An air quality forecast service over Europe and Italy driven by Copernicus data

Sandro Finardi

QualeAria
air quality forecast system

- Meteorological downscaling & air quality forecast

- Built from experience gained in: national project MINNI, EU research projects FUMAPEX and MEGAPOLI, COST Action ES0602-Chemical Weather

- Operational at ARIANET since 2007, continuously maintained and improved

- Results available on the web: http://www.qualearia.it/

- **Daily data provided as boundary conditions to regional/urban forecast systems**

- Accumulated data bases for off-line studies

www.qualearia.it
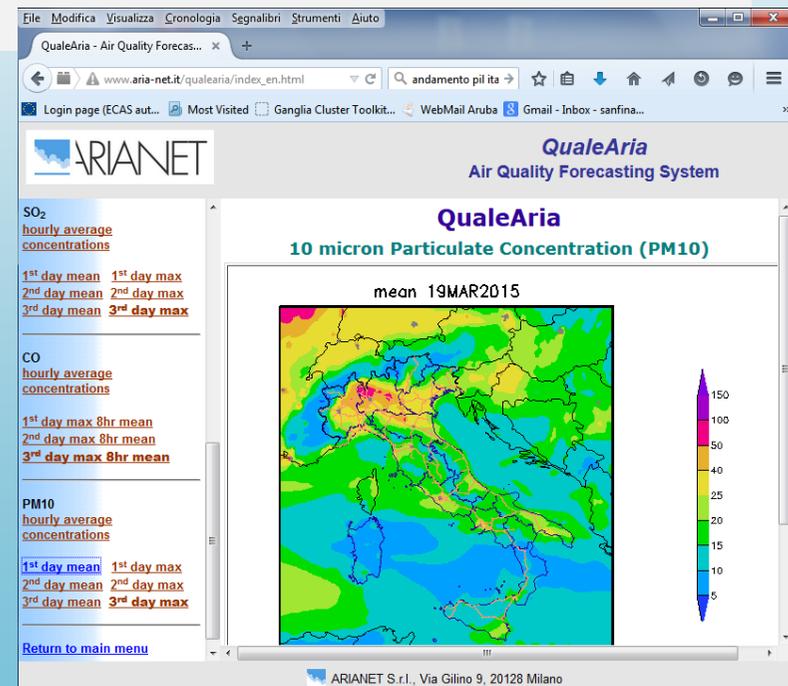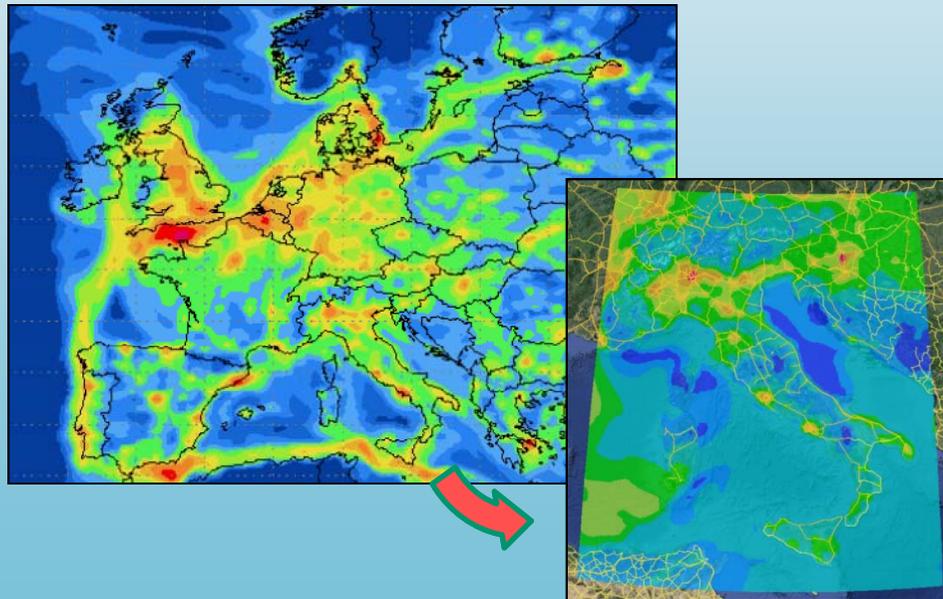
QualeAria workflow
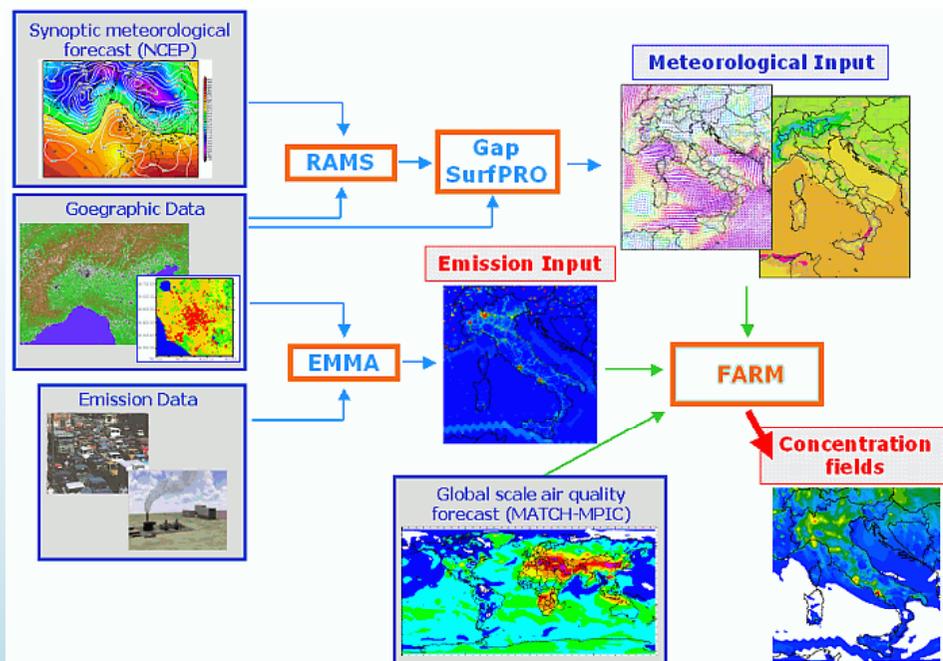
RAMS/WRF weather forecast downscaling;

Eulerian chemical transport model **FARM**

FARM is freely distributed through CINECA HPC-Forge (https://hpc-forge.cineca.it)

Nested grid system

5 days forecast

2 nested domains **48 km** and **12 km** horizontal resolution (two-way nesting) **16 vertical layers** up to 10000m.

Boundary conditions:
GFS, **United States weather service (NCEP)**
Global Air Quality forecast **MACC-Copernicus** *(through Forschungszentrum Jülich data server)*

Description included in: Kukkonen, et al., 2012: A review of operational, regional-scale, chemical weather forecasting models in Europe, Atmos. Chem. Phys., 12, 1-87.)

Emissions treatment


National inventory (ISPRA2010)

European inventory (TNO/MEGAPOLI)
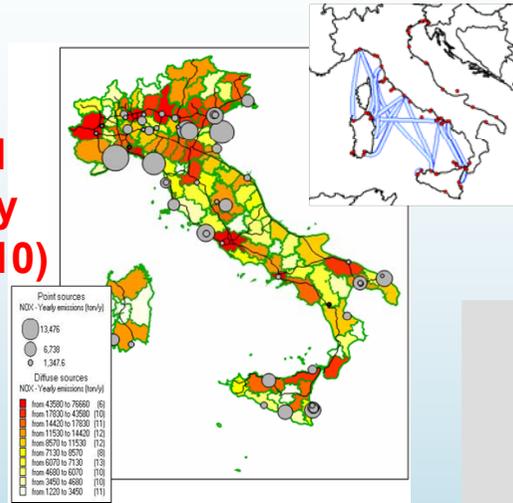
merge, spatialization, time modulation & speciation

CTM input
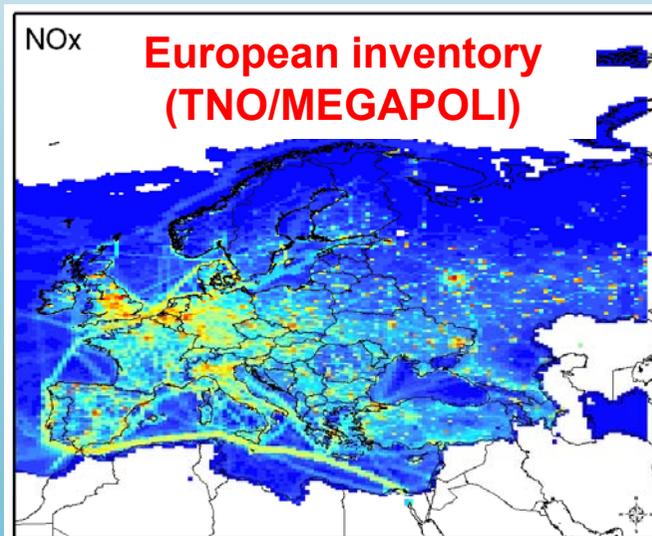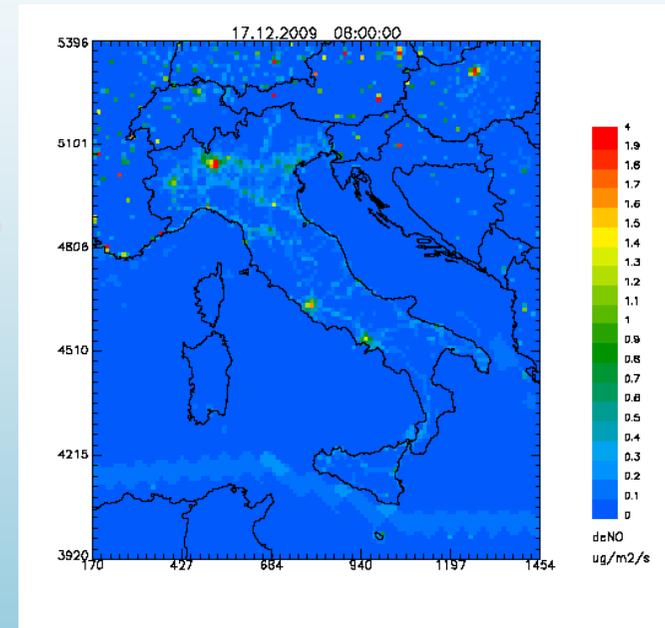
To be updated with MACC-III emissions

Regional/urban forecast & NRT systems using FARM

Driven by QualeAria BCs

VALLE D'AOSTA

FRIULI V.G.

TORINO

LOMBARDIA

ROMA

NAPOLI
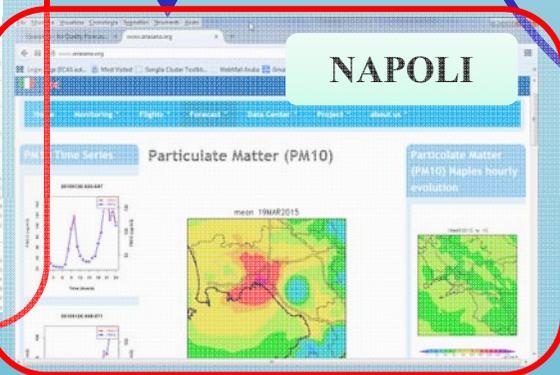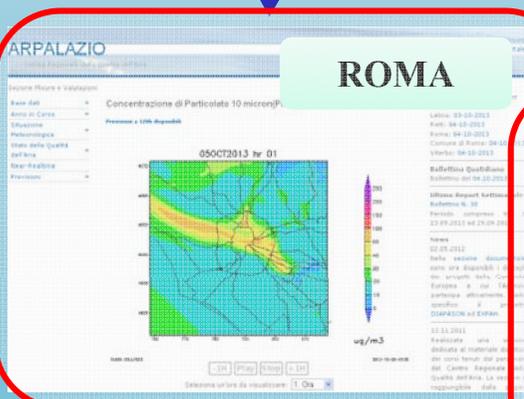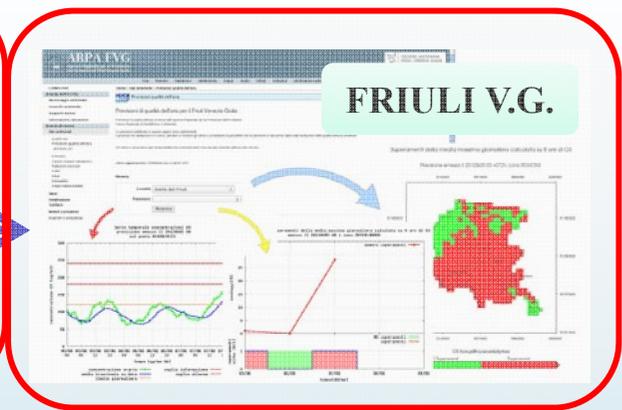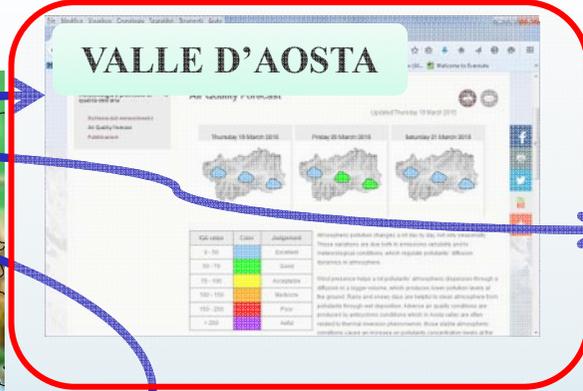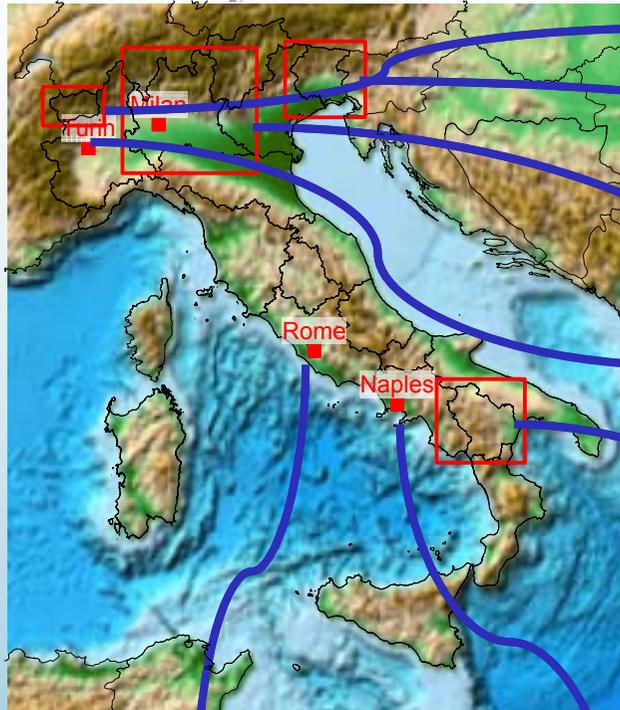
BASILICATA
Still unpublished

Forecast Performance Evaluation
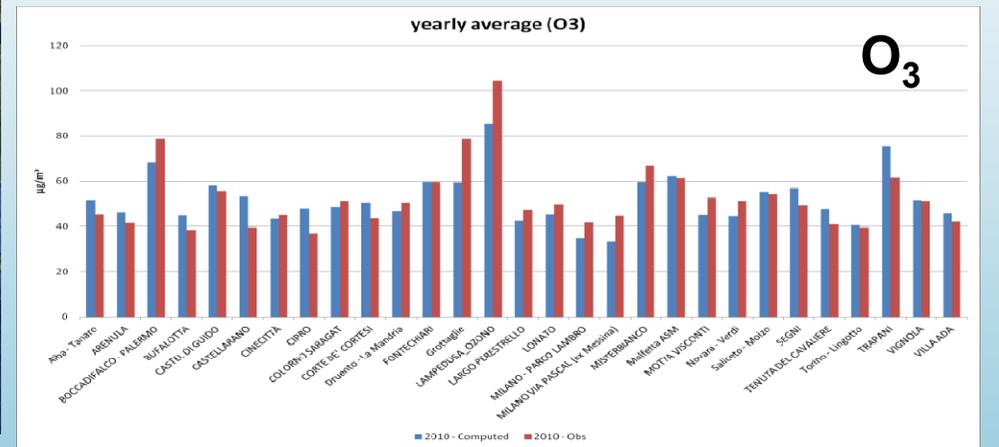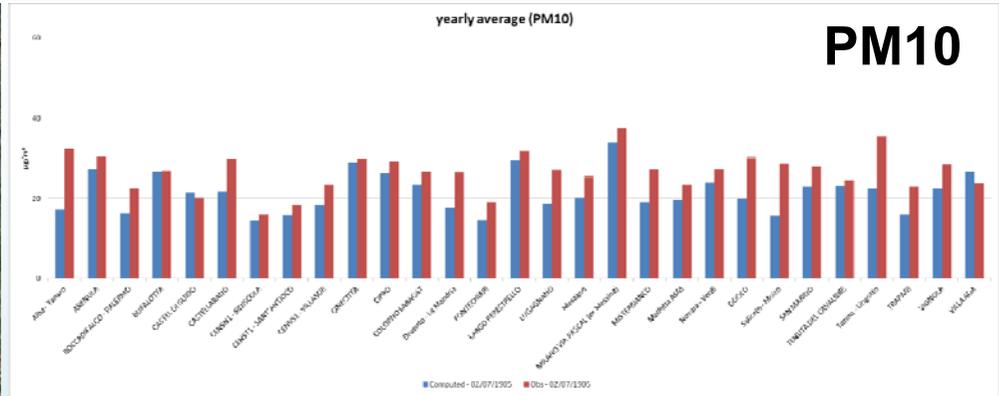
Reference year **2010**

Measurements **BRACE** (www.brace.sinanet.apat.it) Italian national data base
Selected **rural or urban background** stations

PM10 and ozone yearly average concentrations.

2010 - PM10 Daily Average
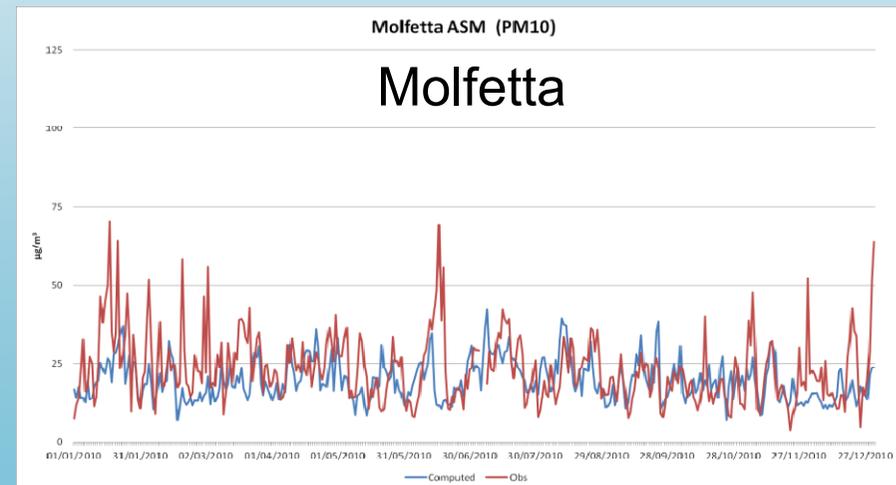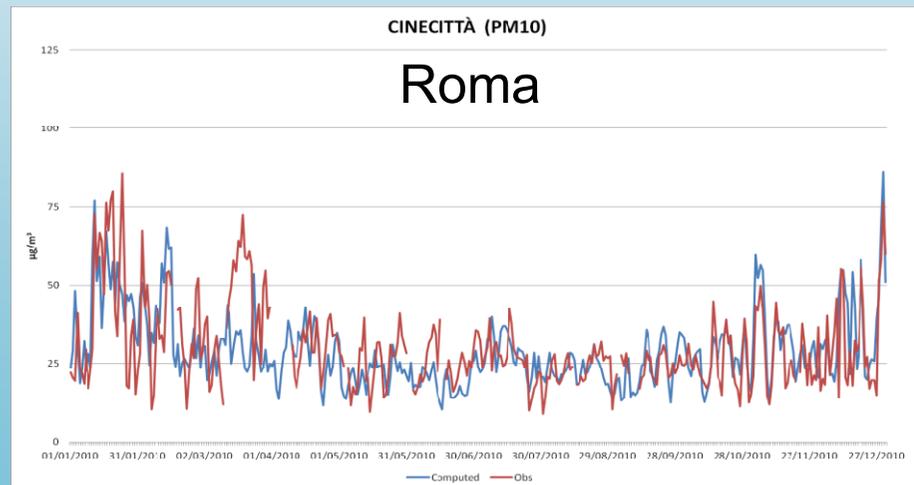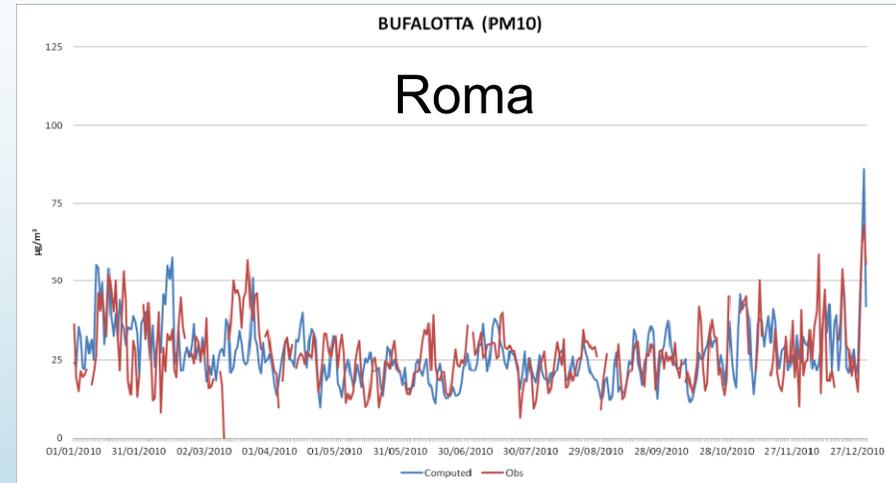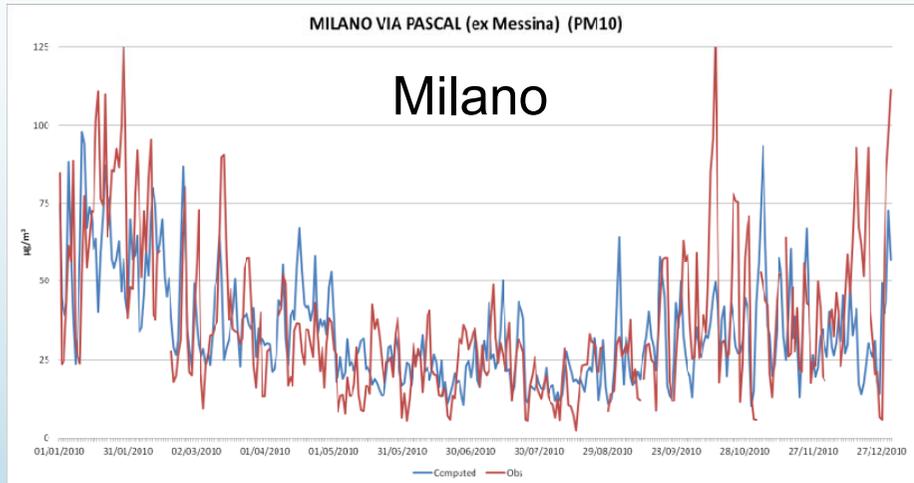
London PM10 EPISODE April 2015

PREV'AIR Analysis

MACC ensemble forecast

QualeAria forecast
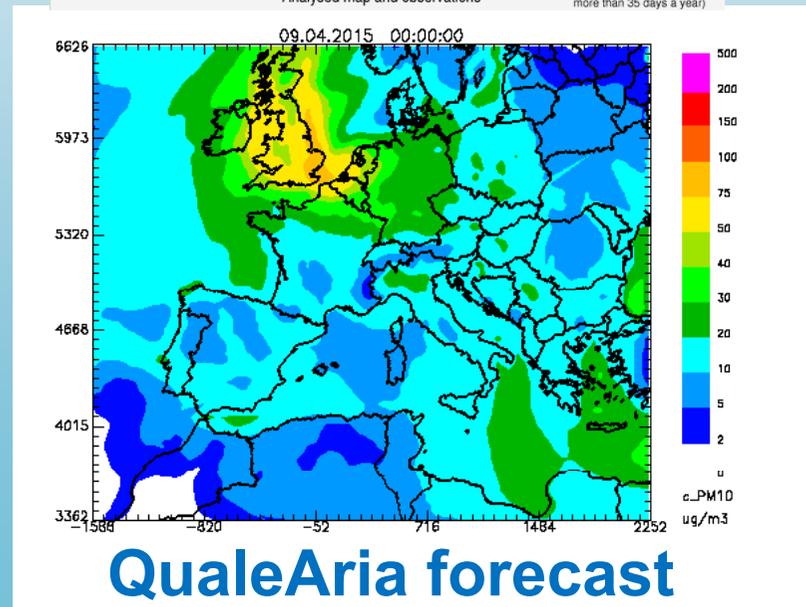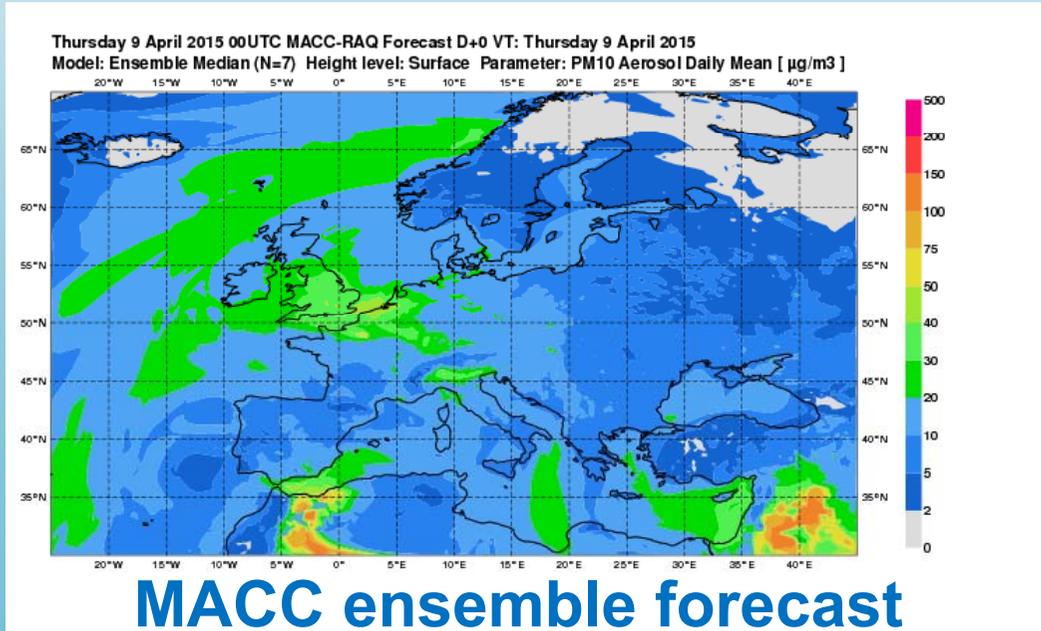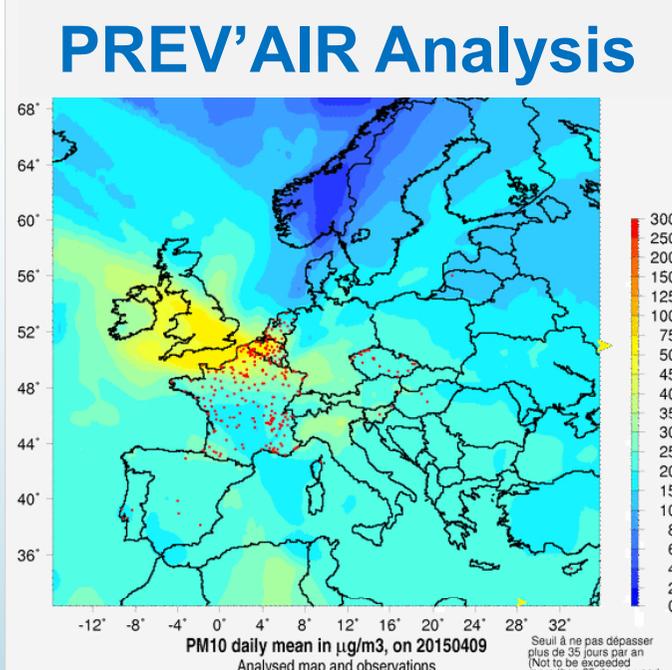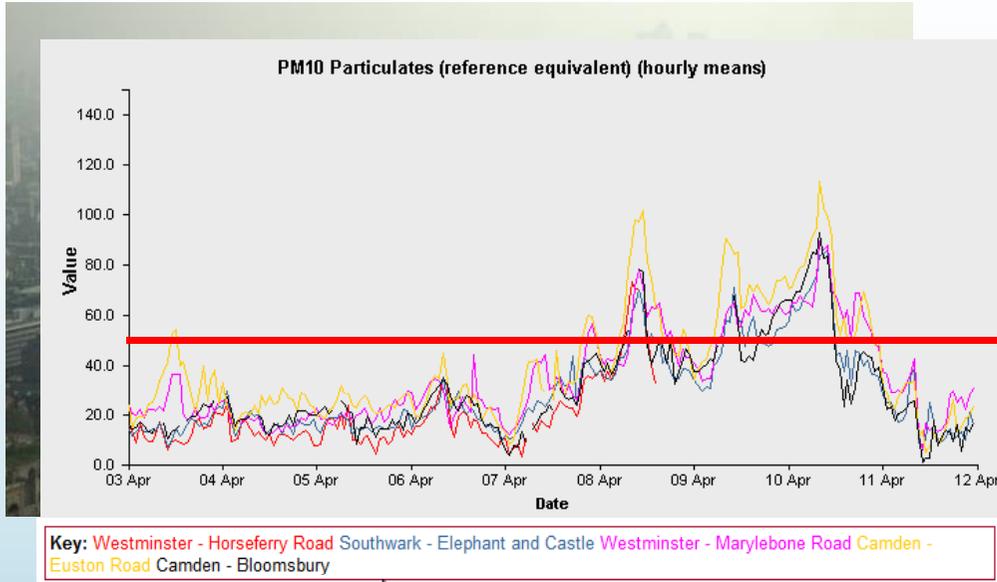
Paris PM10 EPISODE March 2014

PREV'AIR Analysis

PM10 daily mean in μg/m3, on 20140314
Analysed map and observations

Seuil à ne pas dépasser
plus de 35 jours par an
(Not to be exceeded)
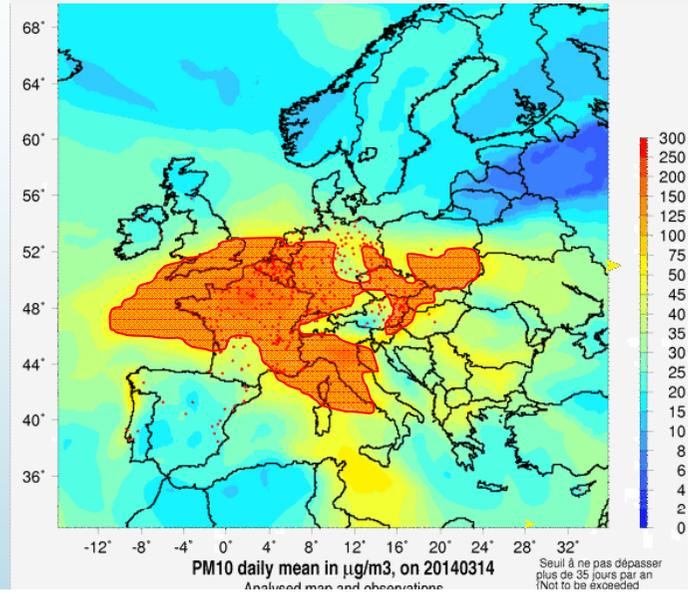
Friday 14 March 2014 00UTC MACC-RAQ Forecast D+0 VT: Friday 14 March 2014
Model: Ensemble Median (N=6) Height level: Surface Parameter: PM10 Aerosol Daily Mean [μg/m3]
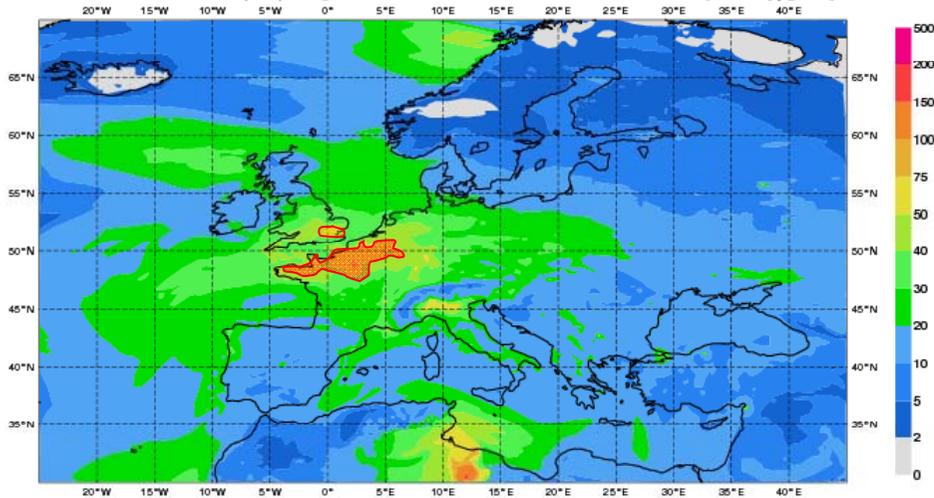
MACC ensemble forecast

mean 14MAR2014
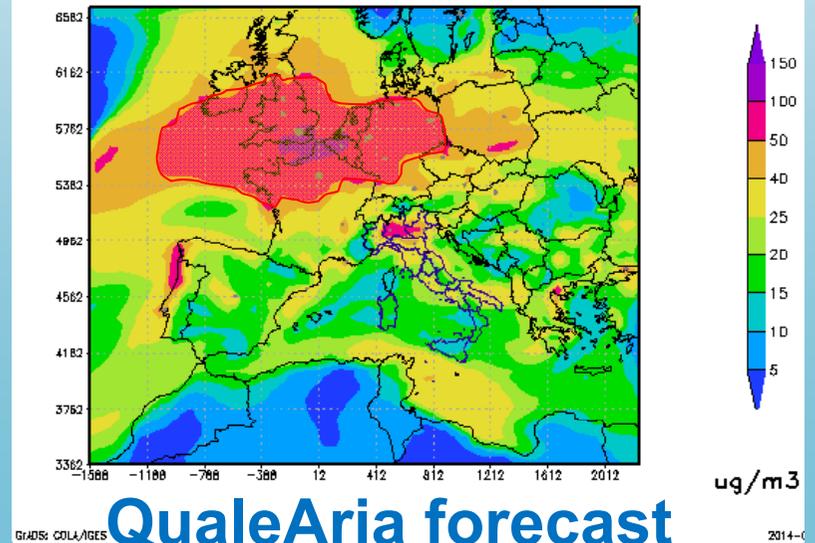
QualeAria forecast

Saharan Dust Episode 5-6/05/2015

medie giornaliere PM10 Roma
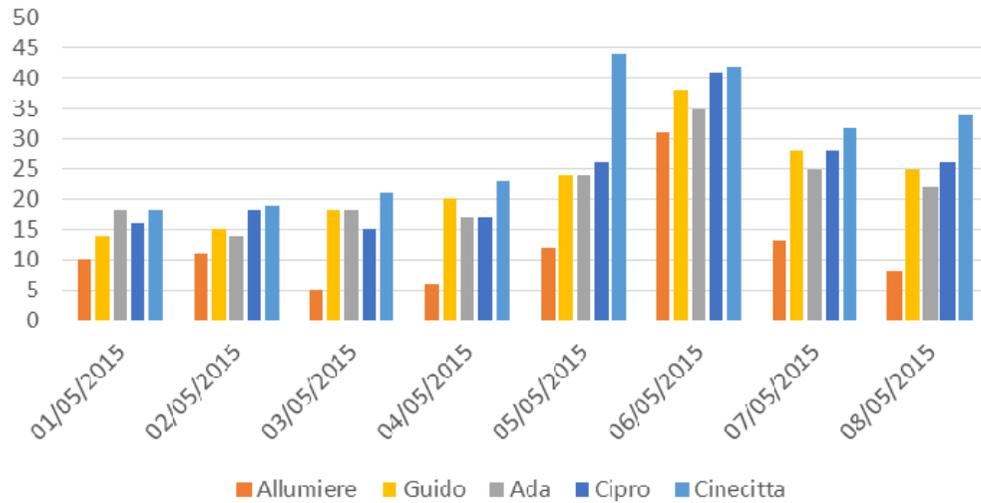
Allumiere · Guido · Ada · Cipro · Cinecitta

MACC-AOD
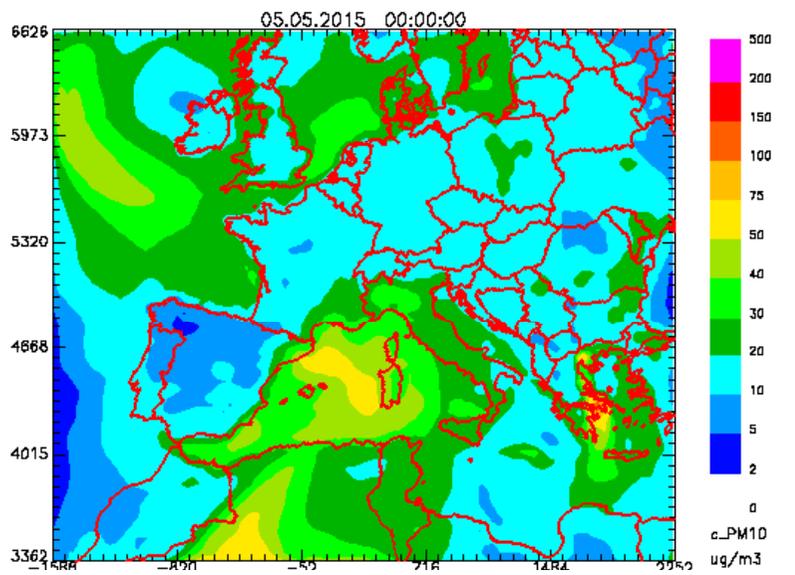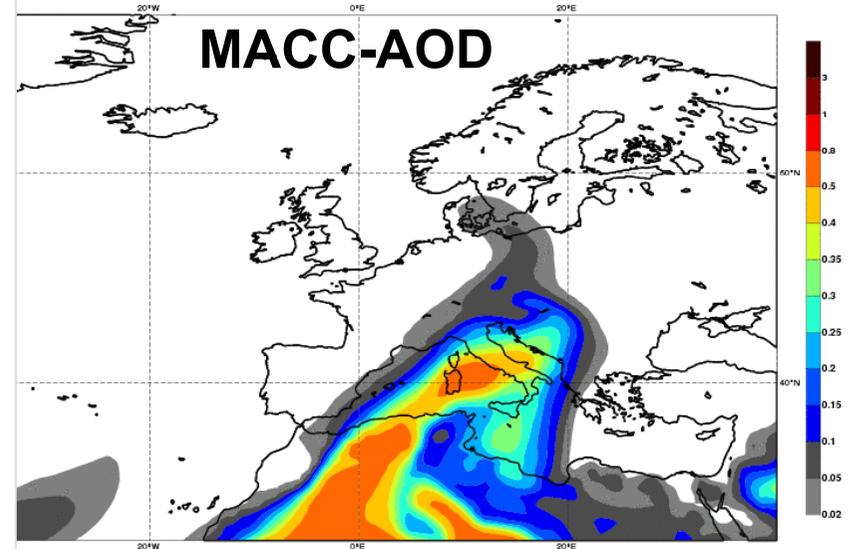
QualeAria PM10 forecast
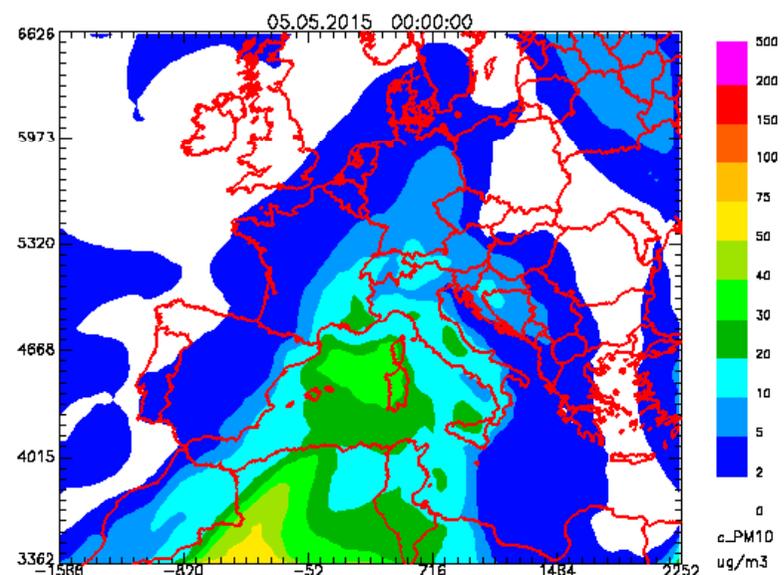
MACC BCs contribution

Resolution effect on air quality forecast

National vs urban scale - Rome

MATCH-MPIC
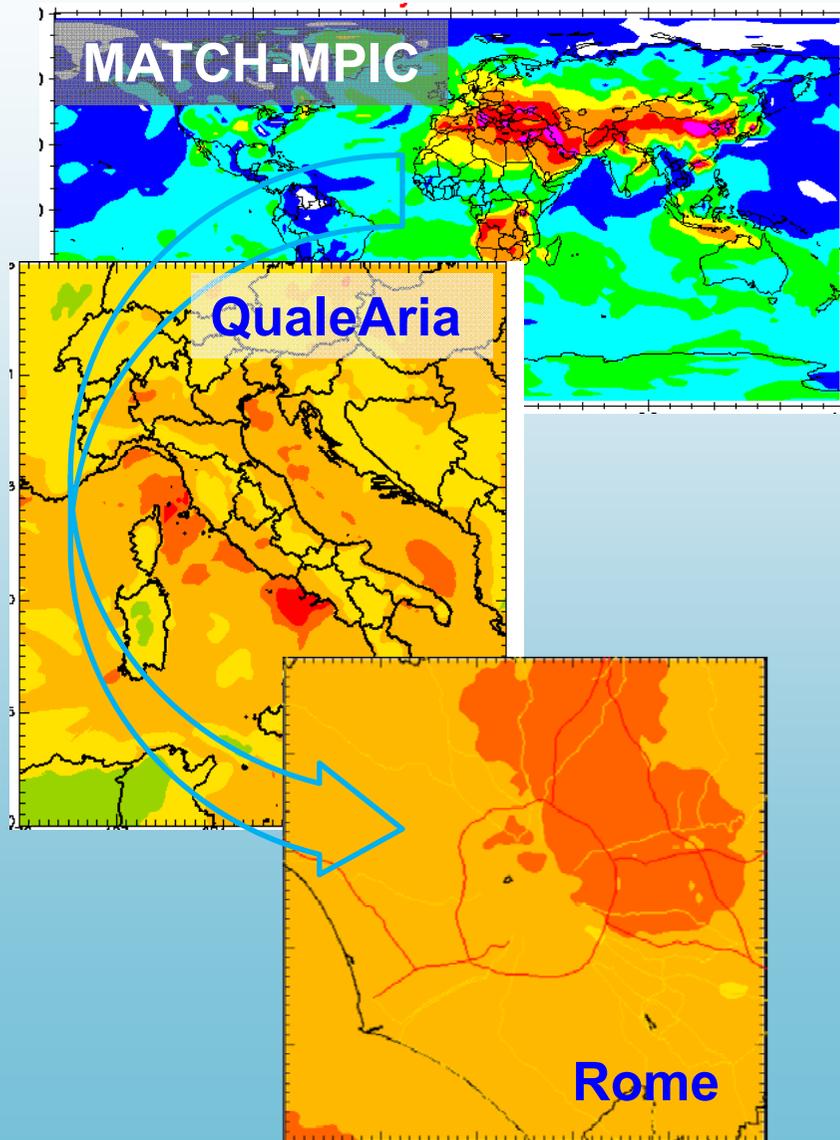
QualeAria

Rome

ARPA Lazio forecast system

- Same Modelling System of QualeAria
- 2 nested domains: 4 and 1 km horiz. grid spacing

EMISSIONS

- Local emission inventory (point sources, ports, etc.)
- Bottom-up traffic emissions from Rome Mobilty Agency fluxes using COPERT IV.

BOUNDARY CONDITIONS from QualeAria

NO_X ton/km/y

PM10 ton/y
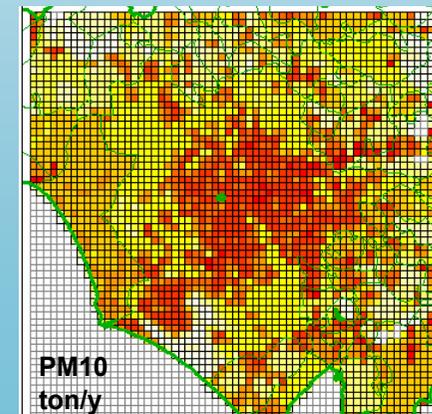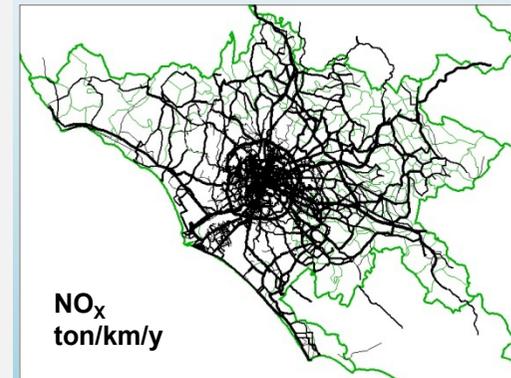
PM10 episode in Rome

January 2012
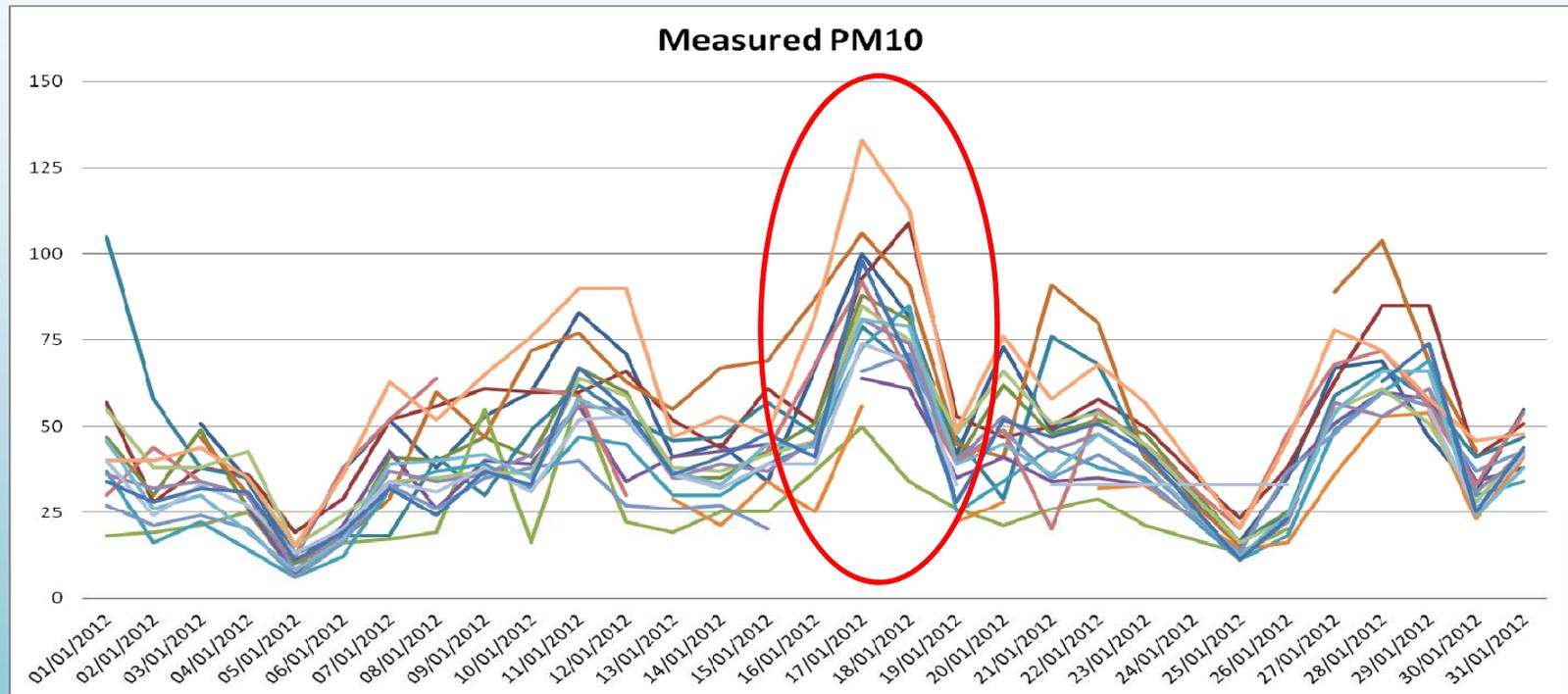
Measured PM10

PM10 EPISODE January 2012
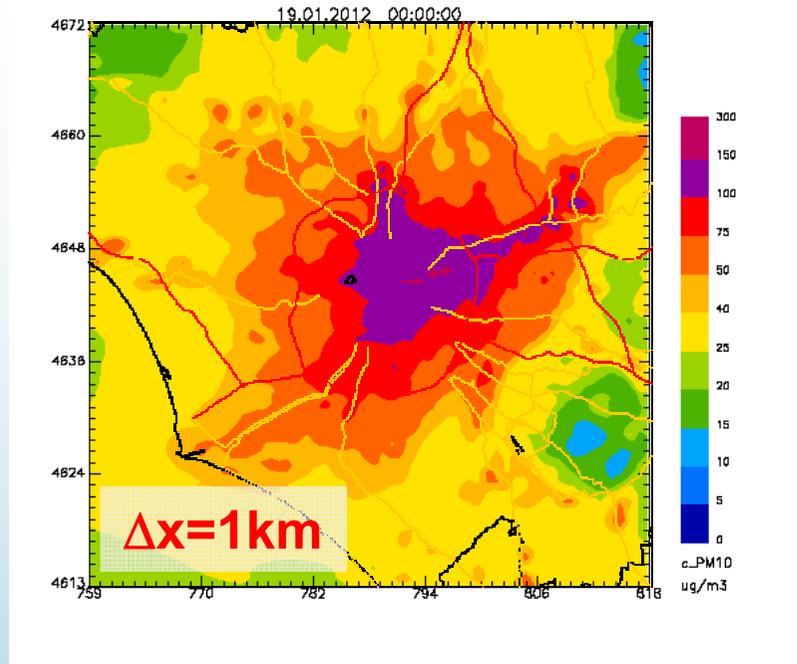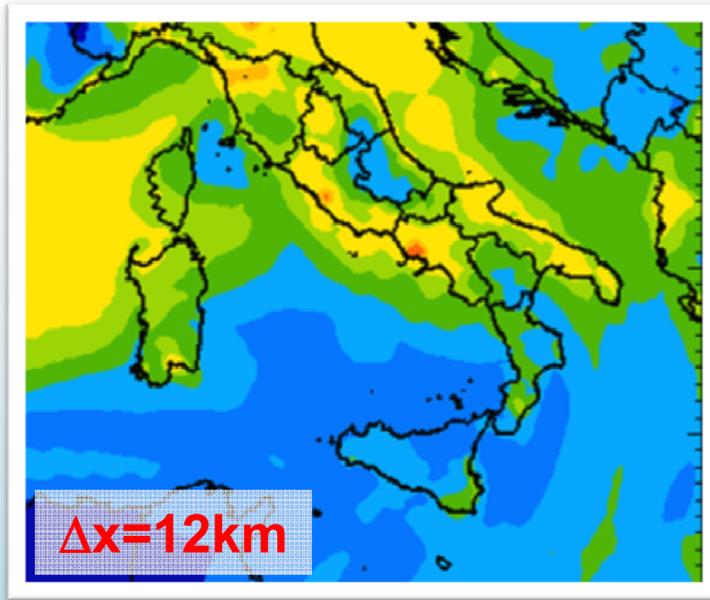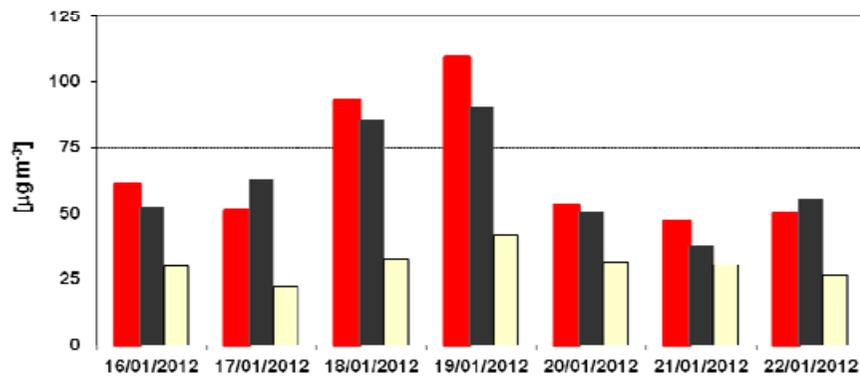
Use of MACC data

ARIANET
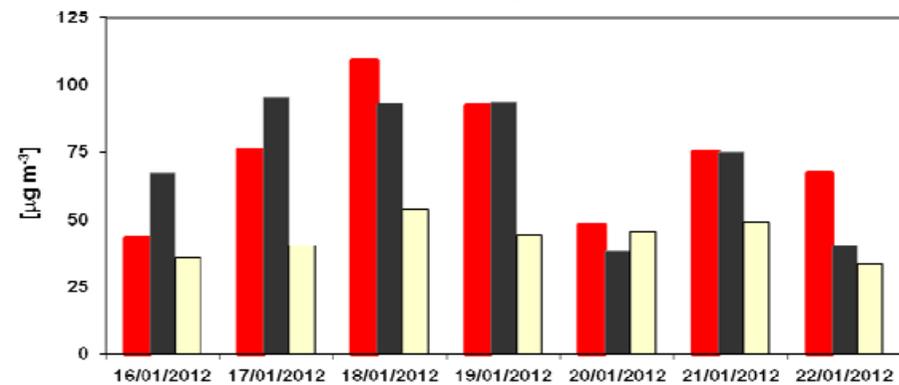
Access to data quickly opened after request

Global files (0.8°, 60 levels)

120 h forecast, 3h frequency

25 chemical species

Global Near-Real-Time Data Access

Data Access Options

Currently MACC-III provides its global NRT analyses and forecasts in three different ways:

Interactive data access to full dataset (ECMWF data server)

Select parameter

- Black Carbon Aerosol Opt
- GEMS Total column ozone

batch data access using ECMWF Web API web services;

ECMWF ftp server:

1025 files x day ~ 17 Gb (GRIB) ~ 12 Gb (netCDF)

No geographic subsetting facilities

Download feasible only by very fast net. connections

Operationally suppor

```
305280 May 14 20:18 z_macc_
305280 May 14 20:16 z_macc_
207096 May 14 20:14 z_macc_
305280 May 14 20:17 z_macc_
207096 May 14 20:18 z_macc_
305280 May 14 20:18 z_macc_
207096 May 14 20:21 z_macc_
305280 May 14 20:18 z_macc_
```

GRIB and NetCDF format;

Interactive data a

Catalog: MACC_fnyp_fc-3hourly_

Selection by mask   Selecti

Year: 2014   Month: 05

Forschungszentrum Jülich data server:

OGC Web service: subsetting, species and time window selection, file aggregation choices

~ 900 Mb x day (netCDF)

Operational download feasible with ADSL net

Conclusions

- ✓ QualeAria is a working forecast system is driven by Copernicus global forecast

- ✓ The European scale results are qualitatively comparable to the Copernicus Ensemble models results

- ✓ QualeAria uses the national model MINNI, implements national emissions (ISPRA2010) and shares FARM model with some Italian institutional users

- ✓ High resolution downstream applications are necessary to obtain reliable urban scale forecast

- ✓ Can we start from *our experiences* to build a collaborative project for a national active contribution to Copernicus?