

# **Servizio Monitoraggio dell'Atmosfera (CAMS)**

*Marco Deserti*

*Responsabile Centro Tematico Regionale Qualità  
dell'Aria di ARPA Emilia Romagna*

## **Seminario**

**Servizi e Collaborative Ground Segment del  
Programma Copernicus**

10 giugno 2015

ROMA Presidenza del Consiglio dei Ministri



# Contenuti:

- potenzialità e criticità del Servizio CAMS,
- livello di risposta ai requisiti dell'utenza,
- potenziali sinergie
  - a) tra i Servizi Copernicus
  - b) con progetti nazionali ed europei in essere
- Possibili linee di indirizzo nazionali per massimizzare il ritorno degli investimenti.
- Questioni aperte per la discussione



# IL SERVIZIO CAMS



# CAMS PRECURSOR PORTFOLIO



## AIR QUALITY AND ATMOSPHERIC COMPOSITION

European air quality analyses, forecasts and assessments in support of reporting and policy making, pollen forecasts, global transport of constituents/pollutants...



## CLIMATE FORCING

Distributions of aerosol components and their radiative impacts, *other radiative forcings*...



## OZONE LAYER AND UV

Monitoring and forecasting of the ozone layer / hole, UV index, *UV radiation (crops, ecosystems)*...



## SOLAR RADIATION

Estimates of solar irradiance at surface, improved potential yield assessments for solar plants...



## EMISSIONS AND SURFACE FLUXES

Estimates of human emissions globally and in Europe (high-resolution), emissions by wildfires, surface fluxes of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O...

## 2015: a year of transition for CAMS

- ★ Service continuity for the existing users
  - ★ Pre-operational service operated and funded by CAMS (ECMWF) and MACC-III (non ECMWF partners) until 30 June 2015
  - ★ Short ad-hoc contracts until operational procurements are in effect
- ★ Procurements in 2015
  - ★ 17 competitive procurements launched in Q1 and Q2 2015 (3-year contracts)
  - ★ 7 directly negotiated procurement (in situ observations, international networks)
- ★ Ramp-up to operations
  - ★ Progressive upgrade to operational status of production activities at ECMWF
  - ★ Hand-over from MACC-III partners to CAMS providers in Q4
  - ★ Establishment of CAMS core documentation (URDB; URAD; SPP; SES)
  - ★ By the end of 2015, full operational budget spending rate established (12M€/y)

<http://www.copernicus.eu/main/tenders-grants>



# POTENZIALITÀ E CRITICITÀ DEL SERVIZIO CAMS



# Potenzialità:

- CAMS offre il miglior livello di servizi ad oggi realizzabile a scala globale e continentale
- utilizza una grande quantità di dati osservati integrati con modellistica numerica avanzata
- ha richiesto e continua ad assorbire notevoli risorse finanziarie,
- rappresenta una opportunità imperdibile per SNPA (e non solo) per migliorare i servizi esistenti e svilupparne di nuovi



- 6 June 2014, Paris: MACC-II Second User Workshop, “The Italian users perspective on Atmospheric services by MACC-II”
- 26 June 2014, Rome: the results were reported to the meeting about Copernicus Atm. Services at the Italian “Presidenza del consiglio dei ministri”.
- 7 January 2015, Paris: “special workshop on the use of MACC European data as boundary conditions for downstream modeling”
- 3 - 4 March 2015 in Wien, the “ second policy user workshop”,
- 11 May 2015, Rome, “user meeting”





Home &gt;

**Home**

[News](#)  
[Press Room](#)  
[About the Project](#)  
[Contact us](#)  
[Jobs](#)

**Today's Forecasts**

[Reactive Gases](#)  
[Aerosols](#)  
[European Air Quality](#)  
[UV Index](#)  
[Ozone Layer](#)  
[CO2](#)

**Latest Analyses**

[European Air Quality](#)  
[Fire Monitoring](#)  
[Reactive Gases](#)  
[Aerosols](#)

**LATEST** [MACC-III User Workshop](#)
**Air Quality and Atmospheric Composition**

**Climate Forcing**

**Ozone Layer & UV**

**Solar Radiation**

**Emissions and Surface Fluxes**
Home > [News](#) > [MACC-III User Workshop](#) >**MACC-III User Workshop**

On 11 May MACC-III organized, in collaboration with the Italian user community, its third User Workshop. The meeting took place in Rome and attracted more than 70 participants from across Europe.

The day started with presentations about the MACC-III products with a focus on regional aspects, user interaction, and the transition to the Copernicus Atmosphere Monitoring Service. The rest of the morning consisted of application presentations by some non-Italian users. The afternoon was used for a diverse range of presentations from Italian MACC-III users.

Both presentations and ensuing discussions provided a very interesting picture of the many uses of MACC-III products as well as of where there is room for further improvement. All presentations are available from the [MACC-III web site](#).

**User Support**

[Documentation](#)  
[Validation](#)  
[E-learning](#)  
[Mailing Lists](#)  
[Operational Info](#)

**Services**

[Air Quality & Atmospheric Composition](#)  
[Climate Forcing](#)  
[Ozone Layer & Ultra-Violet Radiation](#)  
[Solar Radiation](#)  
[Emissions & Surface Fluxes](#)



MACC-III is  
It is coord

rogramme.  
nsortium.

# Expected objectives of the MACC III user workshop

- Inform the potential community of Italian users about the services that are and will be available by CAMS;
- Encourage and promote the development of downstream service at various levels: institutional, research, commercial;
- Identify/suggest the needs of Italian institutional users;
- Define a common working program in order to satisfy the needs by a collaborative activity between the Italian users community and the group developing Copernicus services;

These objectives can lead to the development of new enhanced tools for air quality assessing and forecasting in Italy, starting from the current situation characterized by a wide set of operational models already run by Italian users.



# Requisiti utente (SNPA)

- **Short term air quality forecasts:** most Italian regions have implemented an air quality forecast service, for communication purposes, and in some cases also for management of air pollution episodes [**Product: AQ Europe forecast**]
- **Assessment of air quality and population exposure** (on daily, seasonal and annual basis). Several applications: compliance with legislation, air quality plans, background concentration fields for the evaluation of specific emitting sources. This requires homogeneous spatial coverage and high resolution (often 1 km or less), and is by far the most pressing issue. This kind of product is presently available only in parts of Italy. [**Product: AQ Europe analysis and reanalysis**]
- **Evaluation of future scenarios.** Several applications: design and evaluation of air quality plans, future trends in emissions and AQ, evaluation of new emission policies (e.g. plans for energy production), effects of climate change on air quality, integrated evaluation of air quality and carbon footprint. [**Product: AQ Europe, Policy tools: assessment reports, scenarios, S-R models**]



# I MODELLI LOCALI (Operational CTMs in Italy)

Italian regional environmental agencies (ARPA) have implemented 8 different CTMs:

- they cover different parts of Italy, with a resolution of 5 km or less
- they are used for daily (operational) forecasts, AQ assessment and scenario analysis
- they could be the basis for local-scale, high-resolution ensemble

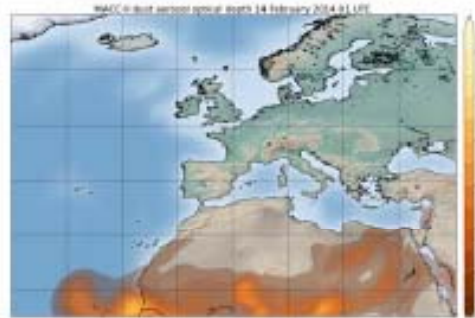
<u>Region</u>	<u>Model</u>	<u>Resolution</u>	<u>Domain</u>	<u>Boundary conditions</u>	<u>Meteorology</u>
Piemonte	FARM	8 to 1 km	N. Italy + zoom	Chimere (INERIS)	Cosmo
Lombardia	FARM	4 km	Part of N. Italy	Chimere (INERIS)	ECMWF
Veneto <sup>1</sup>	CAMx	4 km	Part of N. Italy	Chimere (INERIS)	Cosmo
Friuli	FARM	4 km	Part of N. Italy	FARM (AriaNet)	WRF
Emilia Rom.	Chimere	5 km	Northern Italy	Chimere (INERIS)	Cosmo
Umbria <sup>2</sup>	Chimere	5 km	Central Italy	Chimere (INERIS)	Cosmo
Lazio <sup>2</sup>	FARM	4 to 1 km	C. Italy + zoom	FARM and Chimere	RAMS
Campania <sup>2</sup>	Chimere	5 km	Part of S. Italy	Chimere (INERIS)	Cosmo

(1) pre-operational model

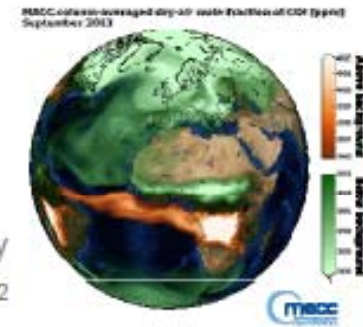
(2) model not included in LIFE proposals



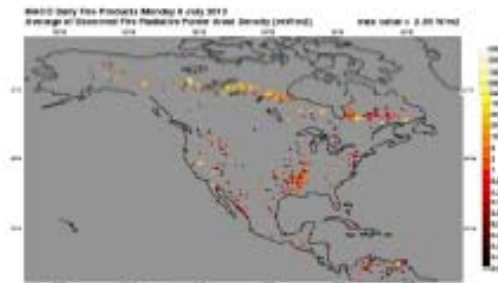
# Air Quality: global model



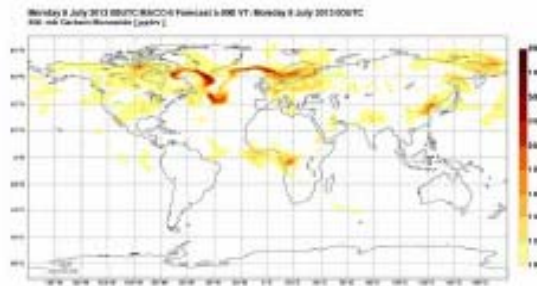
Daily 5-day forecasts of desert dust



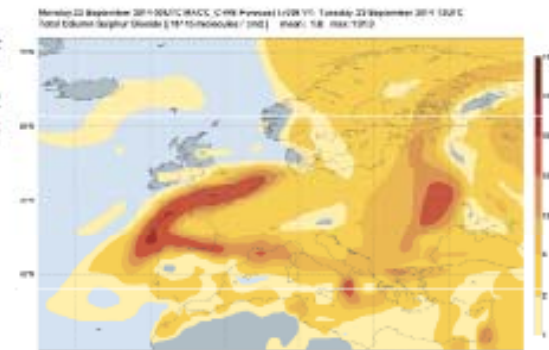
Daily 10-day forecasts of CO<sub>2</sub>



Daily estimates of fire emissions feed into forecast of smoke.



Forecasts of volcanic SO<sub>2</sub> plumes

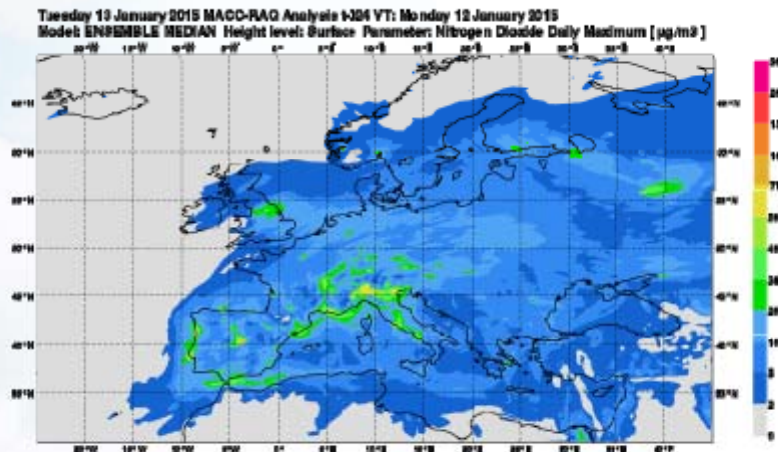


ECMWF's IFS system has been extended to include aerosols, chemical species, and greenhouse gases : **Composition-IFS (C-IFS)**.








# Air Quality: RAQ models

## Regional services production

- Based on an ensemble of 7 models developed and run by European institutes for more than 10 years
- Covers a large European domain
- 0.1° resolution for the Ensemble products
- Daily forecasts and analyses + annual reanalyses
- Pollutants with regulatory limit values or quality objectives targeted : ozone, nitrogen dioxide, PM10, PM2.5
- The use of Ensemble products provides generally better performances than the individual models and the spread gives information on the uncertainties
- All data are free



## The regional air quality ensemble of models

		<i>Current geometry</i>	<i>Assimilation method</i>	<i>Operations</i>
<b>CHIMERE</b> INERIS, CNRS		0.1° , L8, top : 500hpa	Optimal Interpolation	run @ INERIS
<b>EMEP</b> met.no		0.25x0.125° , L20, top : 100hpa	Variational 3d-var	run @ met.no
<b>EURAD</b> FRIUUK		15km, L23, top : 100hpa	Variational, 3d-var	run @ ECMWF/FZJ
<b>L-EUROS</b> TNO, KNMI		15km, L4, top : 3.5km	Ensemble Kalman Filter	run @ KNMI
<b>MATCH</b> SMHI		0.2° , L52, top : 200hpa	Variational, 3d-var	run @ SMHI
<b>MOCAGE</b> MF, CERFACS		0.2° , L47, top : 5hpa	Variational, 3d-var	run @ MF
<b>SILAM</b> FMI		0.2° , L46/8, top : 100hpa	Variational, 4d-var	run @ FMI

# Boundary conditions for downscaling air quality modelling: rationale

1. Pollutants targeted by the Copernicus Atmosphere services in support to policy and health communities are
  - **Pollutants in regulatory fields or in the WHO guidelines for air pollution : O<sub>3</sub>, NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>**
2. Copernicus supports the **Ensemble approach** (giving better performances and an estimate of the uncertainties) which seems more relevant for policy makers
3. Chemistry–transport models used to downscale applications need chemical boundary conditions and their chemical schemes include more species than produced in MACC:
  - **Speciated VOCs for gaseous and particulate chemistry**
  - **PM compounds (inorganics, primary PM, natural dusts, sea salts)**

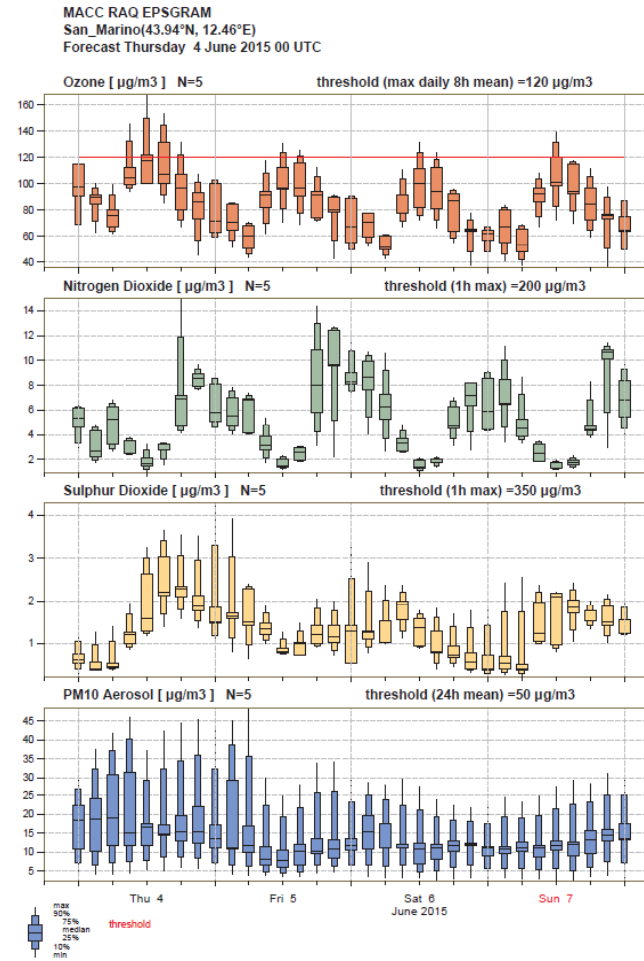
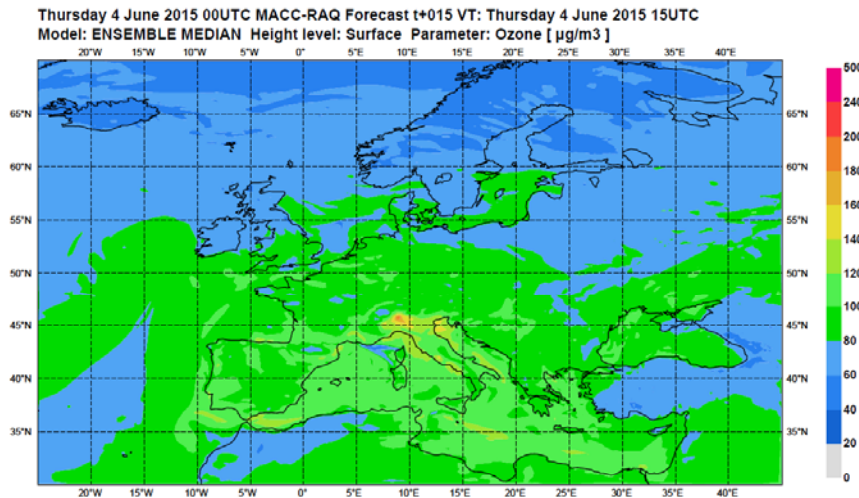


# LIVELLO DI RISPOSTA AI REQUISITI DELL'UTENZA



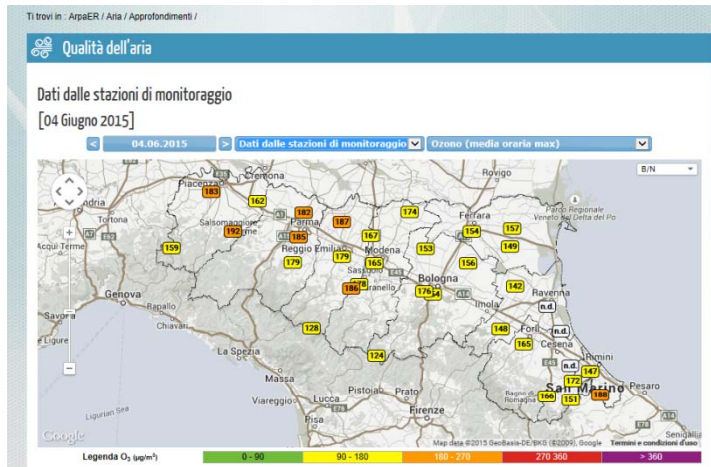
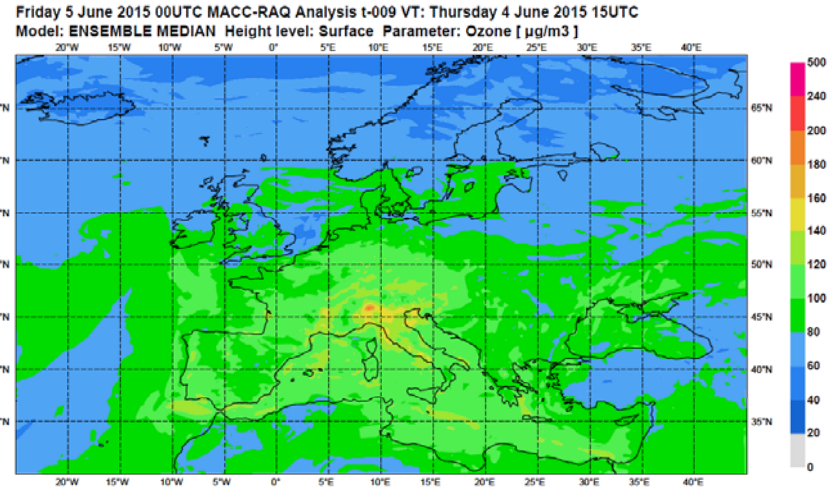
# Forecast products

- Can satisfy most of the needs of Italian users, but:
  - a quantitative verification of ENS performance in Italy is required;
  - post elaboration based on numerical data is required



# NRT analysis products

- To be improved:
  - ENS analysis of PM10 and PM2.5 are not yet produced;
  - horizontal resolution of 10 km is insufficient for most applications.
  - Post-processing is required



Idro-Meteo-Clima

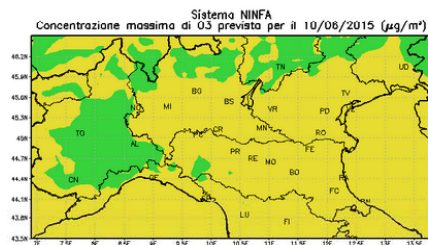
Idro-Meteo-Clima In breve Argomenti Allertamento meteo-idro

TemI ambientali Arpa in regione arpa ER

Previsioni di Qualità dell'Aria

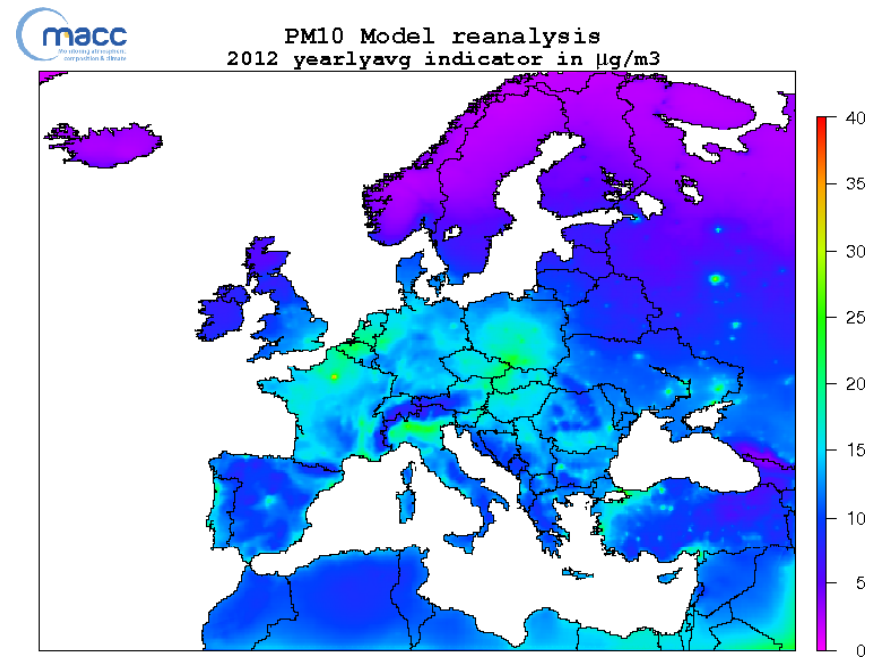
Ozono massimo giornaliero

Emisore e mese: 12 giugno 2015



# Re-analysis

- would be very useful for supporting the reporting about AQ assessment at national and local level but they should be produced in the first months of the following year when the assessment reports are due. (presently available until 2012);



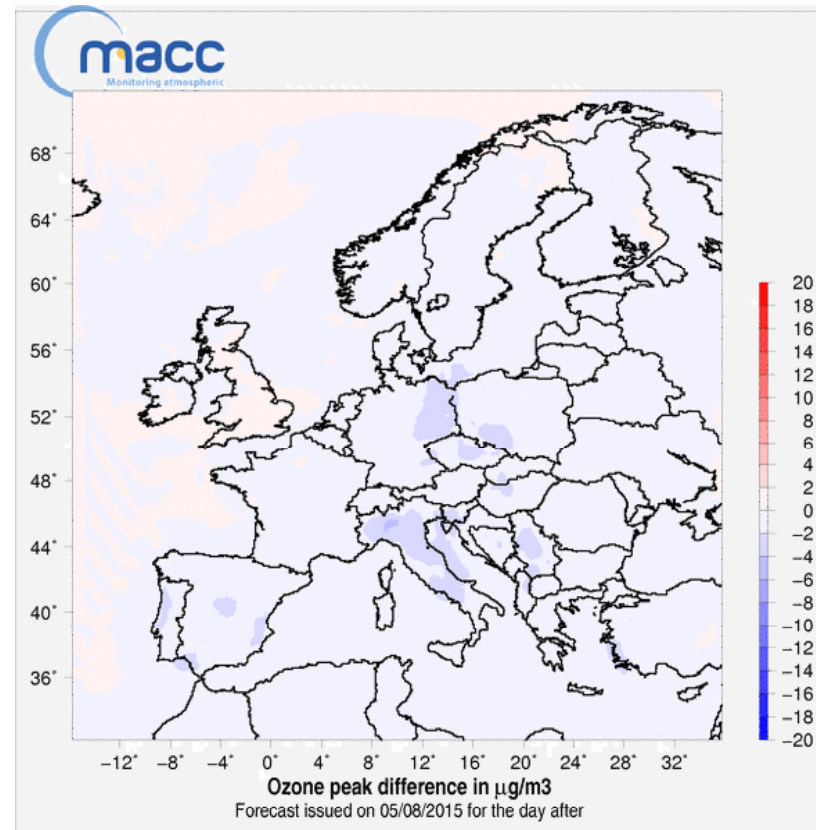
Re-analyses are mainly based on AIRBASE validated observation data issued from member states regulatory reporting ( according to the Air quality Directive). But AIRBASE validated data of the year Y

- Are reported by the member states by end of September of the year Y+1
- Are released by the EEA on February-March of the year Y+2
- Re-analysis products can not be achieved before summer of the year Y+2 -> **too long**

# Policy tools:

- **EU AQ assessment report:** can provide a general frame of reference for regional/local policies, no direct use;
- **Green scenarios:** would be useful but numerical data should be delivered for BCON to regional/local models in Italy;
- **Emissions inventory:** are used by some model suites in Italy, emissions scenarios corresponding to green scenarios can be helpful;
- **Country Source-receptor calculations (on-demand):** we need some more details.

Ozone daily peak difference (stra-ref)

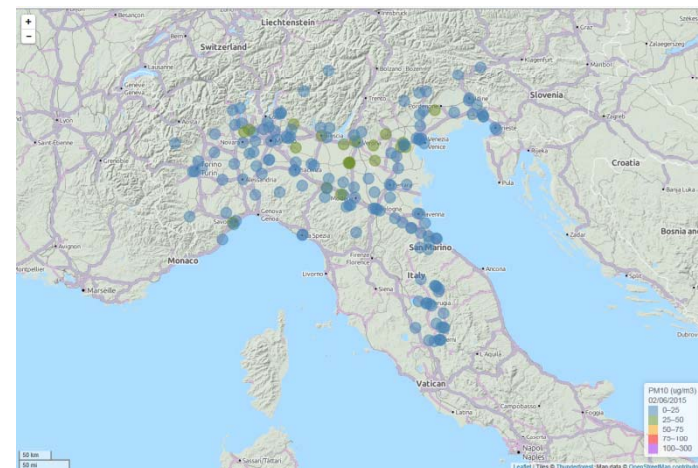
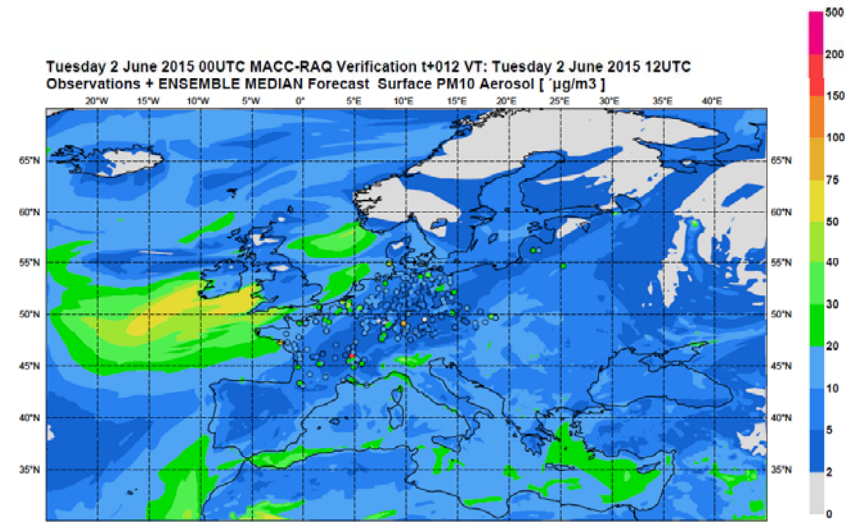


# Criticità: dati NRT per verifica e assimilazione

Air quality in Italy is affected by a great variety of conditions:

topography, urbanization (large areas of diffuse urbanization) and meteorology (regions with Mediterranean, continental, alpine climate); air stagnation in northern Italy, dust transport in southern regions; air pollution hotspots, both diffuse (Po Valley) and localized (large cities and industrial areas, eg. Taranto).

The peculiar characteristics of Italy may require a special verification, and possibly some tuning of CAMS models and Ensemble, especially if aerosols are considered



# Improvements to MACC products:

- near real time ENS analysis of PM10 and PM2.5;
- batch download (ftp) of real time MACC products on user-defined sub-domains (ensemble and single models, all fields presently disseminated);
- download of time series of real-time MACC products (web-accessible database, similar to those already available for global products);
- earlier production of ensemble re-analysis, ideally in the first months of the following year; it is acknowledged that this also depends on the time of availability of air quality observations;
- inclusion of observed daily PM10 concentrations in MACC operational verification (and possibly in data assimilation);
- improved documentation on the actual use of surface observations for data assimilation and verification of ensemble members;
- improved documentation on country source-receptor products.



## Possible extensions to MACC products, to be implemented upon appropriate “User License Agreements”:

- real time EPS-grams relative to a set of Italian cities. EPS-grams are presently produced for two Italian locations (Rome and S.Marino): plots for 20 more locations should be produced in real-time and made available for batch download;
- specific verification of MACC products over special areas (Italy, the Mediterranean), with focus on aerosol concentrations;





# Products required for air quality management in Italy using a national model

have direct access to:

- Near Real Time MACC 3d concentration fields from the global model to be used as boundary conditions for simulations to be performed at European scale and then focused over Italy at high resolution;
- MACC Emission inventory over Europe;
- Near real time meteorological fields from IFS as meteorological inputs;
- Near Real Time surface concentrations observations over the European domain to evaluate the model.

## Products required for air quality management in Italy that appear to be outside the scope of CAMS services:

- High resolution air quality analysis (maps of surface concentrations of the main pollutants, with a target horizontal resolution of 1 km, not requested in real time): this could be the object of an Italian downstream service, based on MACC products.
- Boundary conditions for high-resolutions CTM simulations at national or sub-national scale (needed for the evaluation of specific, user-defined emission scenarios): the limited number of chemical species available for both Ensemble and single models strongly limit the use of present MACC products for these applications.



# Recommendations:

- The data from Italian in situ monitoring stations:
  - year 2013 has been delivered to EEA by the national focal point (ISPRA) by the end of April.
  - It is strongly recommended that the next reanalysis products and verification report include the data from Italian stations.



# QUESTIONI APERTE PER LA DISCUSSIONE



# Conclusioni del workshop

- Il workshop ha definitivamente chiarito che i RAQ models non possono fornire ad oggi BCON ai modelli locali utilizzati dalle ARPA;
- Alcuni prodotti, eventualmente migliorati, possono essere usati tal quale o con opportune post elaborazioni;
- Per consentire il pieno supporto alle attività istituzionali è necessario introdurre un livello di servizi intermedio tra i prodotti CAMS ed i servizi locali prodotti dalle ARPA



# Attività conseguenti:

- Avviare la raccolta di dati NRT\* (entro le 10 del giorno successivo) dalle stazioni di monitoraggio
- Rendere i dati disponibili a EEA/Copernicus per verifica/assimilazione;
- Costruire un servizio di post elaborazione statistica dei dati Copernicus con dati osservati ;
- Implementare un servizio di modellistica operativa a scala intermedia tra il modello globale ed i modelli locali



## Postelaborazioni:

development of a downstream service: NRT analysis

*(an “use case” for Italy and/or Prepair project for Po Valley)*

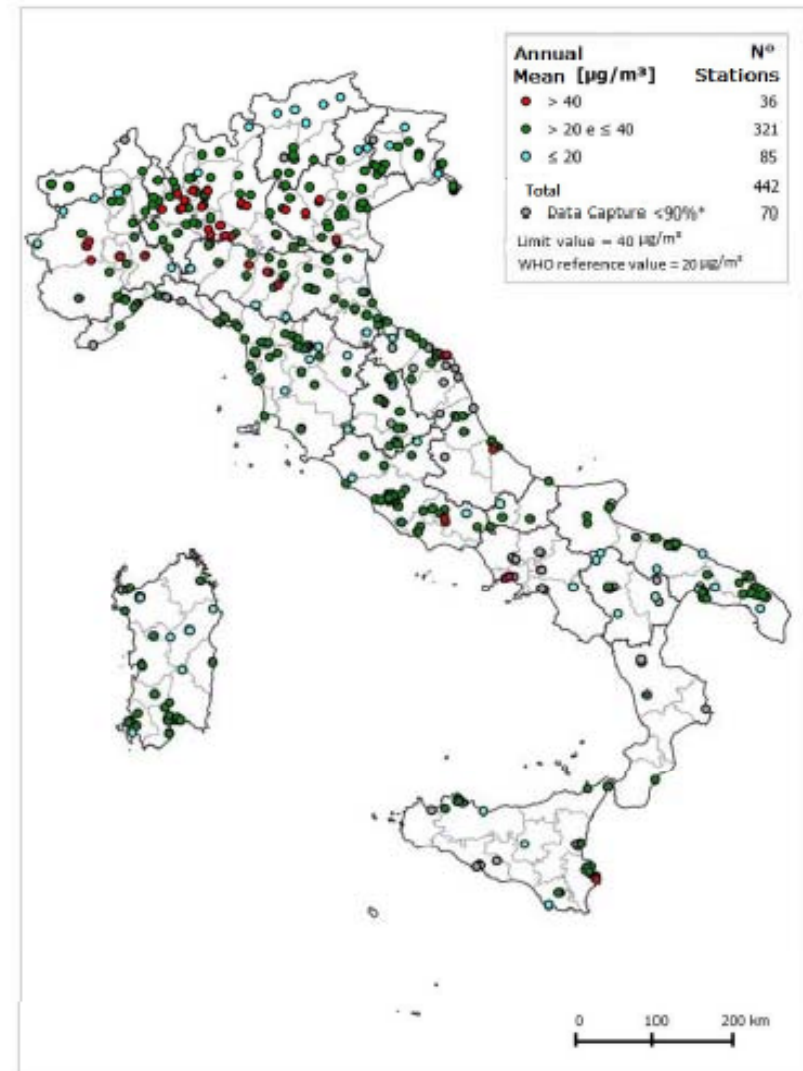
- A geo-statistical post-processing of CAMS-ENS or other CTM fields (data fusion) can be developed
- It would be an extension of services already available in some Italian regions (E-R, PI);
- based on background observations and proxy variables (emissions, elevation), with a target resolution of 1 km;



# NRT analysis:

a possible downstream service based on geo-statistical post-processing of CAMS-ENS:

- Italian monitoring networks are wide (\*), but it has often been difficult to gather a sufficient amount of homogeneous data
- for northern Italy, this issue will be addressed in the near future in project Prepair (if funded).
- (\*) 616 stations 2012





# Il servizio a scala intermedia (nazionale ?)

- Fornisce condizioni iniziali ed al contorno ai modelli regionali/locali anche operativi;
- Fornisce un servizio sussidiario nelle zone dove non sono disponibili modelli locali;
- esecuzione quotidiana per:
  - Previsioni (entro le 8)
  - Analisi NRT + post processing con dati osservati (entro le 10 ?)
- Esecuzione periodica e/o a richiesta:
  - Rianalisi annuale entro marzo
  - Scenari tendenziali secondo necessità



# Il servizio a scala intermedia (nazionale ?)

- BCON: Copernicus globale
- Input meteo: ECMWF + COSMO (I/Med)
- Input emissioni: Copernicus-EU+ISPRA-I
- Validazione e verifica regolare con dati nazionali.
- Possibili domini di lavoro e risoluzione orizzontale:
  - Globale copernicus, 80 km
  - **Continentale: 30-50 km + nazionale: 10-5 km o continentale 10 km**
  - Regionale/Locale (ARPA): 5 – 1 Km
  - [Continentale RAQ copernicus: tra 10 e 25 km] ? utilizzato come benchmark



# Il servizio a scala intermedia (nazionale ?)

- Codice/i di calcolo:
  - Open source (garantire il riuso nella PA, codice sorgente disponibile per sviluppo)
  - Community model: comunità di sviluppatori che ne garantisca la continuità;
  - Input/output compatibile/interfacciabile con standard copernicus e singoli modelli regionali;
- Il servizio può essere basato su più codici tra loro ridondanti e/o intercambiabili



# Il servizio a scala intermedia (nazionale ?)

- Deve essere individuata con chiarezza una struttura che garantisca l'operatività del servizio;
- L'esecutore del servizio deve soddisfare requisiti ben definiti;
- La forma di attribuzione può essere un bando pubblico aperto a soggetti privati o agenzie eventualmente consorziati tra loro.

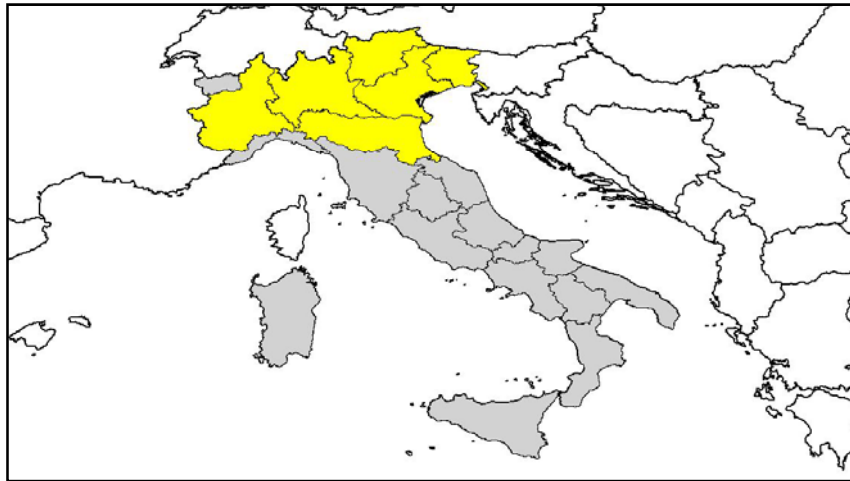


# SINERGIE CON PROGETTI



# L'accordo di programma del Bacino Padano:

- The National and Regional governments of Po valley signed on 19/12/2013 an agreement aimed at developing and coordinating the short and long term actions to improve the air quality of the Po valley basin.

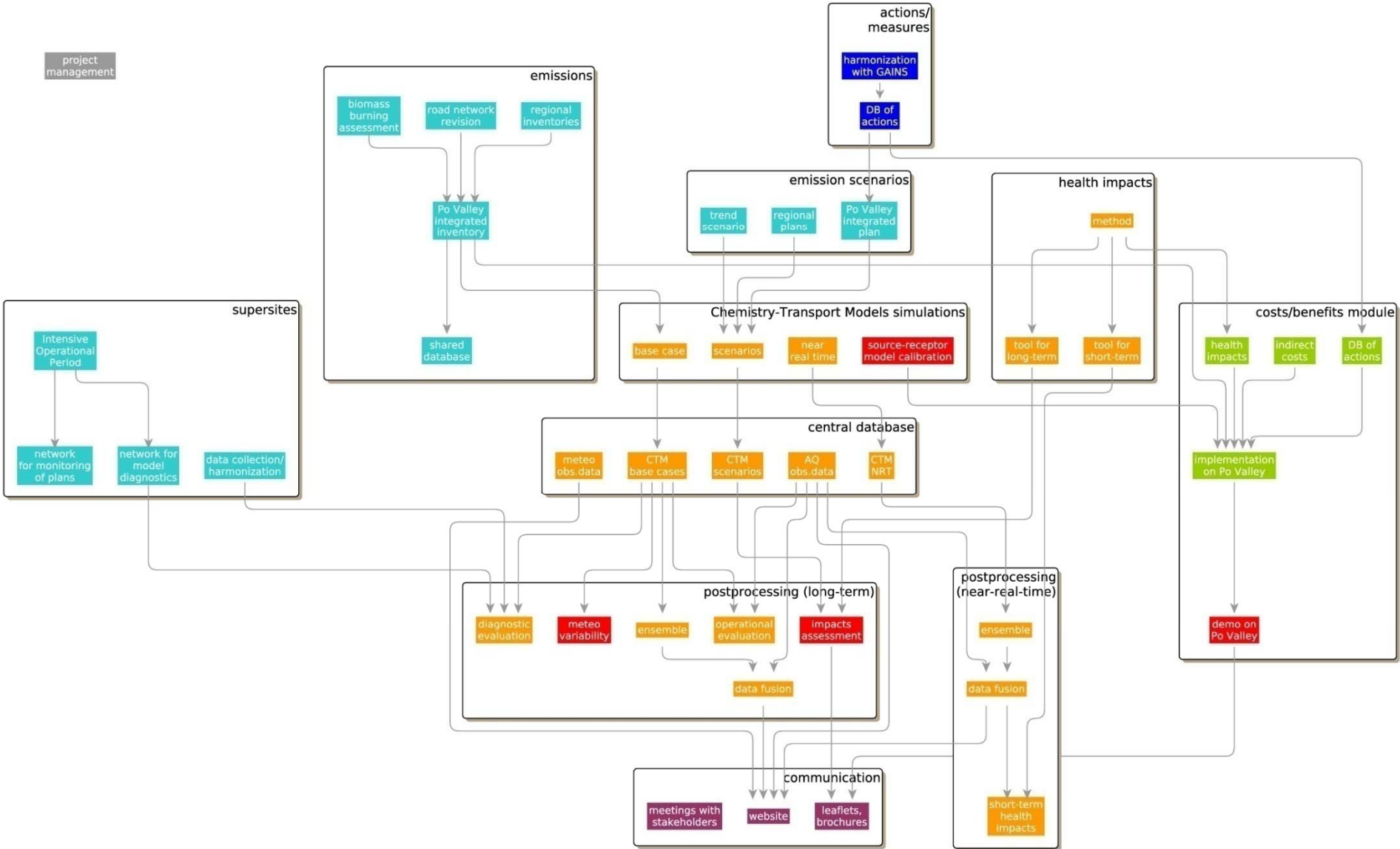


- Regions and ARPAs of Emilia-Romagna, Lombardia, Piemonte, Veneto are part of the LIFE-IP PREPAIR consortium  
(LIFE14 IP)

# Ongoing projects by the Po valley regions:

- LIFE-IP PREPAIR: Implementing the AQ action plans and building the technical tools for monitoring the AQ action plans;
- Some core actions of the project are aimed at:
  - regular runs of an ensemble of 5 CTMs on the northern Italy domain;
  - realizing a permanent infrastructure for sharing air quality monitoring (NRT) and emissions data and CTMs outputs;
  - model outputs will be post-processed by monitoring data for bias correction and enhanced spatial resolution;
  - model outputs will be verified and tuned by data from special stations (supersites) and IO campaigns.







# The ensemble of CTMs models on Po valley:

- Is based on models already implemented by each partner [MINNI, NINFA-ER, FARM-PI, FARM-LO, FARM-FvG, CAMX-VE]
  - The application domains and emissions input data will be unified;
  - The numerical code, model set-up and meteorological driver will remain different;
  - Boundary conditions are different but: *“a special effort will be addressed to interfacing the new operational services to the atmospheric services of the European programme Copernicus”*



[www.arpa.emr.it](http://www.arpa.emr.it)

[mdeserti@arpa.emr.it](mailto:mdeserti@arpa.emr.it)

**GRAZIE PER L'ATTENZIONE**



Some details about the Po valley models

# **MODELING TOOLS FOR AQ MANAGEMENT IN ITALY**



# Operational CTMs in Italy

Italian regional environmental agencies (ARPA) have implemented 8 different CTMs:

- they cover different parts of Italy, with a resolution of 5 km or less
- they are used for daily (operational) forecasts, AQ assessment and scenario analysis
- they could be the basis for local-scale, high-resolution ensemble

<u>Region</u>	<u>Model</u>	<u>Resolution</u>	<u>Domain</u>	<u>Boundary conditions</u>	<u>Meteorology</u>
Piemonte	FARM	8 to 1 km	N. Italy + zoom	Chimere (INERIS)	Cosmo
Lombardia	FARM	4 km	Part of N. Italy	Chimere (INERIS)	ECMWF
Veneto <sup>1</sup>	CAMx	4 km	Part of N. Italy	Chimere (INERIS)	Cosmo
Friuli	FARM	4 km	Part of N. Italy	FARM (AriaNet)	WRF
Emilia Rom.	Chimere	5 km	Northern Italy	Chimere (INERIS)	Cosmo
Umbria <sup>2</sup>	Chimere	5 km	Central Italy	Chimere (INERIS)	Cosmo
Lazio <sup>2</sup>	FARM	4 to 1 km	C. Italy + zoom	FARM and Chimere	RAMS
Campania <sup>2</sup>	Chimere	5 km	Part of S. Italy	Chimere (INERIS)	Cosmo

(1) pre-operational model

(2) model not included in LIFE proposals



esempi

# MODELLI REGIONALI PO VALLEY



# The operational models suite NINFA

Northern Italian Network to Forecast photochemical and Aerosol pollution

**NINFA-E** (daily forecast & analysis, scenarios):

- 5 km horizontal resolution, 8 vertical levels up to 500 hPa

[http://www.arpa.emr.it/sim/?qualita\\_aria/previsioni\\_aria\\_nord](http://www.arpa.emr.it/sim/?qualita_aria/previsioni_aria_nord)

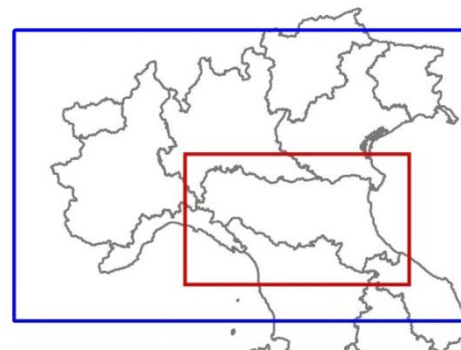
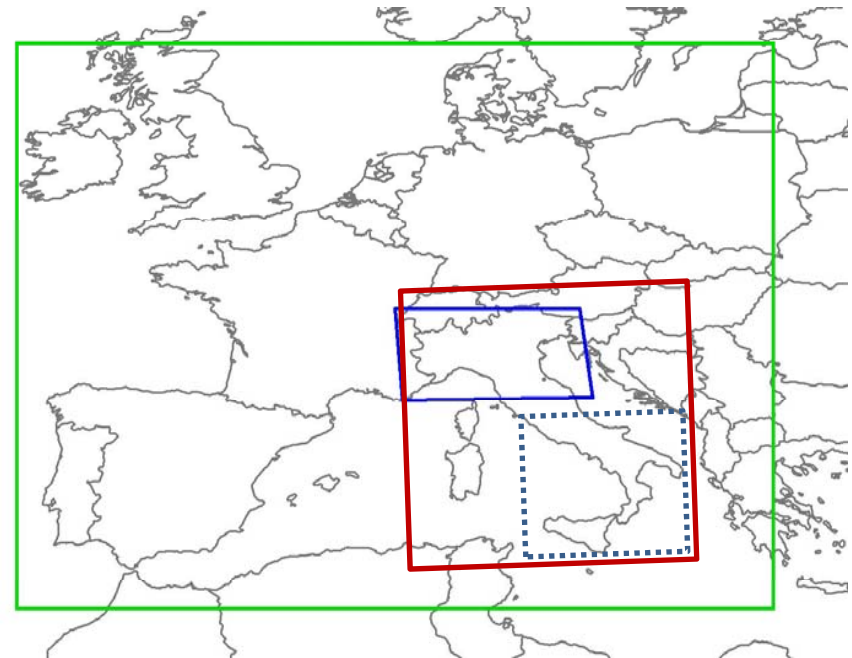
<http://www.arpa.emr.it/aria/>

**NINFA-national :**

- run on demand, scenarios
- Italy: 89\*105, 10 km
- North: 138\*92, 5 km
- South: 110\*100, 5 km

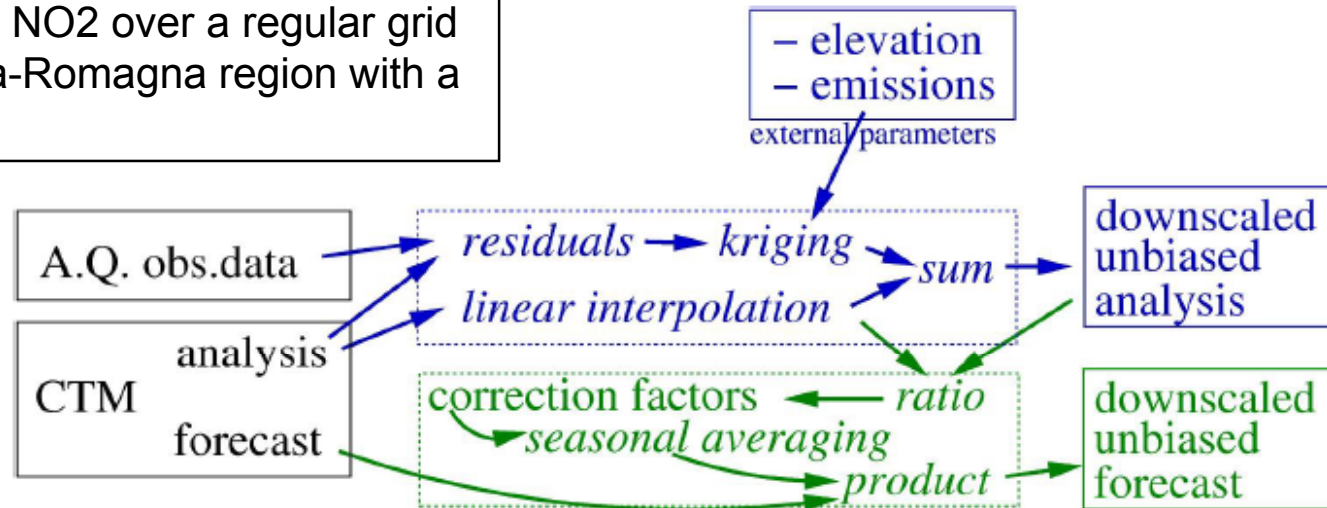
**PESCO** (geo statistical post processing):

- daily and annual compliance evaluation
- NRT data from E-R AQ stations, 1km
  
- CTM: Chimere
- Boundary conditions: Prev'air (0.5° ~ 50 km)
- Meteorological input: COSMO-I7 (7 km)
- Emissions: adapted from INEMAR ER + Ispra Italy + MACCT-TNO

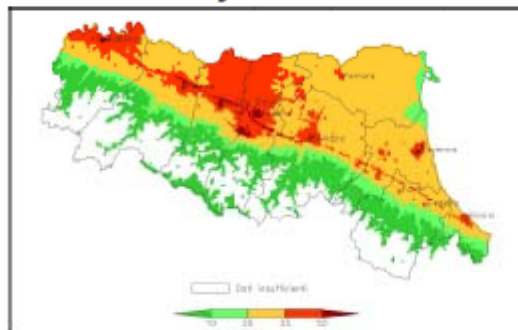


# The PESCO-NINFA postprocessing for unbiassing and downscaling

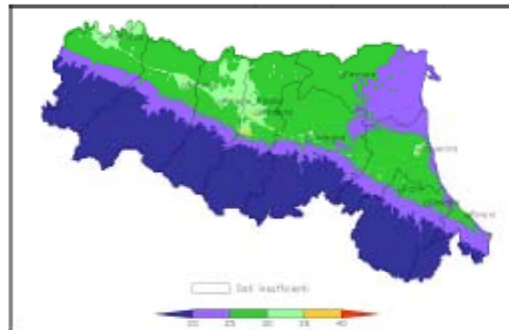
It produces surface concentrations fields of PM10, PM2.5, O3, NO2 over a regular grid covering the Emilia-Romagna region with a resolution of 1 km



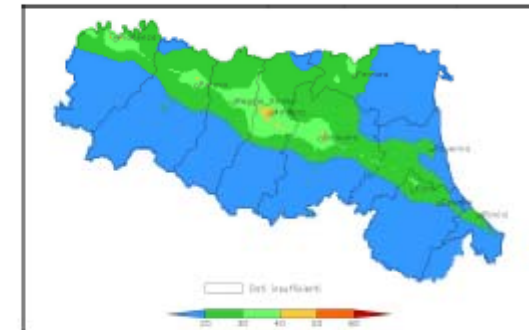
PM10 daily exceedances



PM10 annual mean



NO<sub>2</sub> annual mean



Evaluation of the compliance with EU legislation (year 2010)

# ARPA Lombardia air quality modeling system

Based on **three-dimensional Eulerian model FARM (Flexible Air Quality Regional Model)**, <https://hpc-forge.cineca.it/files/Farm/public/>)

**Domain:** covering the whole Lombardy Region (*horizontal resolution of 4 km*)

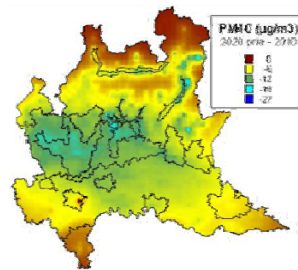
**Meteo driver:** ECMWF, mass consistent model minerve

**Boundary conditions** CHIMERE continental fields provided by PreVAir service

**Emission inventories:** Detailed regional emission inventories, ISPRA national emission inventory, EMEP inventory

## Services

Support to evaluation  
AQ plan



Results from  
scenarios AQ  
regional plan



## Services

Yearly AQ modeling  
assessment AQMA

reports  
available on web  
site from  
AQMA 2009  
year



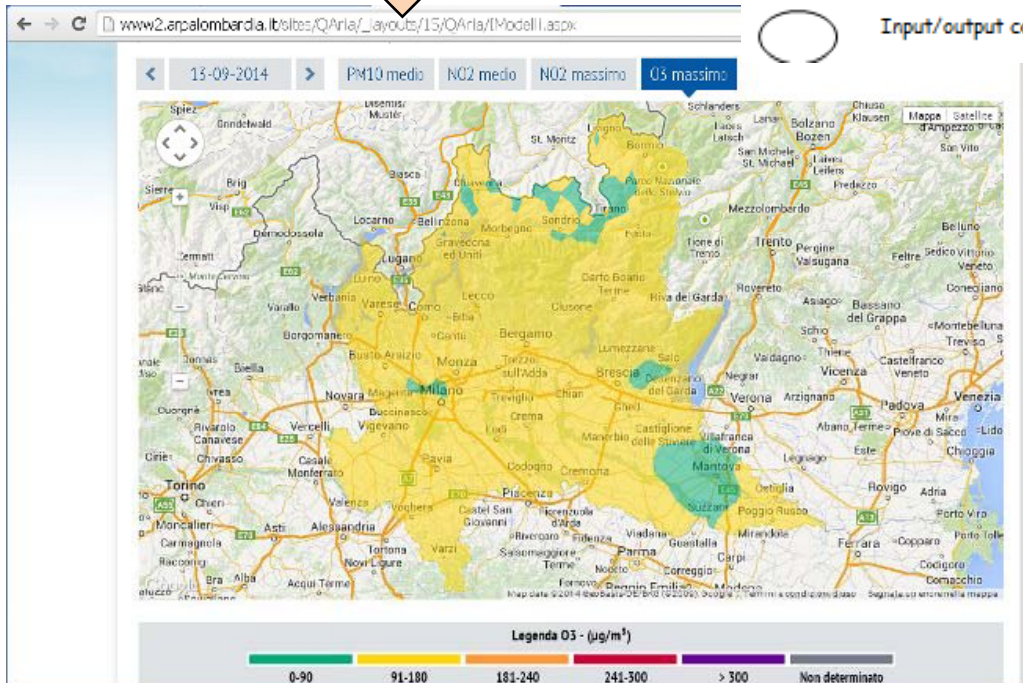
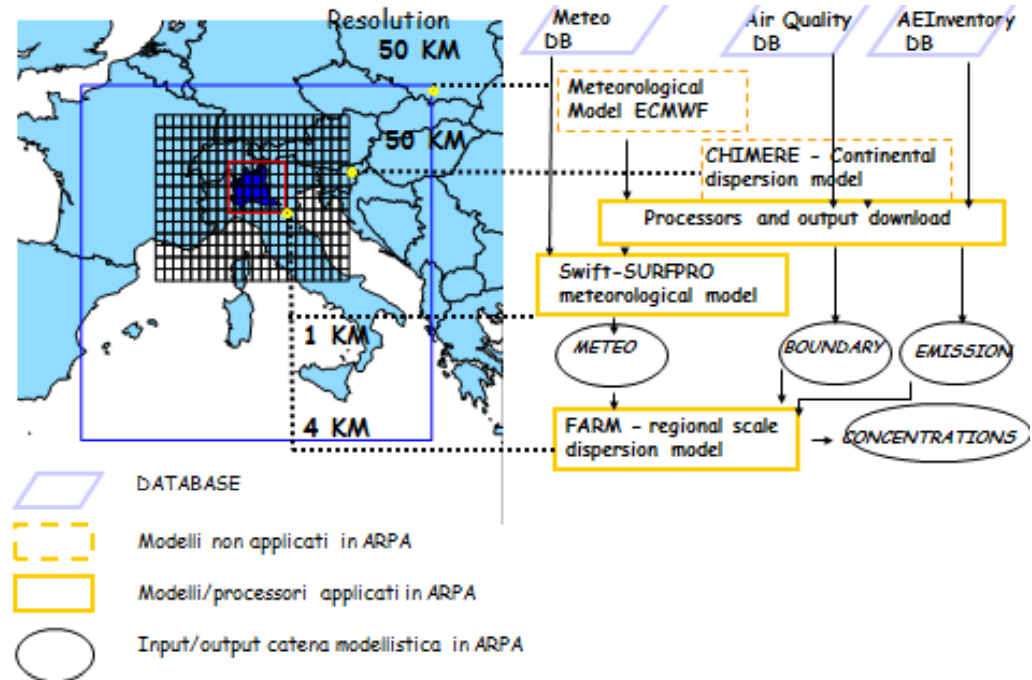


# Services

## Information

Modeling chain operationally used since 2008 for near-real-time analysis

Daily maps over Lombardy of NO<sub>2</sub>, PM<sub>10</sub> and O<sub>3</sub> concentrations referred to the previous day on the ARPA Lombardia web



NO<sub>2</sub>, PM<sub>10</sub> and O<sub>3</sub> daily average concentrations for the 1544 municipalities of the region

The screenshot shows a table with two columns of data for O<sub>3</sub> concentrations. The table is titled 'Concentrazioni medie per comuni (17 maggio 2014)'. The columns are 'Comune', 'Media giornaliera', 'Media giornaliera superiore target', and 'Media giornaliera inferiore target'. The table lists various municipalities and their corresponding concentration values.

# ARPA Piemonte air quality modeling system

Based on *three-dimensional Eulerian model FARM (Flexible Air Quality Regional Model*, <https://hpc-forge.cineca.it/files/Farm/public/> )

Operationally used for:

- **Daily air quality forecasts:** forecast time 72 hours (3 days from today 01:00 a.m);
- **Daily near-real-time analysis;**
- **Yearly assessment of air quality,**
- **Evaluation of future scenarios.**

## **Domain: three nested domains:**

- g1 covering Po valley basin and the Alps (*horizontal resolution of 8 km*);
- g2 covering the whole Piemonte Region (*horizontal resolution of 4 km*);
- 3 g3 domains, with *1 km horizontal resolution* (only in forecast mode)

## **Meteo driver:**

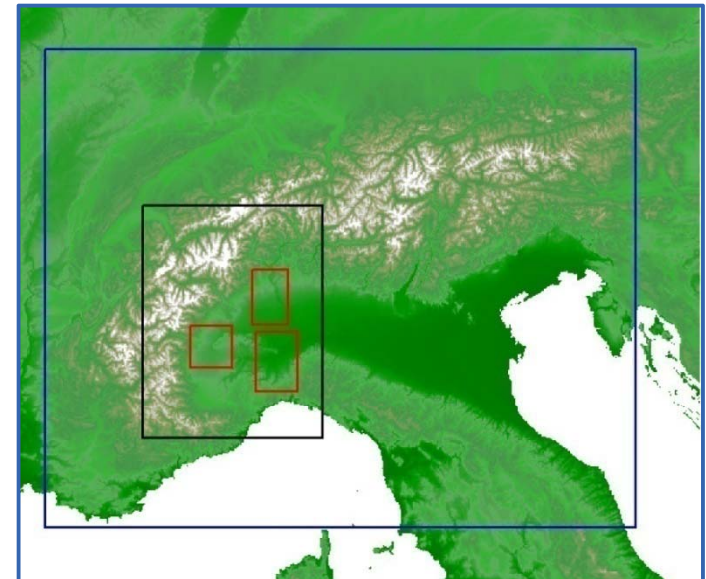
COSMO model (aq forecast); ECMWF, mass consistent model minerve, WRF (aq assessment and nrt);

## **Boundary conditions (only for the g1 domain):**

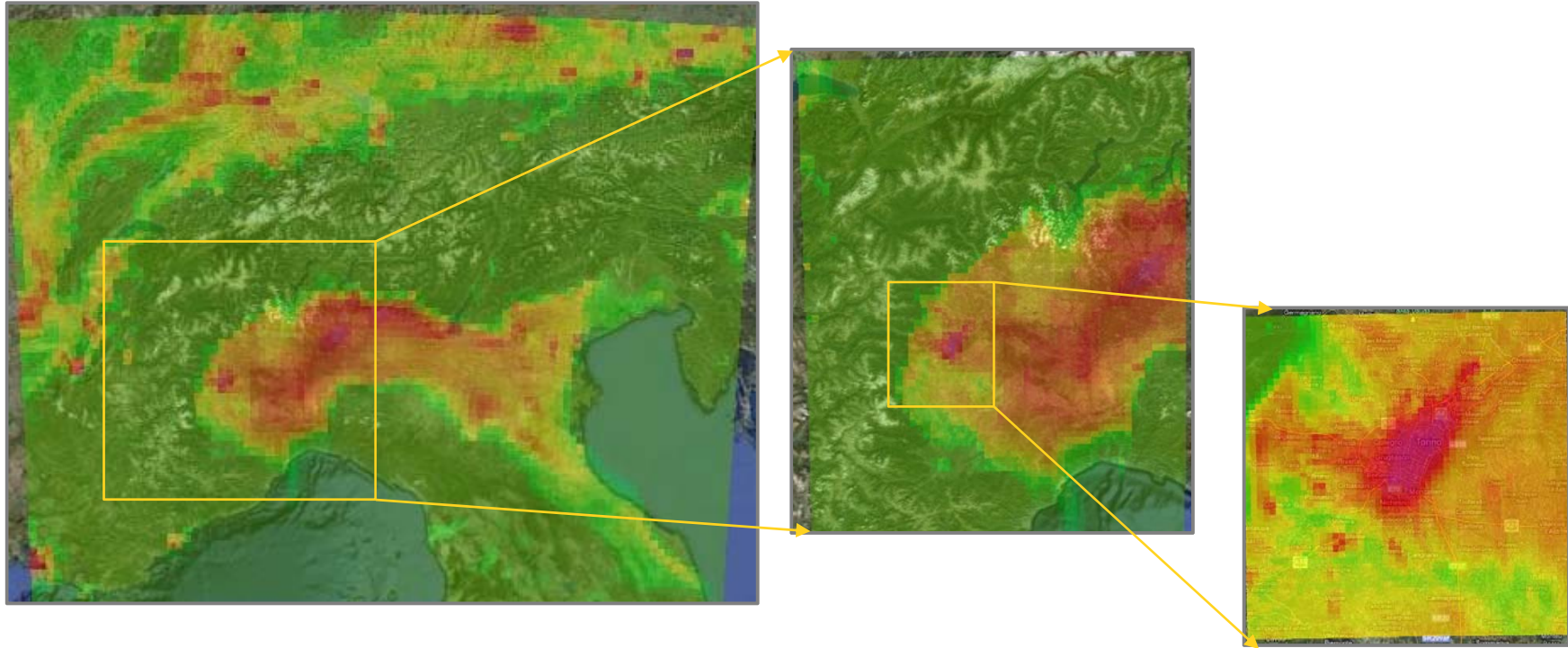
CHIMERE continental fields (analysis and forecast) provided by PrevAir service

## **Emission inventories:**

Detailed regional emission inventories, ISPRA national emission inventory, EMEP inventory



# ARPA Piemonte air quality modeling system



***PM10, NO2 and O3 near-real-time analysis:***

<http://www.sistemapiemonte.it/ambiente/srqa/conoscidati.shtml>

***PM10 and O3 air quality forecasts:***

<http://www.arpa.piemonte.it/bollettini>

***IPQA (forecasted Air Quality Index) over Turin metropolitan area:***

<http://www.provincia.torino.gov.it/ambiente/inquinamento/aria/qualita/ipqa>

/

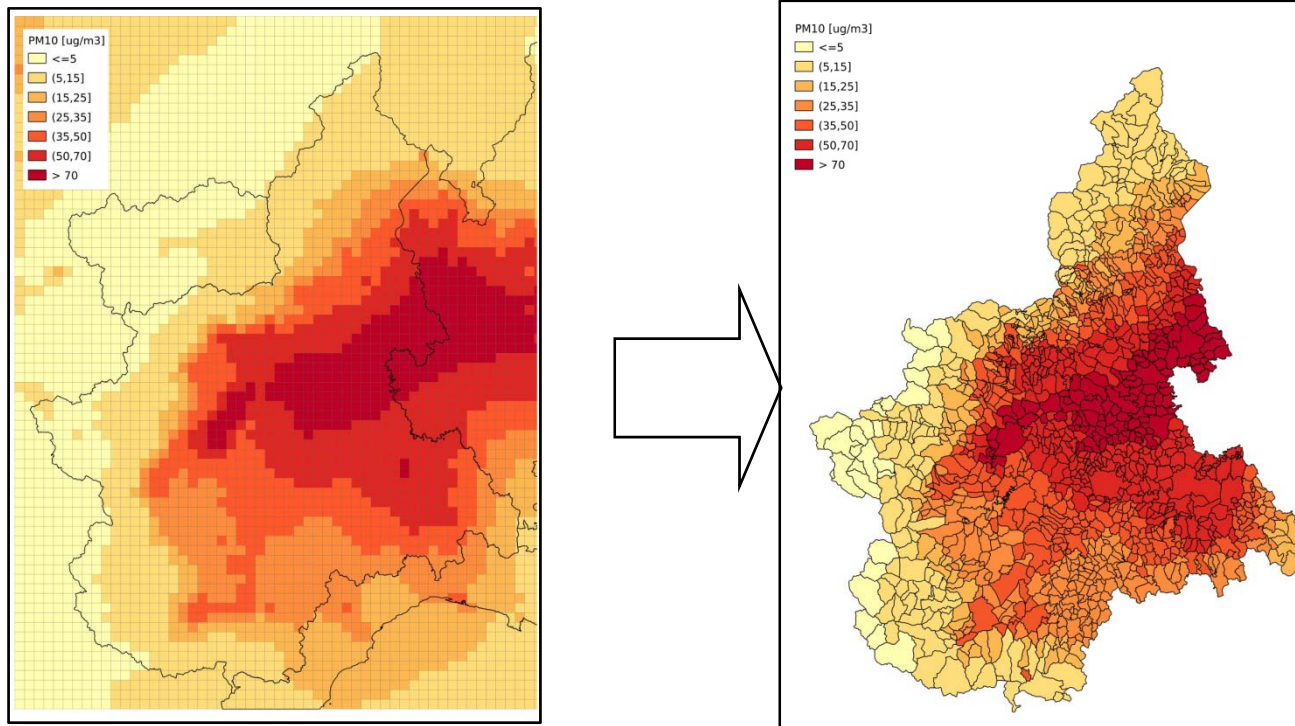
# Postprocessing in ARPA Piemonte

***Kriging with external drift*** is used to reduce bias between observed and simulated data produced by near real time and assessment air quality modelling system.

The kriging is applied on the observed data and the external drift is the CTM output.

The kriged fields are up-scaled to the municipality level using a weighted-average on built-up areas algorithm.

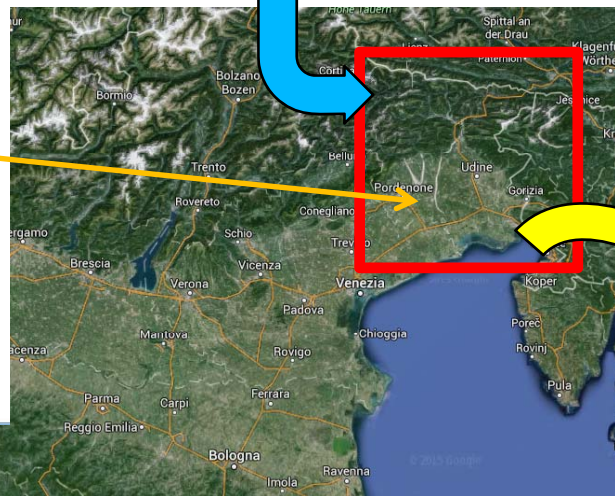
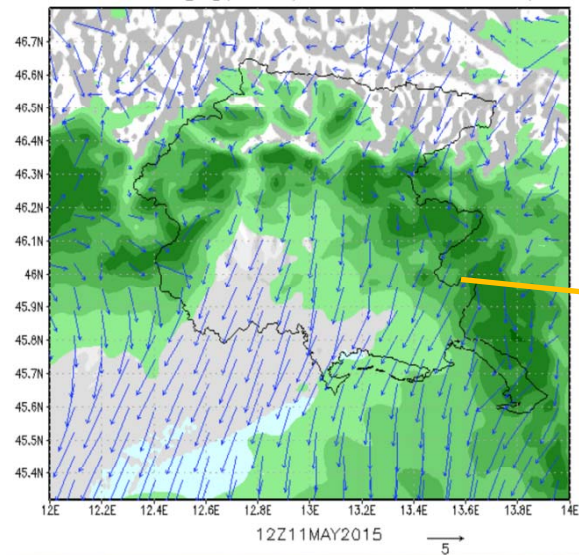
Postprocessing procedure is applied only for PM10, NO2 and O3 over the regional domain (4kmx4km of horizontal resolution) using a background stations.



# ARPA FVG air quality modelling system (off-line weather/air quality)

## Weather forecast and analysis

- **WRF** model
- Boundary condition NCEP/NOAA (GFS)
- 3 nested domains  
Europe, Italy, FVG Region (2 km x 2 km)



## Air quality forecast and analysis

**FARM** model 4 km x 4 km

### Weather simulations

- WRF

### Air quality boundary conditions

- QualeAria (ARIANET)

### Sources

- INEMAR regional inventory

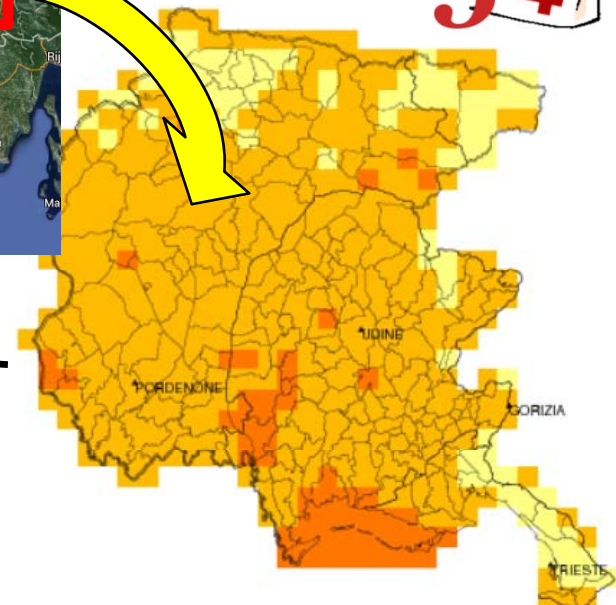
**5 days  
forecast  
+120h**



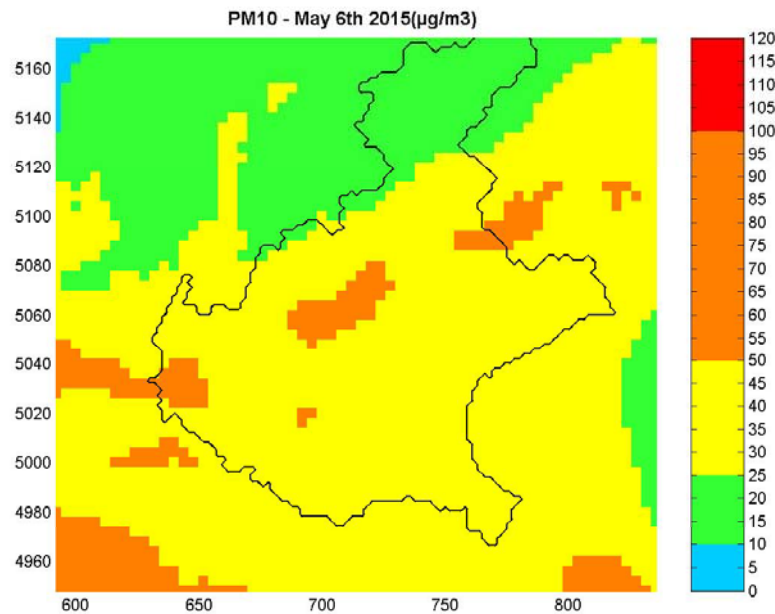
## Operational applications

Forecast and scenarios in support to:

- Municipality mitigation actions activation (PACs)
- Regional government mitigation plans
- Regional operational air quality assessments
- Healthcare applications and warnings



# ARPA Veneto modelling chain



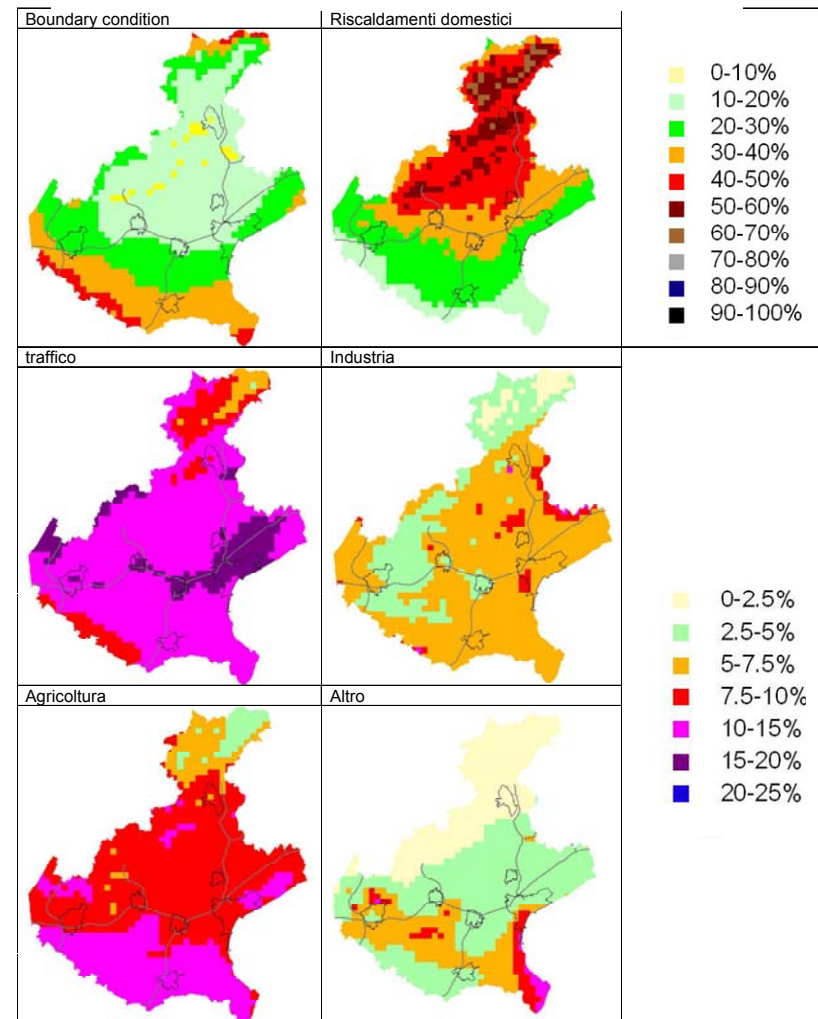
LAMI - CAMx 5.4  
 Domain: 250 x 230 km<sup>2</sup>  
 Resolution: 4 km<sup>2</sup>  
 Boundary conditions: CHIMERE – Prev'air service  
 Emissions: GAINS Italy, INEMAR Veneto 2010  
 Frequency: daily runs

Product typology: annual periodic scenario for planning scope, PM source apportionment analysis

([http://bur.regione.veneto.it/BurvServices/Pubblica/Download.aspx?name=2872\\_AllegatoA\\_245142.pdf&type=9&storico=False](http://bur.regione.veneto.it/BurvServices/Pubblica/Download.aspx?name=2872_AllegatoA_245142.pdf&type=9&storico=False) )

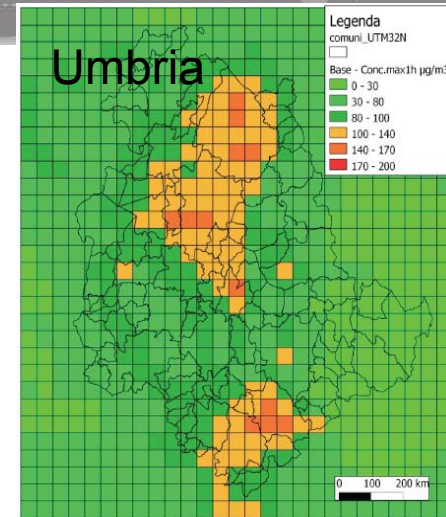
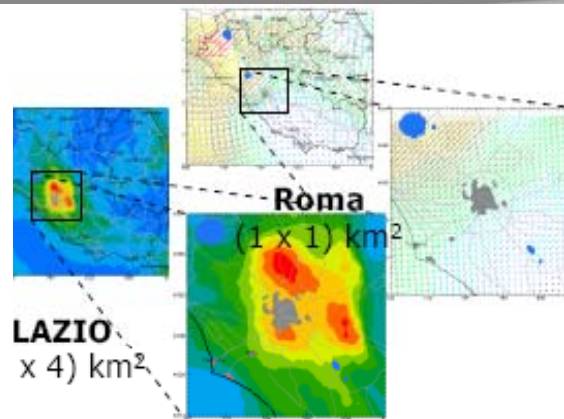
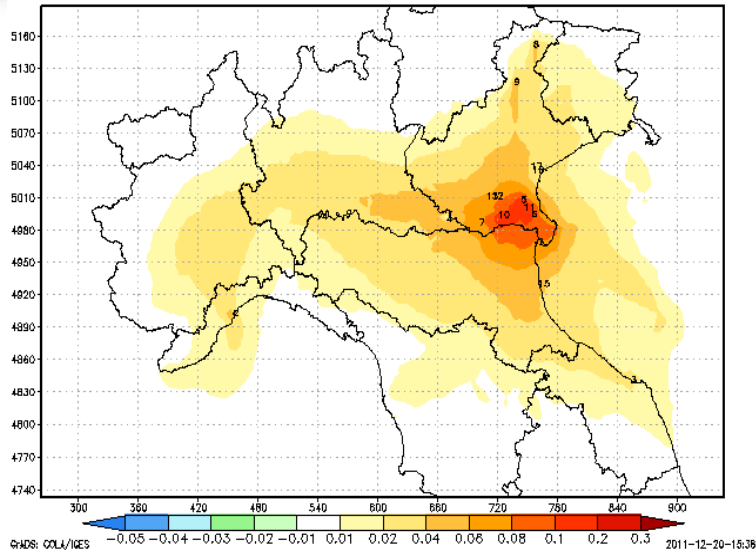
operational daily runs (in testing phase)

## PM10 source apportionment winter scenario

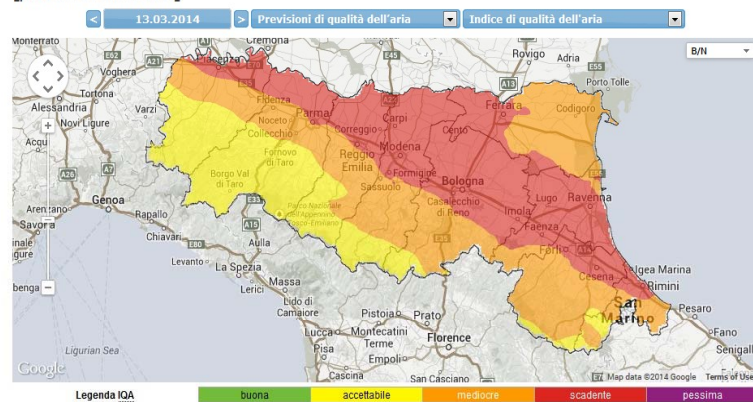


# XII CONFERENZA DEL SISTEMA NAZIONALE PER LA PROTEZIONE DELL'AMBIENTE

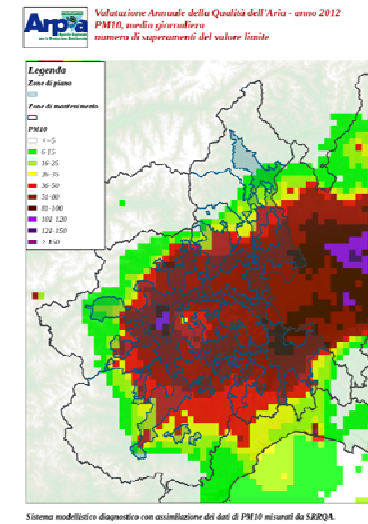
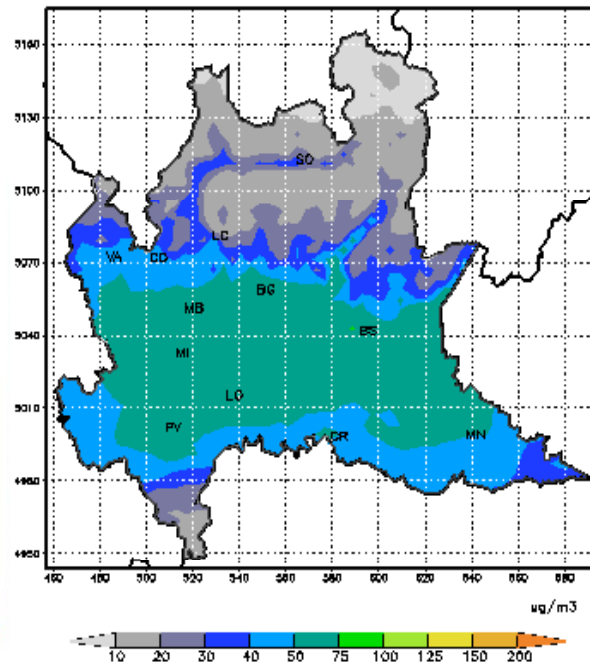
PM10 ( $\mu\text{g}/\text{m}^3$ ), BPAsc1-baseimp, average JAN-DEC2007



Indice di Qualità dell'aria. previsione per giovedì 13 marzo 2014  
[prodotta il 12 marzo 2014]



03APR2014

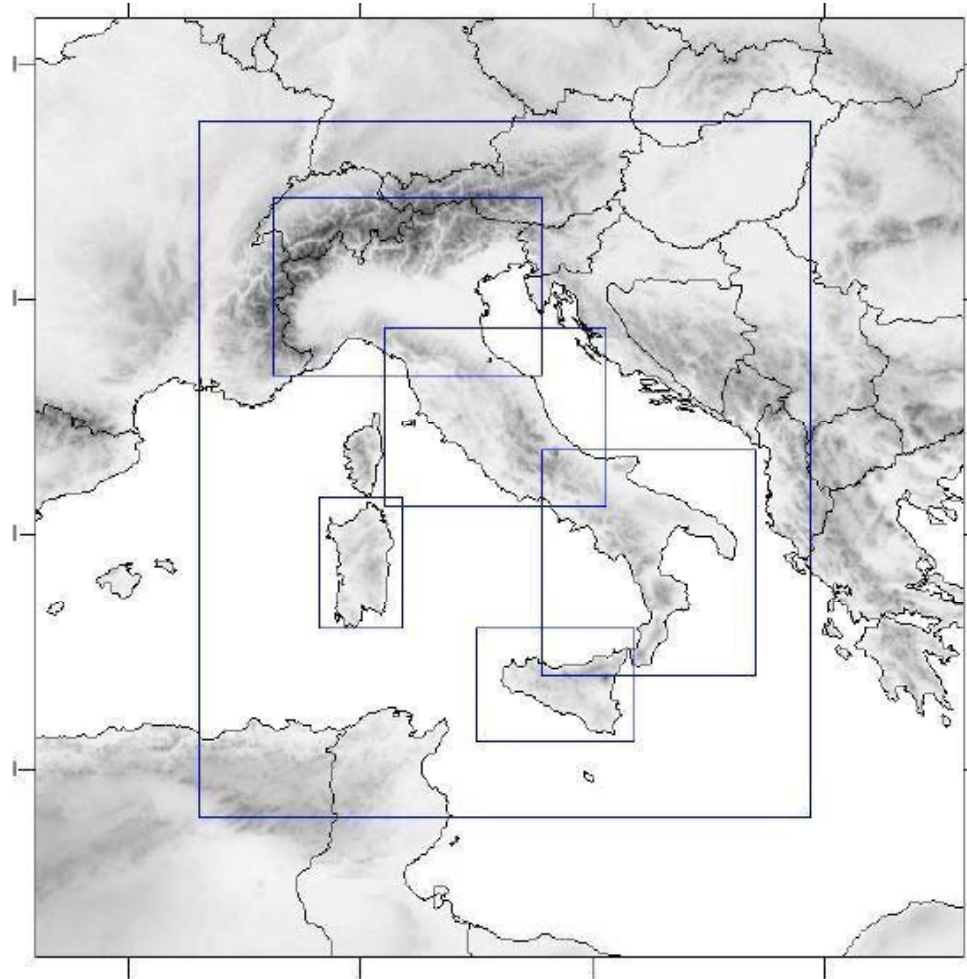


# MODELLI ITALIANI A SCALA NAZIONALE

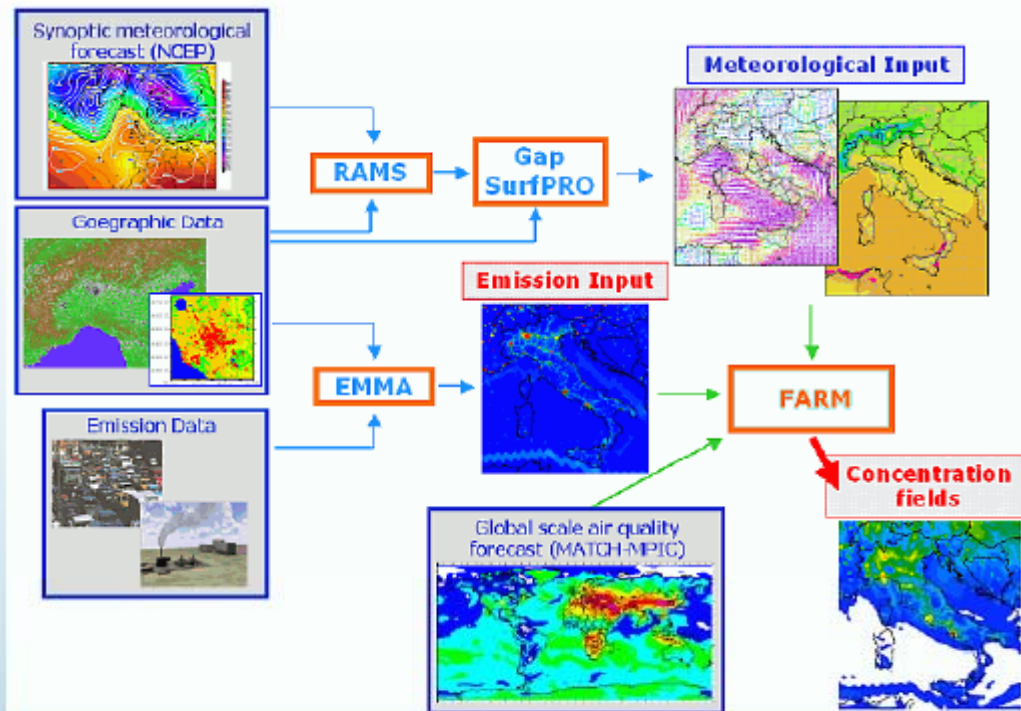




# MINNI – AMS NATIONAL DOMAINS



## QualeAria workflow



**RAMS/WRF** weather forecast downs

Eulerian chemical transport model **FA**

FARM is freely distributed through **CIN**  
**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**)

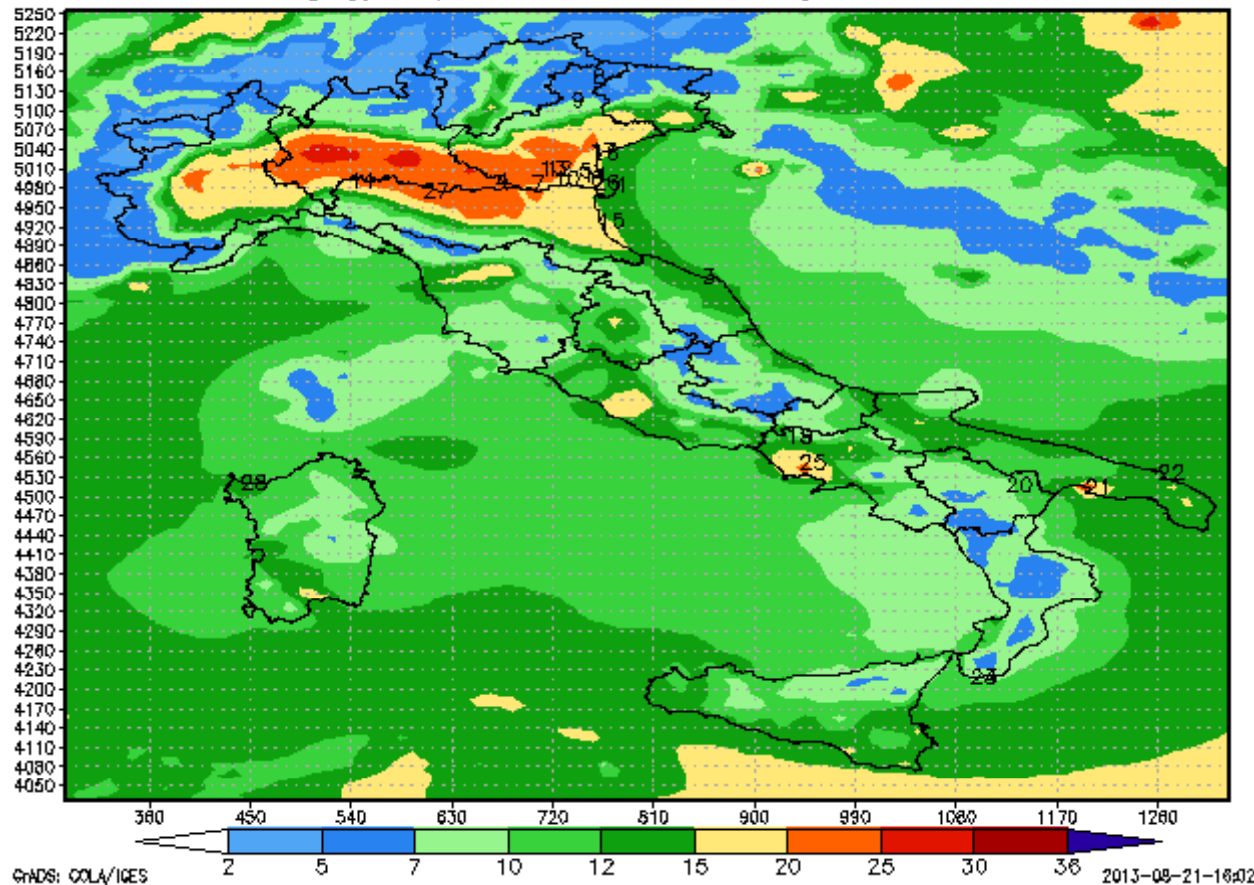
Global Air Quality forecast **MACC-Copernicus** (through  
*Forschungszentrum Jülich* data server)

Description included in: Kukkonen, et al., 2012: A re  
 operational, regional-scale, chemical weather forecast

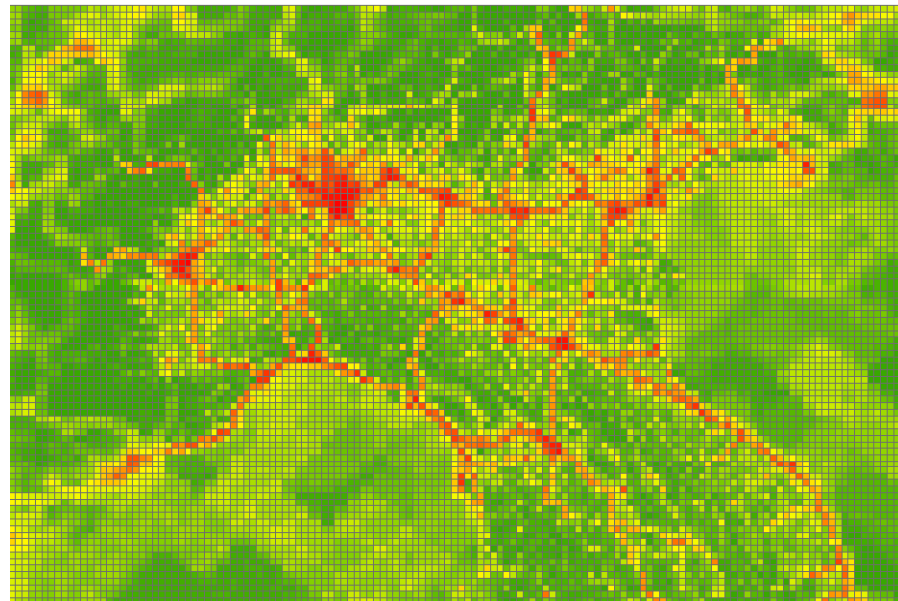
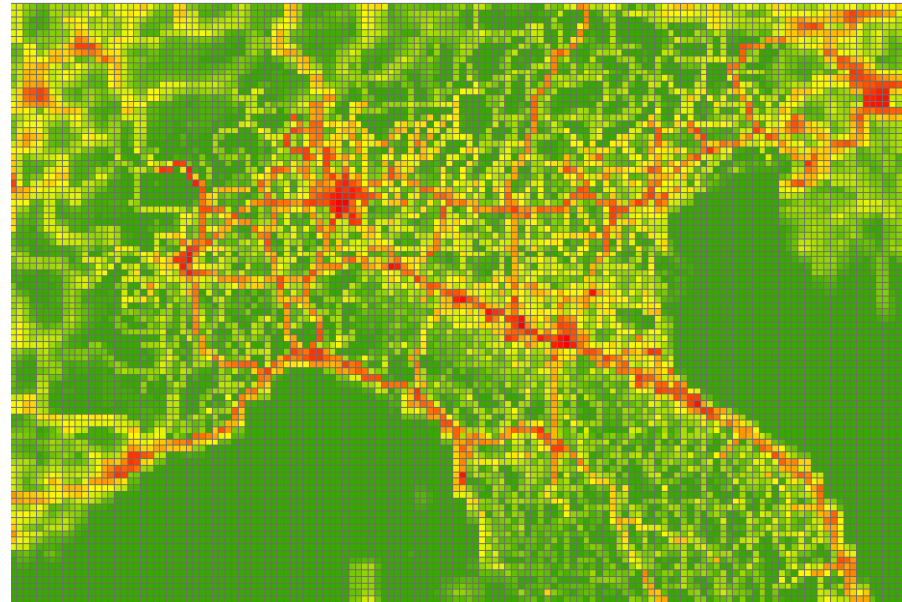
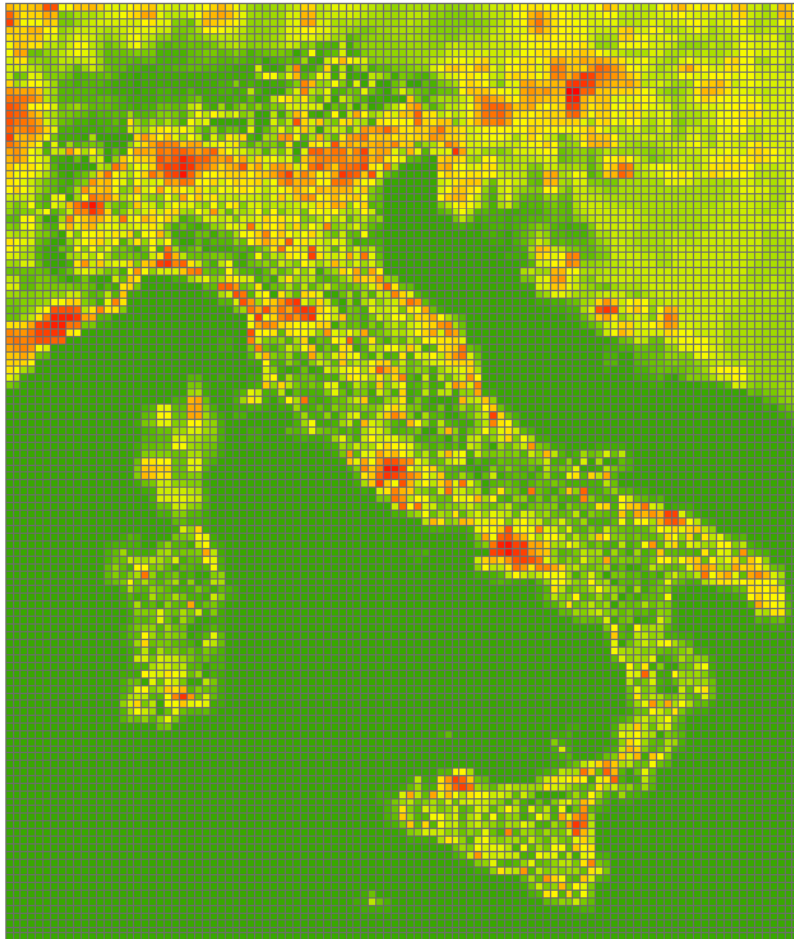
# NINFA-I



PM10 ( $\mu\text{g}/\text{m}^3$ ), base-naz, average JAN-DEC2007



# Emissions data



## The national Meteorological model: COSMO/LAMA

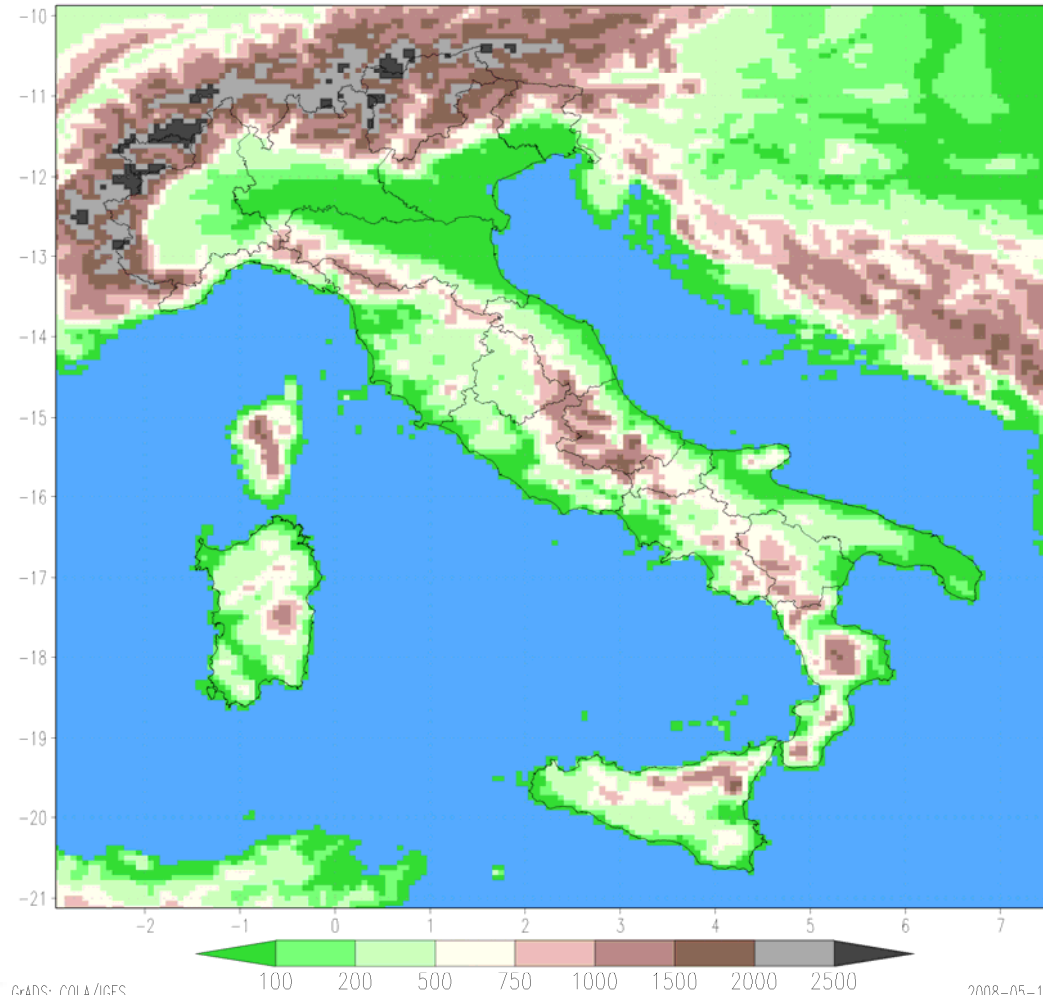
### **Il modello COSMO**

E' il modello di riferimento italiano  
All'interno di ARPA-SIMC a livello operativo produce due volte al giorno previsioni meteorologiche per tutta Italia, con una risoluzione orizzontale di 7 km (COSMO-I7)

### **Il dataset LAMA**

Il dataset LAMA sfrutta il ciclo di assimilazione di COSMO- I. Il modello compie una serie di simulazioni di 12 ore, ciascuna delle quali usa come condizione iniziale i campi in quota prodotti dalla corsa precedente, i campi superficiali del modello. Durante la simulazione, il modello utilizza una tecnica di nudging per assimilare in modo continuo le osservazioni disponibili.

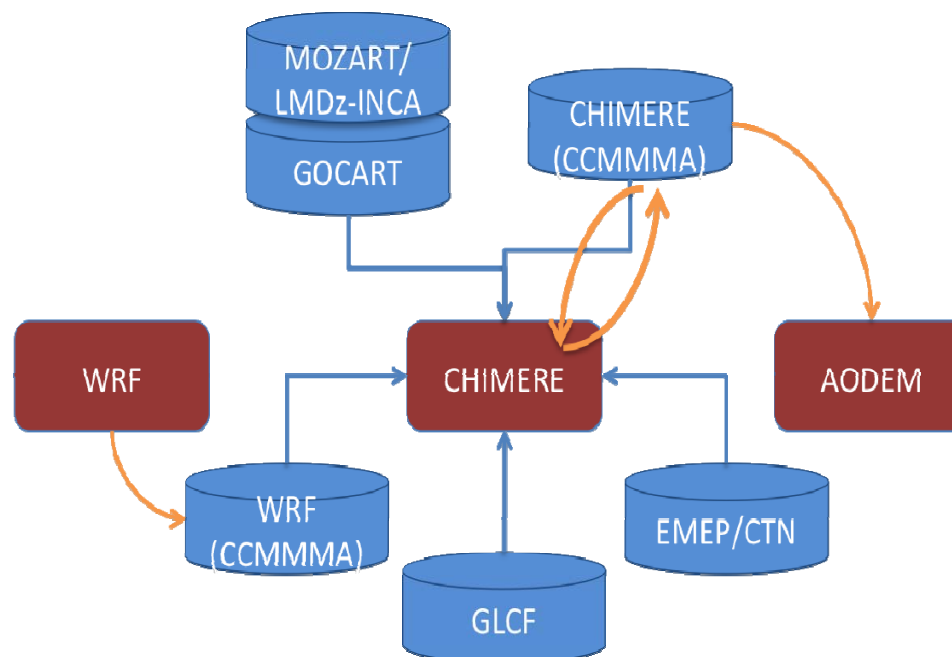
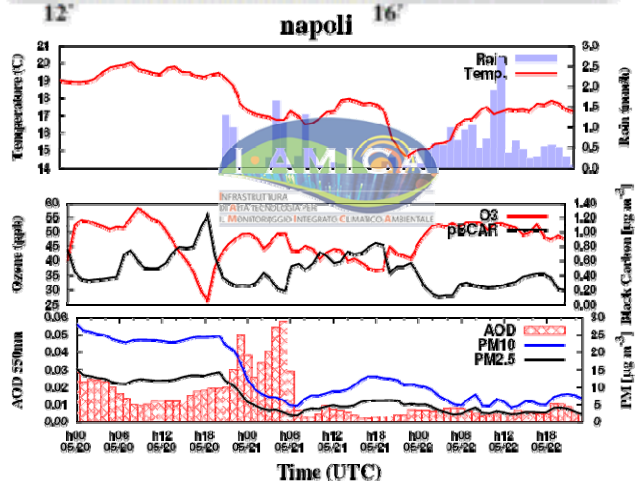
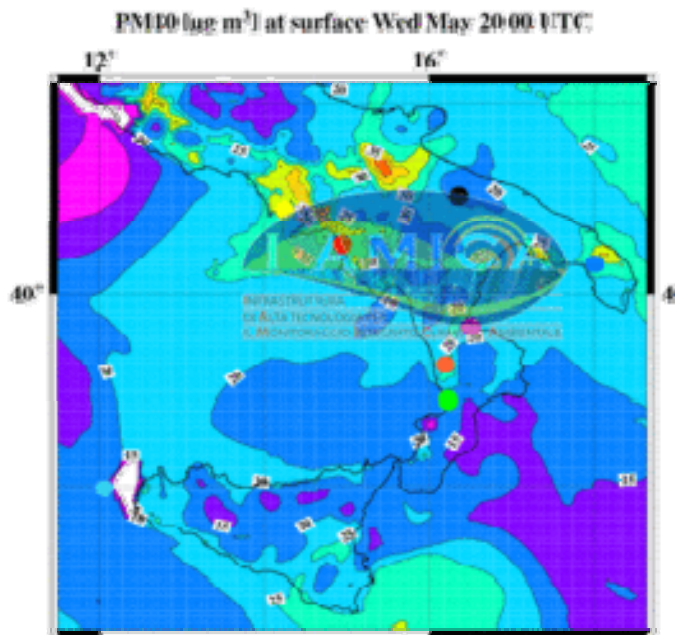
LAMA: griglia di lavoro e orografia (m)



2008-05-16-11:58

# Daily application of I-AMICA modeling system

Air quality forecast  
<http://www.i-amica.it/>



- **WRF** (Weather Research and Forecast system, Shamarock et al., (2008))
- **CHIMERE** (A chemistry transport model, Bessagnet et al., 2008)
- **AODEM** (Aerosol Optical DEpth Module, T.C. Landi 2013) is a post-processing tool designed for a generic chemistry-transport model.



Contact: Tony C. Landi,  
[T.Landi@isac.cnr.it](mailto:T.Landi@isac.cnr.it)



Institute of Atmospheric Sciences and Climate



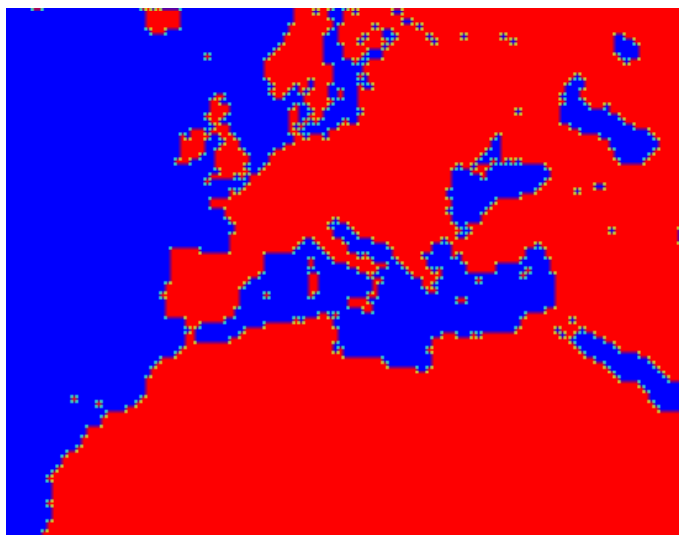
INFRASTRUTTURA DI ALTA TECNOLOGIA  
PER IL MONITORAGGIO INTEGRATO CLIMATICO-AMBIENTALE



## Nesting for I-AMICA modeling system

**EUR54**

Horizontal res. 54 km



**ITA18**

Horizontal res. 18 km



**IAM6**

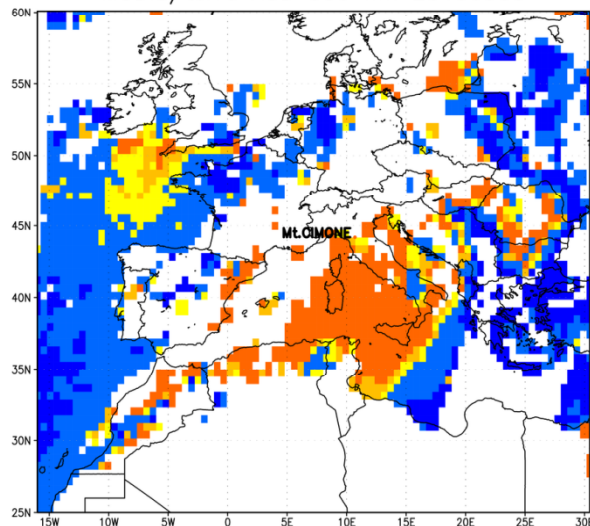
Horizontal res. 6 km





## Daily application of I-AMICA modeling system

MODIS/terra AOD 550 nm 20150505

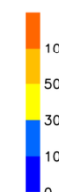
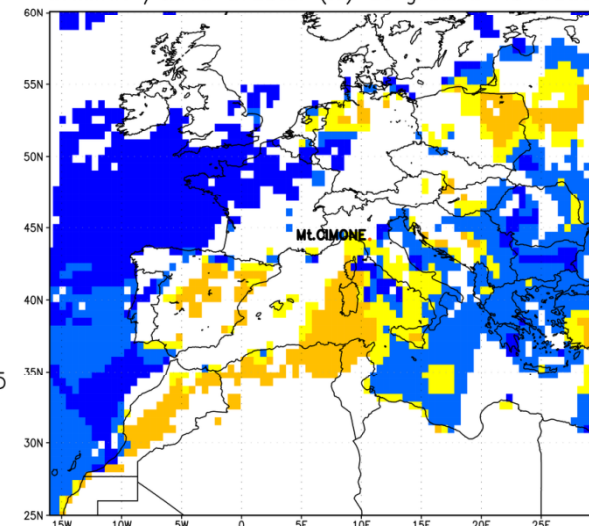


MODIS



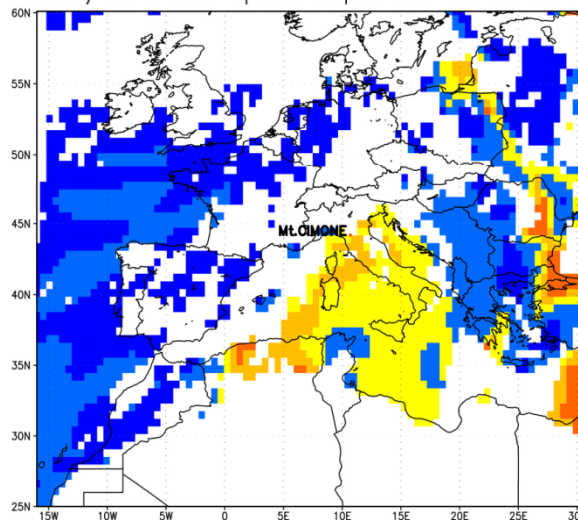
AODEM

CHIMERE/terra Crustal (%) at ground 20150505



CHIMERE

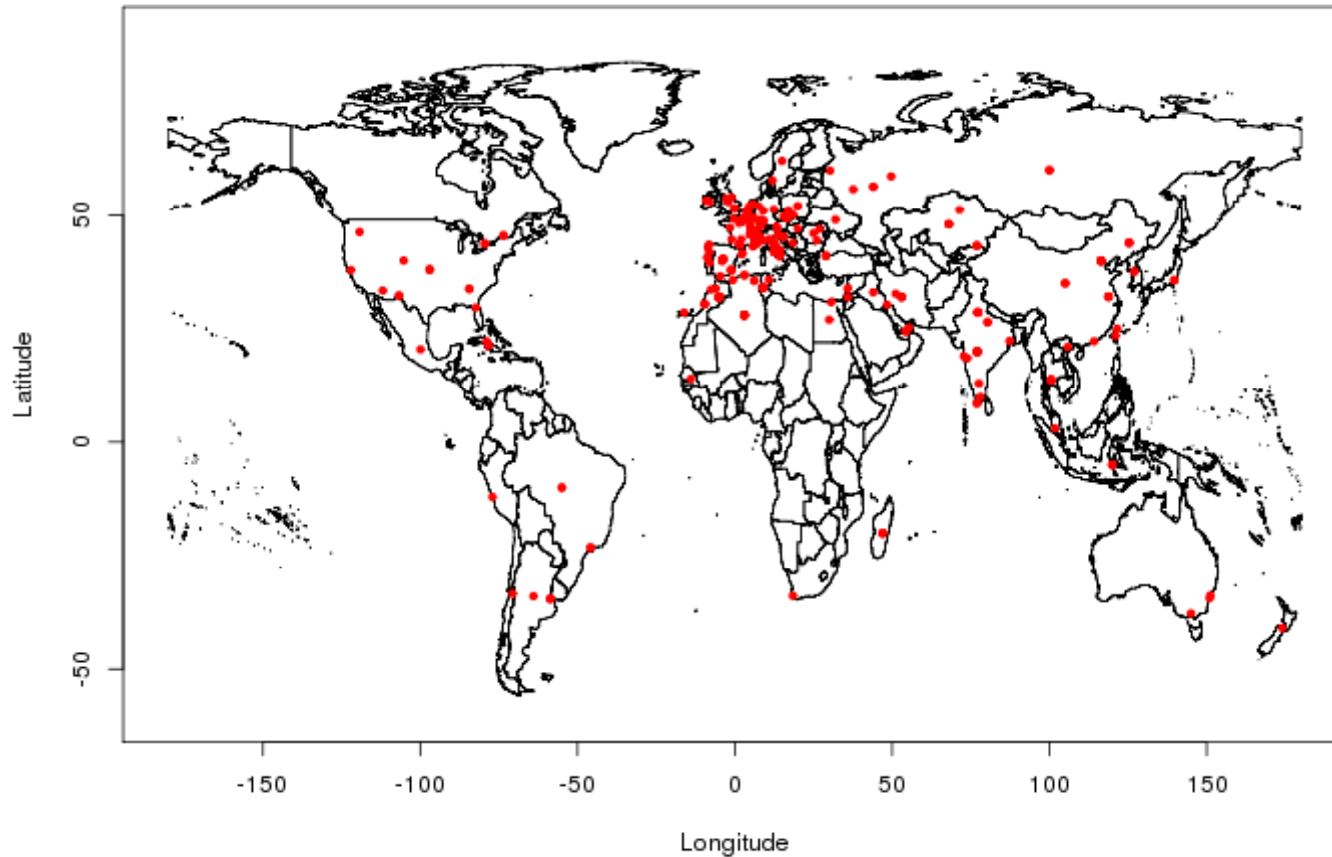
AODEM/terra Dust Optical Depth 550 nm 20150505



Satellite and Aerosol modeling  
<http://www.isac.cnr.it/cimone/SMA>



# Chimere: registered users



by Guillaume Siour

