

Regional services and best use for boundary conditions

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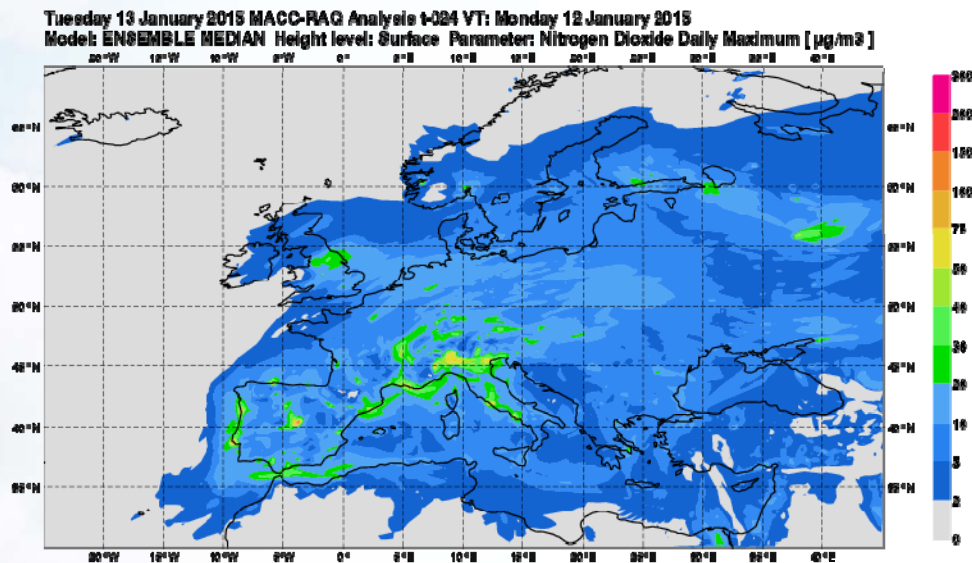


MACC-III User Workshop
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Regional services production

- 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**

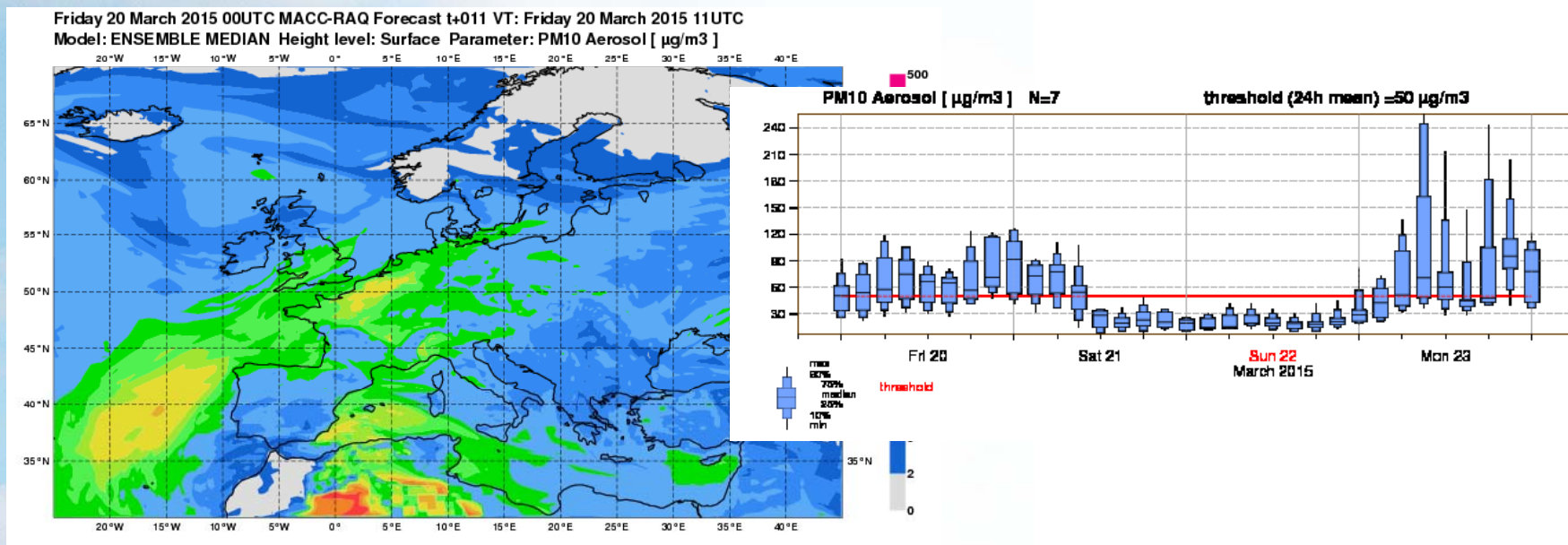


The regional air quality ensemble of models

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

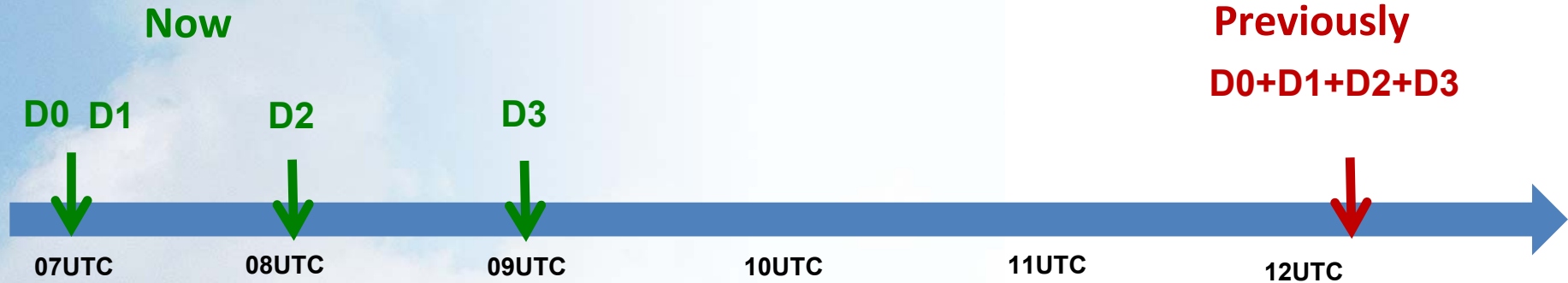
Current daily production

- Same set of input data for all 7 models: MACC/TNO emissions, GFAS fire emissions, chemical BC from MACC global model, IFS meteorological forecasts
- Hourly forecasts of O₃, NO₂, SO₂, CO, PM10, PM2.5 (+ NH₃, NO, NMVOC, PAN) at surface, 50m 250m, 500m, 1000m 2000m, 3000m 5000m (Ensemble+7 models)
- Verification products against available NRT hourly surface data (EEA database)
- EPSgrams for 40 major cities in Europe
- Hourly analysis for the previous day at surface from assimilation of NRT surface data
 - Ensemble for O₃ and NO₂
 - SO₂, CO, PM10, and PM2.5 depending on the model

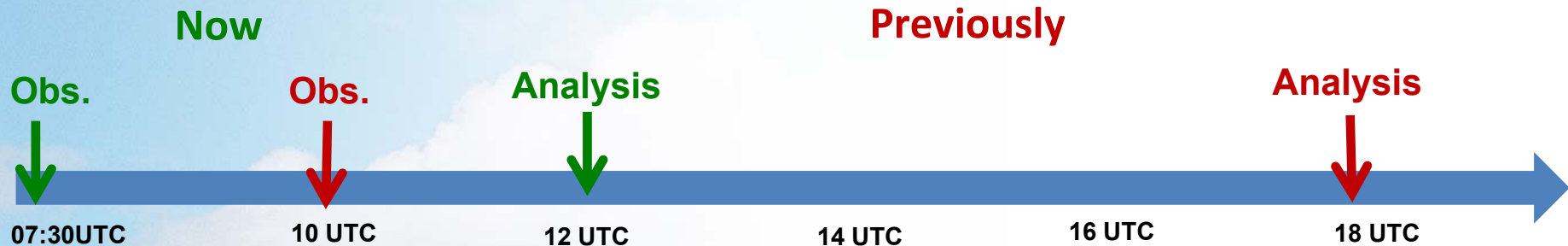


Current production times for the daily forecasts and analyses

ENSEMBLE FORECAST:



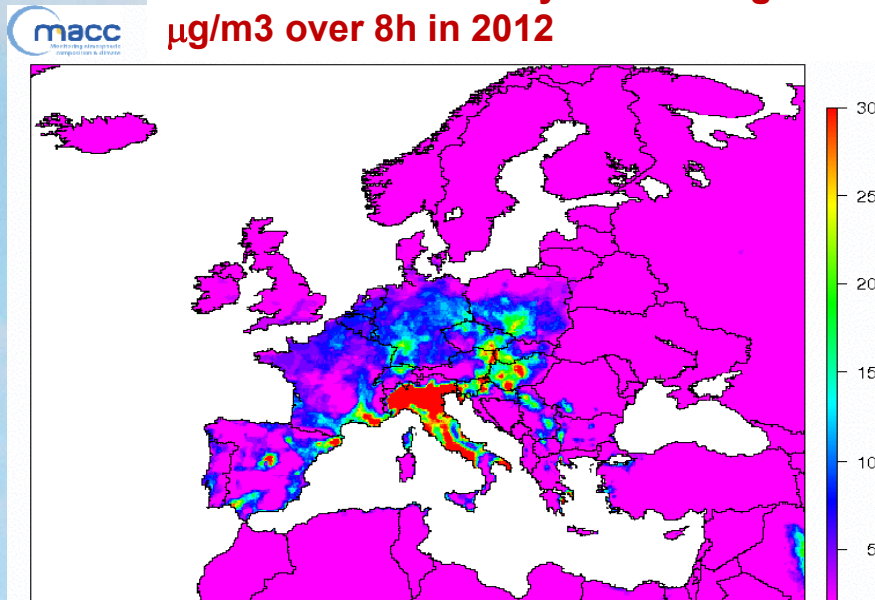
ENSEMBLE ANALYSIS: use of EEA observations available earlier than data gathered country by country



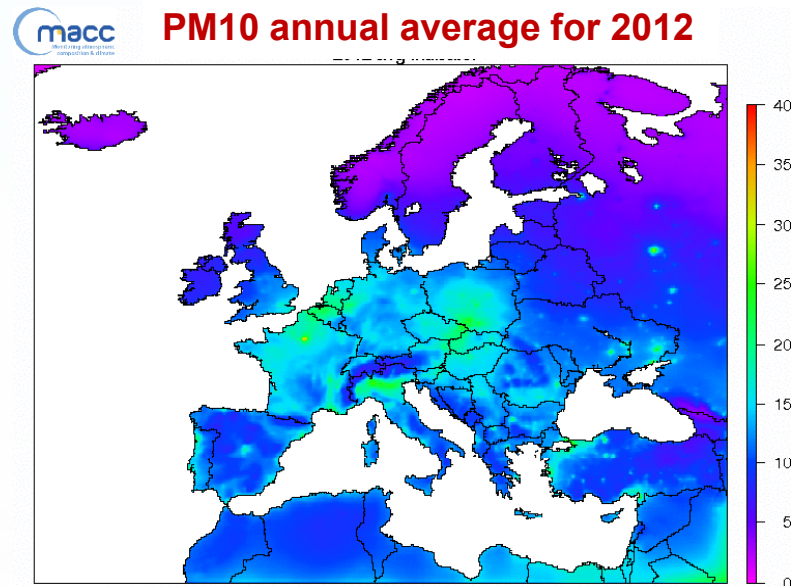
Annual reanalyses production

- Re-analyses result from the combination of simulation and observations thanks to data assimilation techniques
- A unique framework involving the 7 individual results to build up Ensemble re-analyses in a full consistent way :
 - MACC/TNO emissions
 - Boundary conditions issued from the MACC global system
 - ECMWF re-analyses
 - Same set of observation from AIRBASE to be assimilated
- A stringent evaluation process for both the individual models and the Ensemble

Ozone: number of days exceeding 120 $\mu\text{g}/\text{m}^3$ over 8h in 2012



PM10 annual average for 2012



Air quality re-analyses ...What for ?

- Data assimilated fields using an extensive set of validated in-situ data (AIRBASE) and Earth observations



Best representation of air pollution patterns integrating available observations

- Focus on episodes : long range contribution and exceptional events (natural sources)



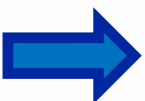
Best estimate of **background** air pollution in Europe

- Possible extraction at the national scale of indicators and provision of boundary conditions to national or local air quality modelling systems



Estimation of the number of exceedances due to such situations

- Ensemble model provides the best estimate and the multi-model approach an evaluation of the uncertainty



Support to national air quality assessment

Transparency : performance of the products ; most uncertain areas for modelling and analysis of the AQ monitoring network

Planned evolutions common to the daily and re-analysis production systems

- **Model and data assimilation improvements** according to the R&D work done in the EDA subproject
- **Improvement of the model resolution** : target is 0.1° for all individual models and the Ensemble.
Significant improvement of the accuracy is expected but not for local exceedance situations (near busy road or industry) which are not in the scope of the service.
- **Improvement of ensemble methods**
- **Full operationalisation within the CAMS services**
- **More easy access to numerical data in NRT** (“DCPC-like” Inspire compliant server with possibility to register as subscribed users and to use data transfer in push mode, also to extract subsets of data)

Specific planned evolutions

Daily production

- Ensemble analyses for PM10

Annual re-analyses

- **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**
- **Provision of Interim reports** based on non validated observation data reported through the NRT (“up-to-date”) fluxes
- The report for the year Y could be released by February of the year Y+1
- Experiment in MACC for the year 2013

Best use of MACC regional products for downscaling air quality modelling

Following last MACC User Workshop in Paris in June 2014 and the recommendations for the MACC User Advisory board

- Meeting on the 7th of January 2015 in Paris on the use of MACC products for boundary conditions for local models
- Outcomes for the meeting: a guide to be published by the end of May 2015 to support use of the current MACC products as BC and to present future perspectives

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 : O₃, NO₂, SO₂, PM10, PM2.5**
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)**

Current solutions (outcomes of the workshop)

- The 7 models involved in the Ensemble are not based on the same chemical schemes and production capabilities are finite
 - It is not **currently possible** to provide the users with **an extensive set of speciated VOCs and PM** for boundary conditions

- **Pragmatic considerations (for now) :**
 - The quality and the resolution of the services should be sufficient to provide high quality information for the national/regional scale

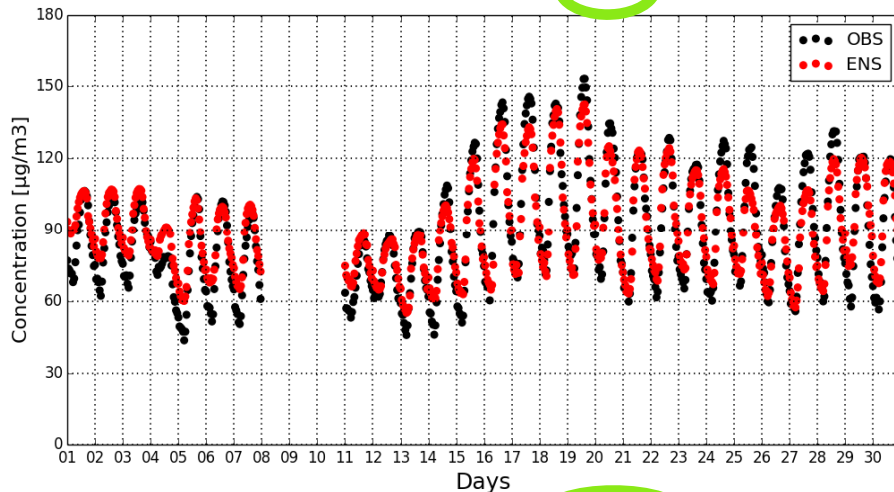
 - The main issue is the city scale where local exceedances develop: to feed in local (city) scale models MACC current regional products are sufficient as BC ; examples are Airtex, Pasodoble, NILU applications

 - For regions which require complementary regional modelling because of too high uncertainties, specific studies (see after)

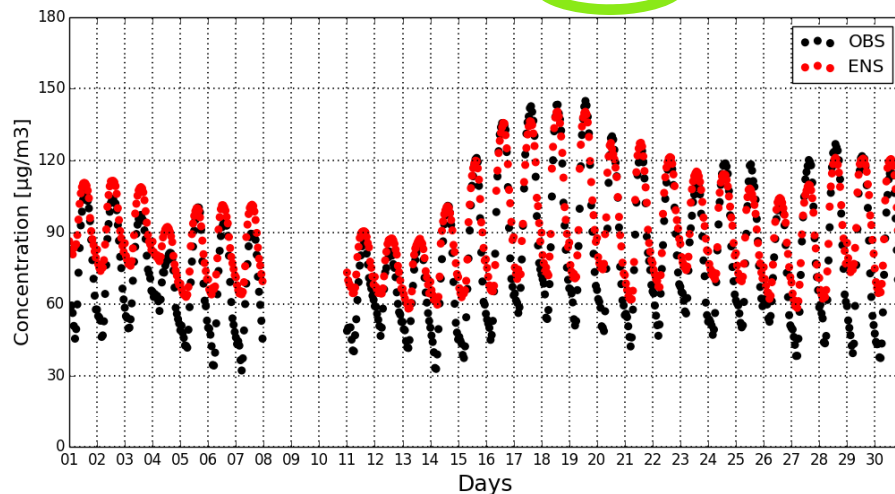
- **In the future :**
 - A study on the most sensitive compounds (VOCs, PM compounds) will be conducted and ensemble of such fields produced by the services

For Italy: Possibility of direct use of MACC products for ozone

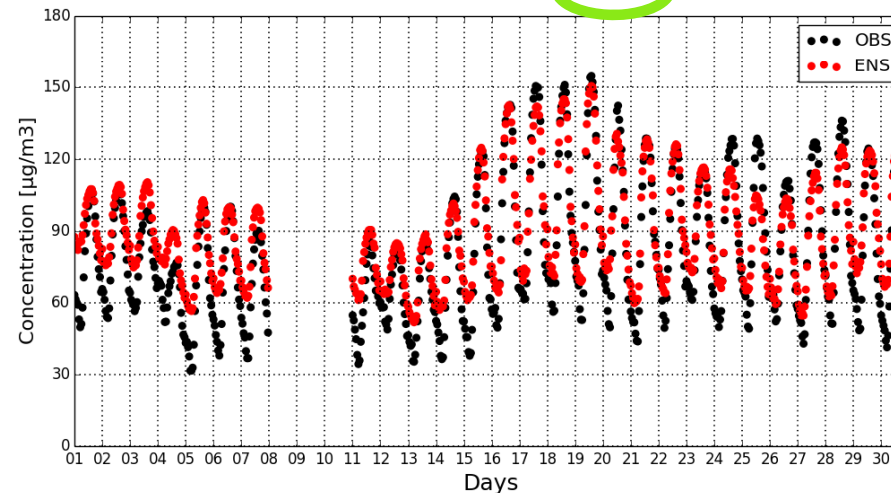
Concentration of o3 for 06/2012 in rural zone of Italie



Concentration of o3 for 06/2012 in suburban zone of Italie



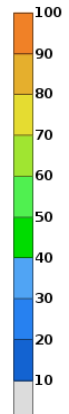
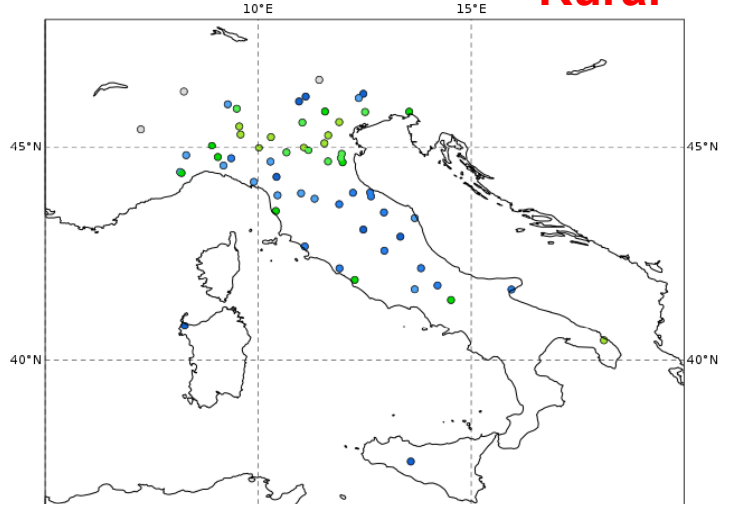
Concentration of o3 for 06/2012 in urban zone of Italie



Comparison between the Ensemble forecast and Airbase observations for Italy for ozone for June 2012 (similar results for July and August)

20120601-20120831 Hit Rate for OBS/ENS Timeseries
[Type = rural | Parameter = o3 | Threshold = 120.0 $\mu\text{g}/\text{m}^3$]

Rural

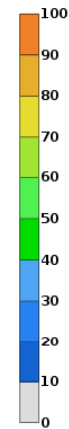
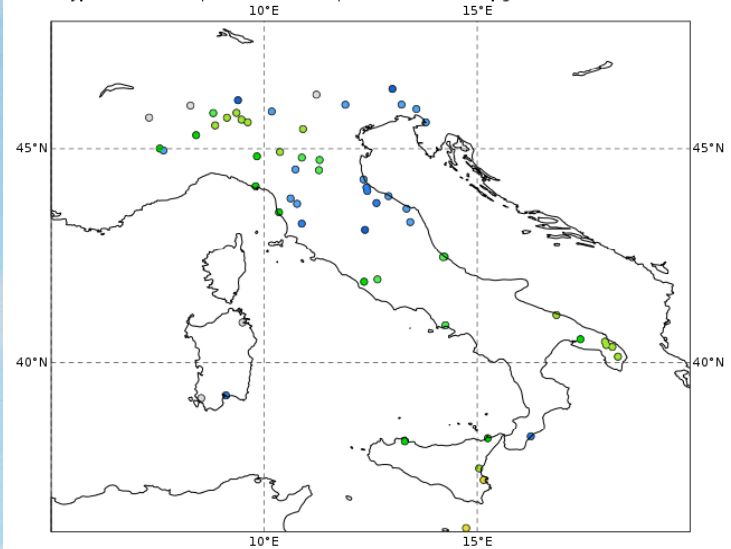


Hit rate of MACC forecasts for surface ozone above 120 $\mu\text{g}/\text{m}^3$ for June July August 2012

(false alarm rates are below 10%)

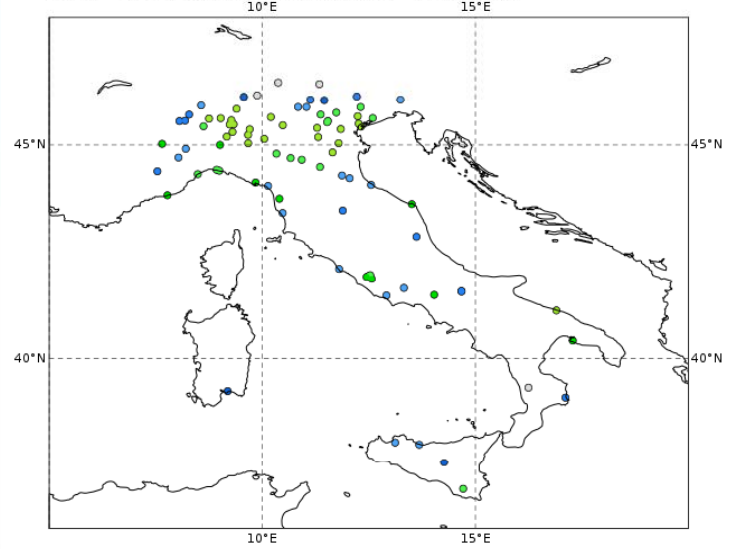
20120601-20120831 Hit Rate for OBS/ENS Timeseries
[Type = suburban | Parameter = o3 | Threshold = 120.0 $\mu\text{g}/\text{m}^3$]

Suburban



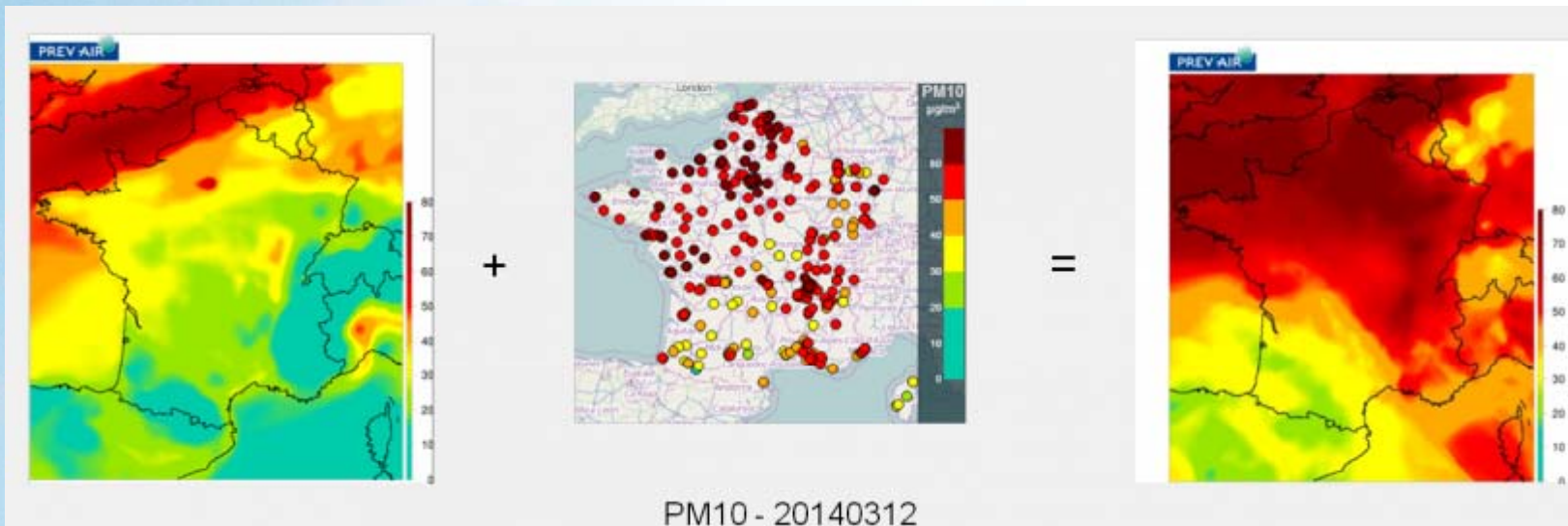
20120601-20120831 Hit Rate for OBS/ENS Timeseries
[Type = urban | Parameter = o3 | Threshold = 120.0 $\mu\text{g}/\text{m}^3$]

Urban

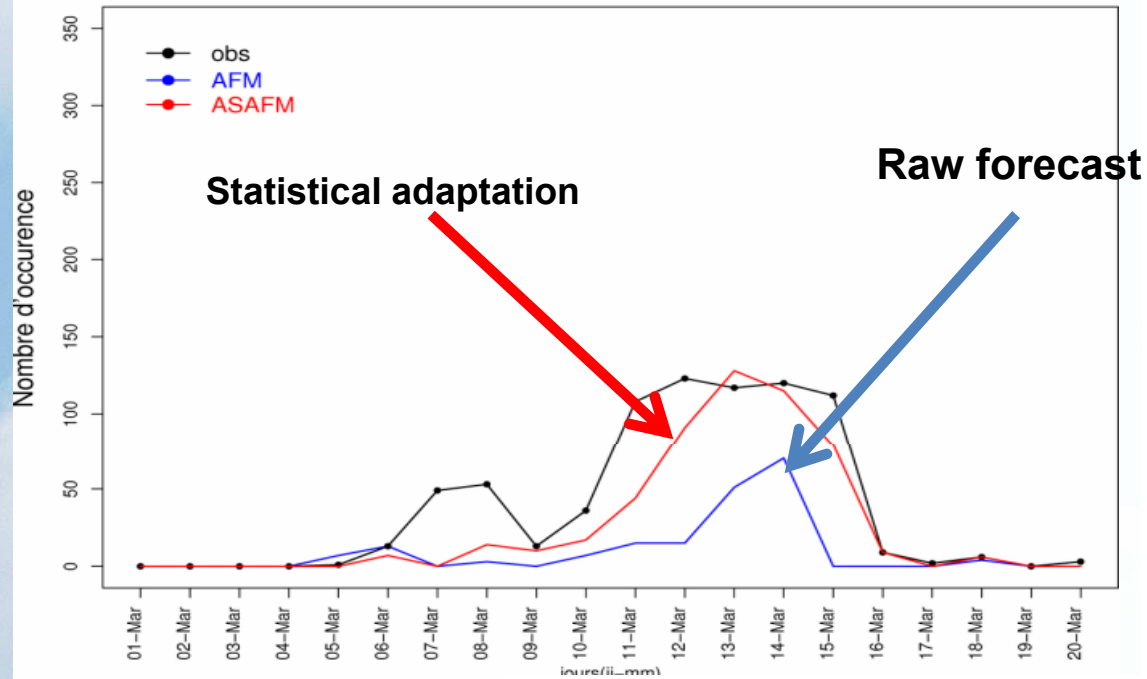


Other possibilities of use of MACC regional products for air quality forecasts over Italy (1)

- **In the short-term:** application of **statistical adaptation methods** at observation locations → removes systematic biases keeping the variability predicted by MACC products
- It is based on the analysis of historical datasets that allow to detect systematic biases and to correct them accounting for other parameters (meteorology, emissions, geographical area and season...)
- Largely developed in the weather forecast community and implemented operationally in PREV'air, the French air quality forecasting platform



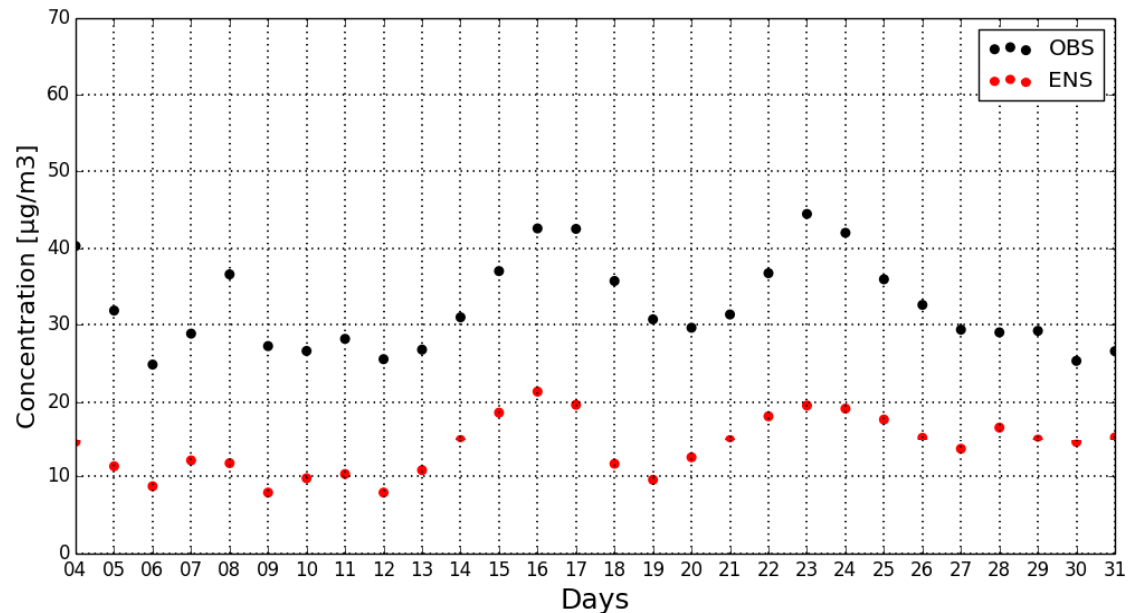
PM10 dépassements du seuil de 50 µg/m3 D+0 Année: 2014



Example of statistical adaptation in PREV'air

Possible application for Italy to remove PM10 biases but keeping day to day variability

Concentration of pm10 for 03/2012 in suburban zone of Italie



Other possibilities of use of MACC regional products for air quality forecasts over Italy (2)

In the mid-term : work on the emission inventories for a better match between the MACC inventory over Italy and best Italian inventories

→ detailed comparisons of MACC forecasts using these improved inventories region by region

→ possible direct use of MACC forecasts for more species and more regions of Italy



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