

Apart from the timing and Country where these adaptation and mitigation techniques took place, all have in common the following philosophy:

1) **problems are local and they have to be solved locally**;

2) **health (even workers health) was not the primary concern**;

After 1870, things changed. Because of the increased use of coal and the increasing number of inhabitants in large towns, pollution episodes started to become a large-scale problem.

1880 is the first year (I found) with casualties reported in London because of a "smog episode" (roughly 1000 casualties).

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Historical introduction

The in-famous "London smog episode" occurred during December 1953. It is believed that roughly 4000 people died in four days because of the high PM and SOx concentrations.

This pushed policy makers to issue the famous "Clear Air Act" (1956) which was already effective in 1962 when a similar "London smog episode" took place. It is estimated that during that 5-days episode, roughly 700 people died.

Almost in the same period, even US experienced similar problems, but, differently from UK, US towns started to suffer from car emissions. These were considered the main cause of "Los Angeles photosmog episodes". These episodes pushed policy makers to issue the "Clean Air Preservation Law (1955)

Modern history

1963 US Clean Air Act. This act has two major aspects that make it a "modern" legal framework:

1) Thresholds are fixed in ambient air for each pollutant. Thresholds can not be exceed to avoid (or considerably reduce) risks for health and environment;

2) Each State has to prepare a plan (a set of actions) with expected benefits to reduce (or maintain) the pollutants concentrations beneath the above thresholds.

This is the philosophy adopted even by the EU legislation on air quality.

The approach : DPSIR

Determinants	→	Meteorology,Orography, ...
Pressures	→	Emissions
State	→	Current air quality
Impact	→	Health and environmental costs
Responses	→	The proposed actions

Gabrielsen and Bosh, 2003. EEA Report

DETERMINANTS
(climate, orography population density etc.)

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The approach : Determinants

Areas which are more windy than others are more prone to diffuse pollutants

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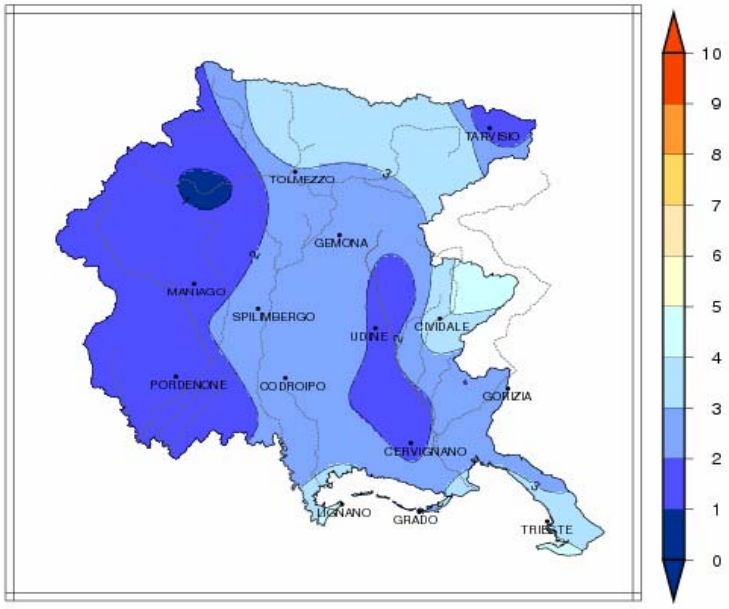
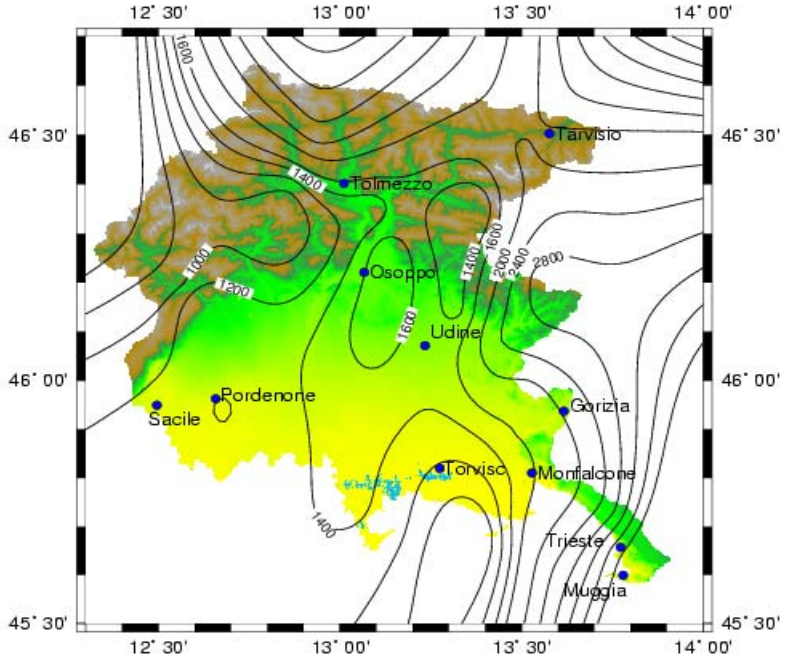
Determinants – Ventilation and dilution

average 2000–2009 – daily average wind speed at 10m (m/s)



Diluizione media annuale

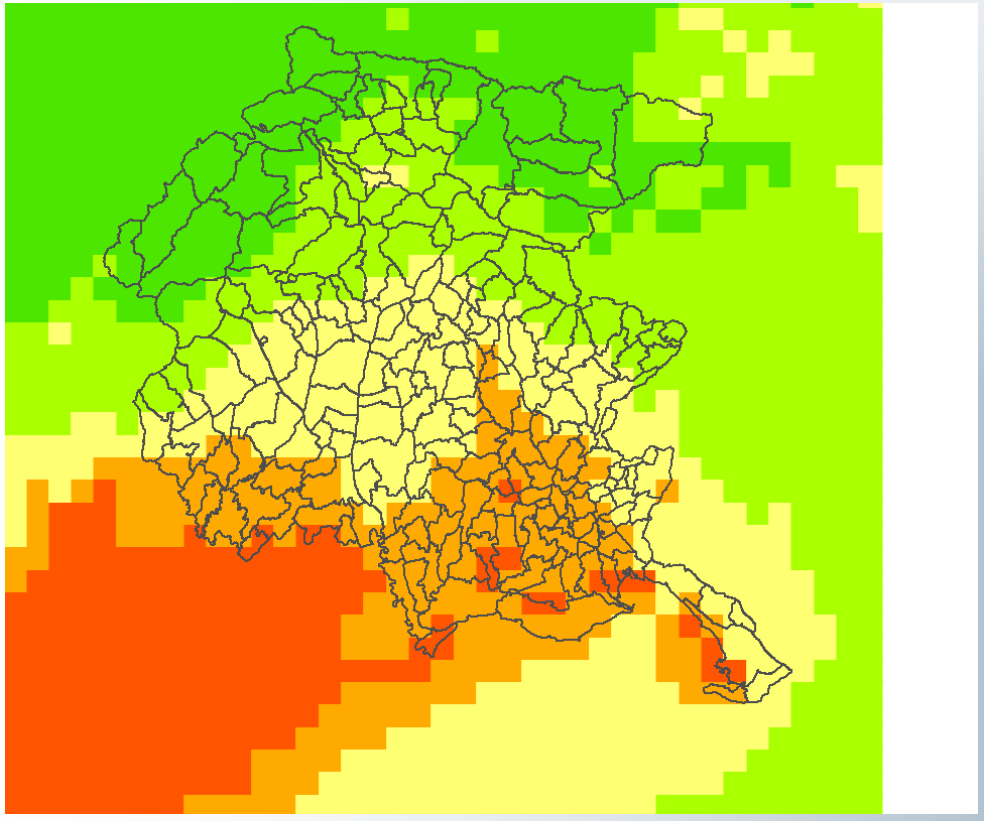


Areas which are more windy than others are more prone to diffuse pollutants

STATE

(values of air quality but even average behaviour of pollutants)

State – PM10 risk of exceedance (Numerical simulations and data interpolation)

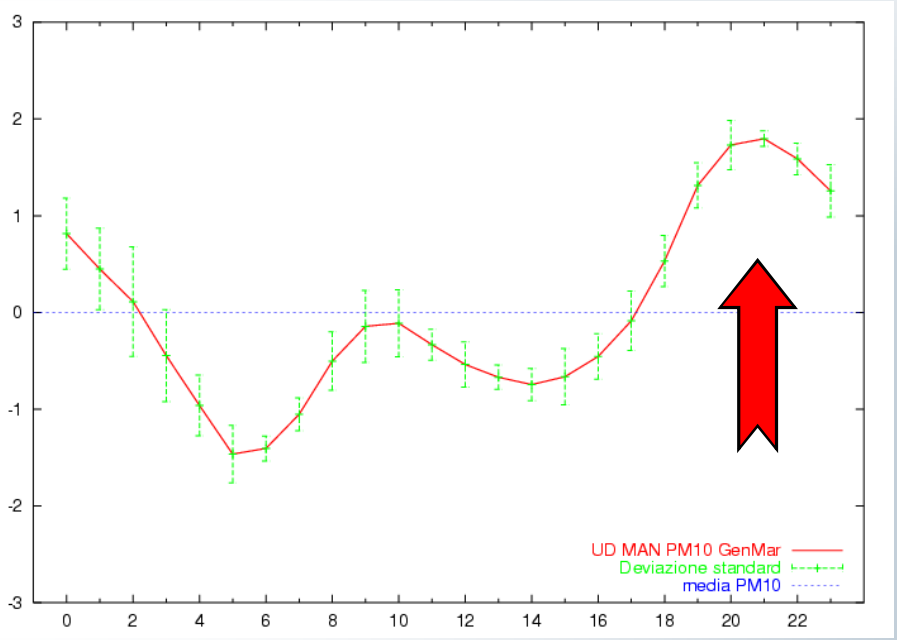


Number of days with exceedances of the daily threshold for PM10

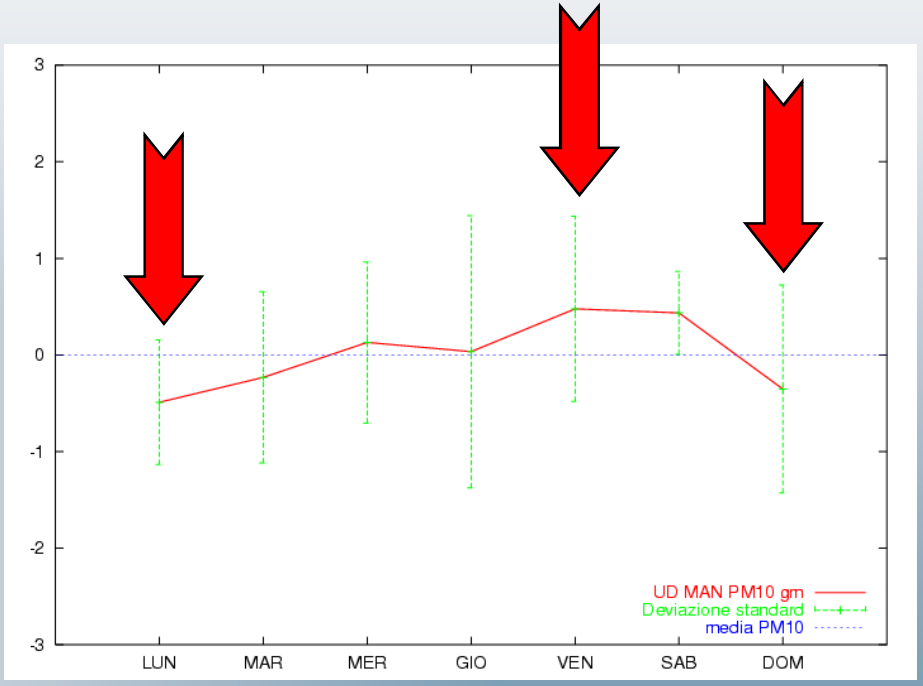
Orange over the minimum value admitted by law (35 days on a year)

Kriging spatial interpolation (numerical model plus monitoring stations)

State – diurnal and weekly cycles (PM10)

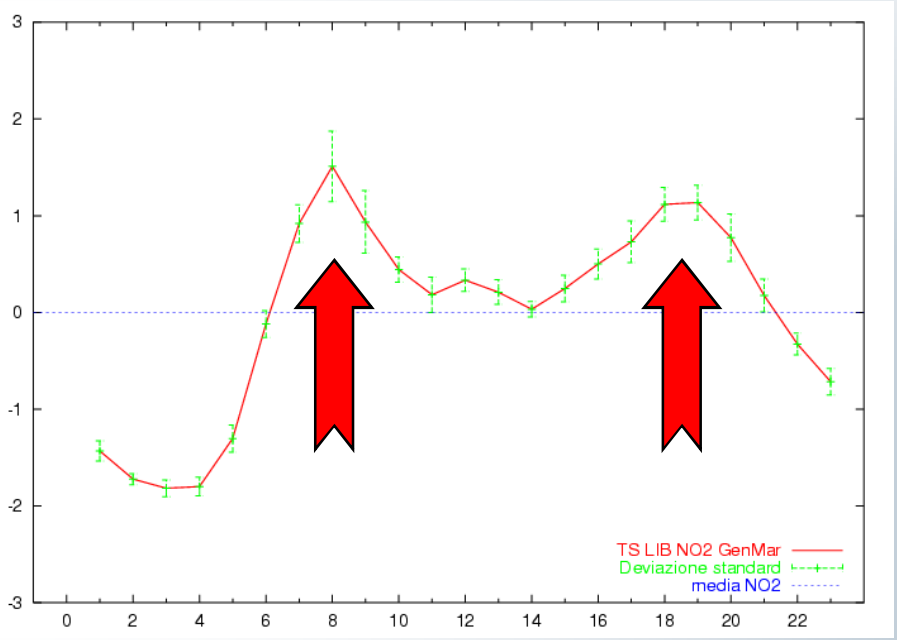


Diurnal

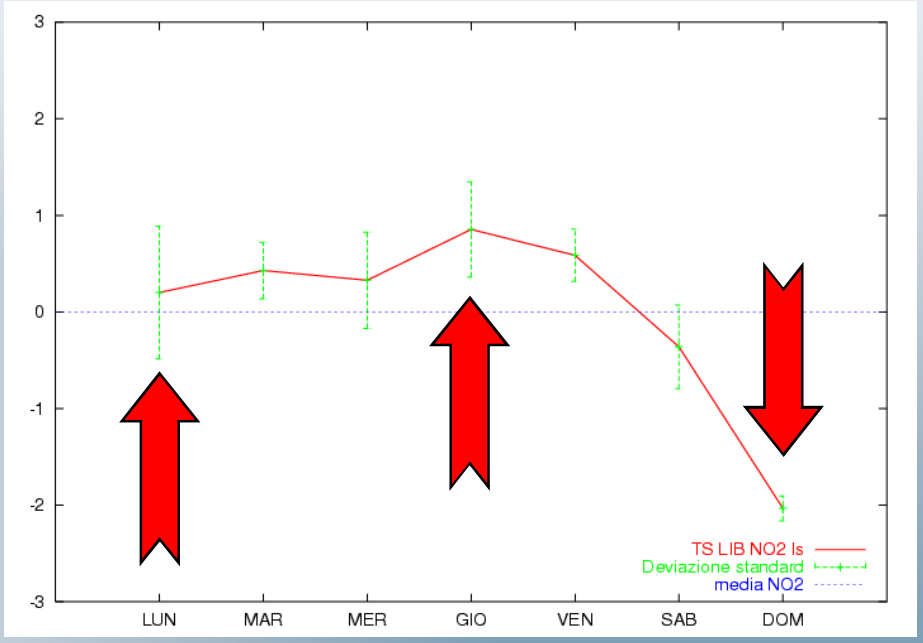


Weekly

State – diurnal and weekly cycles (NO2)



Diurnal



Weekly

PRESSURES

(Emissions and their cycles)

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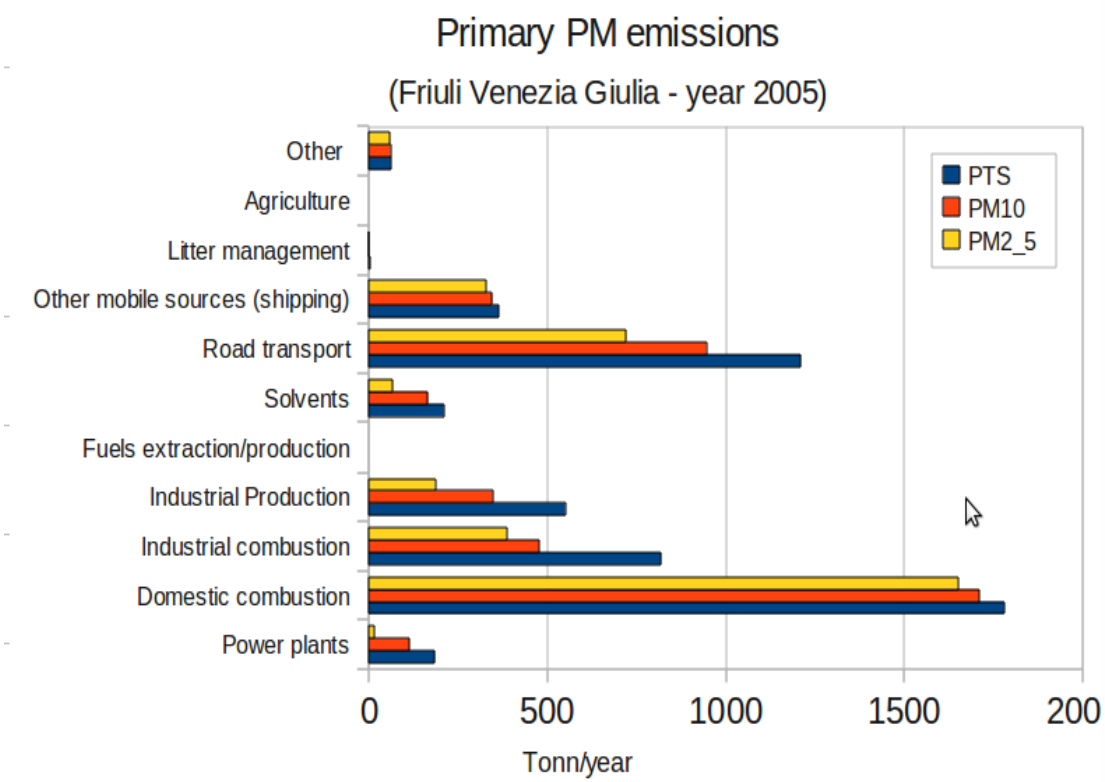
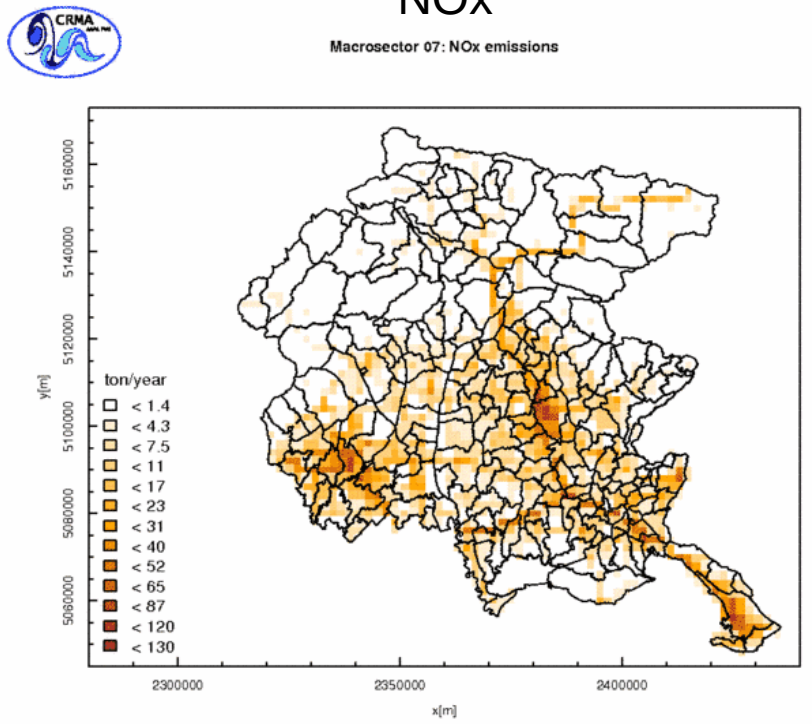
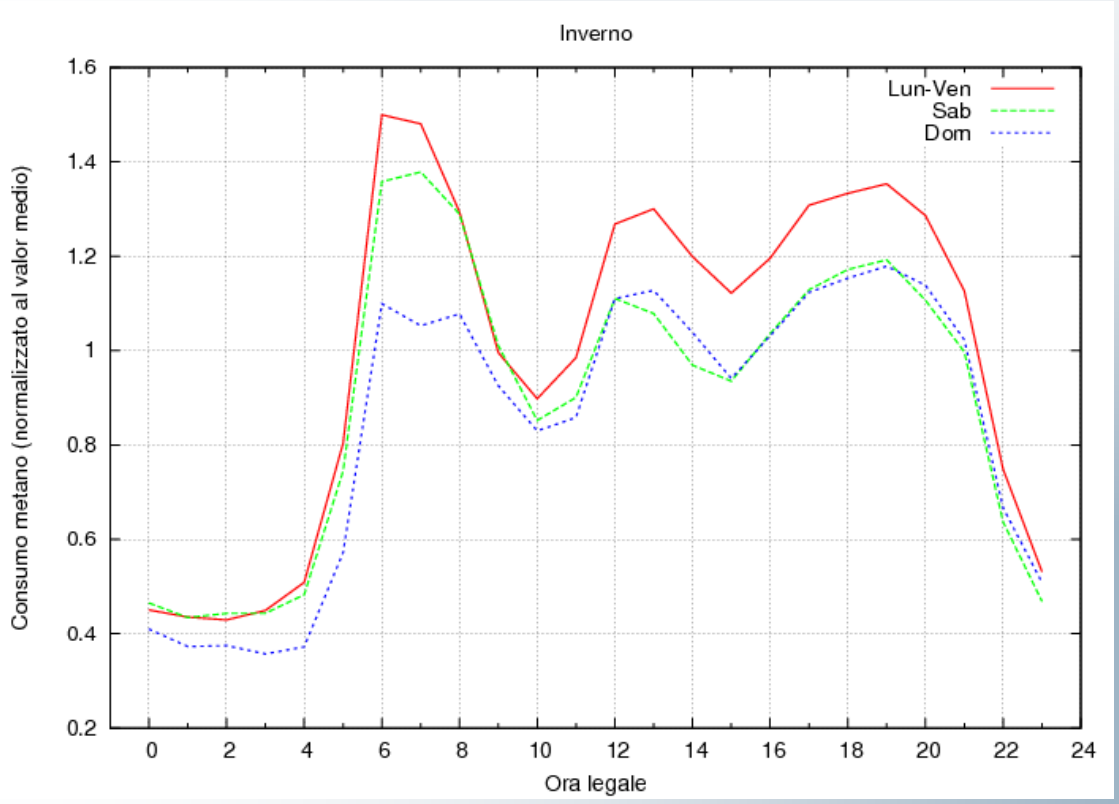
Pressures – emissions and their modulation



NOx



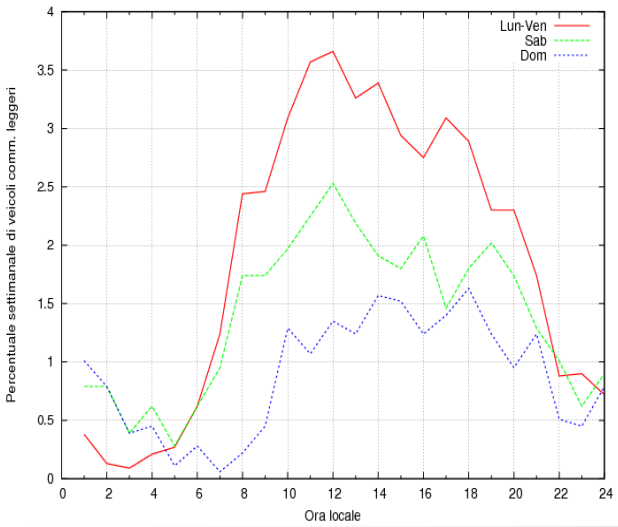
Pressures – emissions and their modulation



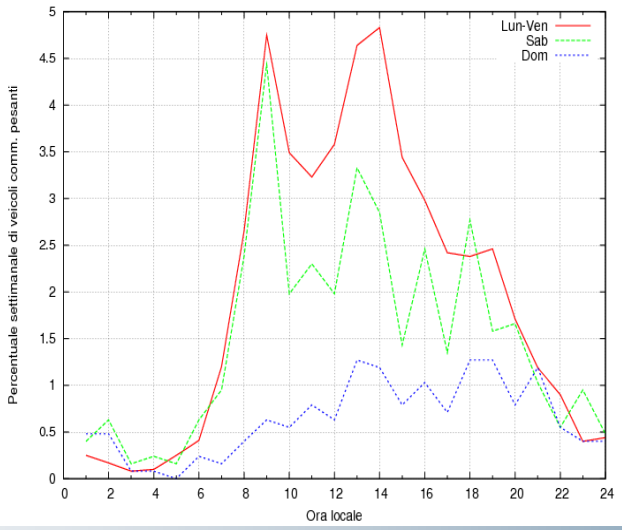
Weekly winter methane consumption in FVG (normalized) in a week where temperature varies less than 1 C
(two major towns were used, normalized values)

Pressures – emissions and their modulation

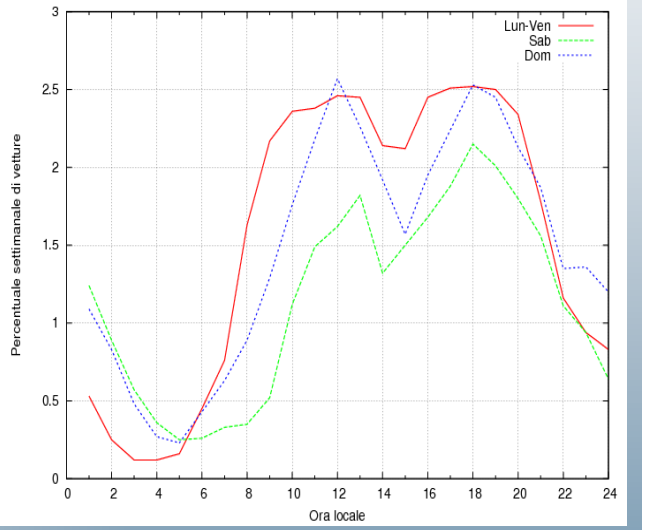
Light duty



Heavy duty



Cars



Road transports for a typical week on a typical town of Friuli Venezia Giulia

IMPACTS

(Relative effects of the pressures)

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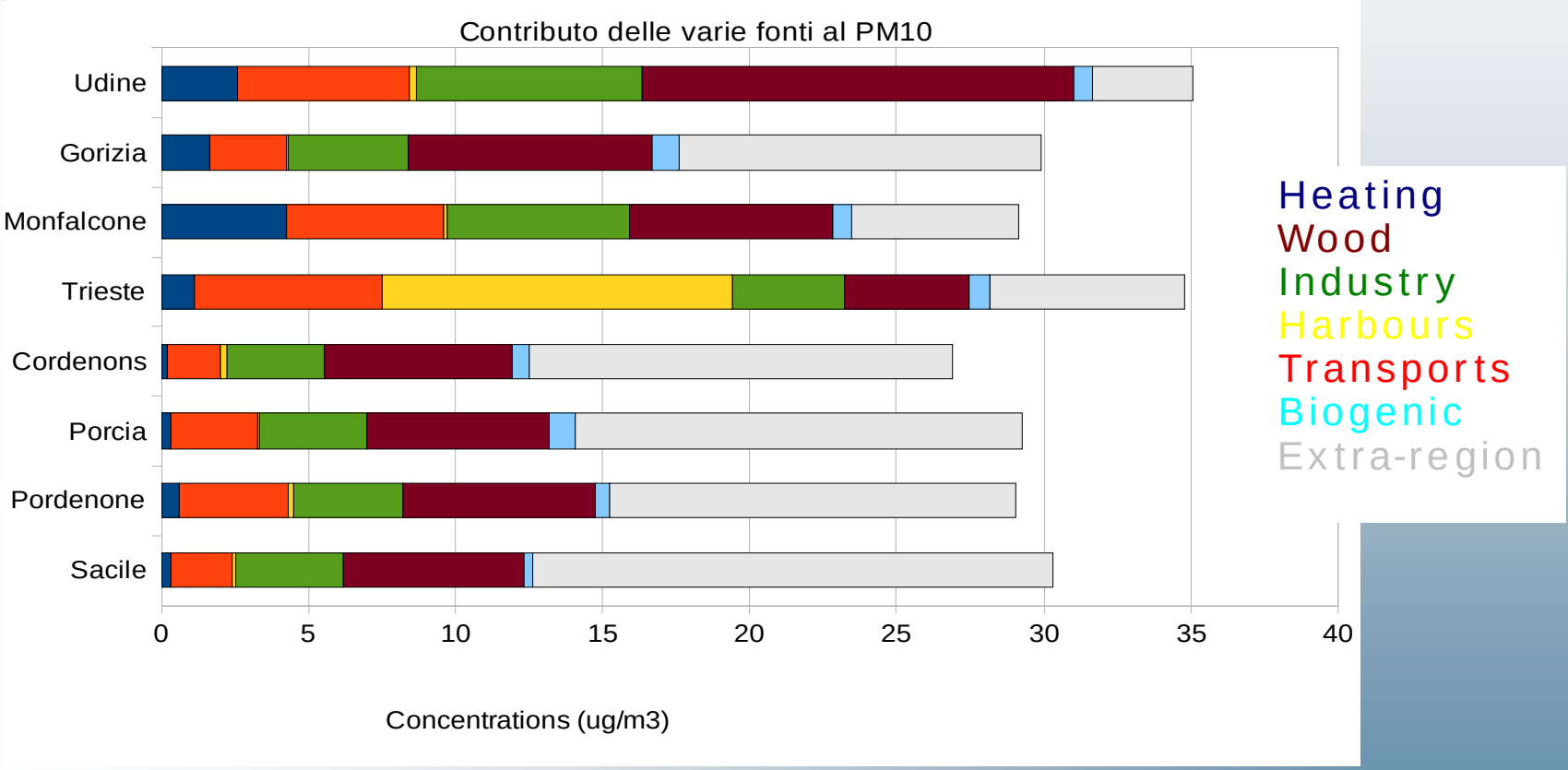
Impacts



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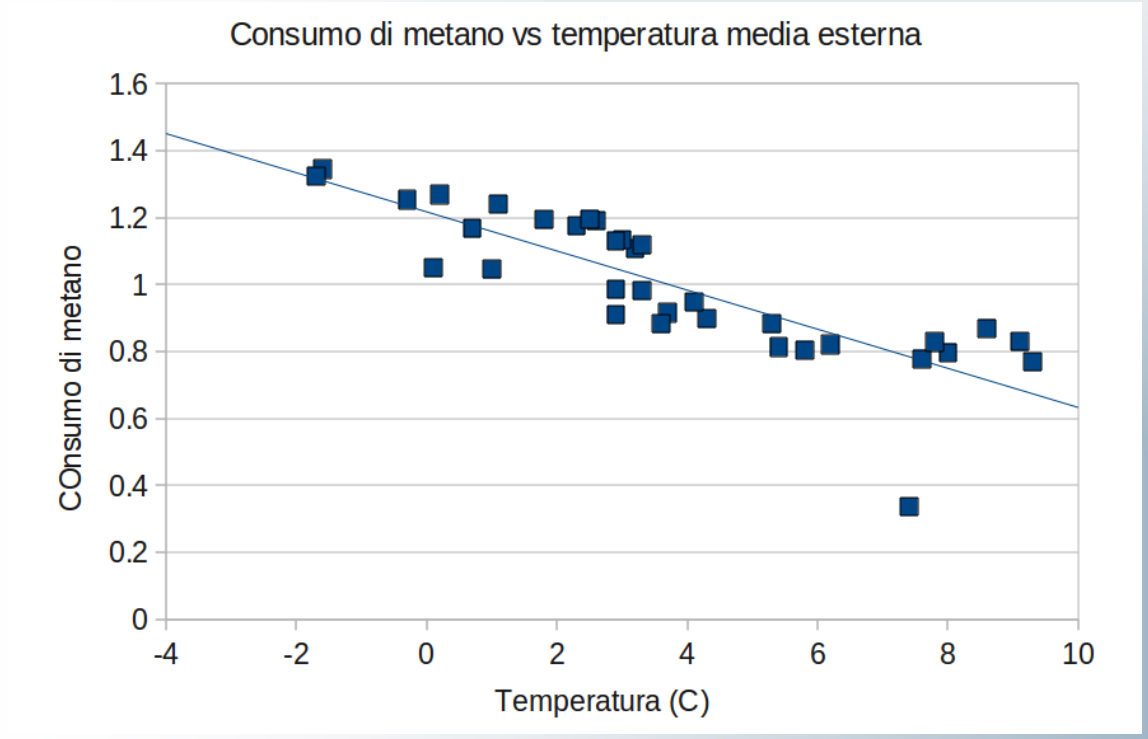
Impacts



Methane consumption versus average external temperature

Methane is considered as a marker for domestic heating (emissions)

2 °C increase in outdoor temperature implies a reduction of roughly 15% in emissions

RESPONSES

(Test the potential effects of proposed actions)

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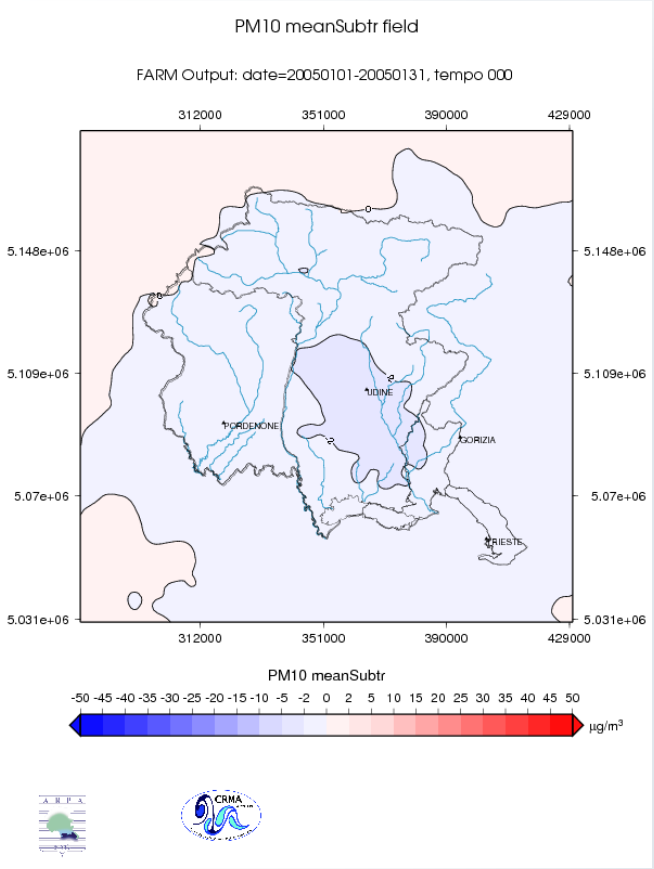
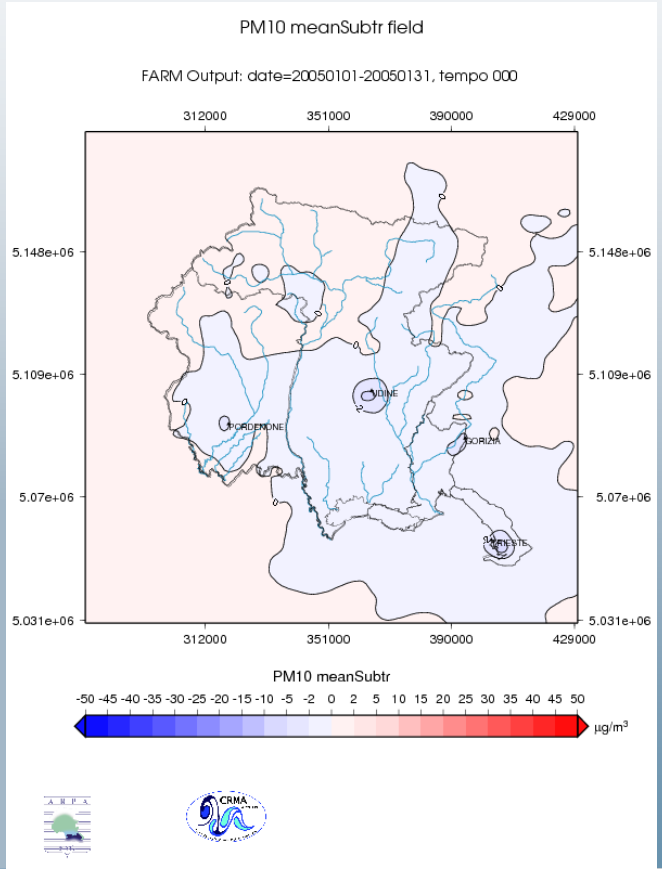
Responses: reductions of average PM10 concentration



Result of 2 °C temperature decrease in houses on the whole plain

Reduction of total emissions from the four major towns



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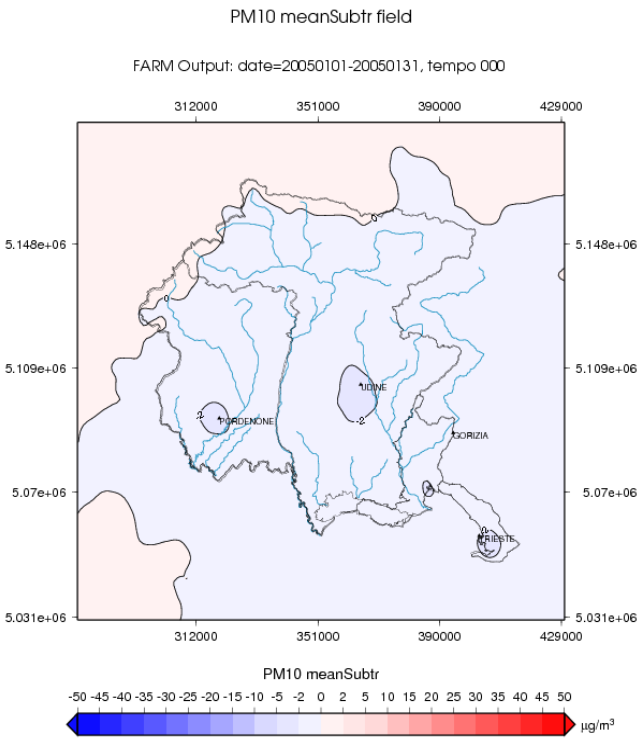
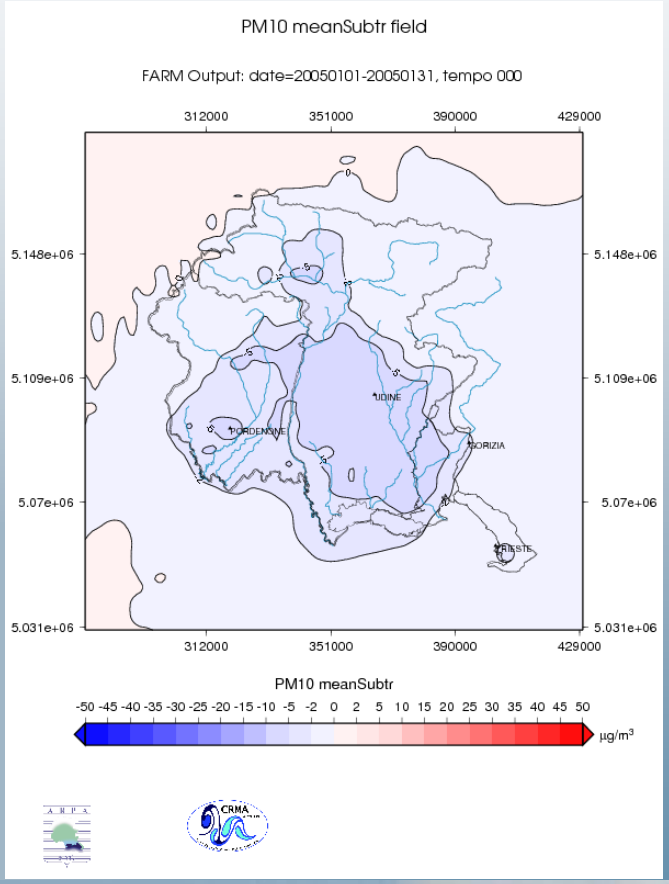
Responses: reductions of average PM10 concentration



Reduction of the whole road transport (caveat: no resuspension taken into account)

Substitution of wood combustion on domestic heating



Responses: Lessons learned

0) aerosol pollution has to be faced on a basin wider than that of a single region

1) early actions have potentially a greater effect

2) soft but widespread actions have a higher potential than drastic an local actions (non technical actions have high potentials)

3) no magic in actions: aerosols (PM) are emitted by different sources and all of them have to be reduced

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Responses: Communication aspects

1) fear is not the right answer (apart if you do not have a prompt solution) called even "Titanic syndrome" (Leventhal et al., JP&SP, 2, 1965.)

2) principle of social evidence (people behave like people behave; Cialdini R., CDPS, 12, 2003)

3) principle of the sense of lost (people take cares of things that loose; Kahneman and Tversky, Econom., 47,1993)

4) principle of asymmetry (small and near benefits pay more than far away huge advantages; Dolto F., 2010)

4.1) actions should have both "push" and "pull" aspects to be effective

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Responses: Communication aspects

THANK YOU

Car pooling?