



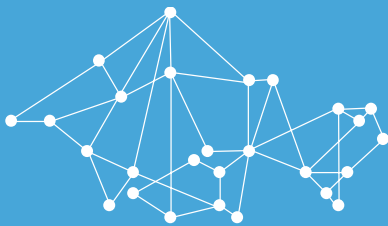
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UPDATE: FORECAST ACTIVITIES (CT3)

STATUS OF THE ACTIVITY

ANTONIO PIERSANTI, STIJN JANSSEN

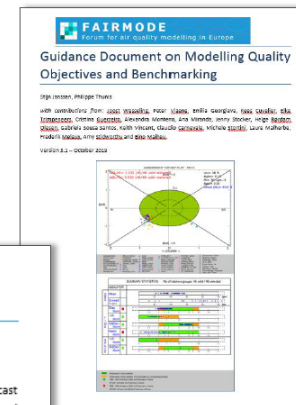


FAIRMODE PLENARY MEETING, BRUSSELS, 27-28 APRIL 2022

CT3 - Quality control indicators for AQ forecasts



- ❑ Test the proposed indicators (national and CAMS data).
- ❑ Elaborate a guidance document on the use of forecast indicators



10. FORECASTING & EXCEEDANCES INDICATORS

10.1. Introduction

In this chapter, indicators and diagrams are proposed for the evaluation of model results in forecast mode. The main objective is to offer a common standardized template to facilitate the screening and comparison of forecast results. It has to be stressed that this methodology is not as mature as the Modelling Quality Objective for assessment and requires further testing and fine tuning.

First, it should be mentioned that the proposed Forecast Modelling Quality and Performance Indicators come on top of FAIRMODE's assessment MQO as defined in the previous chapters of this document. Therefore, it is recommended that forecast models fulfill the standard assessment MQO as well as the



TEST THE PROPOSED INDICATOR (NATIONAL AND CAMS DATA)



DONE

2021

- the proposed indicators were tested by CT3 community and feedback of the users was collected and discussed during a couple of hackathons (9 February, 26 May) and during the CT3 session at FAIRMODE Technical Meeting (6-8 October)
- CT3 discussion led to some adjustments of the proposed methodology, concerning both the formulation of the indicators and the layout of the plots → Some consensus was reached on the final current formulation

2022

- a new version of the DELTA Tool (7.0) was developed including the new indicators and it is now available for the download (<https://aqm.jrc.ec.europa.eu/index.aspx>)
- the DELTA Tool User's Guide was revised in order to include the formulation and the use of the new indicators



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DONE

2021

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2022

*Augustin Colette, Frédéric Meleux (INERIS), Adrien Royer (MétéoFrance)
and Micheal Gauss (Met Norway) [for CAMS Regional]*



ELABORATE A GUIDANCE DOCUMENT ON THE USE OF FORECAST INDICATORS



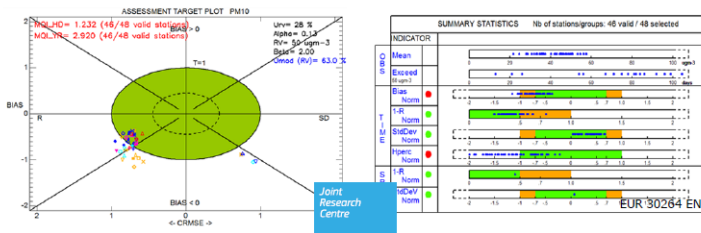
JRC TECHNICAL REPORT

FAIRMODE Guidance Document on Modelling Quality Objectives and Benchmarking

Version 3.3

Janssen, S., Thunis, P.

With contributions of: Adani, M., Carnevale, C., Cuvelier, C., Durka, P., Georgieva, E., Guerreiro, C., Malherbe, L., Maiheu, B., Meleux, F., Monteiro, A., Miranda, A., Olesen, H., Pfafflin, F., Stocker, J., Sousa Santos, G., Stidworthy, A., Stortini, M., Trimpeneers, E., Viaene, P., Vitali, L., Vincent, K., Wesseling, J.



DONE

A revised version of the FAIRMODE Guidance Document on Modelling Quality Objectives and Benchmarking was produced including the formulation of the new forecast indicators.

Available on FAIRMODE website as EUR technical report shortly after this meeting

8 FORECASTING & EXCEEDANCES INDICATORS

In this chapter, indicators and diagrams are proposed for the evaluation of model results in forecast mode. The main objective is to offer a common standardised template to facilitate the screening and comparison of forecast results.

First, it should be mentioned that the proposed Forecast Modelling Quality and Performance Indicators come on top of FAIRMODE's assessment MQO as defined in the previous chapters of this document. Therefore, it is recommended that forecast models fulfil the standard assessment MQO as well as the additional forecast MQO as defined here.

When evaluating a forecast model, two additional features of the model should be tested:

1. Sudden changes in the concentration levels (episodes) should be captured by the model
2. The exceedance of specific thresholds should be modelled well as such threshold exceedance can be used as trigger for short term action plans

To account for this, we will benchmark the forecast model with the so called "persistence model", which is the simplest method for predicting the future behaviour if no other information is available. The persistence model uses the measurements of the previous (day -1) as an estimate for the full forecast horizon and is by default not able to capture any changes in the concentration levels.

The methodology in its current form supports the following pollutants and time averages: the hourly NO₂ daily maximum, the 8h O₃ daily maximum and the daily PM10 and PM2.5 averaged concentrations. Note that only one value per day is used and that no evaluation of the entire hourly time profile is made.

In section 8.1 and 8.2 the Modelling Quality Indicator and the Modelling Performance Indicators are defined, respectively. Section 8.4 deals with the threshold indicators and in 8.44 the benchmarking diagrams as currently implemented in DELTA (vs6.1) are described in detail.



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FINAL PROPOSED FORMULATION

Within the proposed formulation, Forecast Evaluation addresses three main topics

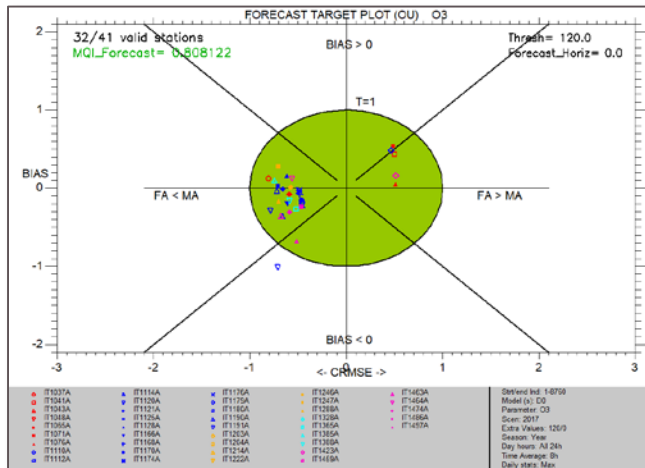
1. An overall assessment in order to evaluate if the forecast application is “good enough” based on the Comparison with the Persistence Model
2. An assessment of the model Capability in predicting Exceedances
3. An assessment of the model Capability in predicting Air Quality Indices



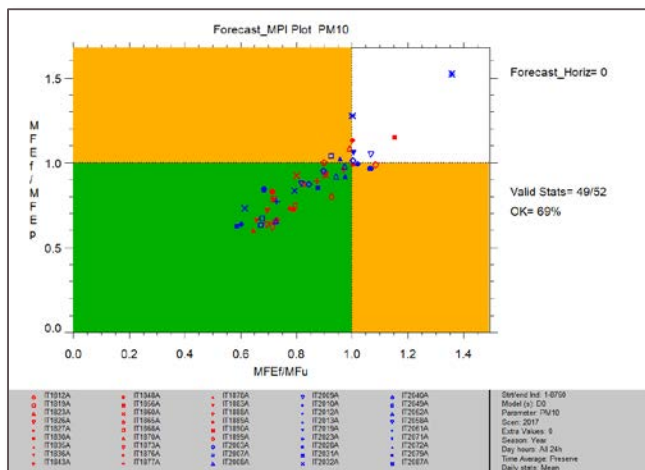
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COMPARISON WITH THE PERSISTENCE MODEL



- Target Plot approach turned out to be suitable for the comparison of the model performances with the Persistence Model ones
- Compared to the original one, **a revised version of the MQI was proposed and implemented including measurement uncertainty** within the definition of the Persistence Model
- Concerning the possibility of defining lower cut off values, their arbitrary choice turned out to influence the outcomes (i.e. the fulfilment of the MQO) in a not negligible way. So consensus was reached on taking this option ultimately off from the current MQI formulation



- A **new evaluation diagram** was proposed and turned out to be useful to support the interpretation of results → **the Forecast MPI Plot**, where MPIs are defined for the Mean Fractional Error (MFE) statistical indicator

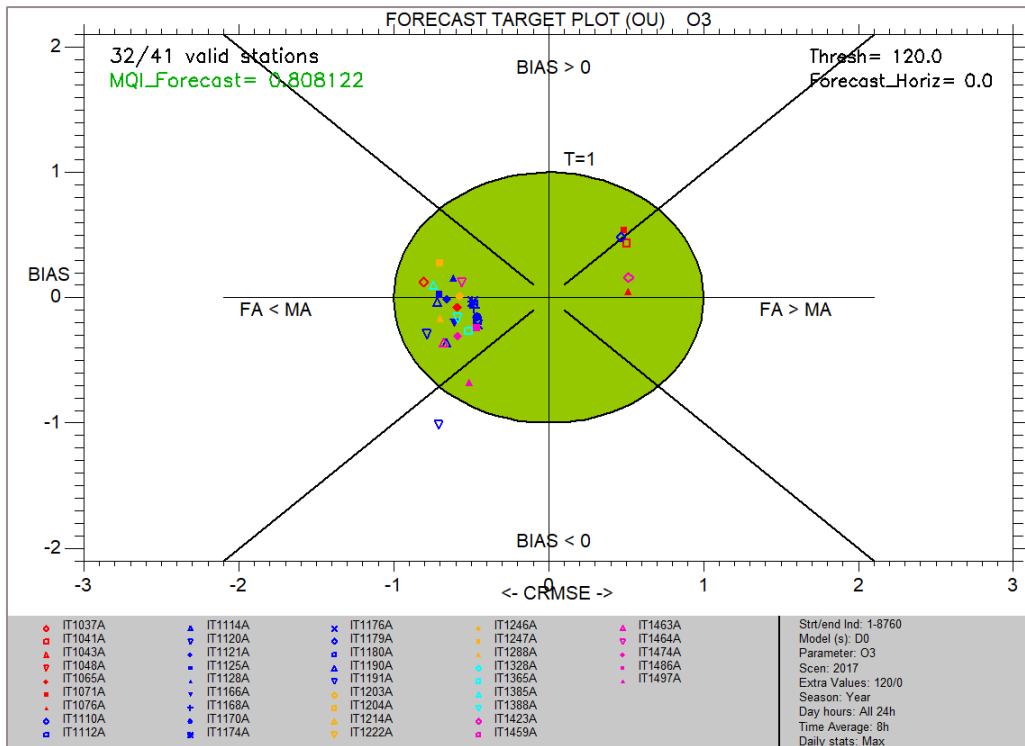
See the Guidance for the details



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COMPARISON WITH THE PERSISTENCE MODEL



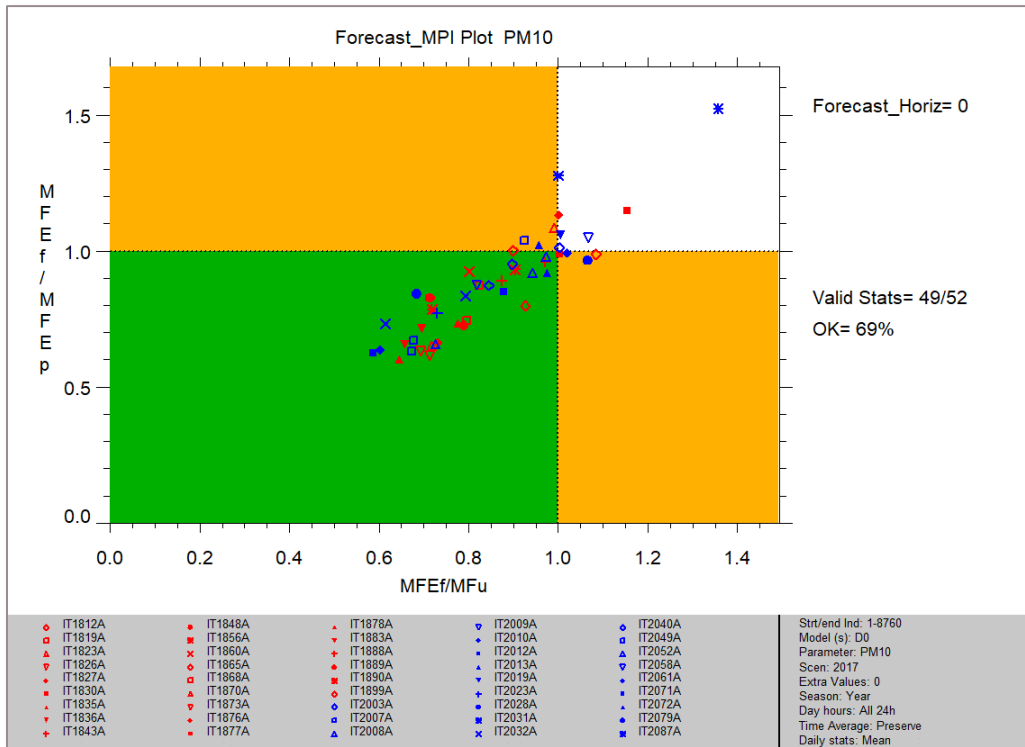
FORECAST TARGET PLOT FINAL PROPOSED FORMULATION

$$MQI_{forecast} = \sqrt{\frac{\frac{1}{N} \sum_{i=1}^N (M_i - O_i)^2}{\frac{1}{N} \sum_{i=1}^N (P_i - O_i)^2}}$$

$$P_i = O_{i-1-forecast\ horizon} \pm U(O_{i-1-forecast\ horizon})$$



COMPARISON WITH THE PERSISTENCE MODEL



FORECAST MPI PLOT FINAL PROPOSED FORMULATION

$$MFE_f = \frac{2}{N} \sum_{i=1}^N \frac{|M_i - O_i|}{(M_i + O_i)}$$

$$MFE_p = \frac{2}{N} \sum_{i=1}^N \frac{|P_i - O_i|}{(P_i + O_i)}$$

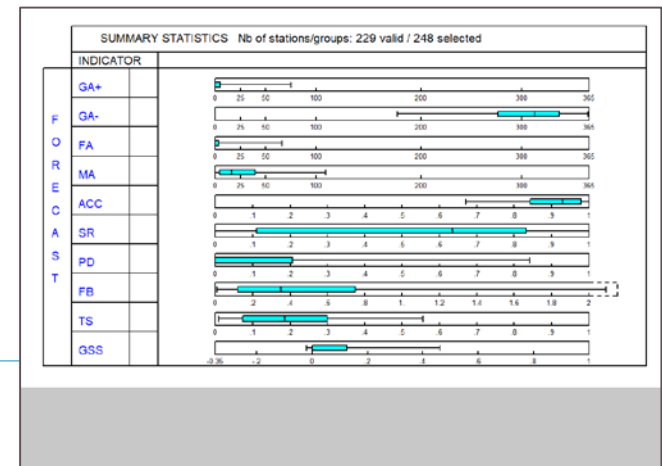
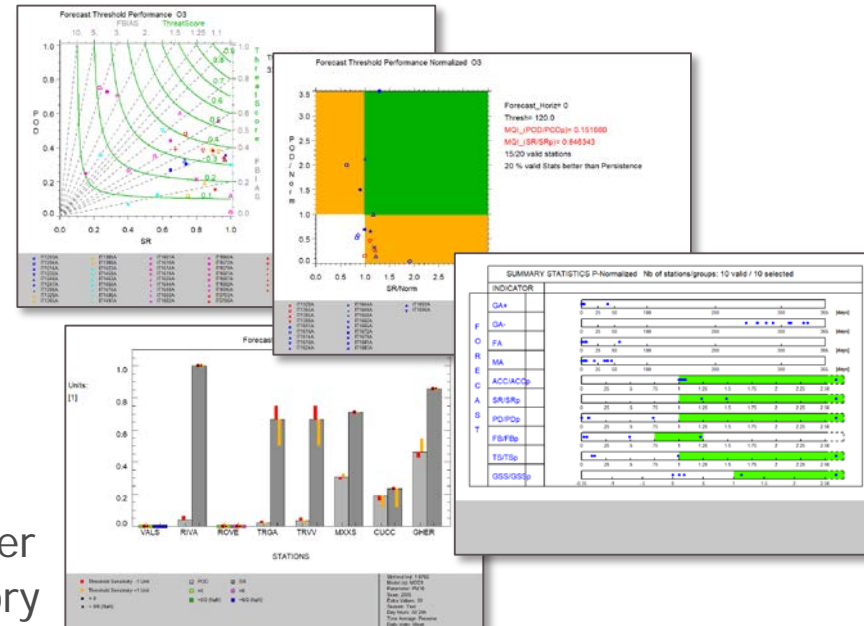
$$P_i = O_{i-1-\text{forecast horizon}} \pm U(O_{i-1-\text{forecast horizon}})$$

$$MF_U = \frac{1}{N} \sum_{i=1}^N \frac{2U(O_i)}{O_i}$$

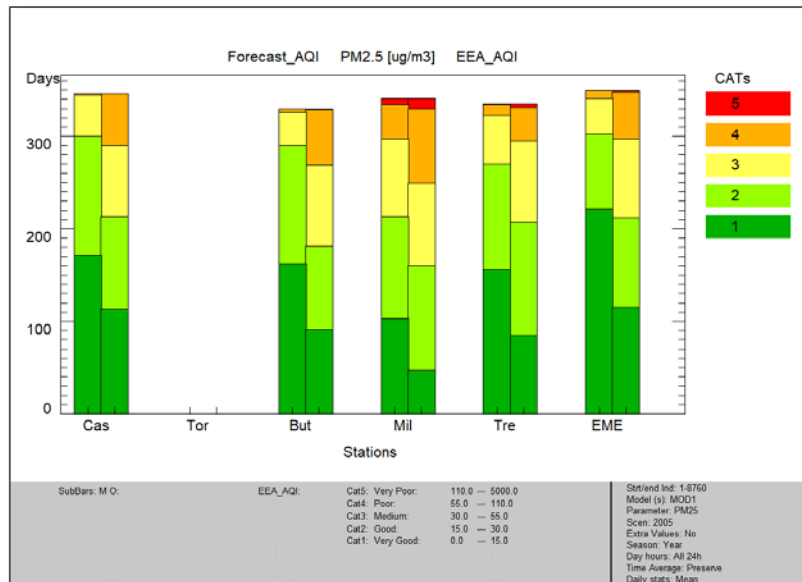


CAPABILITY IN PREDICTING EXCEEDANCES

- It turned out that Persistence Model is very difficult to beat in predicting exceedances
- Model performances skills in predicting Exceedances are presented both with and without the comparison with Persistence Model ones
- The comparison with the Persistence Model can be included by the user in order to better understand the results but it is not mandatory
- **Forecast Summary Report: a different graphical layout is applied depending on the number of stations** taken into account in the analysis:
 - if number of stations < 15 → “dots style”
 - if number of stations ≥ 15 → “boxplots style”



CAPABILITY IN PREDICTING AIR QUALITY INDICES



- In the current version the plot is produced without the comparison with the Persistence model

- During the CT3 discussion it was highlighted that AQI forecast bar plots give information about the total number of occurrences in each AQI class but there is no information about the timing of the forecasted AQI levels
→ There is room for future improvement (e.g. other additional outputs based on Multi-category Contingency Table)

NEXT STEPS

- ❑ Joint publication
- ❑ In the meantime...
an abstract was submitted to Harmo21 Conference
(27-30 September 2022 | Aveiro, Portugal)



- ❑ Additional tests and feedback by CT3 community are welcome towards the next FAIRMODE Technical Meeting about the usefulness of the revised approach in highlighting shortcomings and strengths of forecasting applications

Thank you