Applying the FAIRMODE tools to support air quality directive: the experiences of ARPAE

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Who are we?

The Air Quality Center ARPAE (CTR_ARIA) is responsible for Emission Inventory, air quality measurement and air quality modelling for the region of Emilia Romagna.

ARPAE produces its own emission inventory to give more accuracy for local authority decision making.

ARPAE participates in Fairmode pilot region exercises

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FAIRMODE PILOT EXERCISE

- Promote an efficient use of the methodological approaches and guidance developed in FAIRMODE
- Support and improve the use of modelling for air quality management Practices
- Pilot regions and cities apply and test methodologies and guidance developed in FAIRMODE and receive support by the FAIRMODE chairs in charge of the applied methodology/guidance
- Pilot feedback will improve FAIRMODE methodologies and guidance

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EMILIA ROMAGNA
EMISSIONS INVENTORY

Emilia regional emission (bottom up) inventory is a bottom-up inventory, and we suppose that at the end of this month we officially released a new version up to reference year 2013.

INEMAR7, is a emission inventory tool based on CORINAIR-SNAP97 methodology developed by Lombardy region and used in may italian regions

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Point sources

agriculture

Biogenic emission

Forest sink

Areal sources

Waste

airports

traffic

ports

Domestic and commercial heating

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BENCHMARKING METHODOLOGY FOR EMISSIONS INVENTORIES

Here we present a first comparison of Emilia Romagna emission inventory 2013 with the **TNO-MACC3 inventory for 2011** (the most recent European inventory available in Delta Tool)

We analyze the macro-sectors 2 (**domestic heating** - DOM), 3 and 4 together (**industrial combusion and production** - IND34) and 7 (**road transport** – TRAF)

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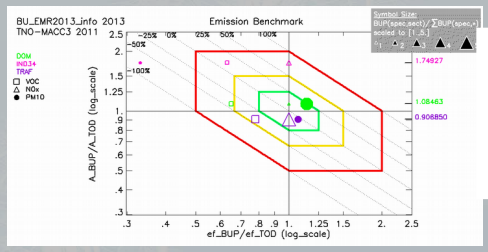
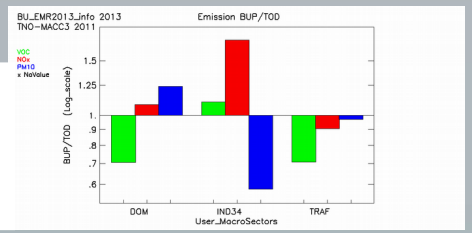
BENCHMARKING METHODOLOGY FOR EMISSIONS INVENTORIES

FAIRMODE is the Forum for Air Quality Modelling in Europe (http://fairmode.ew.eea.europa.eu/), created for exchanging experience and results from air quality modelling in the context of the Air Quality Directive (AQD). A Delta emission has been developed to compare top-down versus bottom-up emission estimates, often not consistent with each other, in order to better understand the differences between these two approaches and reduce the uncertainties in the emissions evaluation.

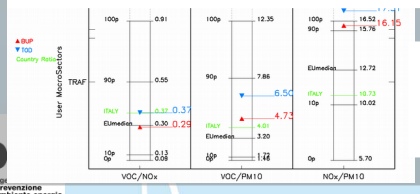
Delta Tool - different comparison methods representing different complementary aspects



diamond diagram: it is designed to identify discrepancies between inventories; it allows to assess whether the differences can be mostly related to different emission factors or in the choice of activity data

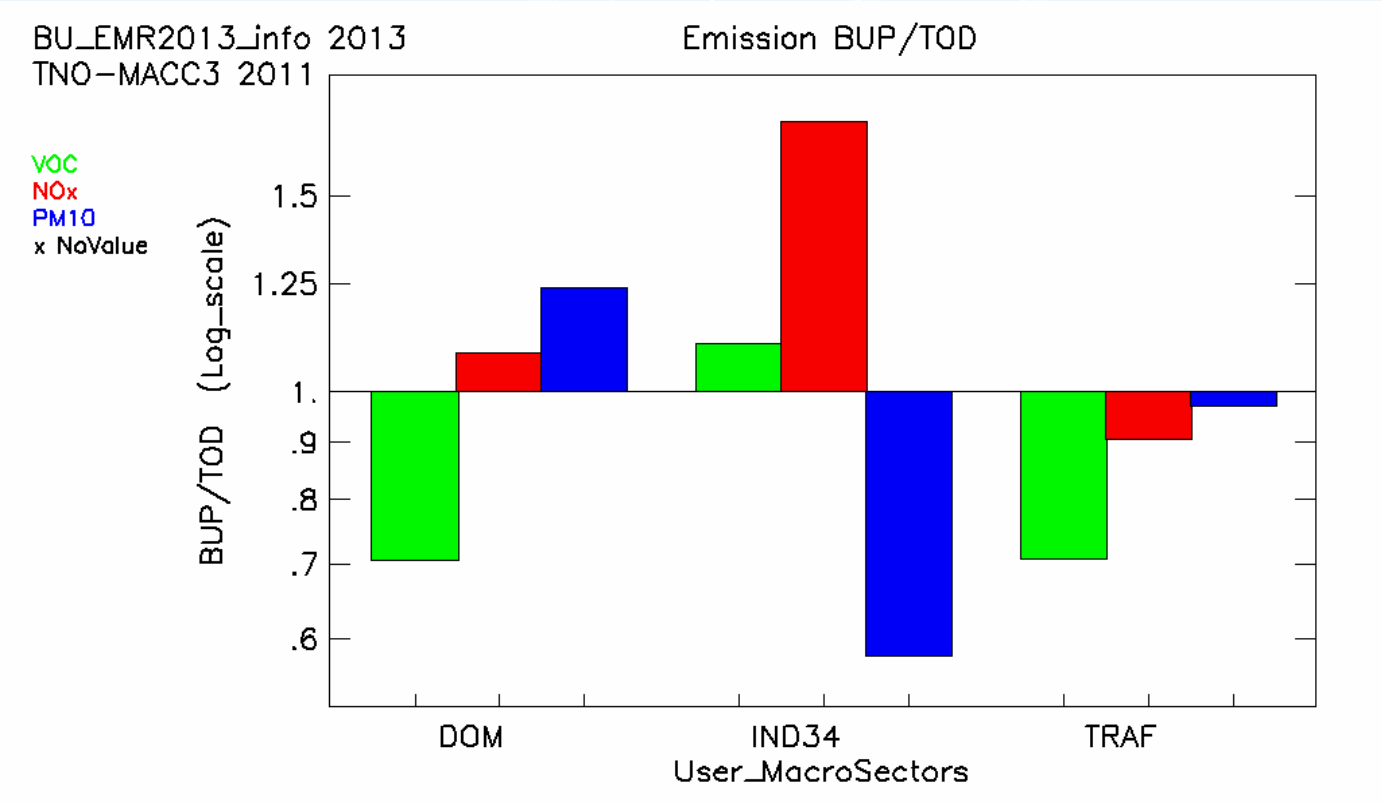


bar-plot: it represents the comparison of pollutant emissions in macro-sectors through ratios between bottom-up and top-down for each pollutant



ratio diagram: it represents the comparison between ratios of various pollutants for each inventory and for GAINS

Bar-plot diagram with ratios of bottom-up/top-down emissions



ROAD TRANSPORT: the diagram presents a ratio near to one for NOx and PM10

DOMESTIC HEATING: the diagram presents for NOx and PM10 low ratios and in agreement between them, and a low ratio for VOC although of the opposite sign; we think that this fact is due to overestimated emission factors for VOC in the case of top-down inventory

PRODUCTIVE ACTIVITIES: significant differences due to the different methodology of compilation of the inventories

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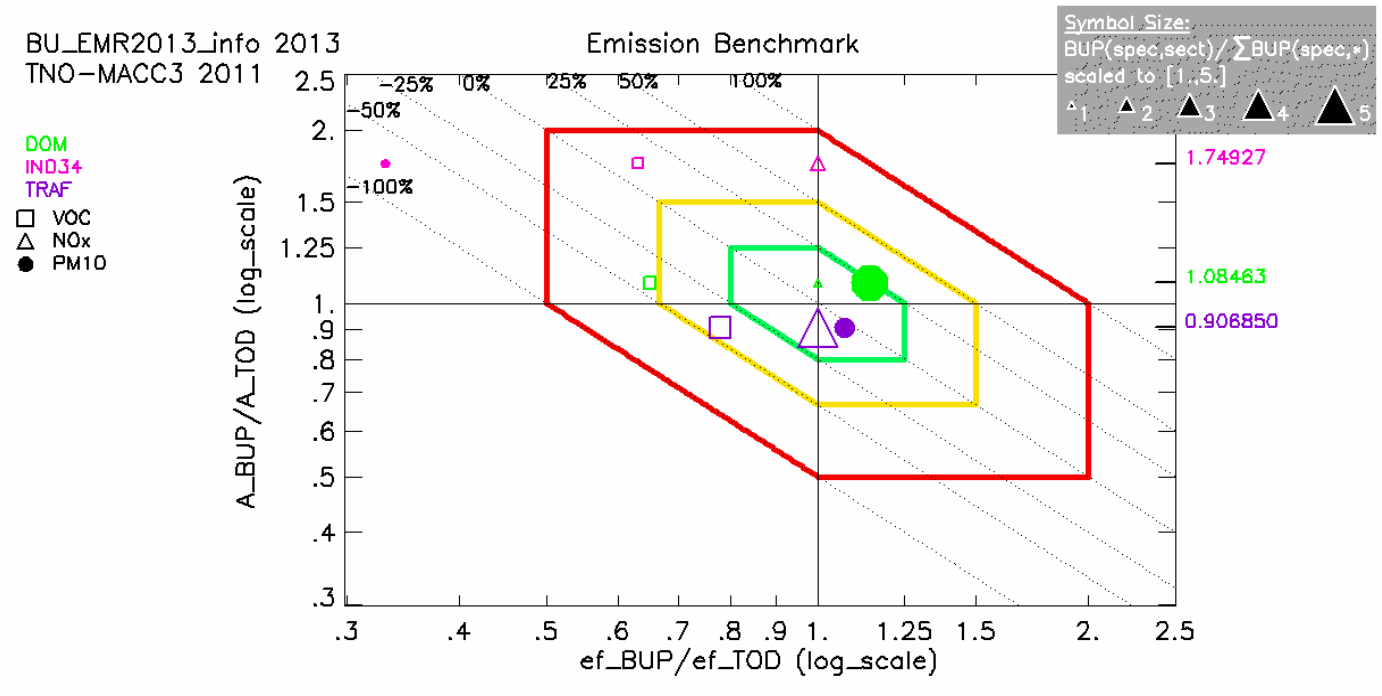
Diamond diagram for NOx, PM10, VOC in domestic heating, traffic, industrial sectors



- in the diagrams the quantities of pollutants have been normalized respect to NOx, which is the proper pollutant for the analyzed sectors

ROAD TRANSPORT: BUP and TOD inventories are consistent both in terms of activity, slightly lower in the bottom-up, and in terms of emission factors; markers close to the unit in particular for PM10

DOMESTIC HEATING: BUP and TOD inventories are consistent in terms of activity indicators, slightly higher in the bottom-up, and in terms of emission factors; all markers close to the unit; good proportionality between emission factors of PM10, fairly good proportionality in emission factors of VOC

PRODUCTIVE ACTIVITIES: significant differences observed, higher activity indicators and lower emission factors in bottom-up, with effects which partially cancel each others

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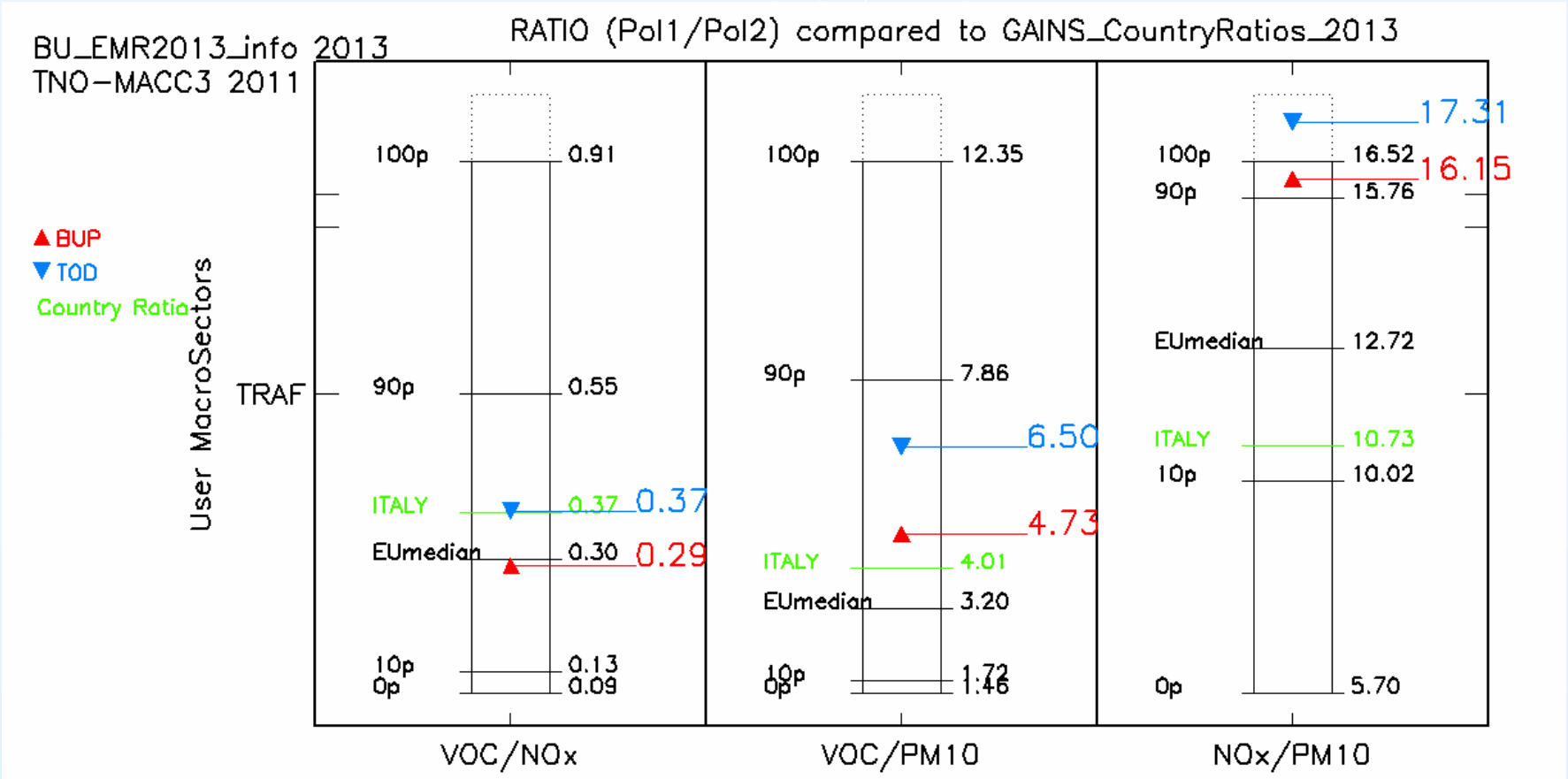
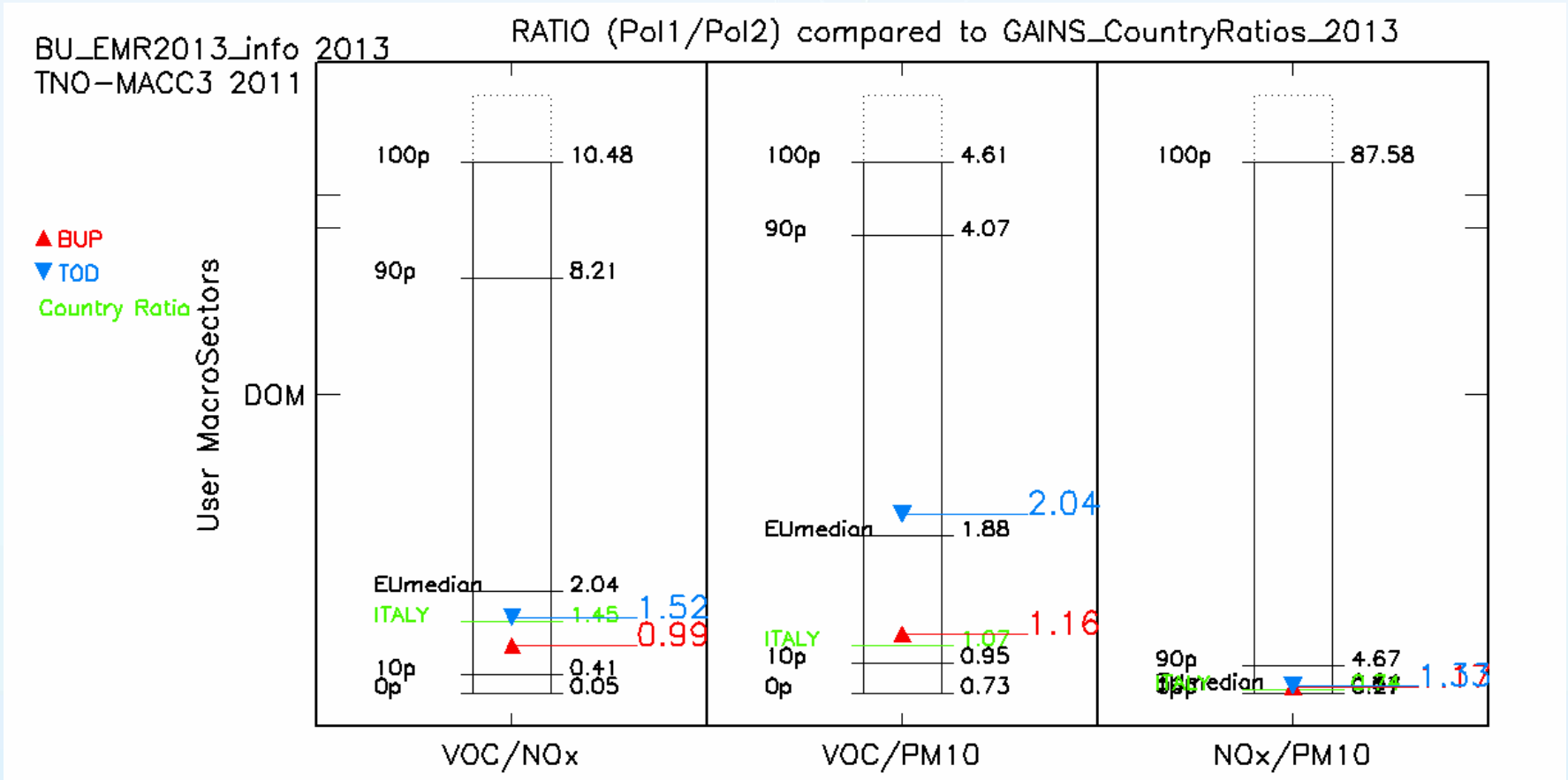
Pollutants ratios for traffic sector



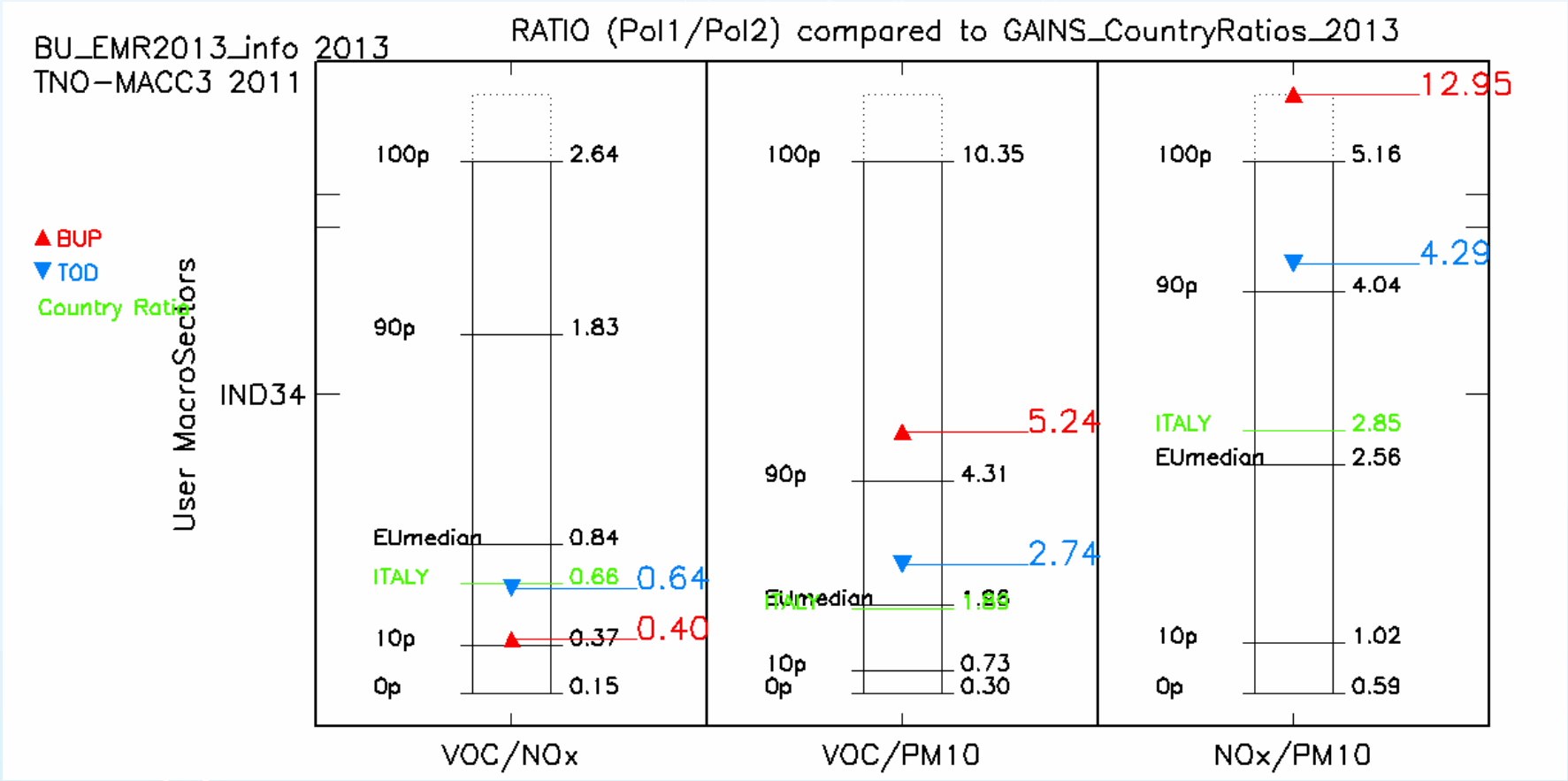
the two compared inventories present a good agreement while the NOx/PM10 ratio deviate from the GAINS national average

Pollutants ratios for domestic heating sector



good agreement on the ratios NOX/PM10, VOC/PM10 TOD are higher than the European average and GAINS Italy.
TOD VOCs emission factors are overestimated?

Pollutants ratios for industrial sector



Very high ratio VOC/PM10 and NOx/PM10 in BUP

SUMMARY: benchmarking methodology for emission inventories

Immediate evaluation of the consistency between two inventories and in some cases it was able to highlight the causes of discrepancy

DOMESTIC AND TRAFFIC SECTOR

good agreement was reached between the bottom-up and top-down inventories for domestic heating and traffic; VOC TOD emission factors are probabily overestimated

INDUSTRIAL SECTOR

significant differences partly due to the different reference year, very significant for the industrial sector, and to the different methodology of compilation. Industry emissions are the result of a systematic analysis of industrial plant documentations and of production cycles, therefore it provides a more accurate result.

Regional Emission factors are different than those of the Guidebook, (i.e. lower than TOD) in order to better describe the production and the abatement systems really implemented, or we have used the results of direct measurement of stack emissions. So it is not surprising that the ratios of NOx and PM10 in the industrial sector have opposite sign.

Other analysis are going on in framework of the FAIRMODE pilot exercise

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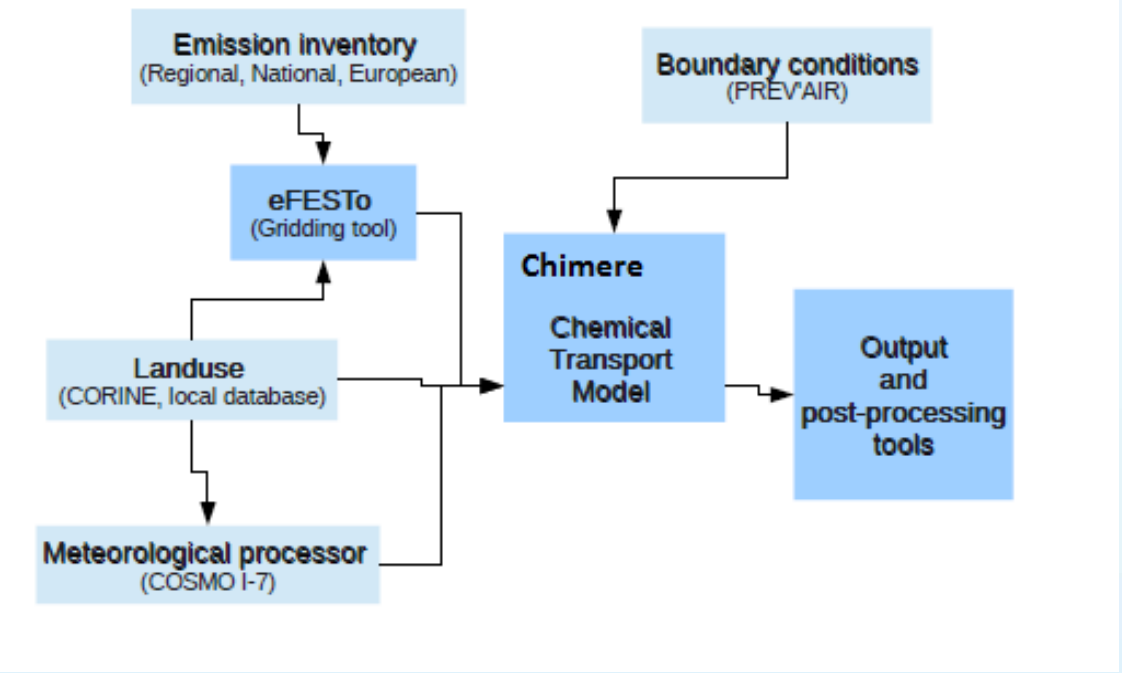
NINFA Air Quality Modeling System

Starting from 2003 in ARPAE use NINFA for operational and assessment purposes.



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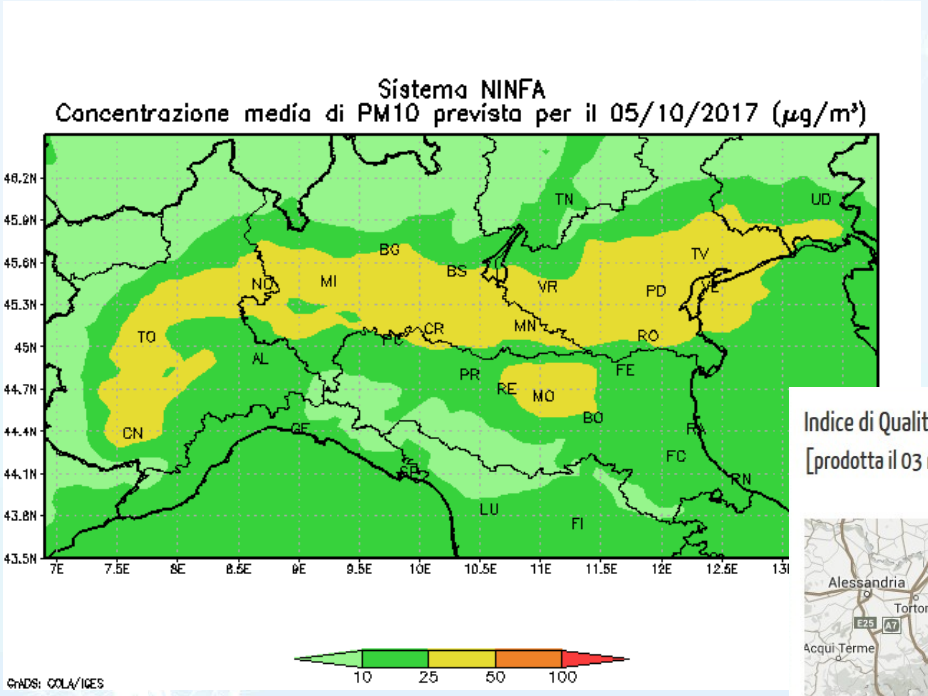
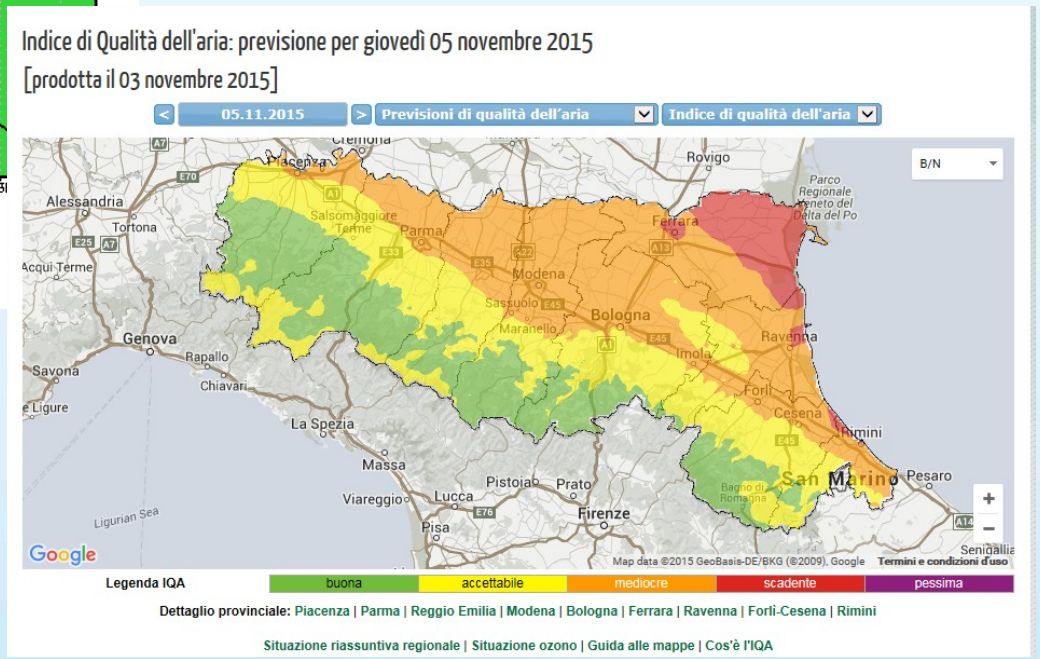
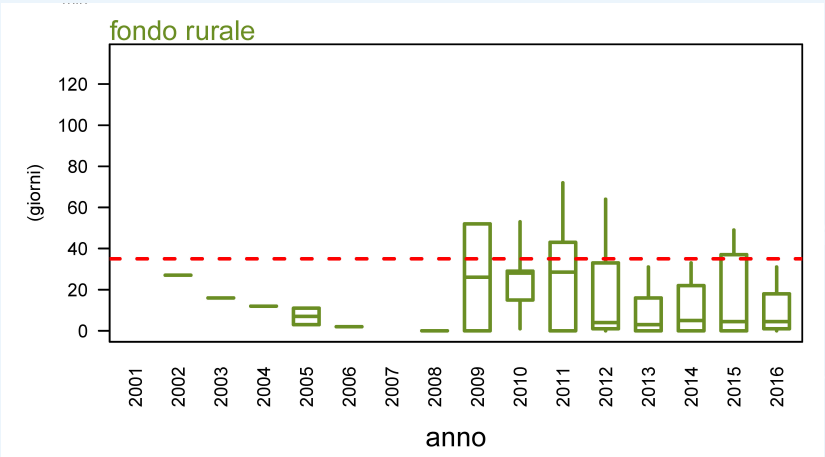
NINFA output

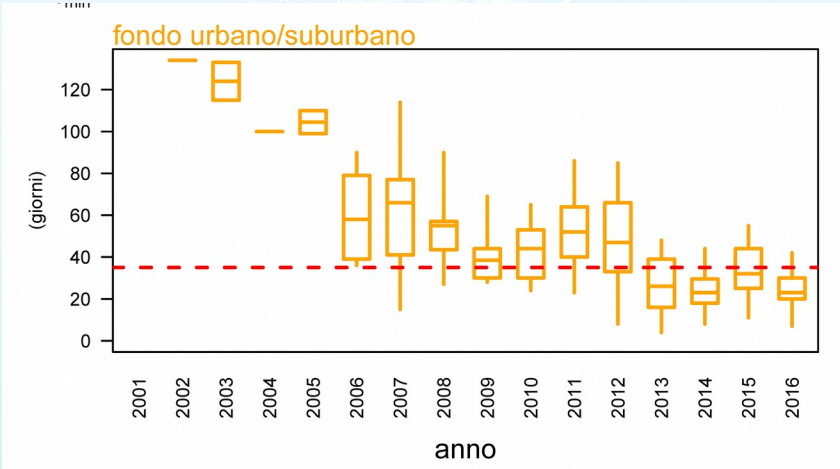


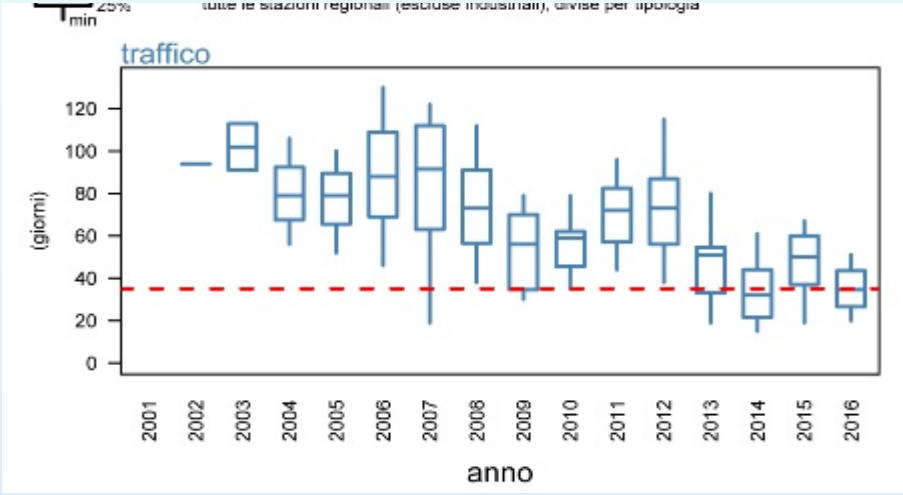
NINFA "correct" output



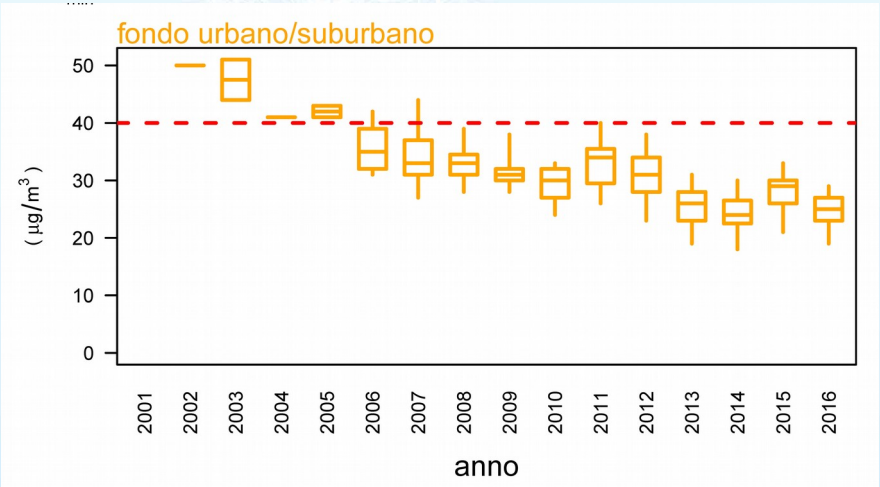
PM10: Number of exceedances of daily values

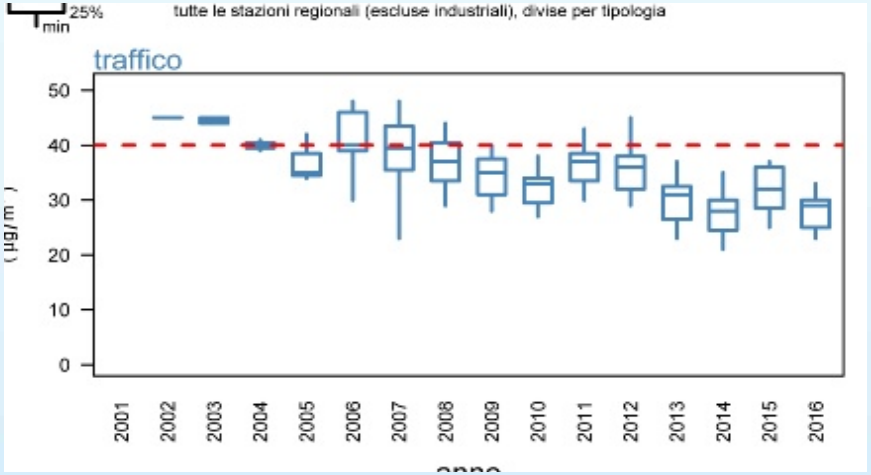


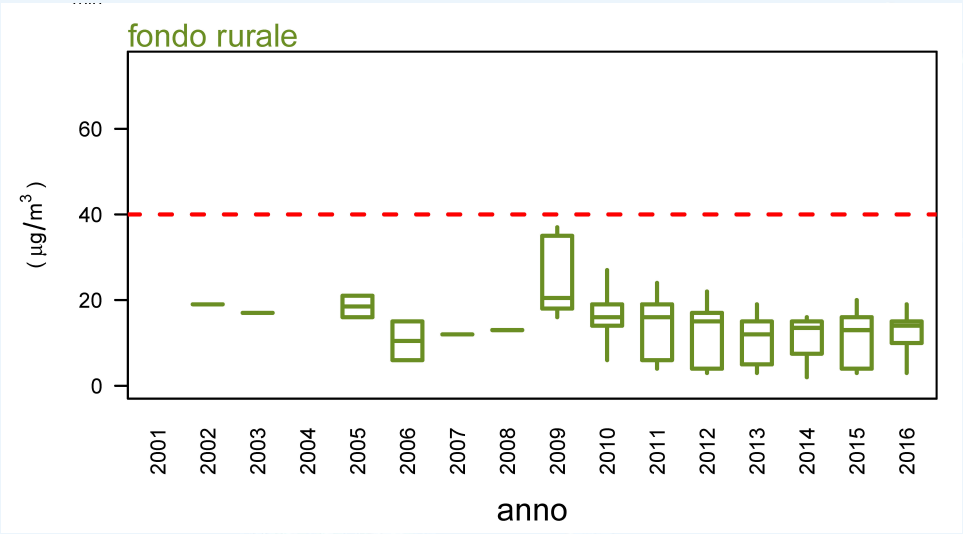




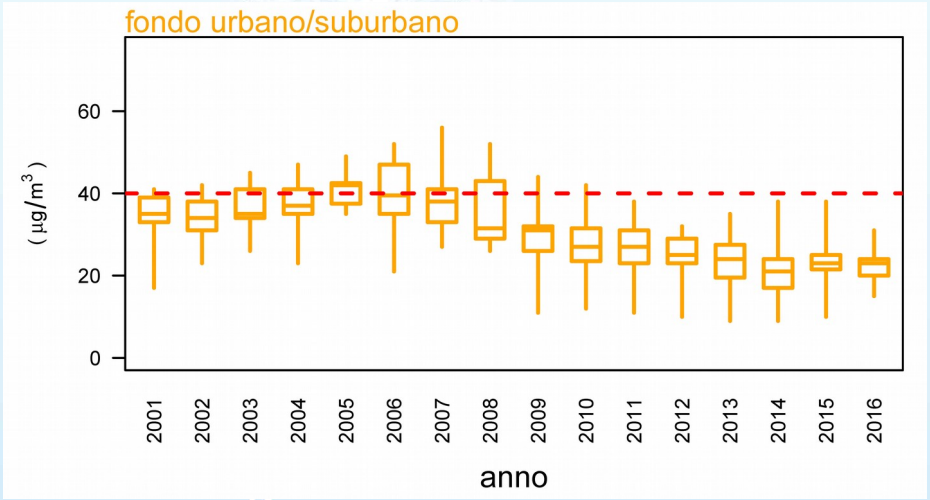
PM10 Annual mean

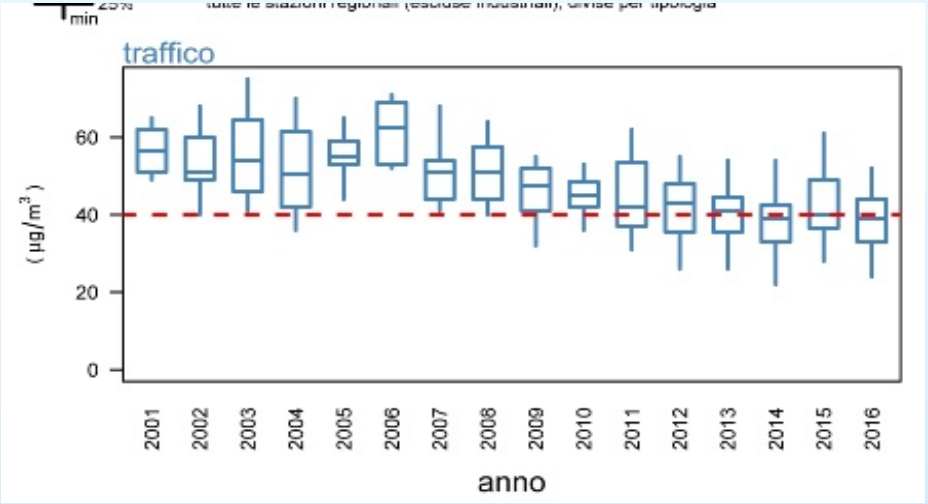






NO_2 annual mean





BENCHMARKING METHODOLOGY FOR AQ MODELS

FAIRMODE DELTA TOOL

- based on pairs of measurement and modelled data at given location and it takes into account the measurement uncertainty while calculating model performance indicators related to RMSE, correlation, BIAS and standard deviation
- several statistical diagram, i.e taylor plot, Q_Q_plot, mean bar plot, are also available
- the main model performance indicator, called modelling quality indicator (MQI), is expected to fulfil the criteria (the model quality objective), easily viewable at the target diagram
- the ”Target diagram” plots for each station the normalized CRMSE against the normalized BIAS, the distance from the origin represents the normalized RMSE; the screen is divided into four areas distinguishing the main source of error type for each station, positive and negative bias (top and lower zones), correlation and standard deviation (left and right areas)

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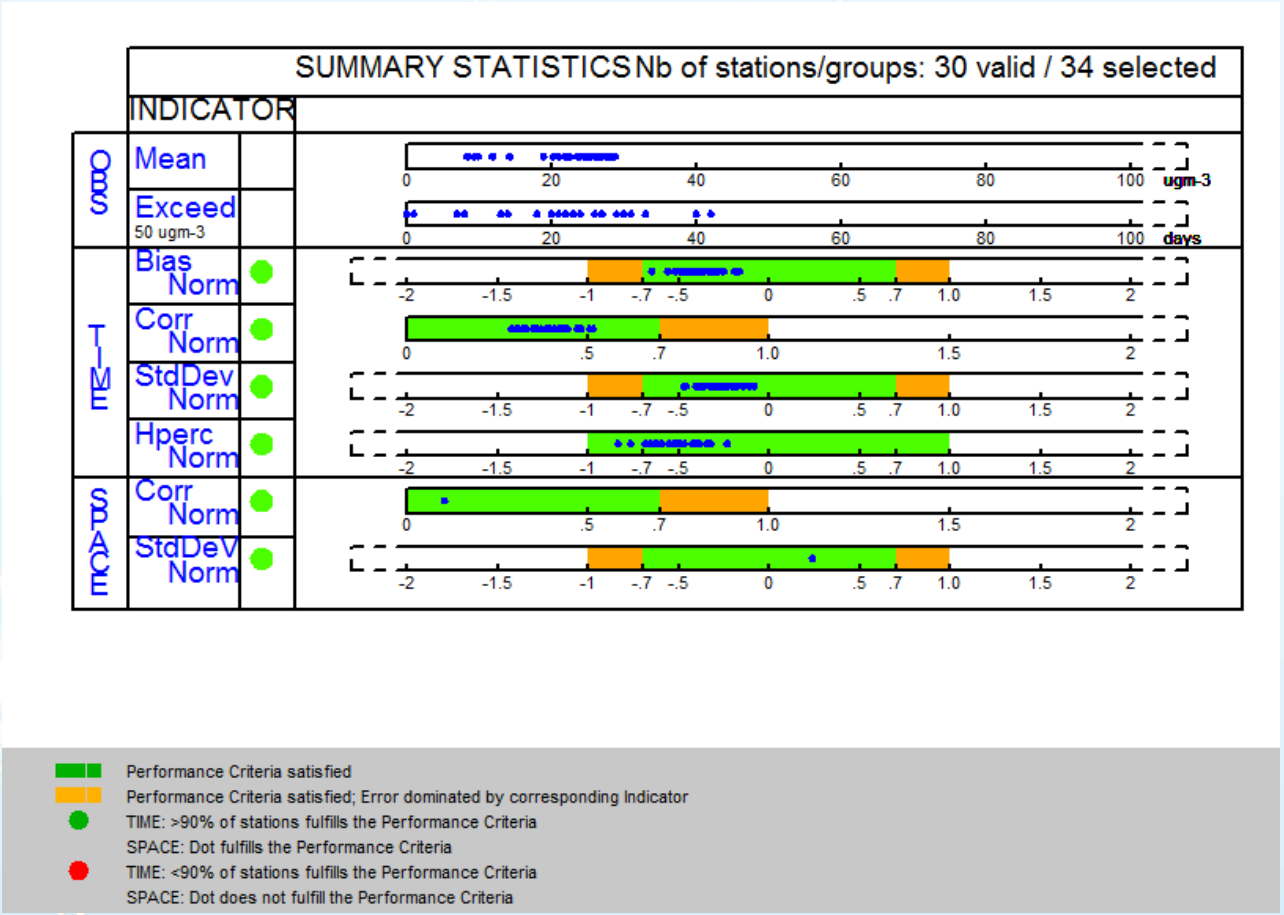
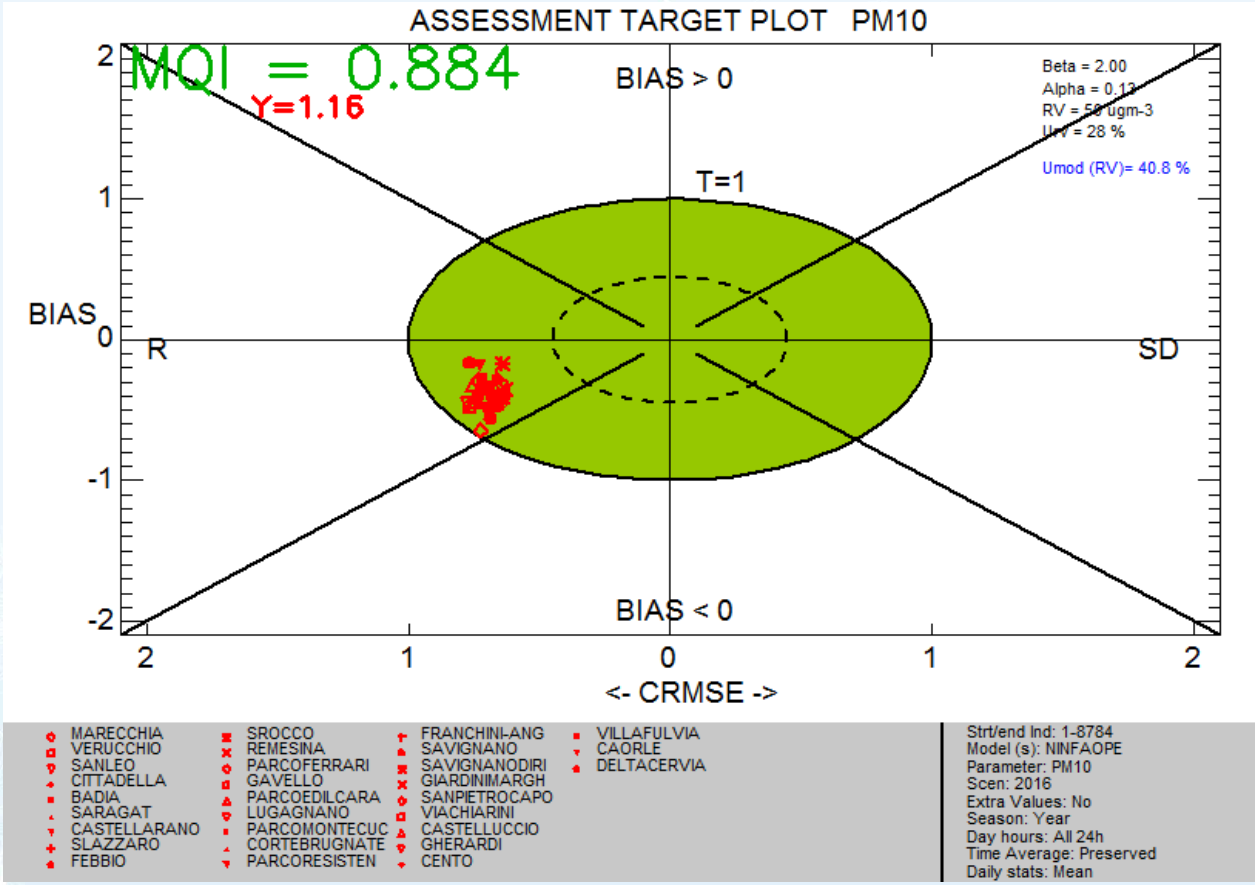
Summary statitics for PM10

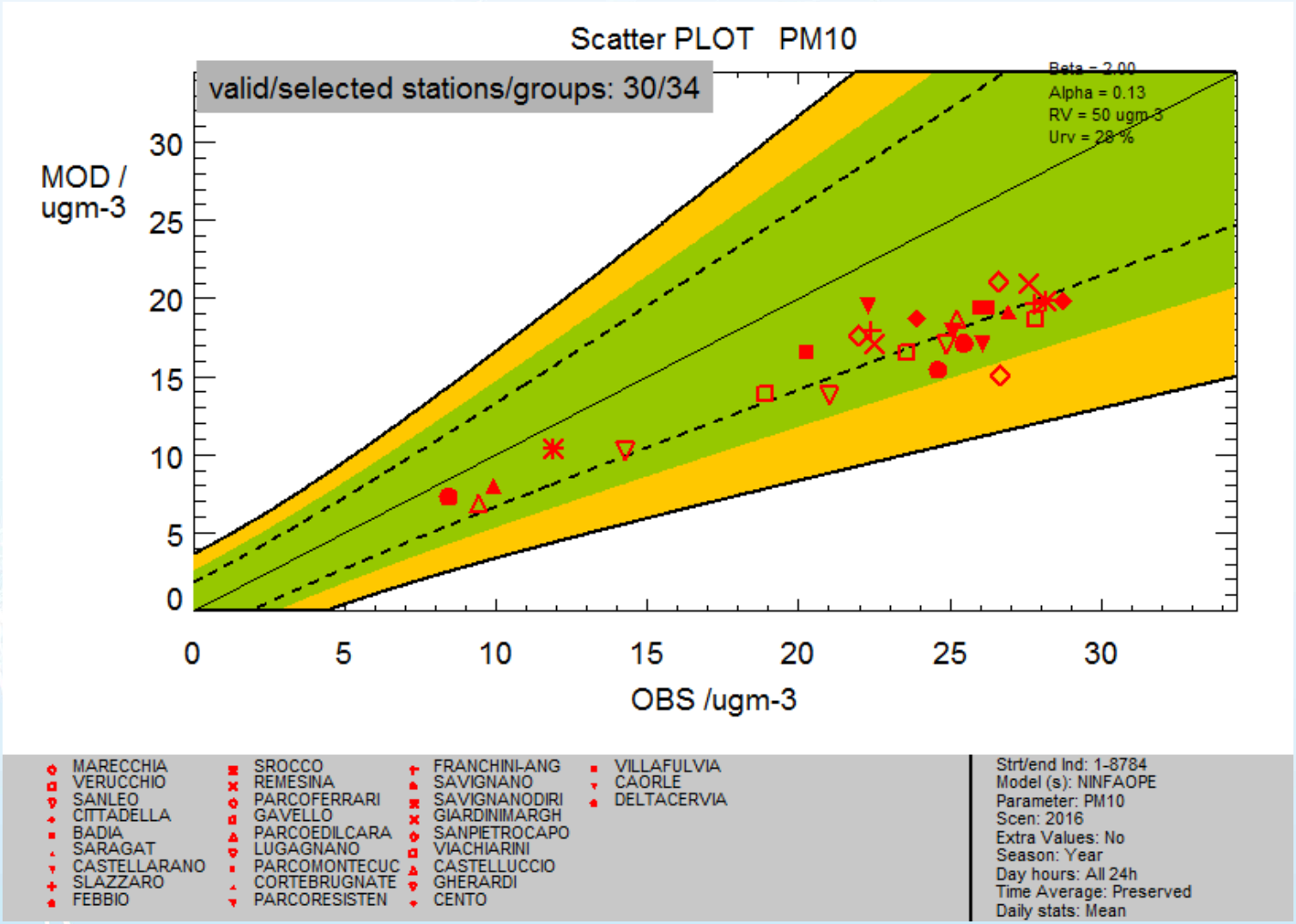


Target plot for PM10 NINFA concentrations

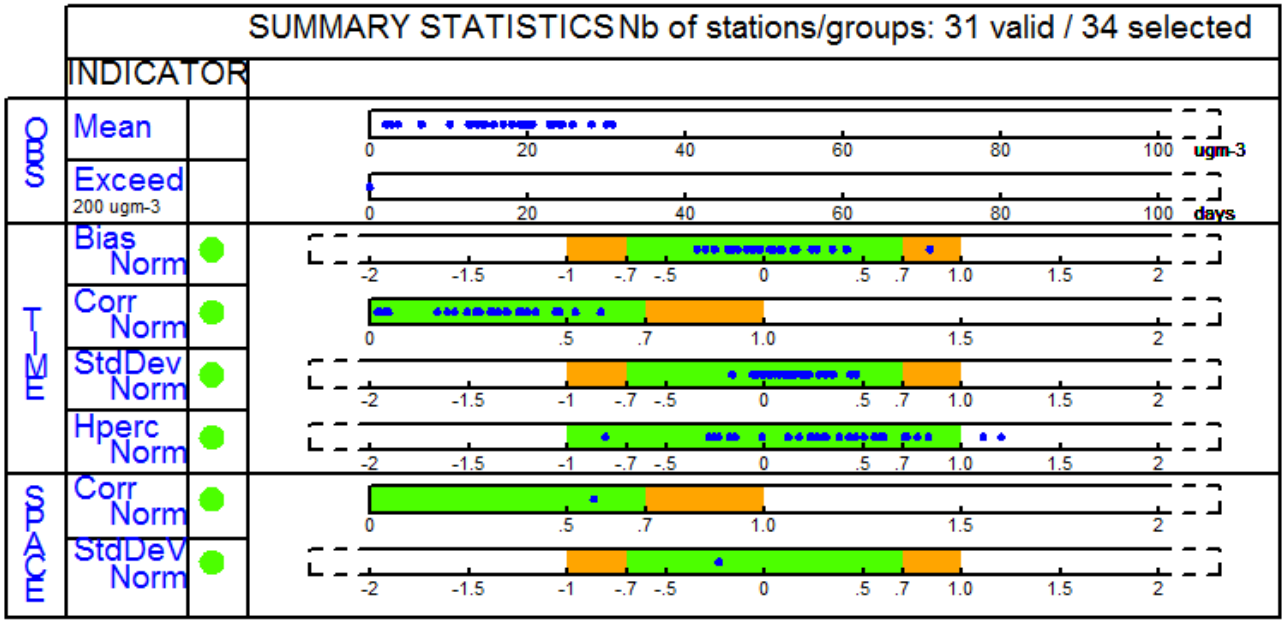


All stations fulfil the criteria, the bias is always negative, indicating a general underestimation of the PM10 by the model, attributable to the well-known difficulties of air quality model performing over the Po valley. Inside the random error, the source of error is due to the correlation between the modelled and observed data. All dots are also outside the dashed circle which represents the area where the model is within the range of observation uncertainty, this suggests that further improvements to the model can be achieved.

PM10 scatter plot



Summary statistics for NO2



Performance Criteria satisfied

Performance Criteria satisfied; Error dominated by corresponding Indicator

TIME: >90% of stations fulfills the Performance Criteria
SPACE: Dot fulfills the Performance Criteria

TIME: <90% of stations fulfills the Performance Criteria
SPACE: Dot does not fulfill the Performance Criteria

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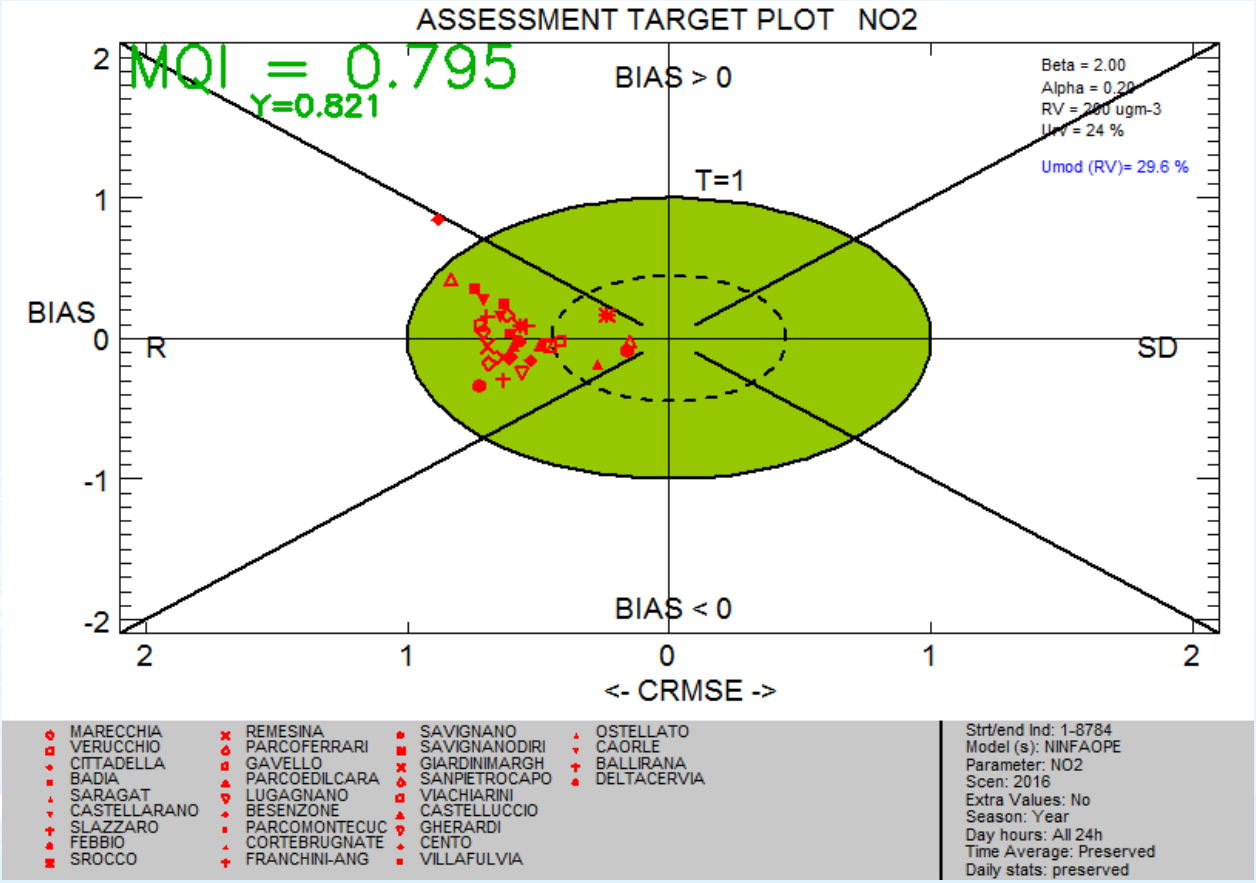
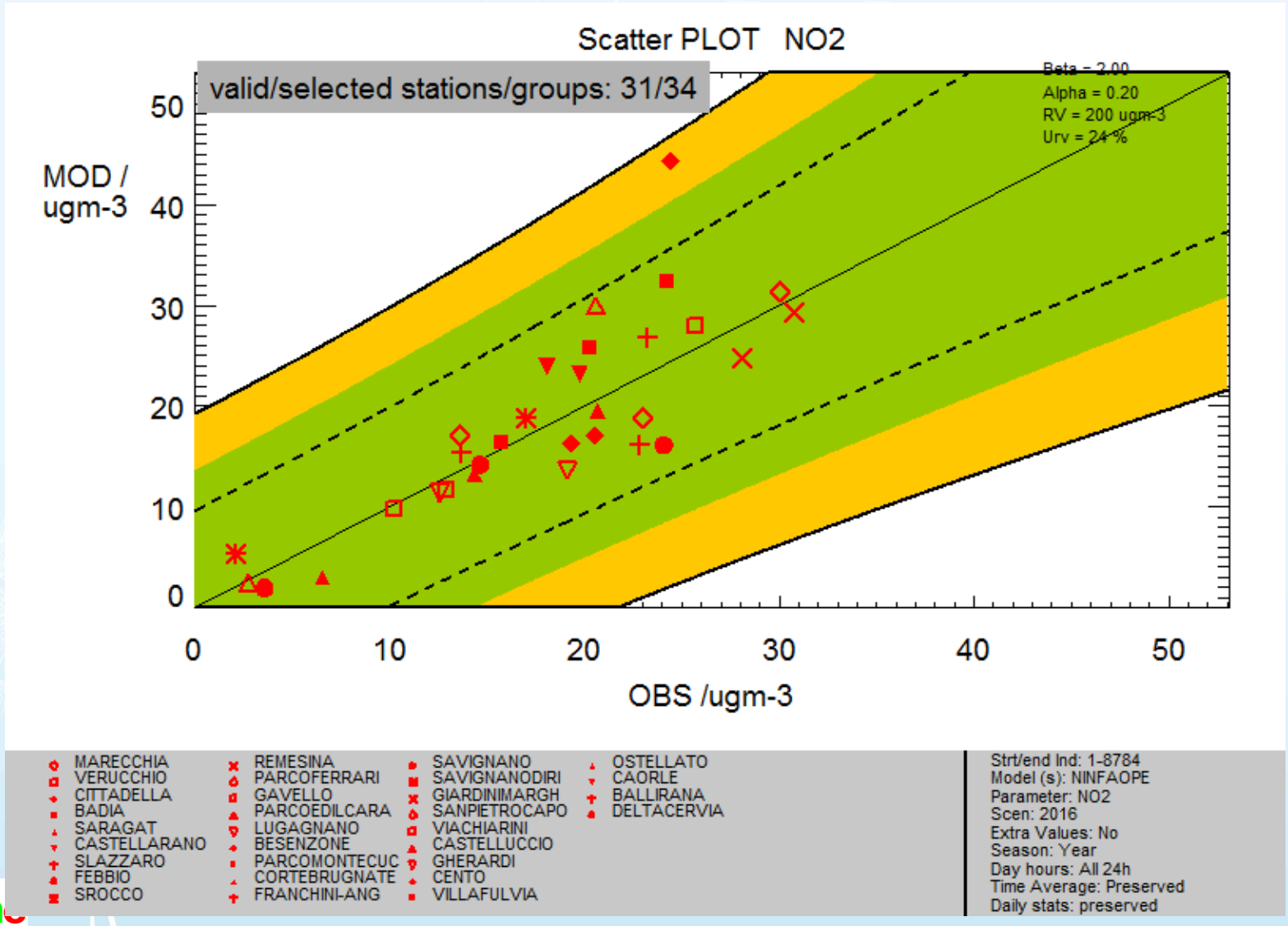
Target plot for NO2 NINFA concentrations



Only one station is outside the green circle. The 54% of sites shows negative bias, indicating an underestimation. The 16% of the points lie inside the dashed circle, thus there is no margin for a model improvement at these sites. The correlations is the source of error inside CRMSE zone.

NO2 scatter plot



SUMMARY: benchmarking methodology for AQ model

Model results provided by NINFA for PM10 and NO2 have been compared to measured data provided by 34 monitoring background Emilia Romagna air quality stations for year 2016

The target plot analysis shows that NINFA fulfils all criteria for all sites for PM10 and for 97% of sites for NO2

The application to a real modelling case shows that the Tool can be used to support modellers for evaluation of theirs models in the frame of AQD

Other analysis are going on in framework of the FAIRMODE pilot exercise

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