Joint Research Centre (JRC)

IMPACT OF METEOROLOGICAL MODELLING ON AIR QUALITY: SUMMER AND WINTER EPISODES IN THE PO VALLEY (NORTHERN ITALY)

Pernigotti D., E. Georgieva, P. Thunis, B. Bessagnet

IES - Institute for Environment and Sustainability

Ispra - Italy

http://ies.jrc.ec.europa.eu/

http://www.jrc.ec.europa.eu/

Outline of presentation

Motivations:

2005 - POMI-Po Valley Model Inter-comparison exercise data availability

Experimental design

MM5 (Mesoscale meteo):
with different Data Assimilation

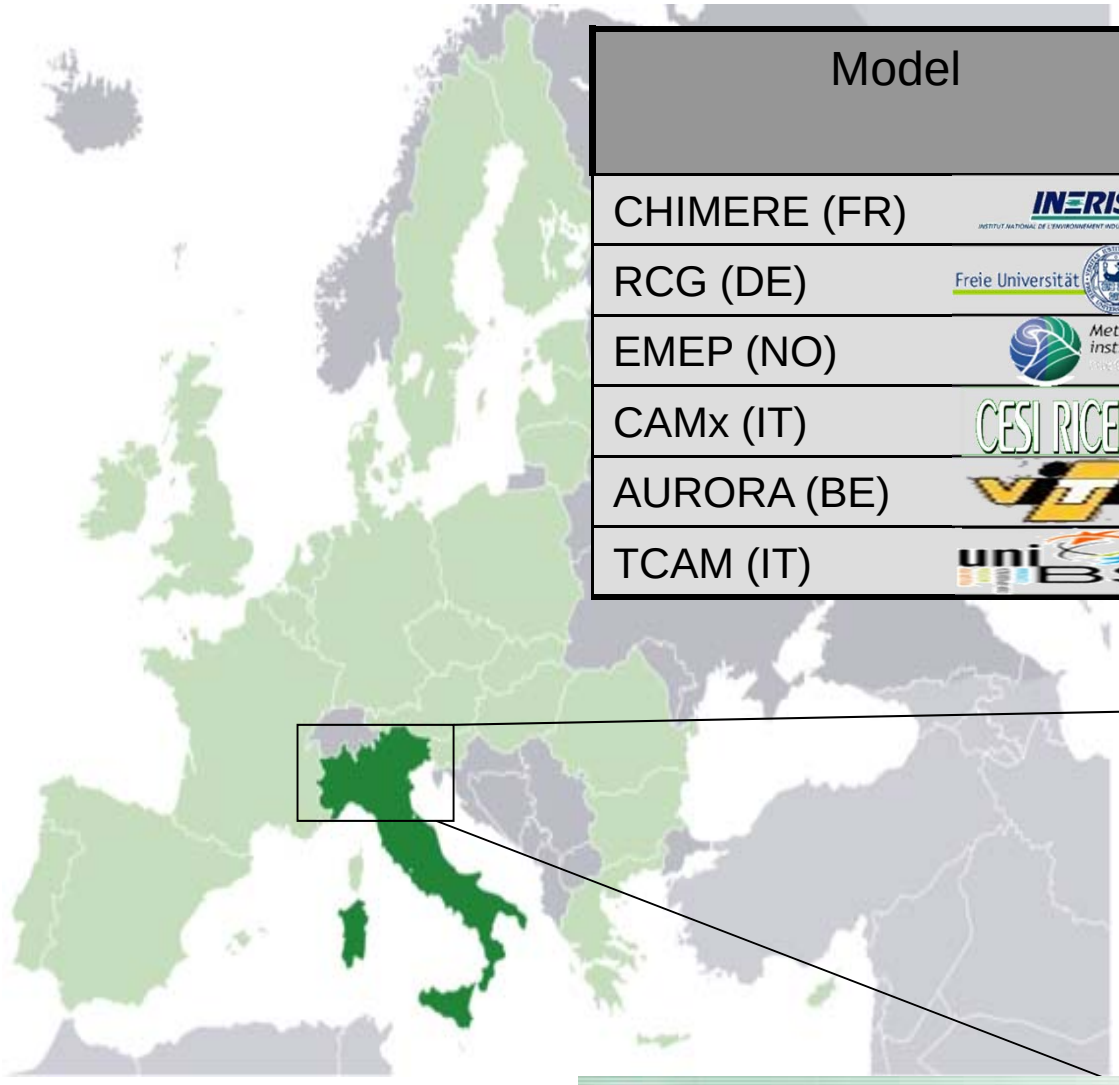
CHIMERE (Chemistry-transport):
response on PM10 and O_3

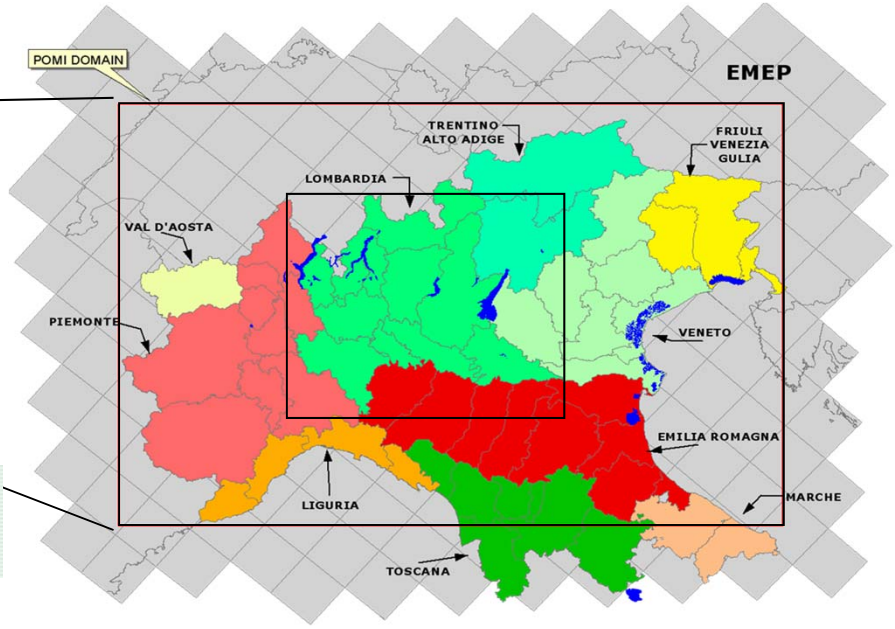
Conclusions

17 March 2005
NASA Visible Earth
http://visibleearth.nasa.gov/)

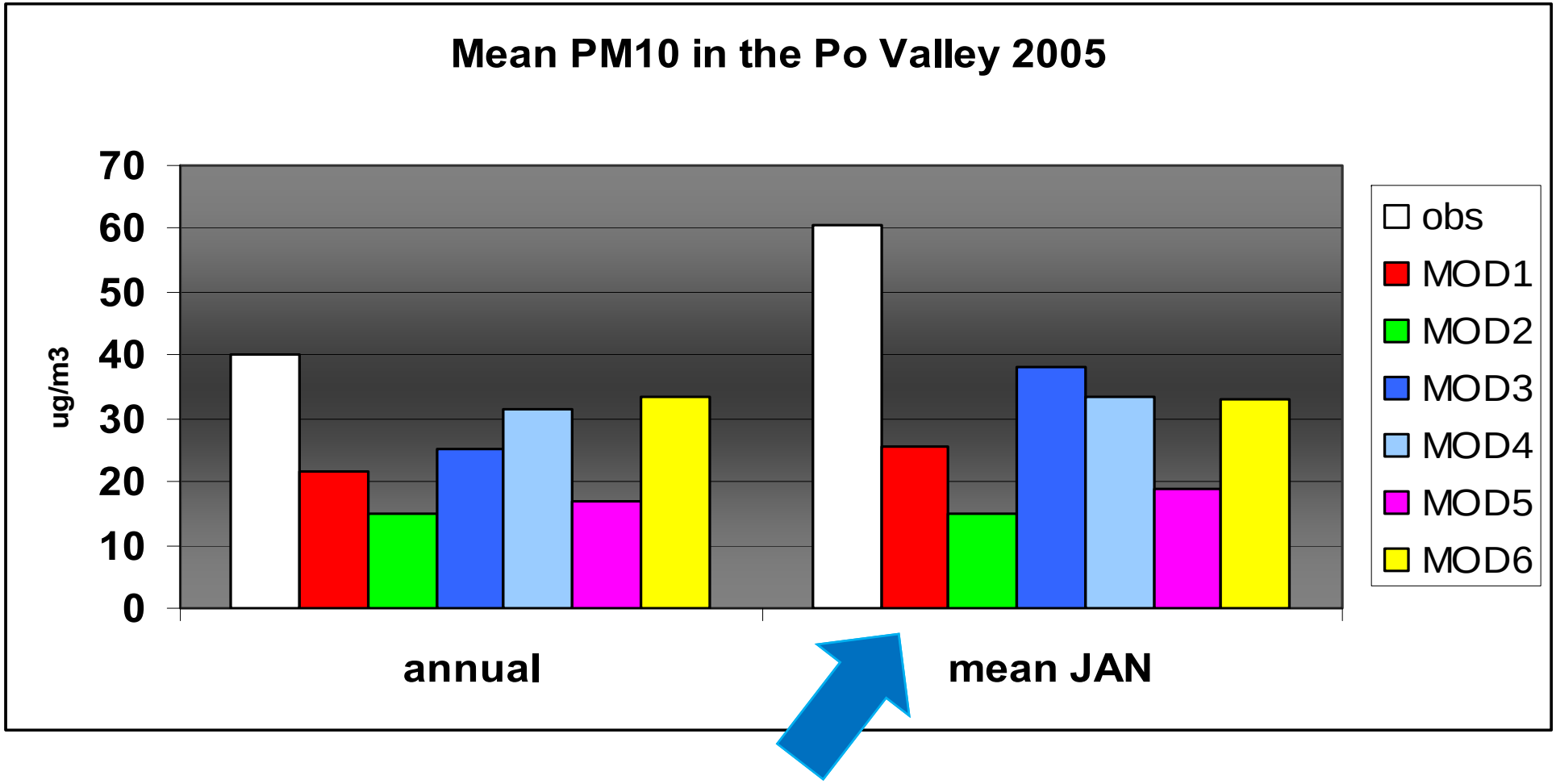
POMI: Po Valley Model Intercomp. Exercise

Model	50 km Europe	6 km Po-Valley	3 km Lombardy
CHIMERE (FR)	X	X	X
RCG (DE)		X	X
EMEP (NO)	X	X	
CAMx (IT)		X	X
AURORA (BE)		X	X
TCAM (IT)		X	





http://aqm.jrc.it/POMI/

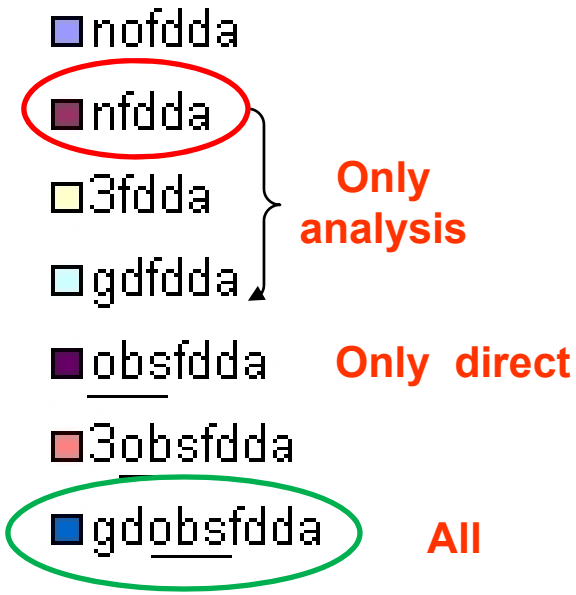


It is believed that much of this PM underestimation is due to wind overestimation

MM5 Four Dimensional Data Assimilation

"… is a continuous dynamical assimilation where forcing functions are added to the governing model equations to gradually '*nudge*' the model state toward the observations."

(NCAR technical note 1995)



Analysis FDDA *(MM5 preprocessor checks and interpolate with NCEP as first guess)*

→**n**: ncep (6h)

→**3**: n + radiosoundings (6h)

→**gd**: 3 + 70 surface obs (3h)

Direct FDDA

→**obs**: 56 surface stations directly into MM5 (1h)

MM5 v3:

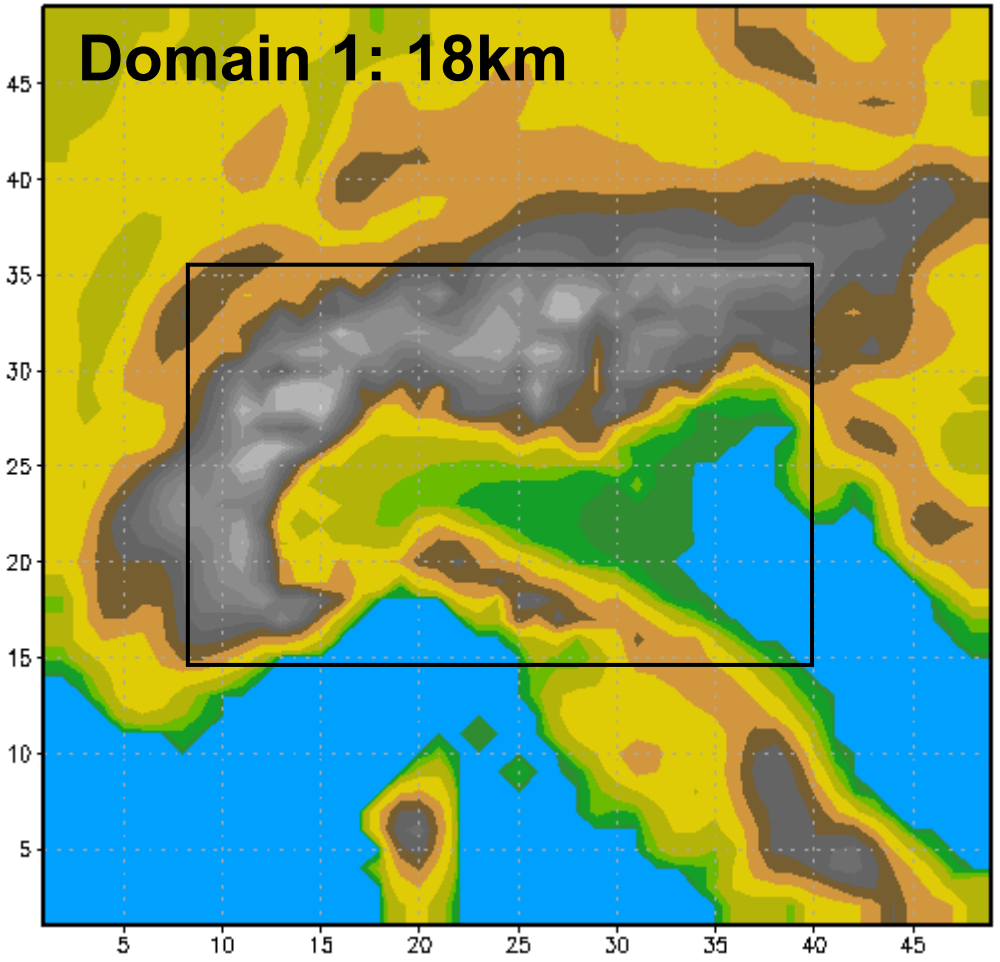
- Boundary and Initial conditions from NCEP FNL reanalysis (6h, 1° x 1°)
- 2 domains (18km, 50x50; 6km 97x70)
- 23 vertical levels (surface-100hPa)

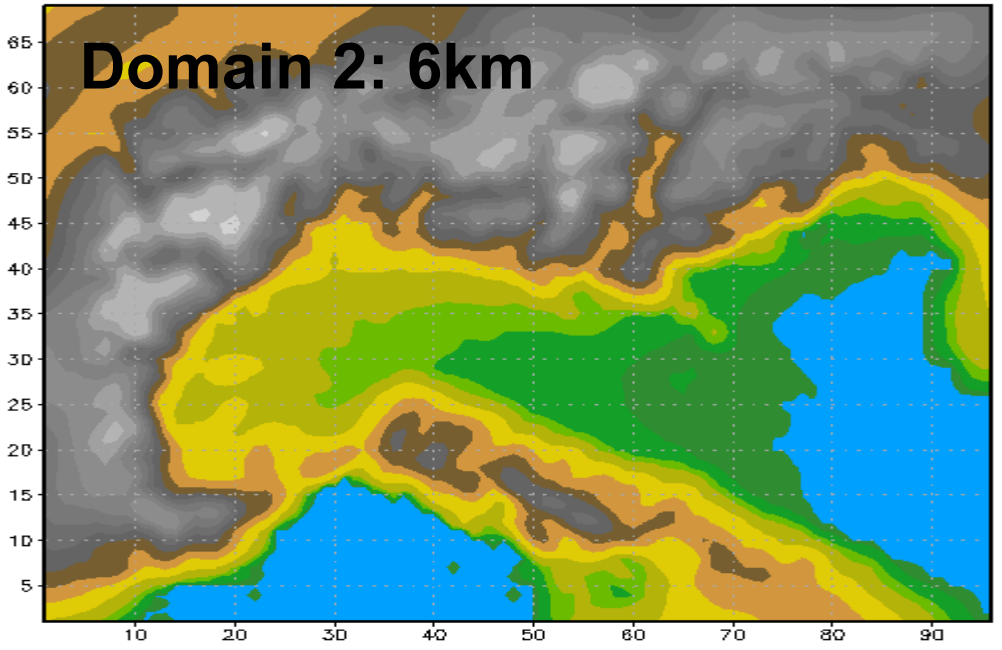
CHIMERE (2008b):

- Emissions – POMI inventory (municipality level INEMAR merged with national emission inventories, Triacchini, 2009)
- Boundary condition from EMEP run at 50km
- 95x65 grid points
- 8 vertical levels (surface-500hPa)

Key parameters on both domains:

IMPHYS=7 (graupel moisture scheme);
ICUPA=3 (Grell cumulus scheme);
IBLTYP=5 (MRF planetary boundary layer);
FRAD=4 (rrtm solar radiation);
ISOIL=2 (Noah land-surface scheme)
IMDIF=1 (moist vertical diffusion in clouds)
ITHADV=1 (ad. of potential temp.)
ITPDIF=1 (sigma diffusion using perturbation)
ISSTVAR=1 (varying SST in time);
IOVERW=1 (overwrite nest input)

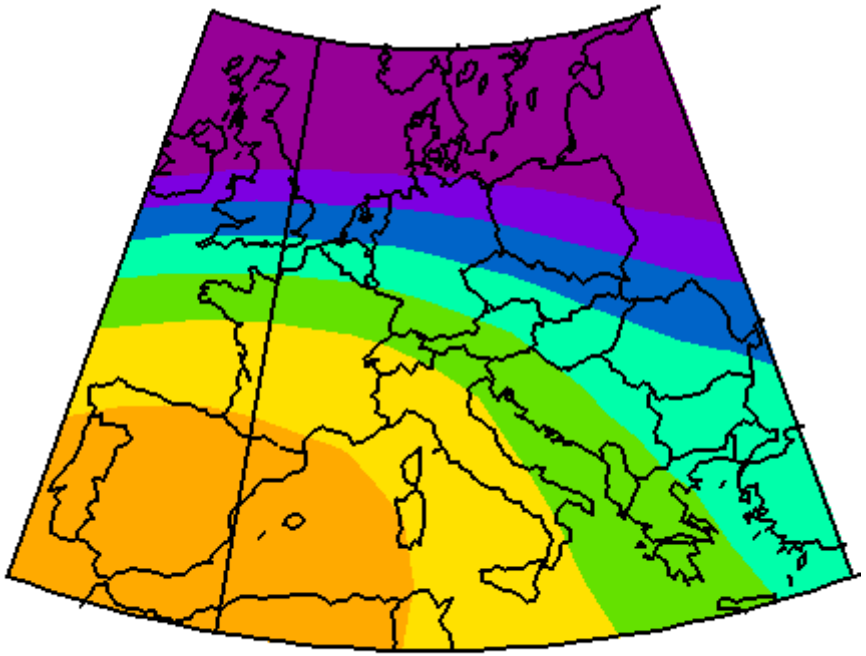




Selected periods

January 2005: high pressure especially from 5 to 15th with fog and PM10 exceedences

June 2005: high pressure especially from 15th to 30th with high temperatures and Ozone exceedences



500mb GEOPOTENTIAL HEIGHTS (dam) 11-DAY MEAN FOR:
Wed JAN 05 2005 - Sat JAN 15 2005

500mb GEOPOTENTIAL HEIGHTS (dam) 11-DAY MEAN FOR:
Mon JUN 20 2005 - Thu JUN 30 2005

http://www.esrl.noaa.gov/psd/data/histdata/

Average geopotential at 500hPa is over 570 dam for over 10 days

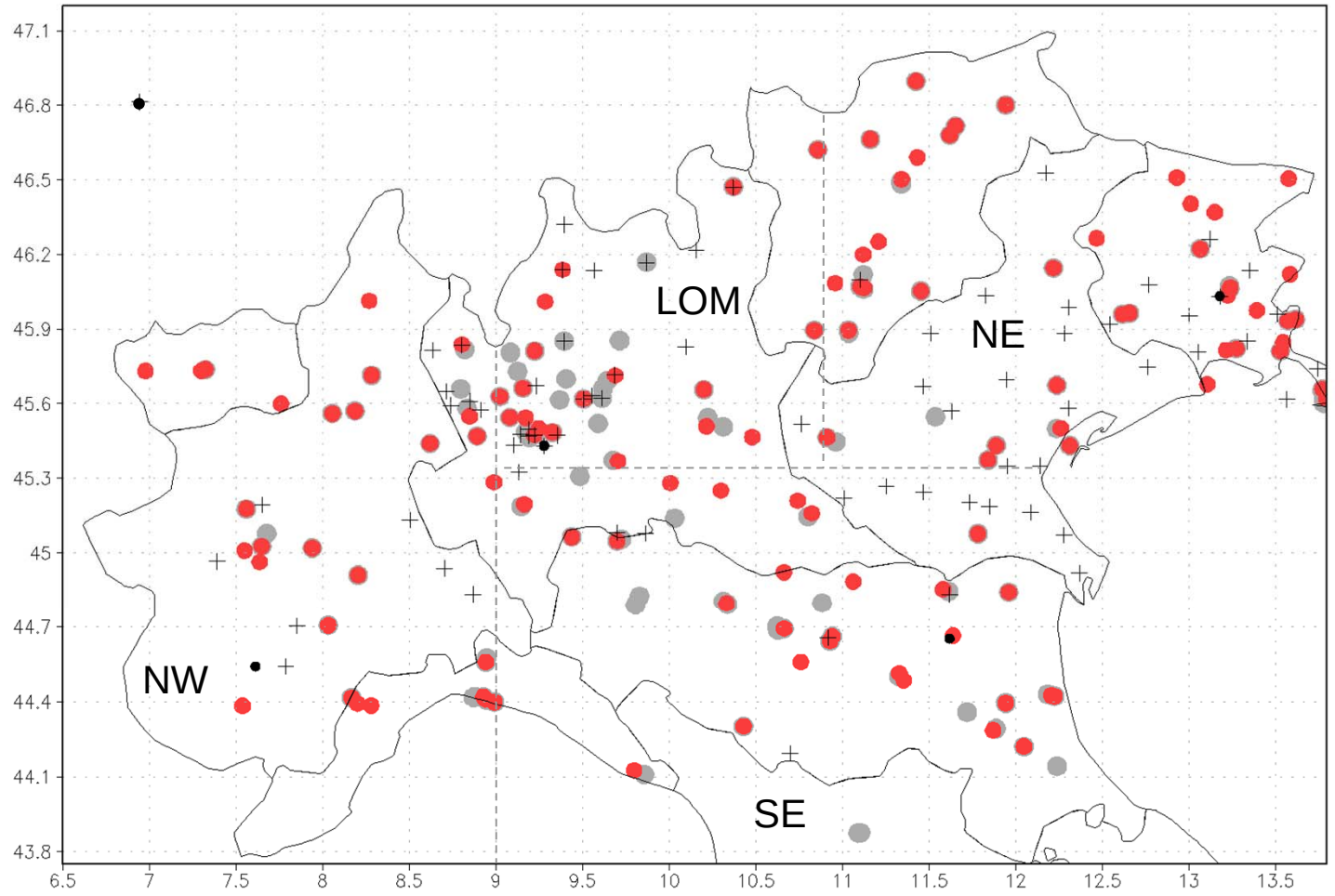
Data availability

70 meteo stations (+)
(55 used for FDDA)

5 radiosoundings (•)

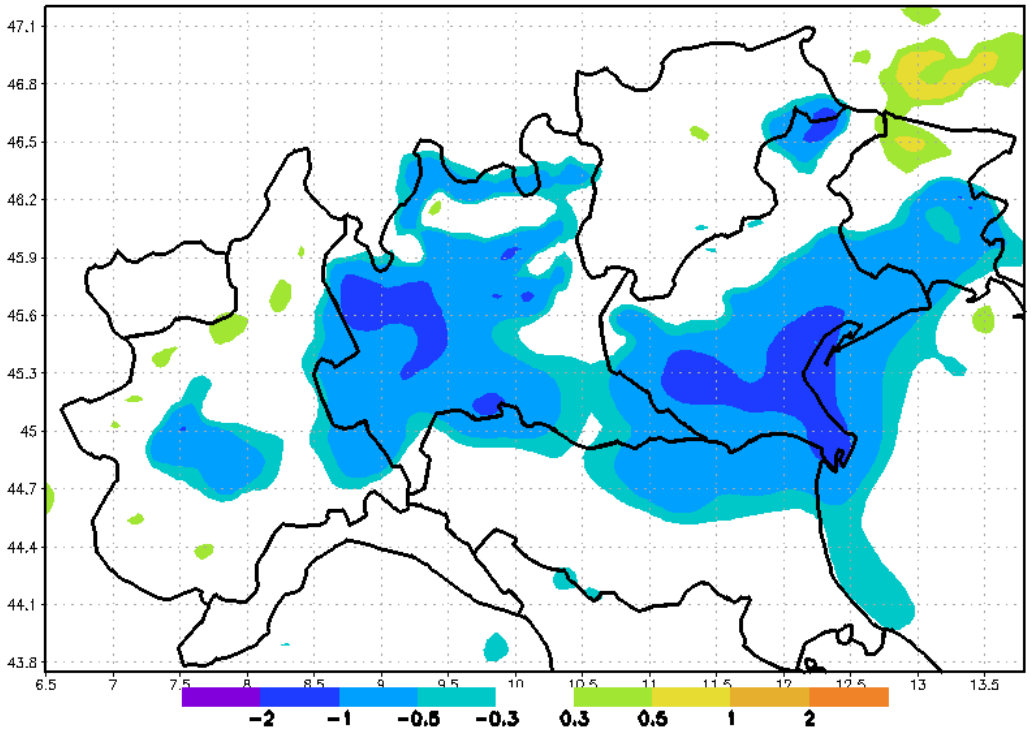
97 PM10 stations (•)
(Airbase)

88 O3 stations (•)
(Airbase)



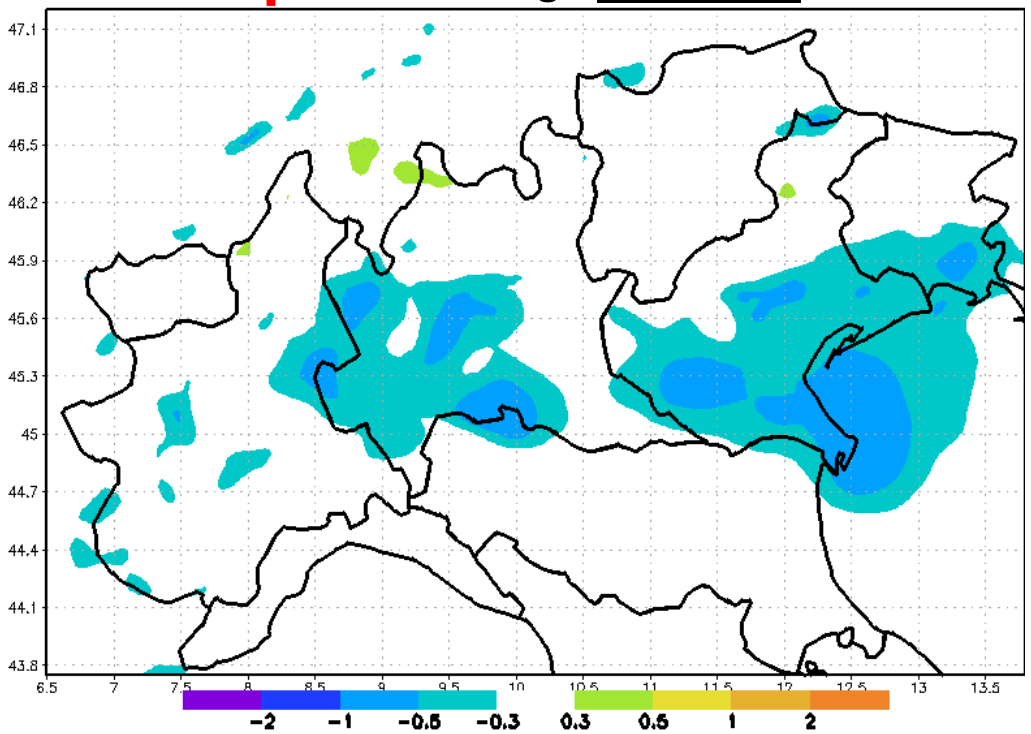
Effect of FDDA on MM5 model wind speed

In winter reduction of wind speed over 1 m/s



Wind speed average <u>difference</u> in **January**

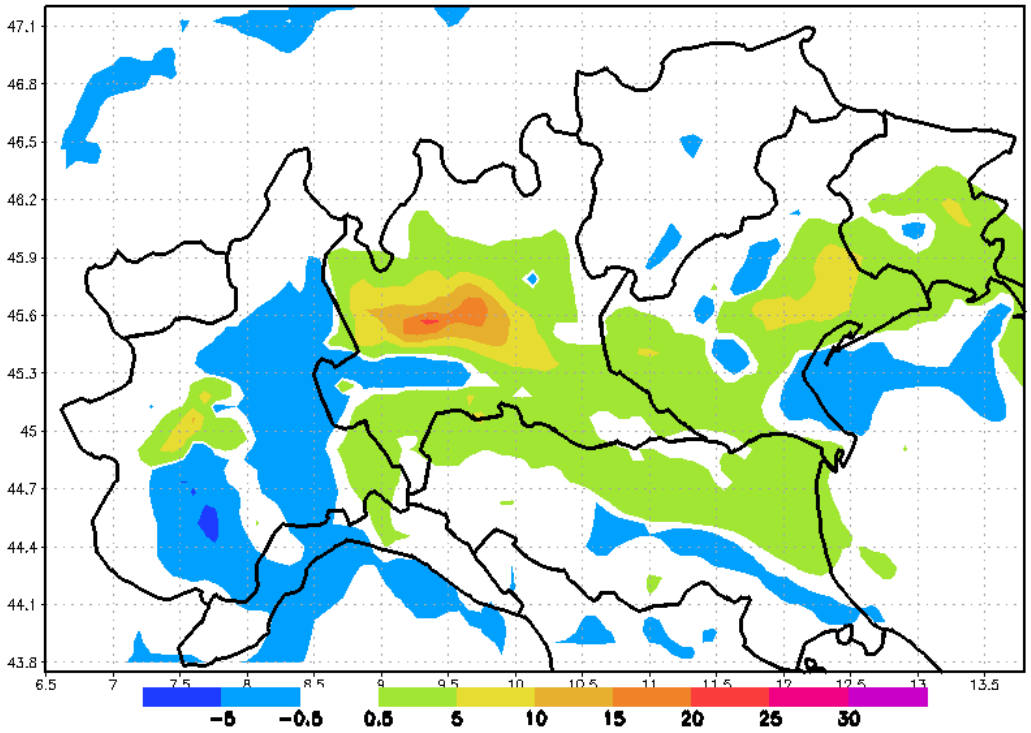
Wind speed average <u>difference</u> in June



In summer reduction of wind speed over 0.5m/s (more wind in the data)

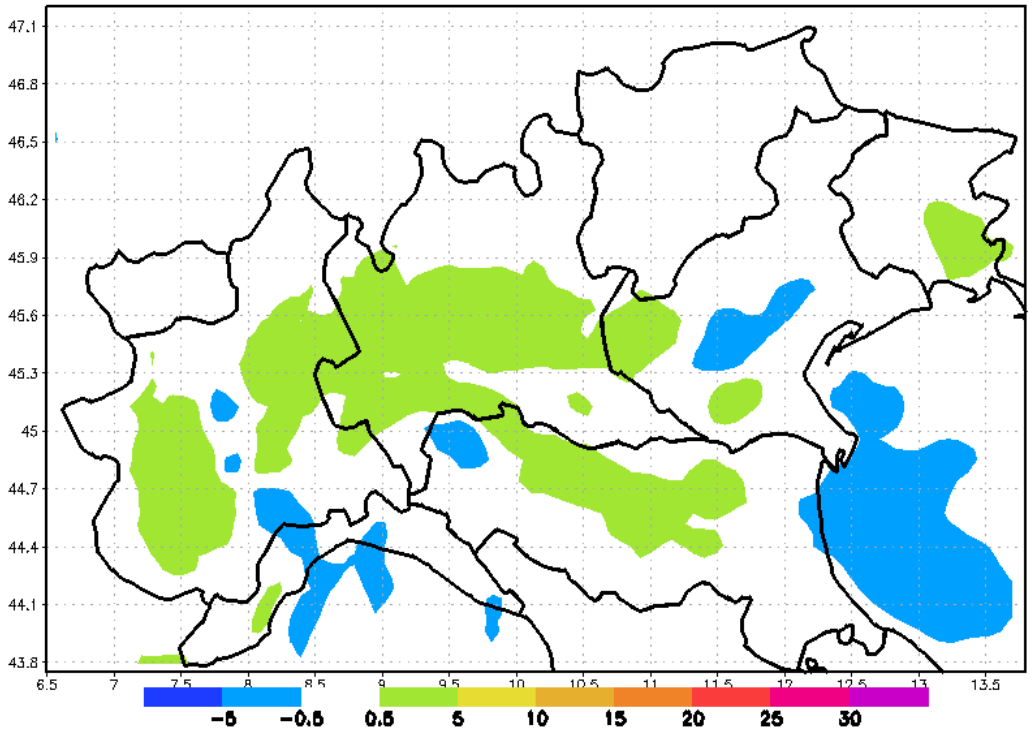
Effect of FDDA on PM10

Increment of PM10 up to 20μg m^{-3} in Milan area



PM10 average difference in January

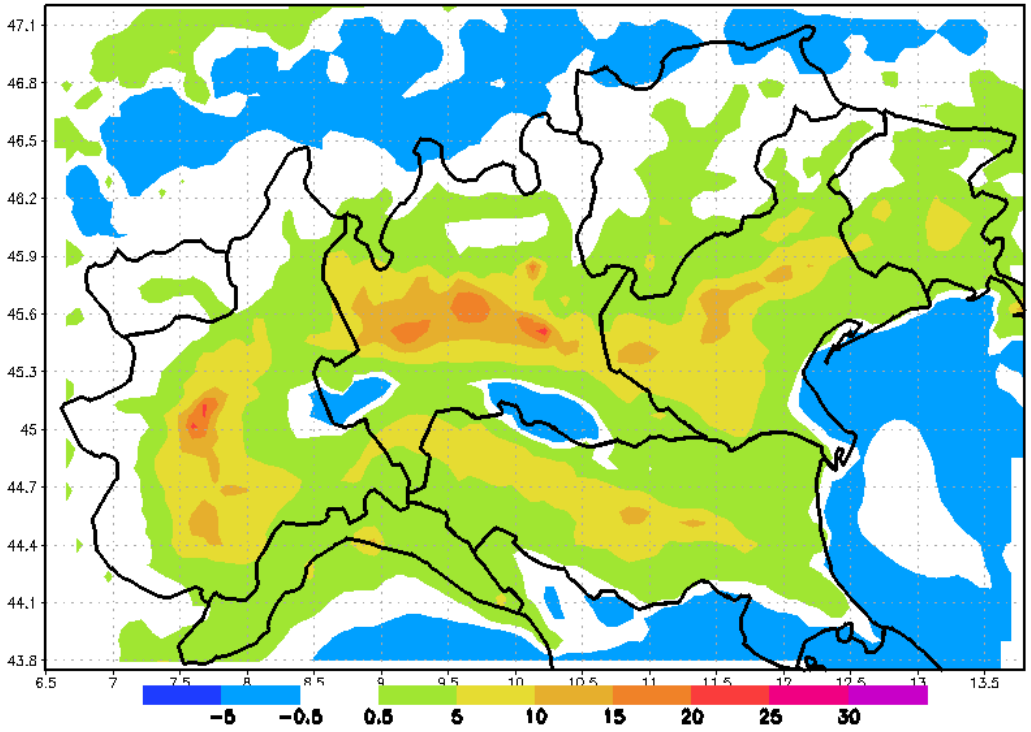
PM10 average difference in June



Very little increment in summer (< 5 μg m^{-3})

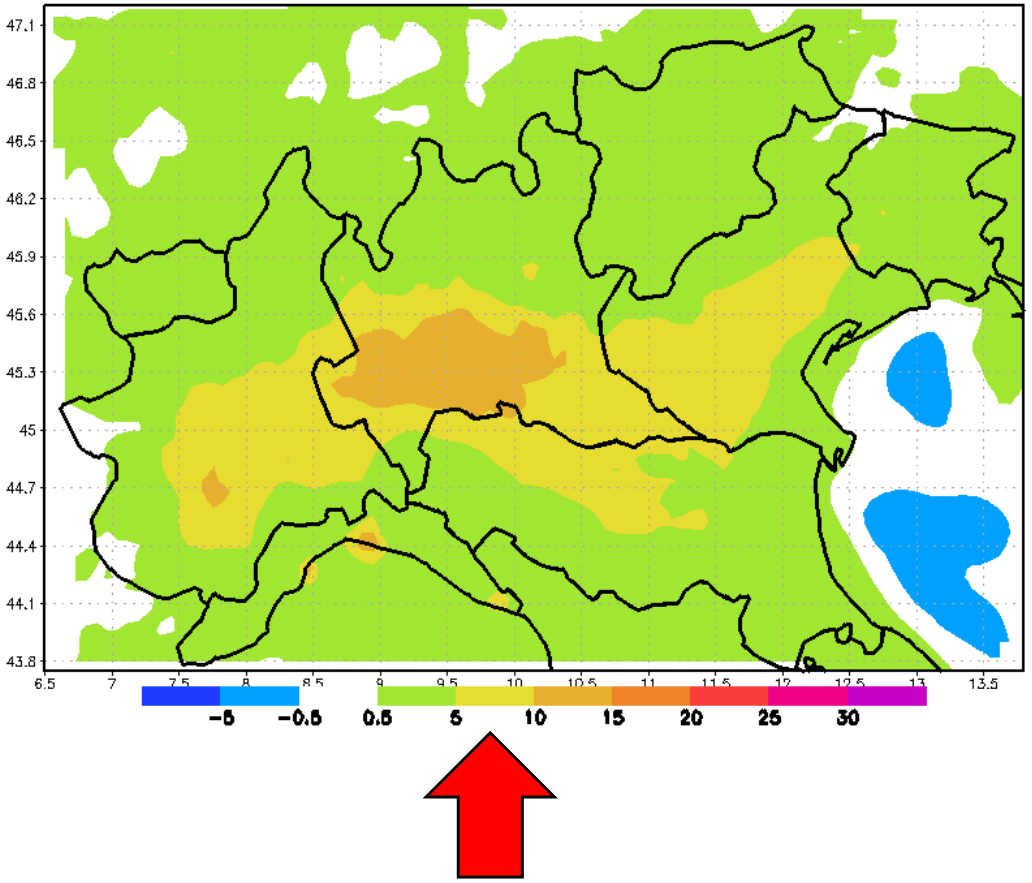
Wind and PM10, a test CHIMERE wind/2

Increment of PM10 more homogeneous, under 20μg m^{-3} in Milan area



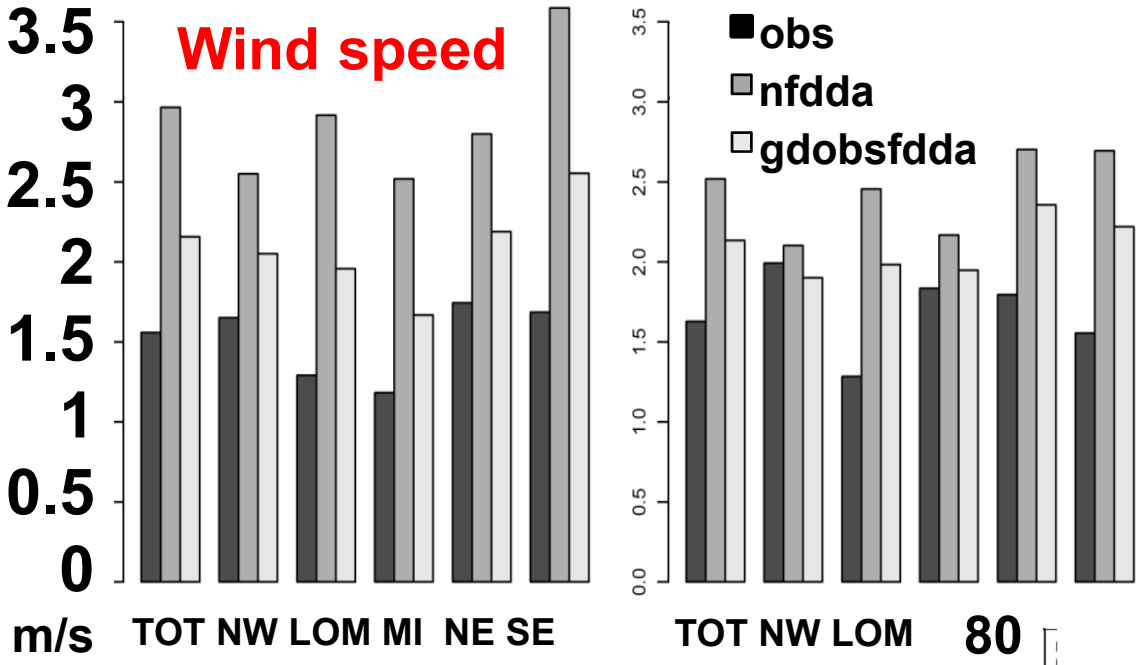
PM10 average difference in January

PM10 average difference in June



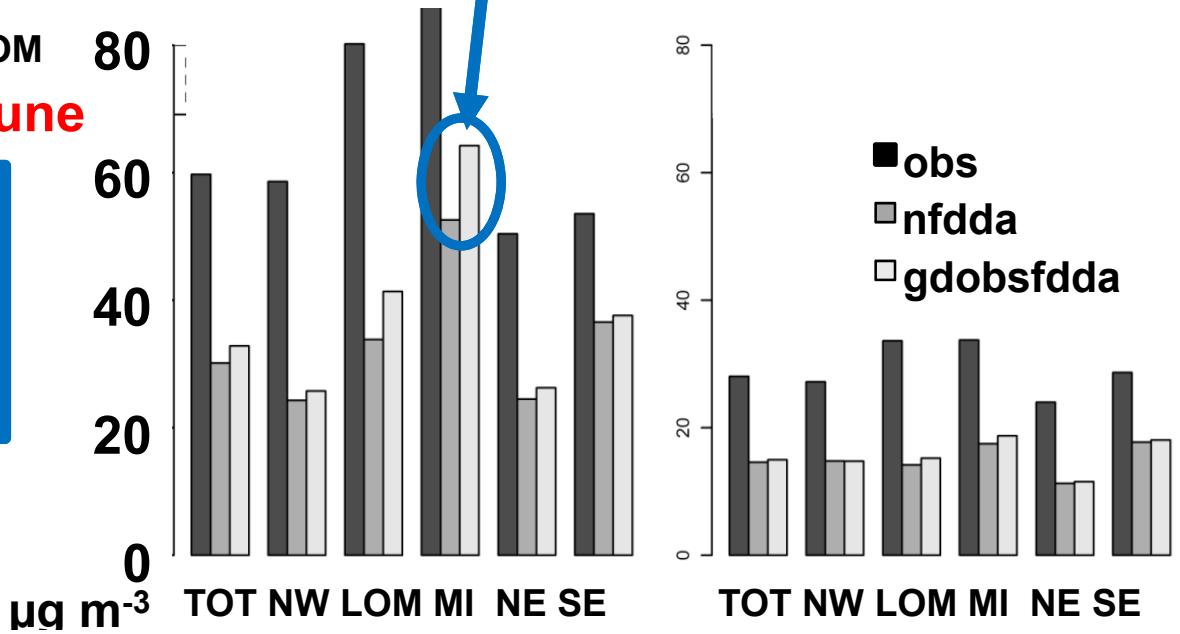
Increment still over 10 μg m^{-3} in summer

Effect of FDDA on PM10



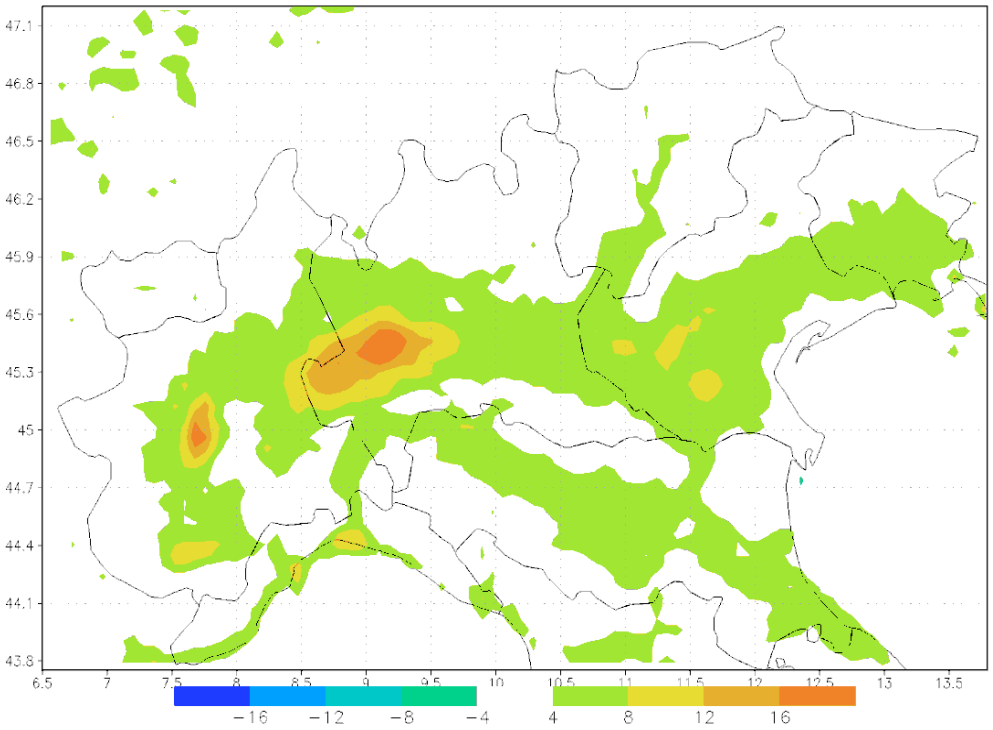
Important reduction of PM10 in Milan area

With nudging wind speed reduces both in January and June



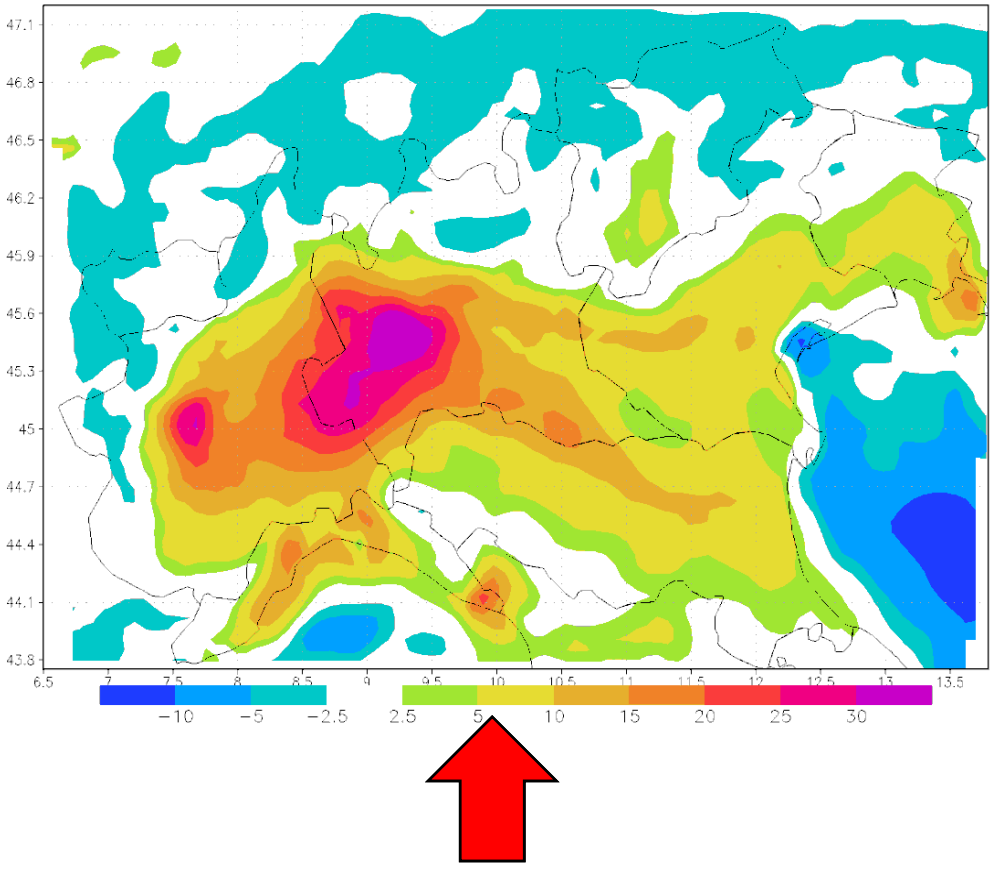
Wind and ozone in June, CHIMERE wind/2

+ precursors in colder hours



NO_2 average difference at 6LT

O_3 average difference at 15LT



+ formation

- plume transport

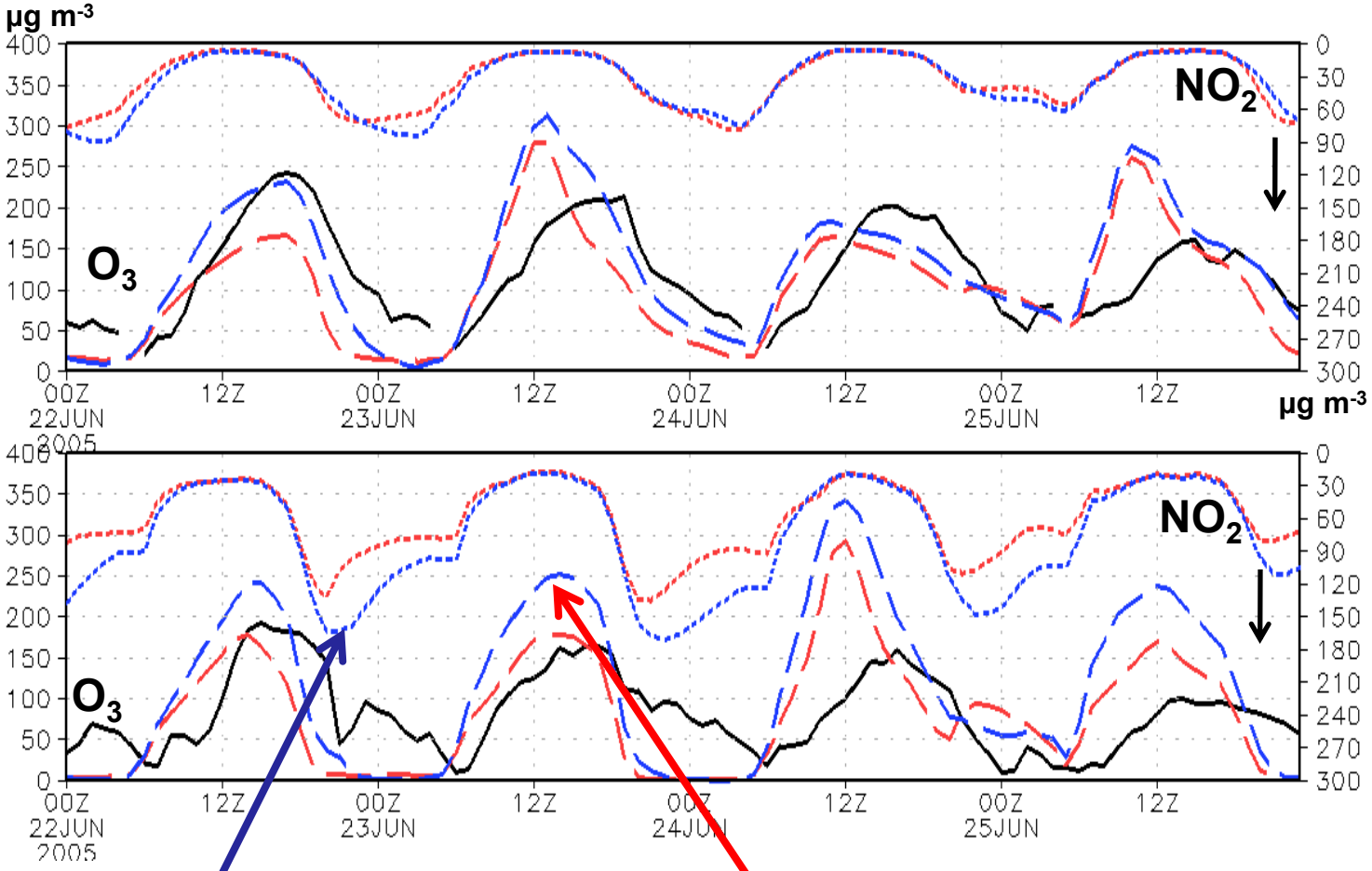
Wind and ozone in June, CHIMERE wind/2

Kos Island, 2-6 October 2011– 14th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes

Crema
(small town 50km SE of Milan)
IT0839
Urban Background

Milan
IT0770
Arese
Urban Background

observations nfdda nfdda_halfw

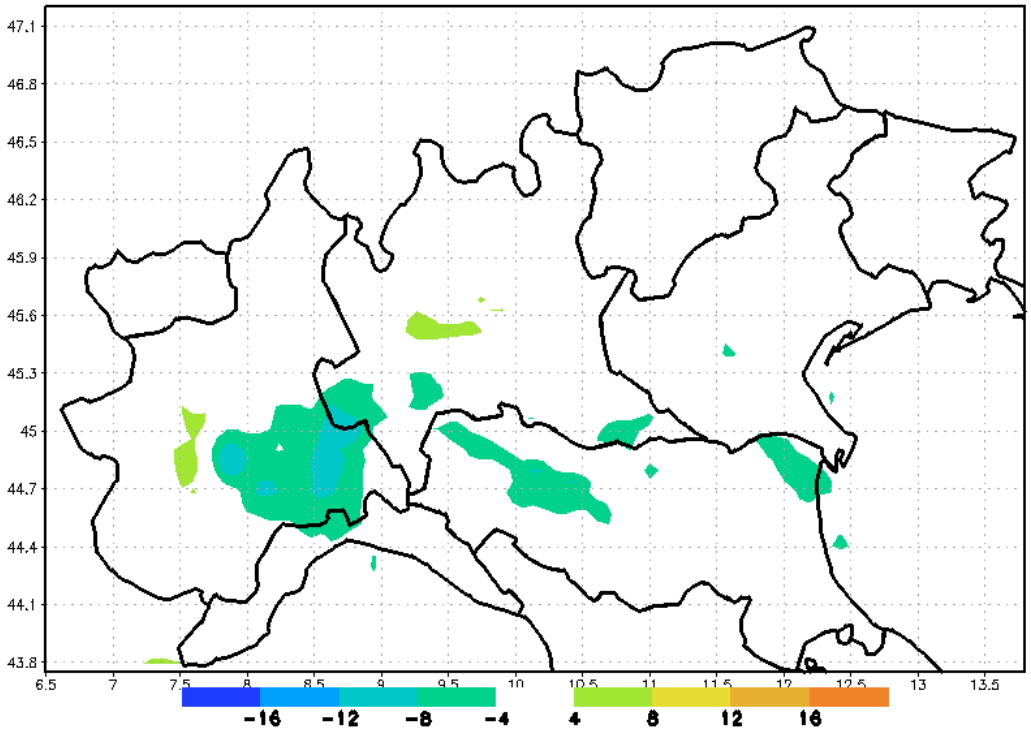


+ precursors in colder hours

+ O3 formation

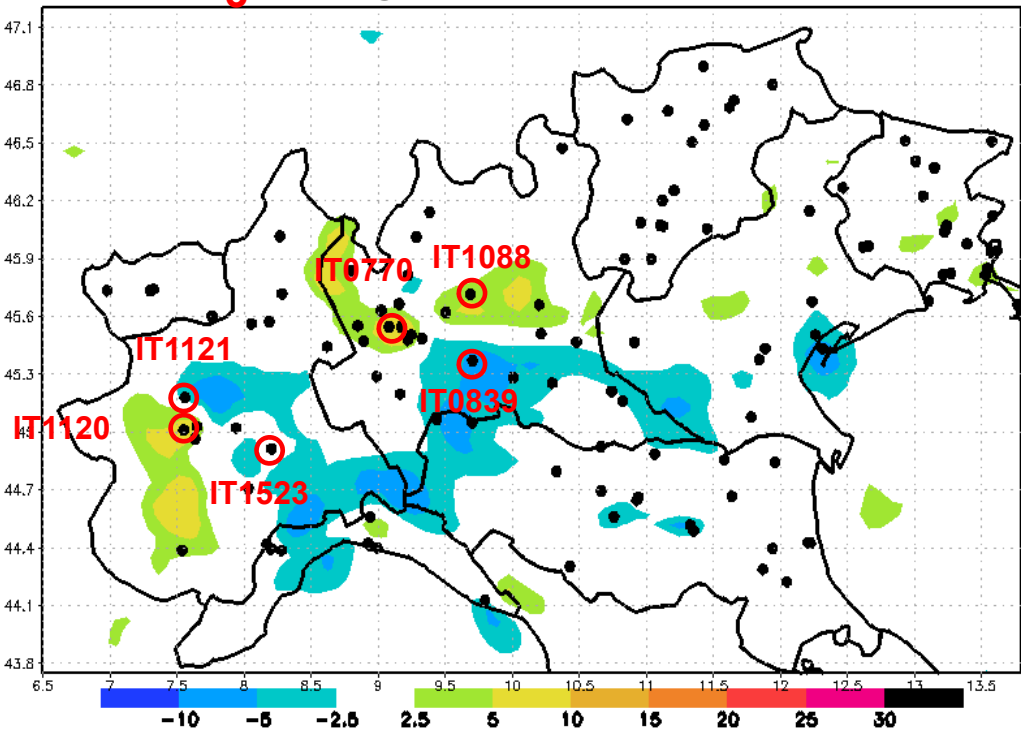
Effect of FDDA on O_3 (June)

Small increment of NO_2 in big cities, small decrement in other areas



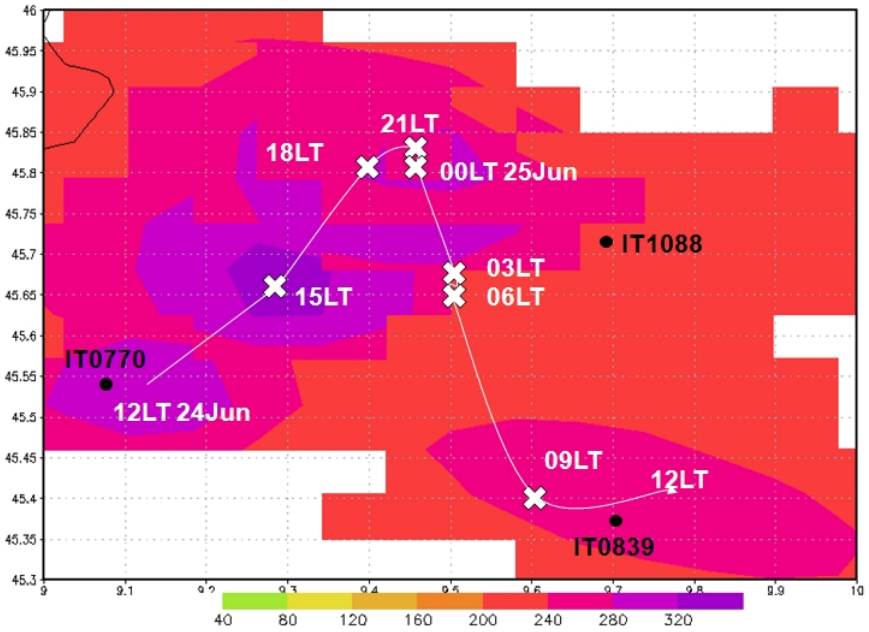
NO_2 average difference at 6LT

O_3 average difference at 15LT



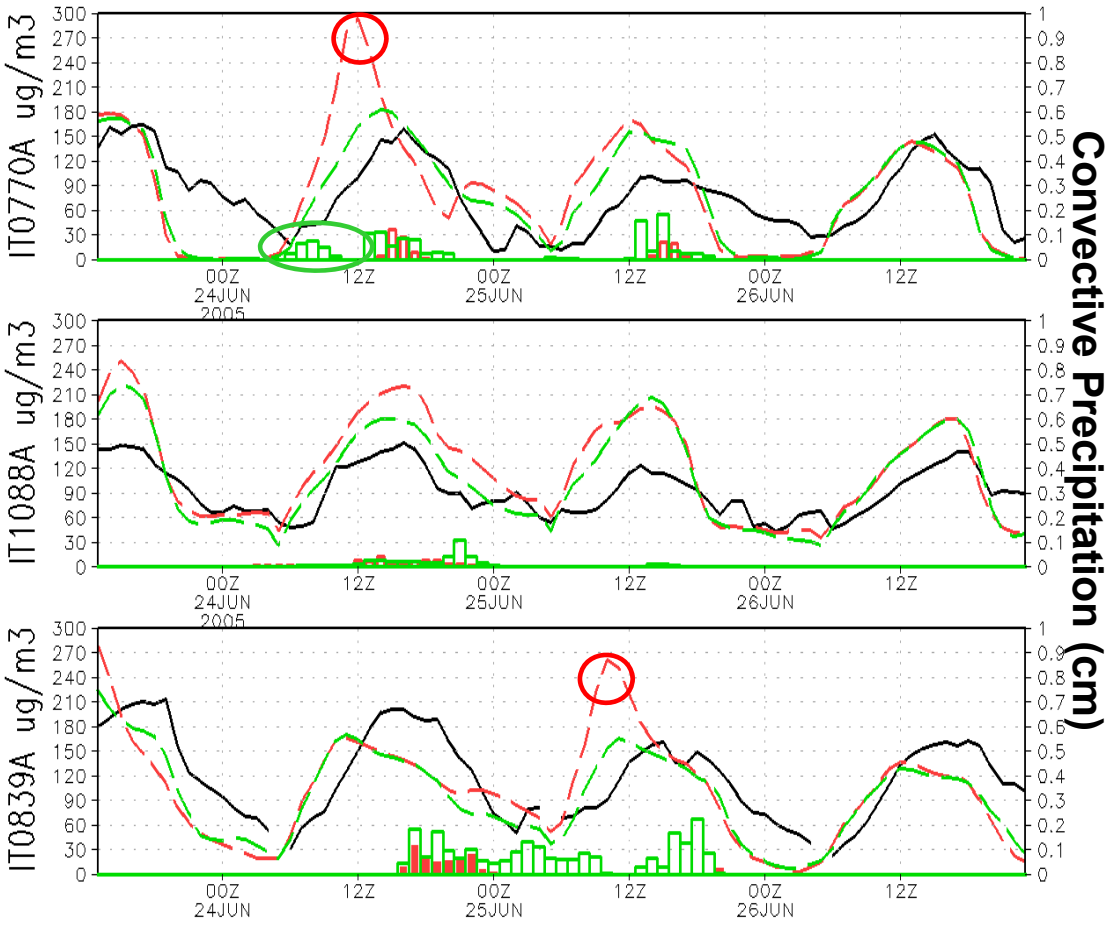
Small variation for O_3 with similar pattern

nfdda: a peak is in IT770 (Cormano, Milan) on 24th and moves to IT839 (Crema) on 25th
disapperas in gdobsfdda



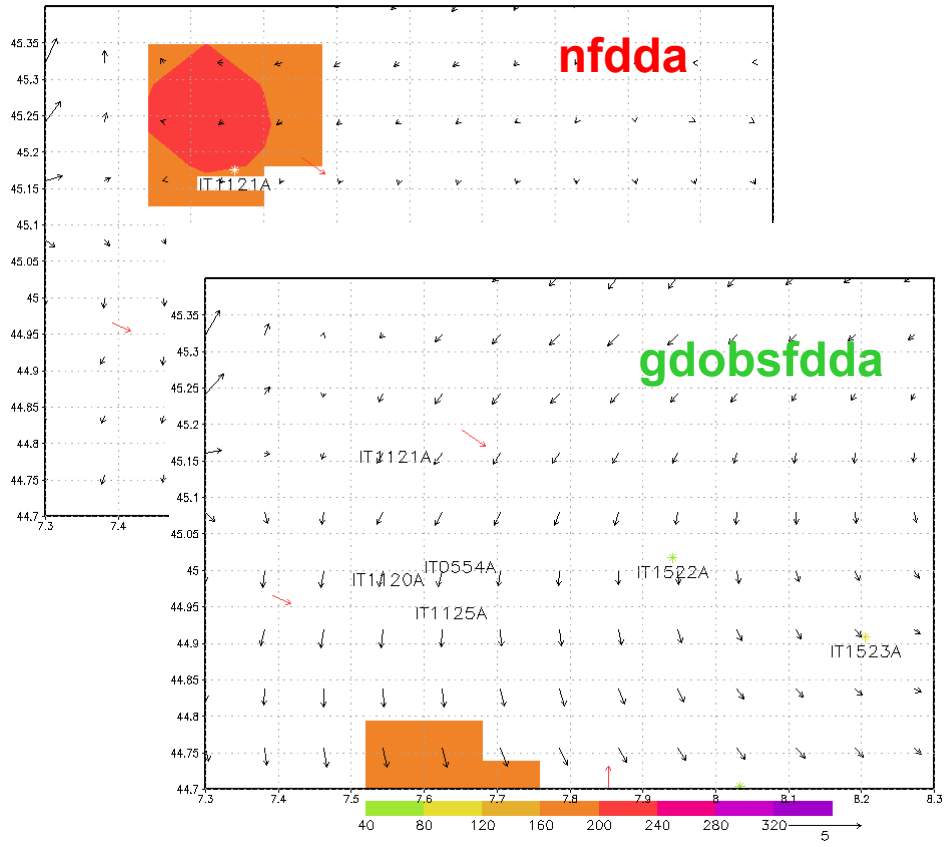
O3 concentrations plotted over 200µg m^{-3} at σ level 5 (about 500m)

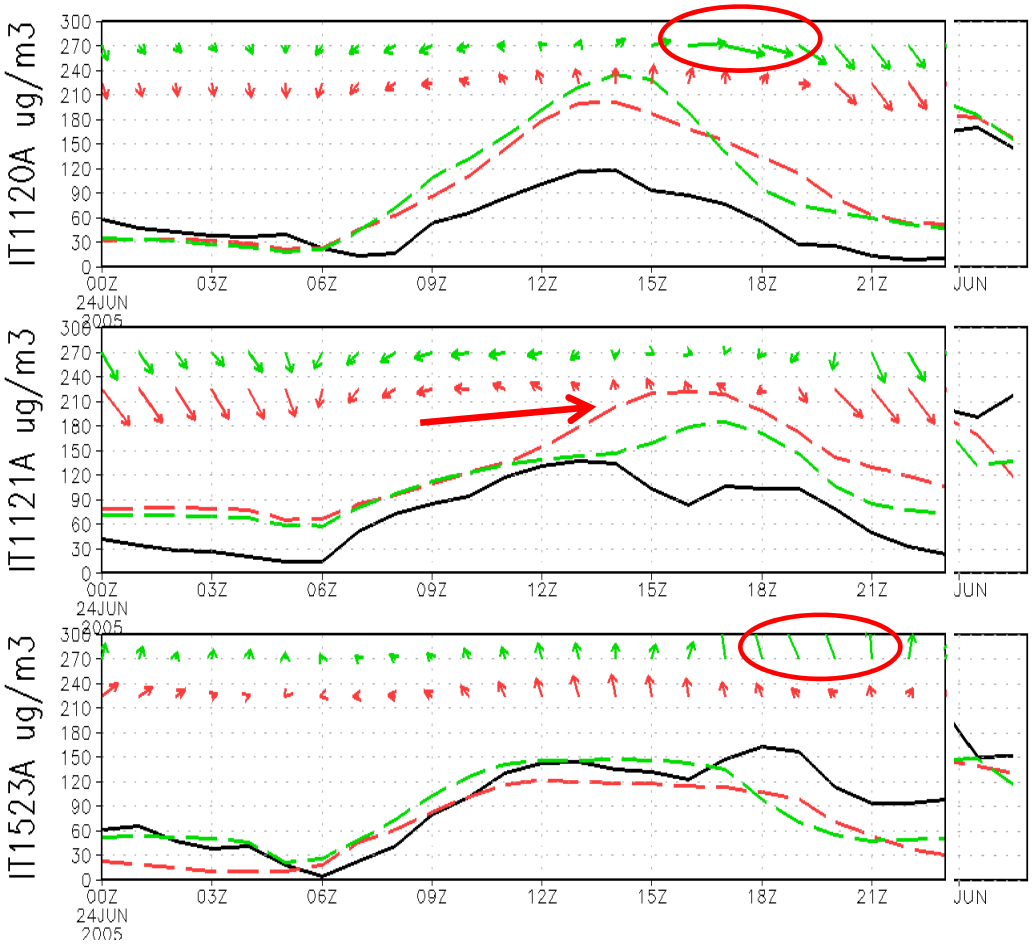
nfdda **gdobsfdda**



Effect of FDDA on wind direction and speed

nfdda: a peak is in IT1121 (Druento, north of Turin) on 24 is smoothed in gdobsfdda





O3 (over 160µg m^{-3}) and wind at about 500m at time 23Z 24JUN2005

Conclusions

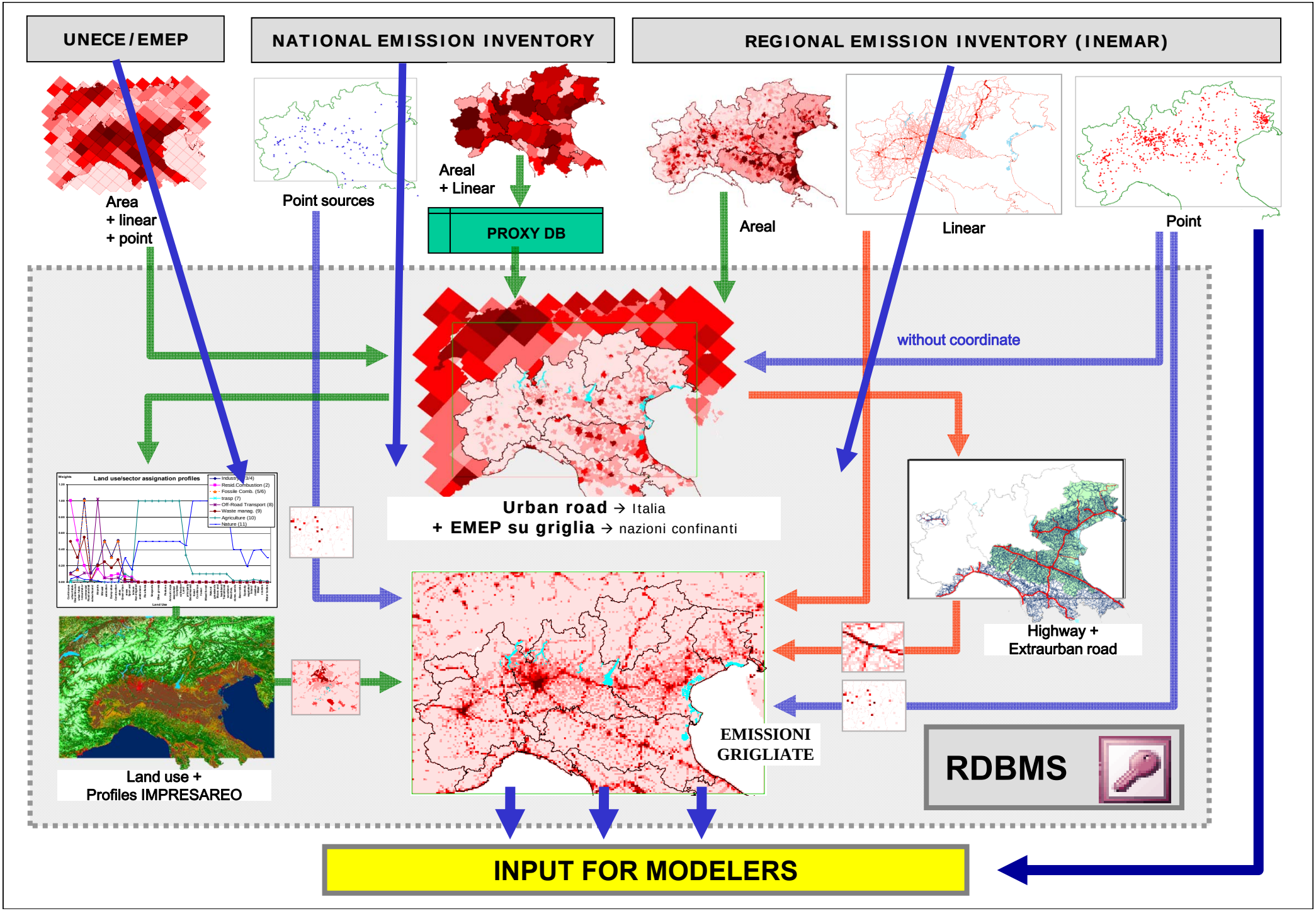
FDDA of analysis and observations in MM5 decrease of BIAS in wind speed by 50% both for winter and summer

→ *the more observations the best the result (gdobsfdda)*

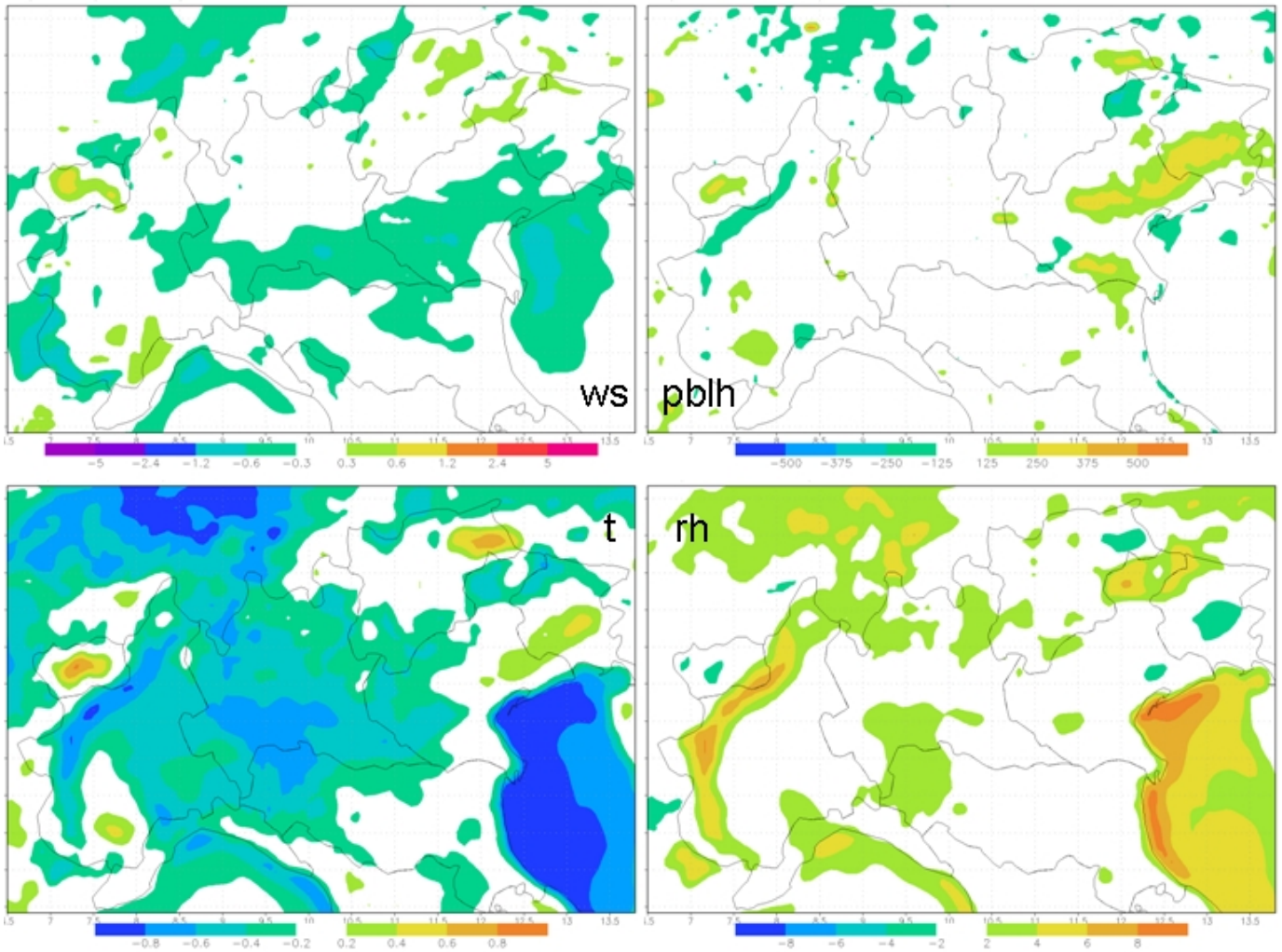
Increase of modelled PM10 by CHIMERE up to 20µg m^{-3} on stations in central Lombardy (Milan area) in January 2005.

For Ozone the dependence on wind speed is limited as expected, with little variation due to nudging. Dependency on wind direction and precipitation can be important on specific events and is difficult to catch (in different place and/or in different time).

The nudged version of MM5 can be used for 'perturbation' study on specific episodes to gain more insight on modelled O_3 behavior.


UNECE / EMEP
NATIONAL EMISSION INVENTORY
REGIONAL EMISSION INVENTORY (INEMAR)
Area
+ linear
+ point
Point sources
Areal
+ Linear
PROXY DB
Areal
Linear
Point
without coordinate
Urban road → Italia
+ EMEP su griglia → nazioni confinanti
Land use/sector assignation profiles
Industry (3/4)
Resid.Combustion (2)
Fossile Comb. (5/6)
trasp (7)
Off-Road Transport (8)
Waste manag. (9)
Agriculture (10)
Nature (11)
Land use +
Profiles IMPRESAREO
Highway +
Extraurban road
EMISSIONI
GRIGLIATE
RDBMS
INPUT FOR MODELERS

Meteo summary variation



June 2005 difference of meteo parameters at 15LT