CAPABILITIES OF BULGARIAN CHEMICAL WEATHER FORECAST SYSTEM EVALUATED WITH THE FAIRMODE DELTA TOOL

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NIMH
BAS

Scope

Why?

- positive previous experience with “DELTA-assessment” as fast diagnostic tool
- what can “DELTA-forecast” tell us about the performance of our modelling system

Purpose:

Preliminary check of 1 year of simulations (2015)

daily meanPM_{10}, daily max of 8h running mean O_3

Compare to previous evaluations

Outline

- The modelling system
- The AQ data set
- “DELTA forecast” parameters
- Sensitivity check
- Results
- Concluding remarks

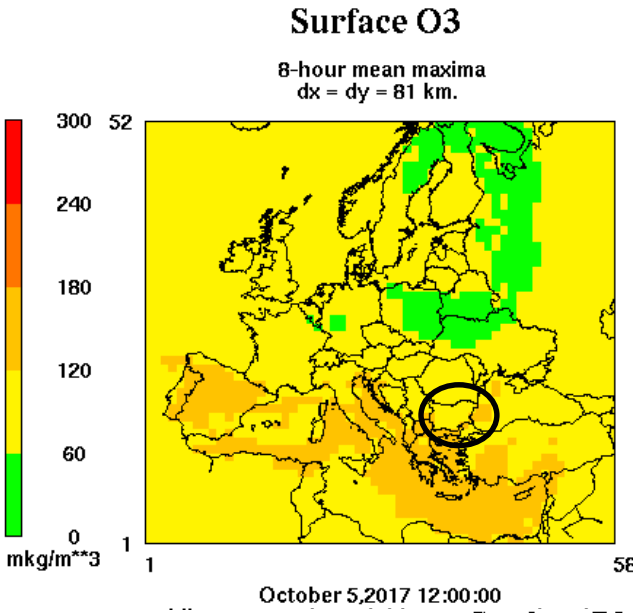
WRF – CMAQ @ NIMH – 1/2

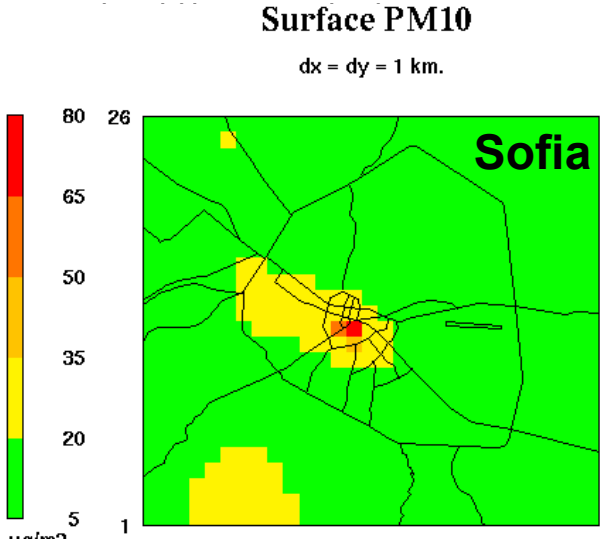
- Operational runs for +72h forecast
- 5 domains – EU-81km 27km, **9km**, 3km, SOF-1km
- SO_2, NO_2, O_3, PM_{10}
- Maps on

http://info.meteo.bg/cw2.1

http://info.meteo.bg/cw2.2

- Not used for regulatory purposes



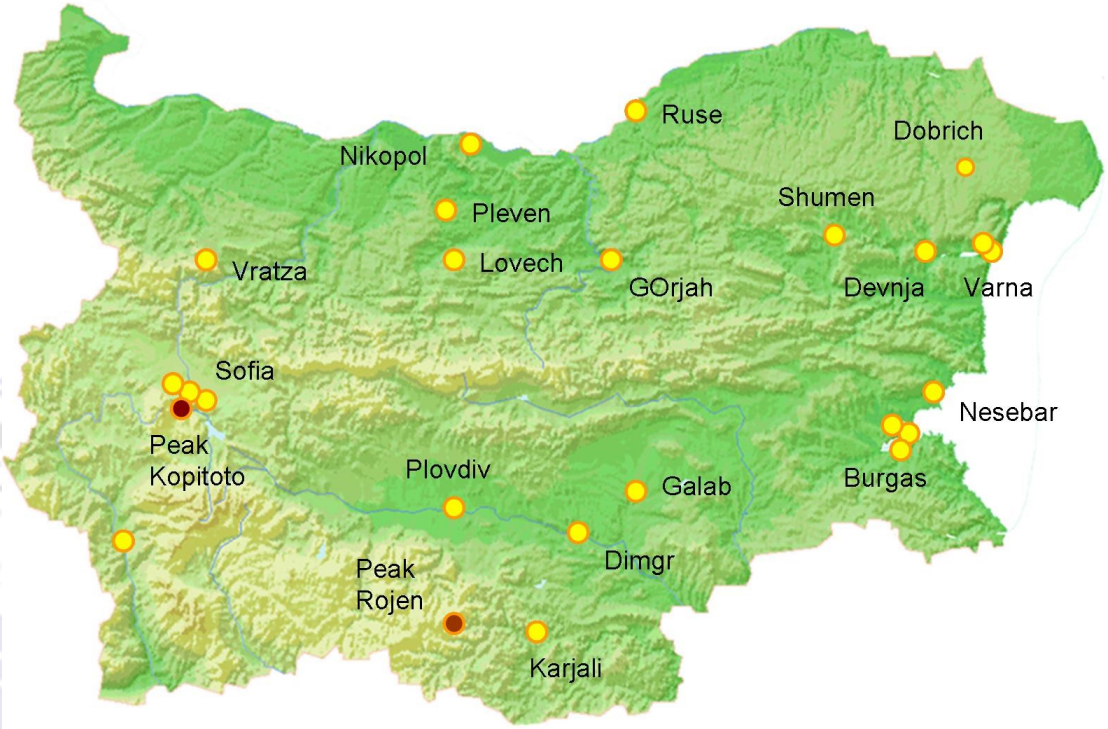


WRF_CMAQ @ NIMH 2/2

- WRF v.3.6.1. - NCEP/GFS, Analysis nudging in D1
- CMAQ v.4.6 – CB-4, 14 vertical levels
- Emissions: TNO 2009 outside Bulgaria & National inventory for 2010, temporal allocation based on TNO profiles, GIS based system for spatial disaggregation
- Here use of model results with dx = 9km (Bulgaria domain)

The AQ dataset - 2015

33 background stations maintained by the National Executive Environment Agency



- Urban, suburb
- Rural (MNT) mountain 1750 m and 1325m

No.stations	O3	PM10
Background with data >75%	19	22

DELTA v5.5 – Forecast mode

- based on pairs of surface data mod-obs.
- in process of fine tuning
- Main MQI

$$\mathrm{Target}_{\mathrm{forecast}} = \frac{\sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(M_i^* - O_i\right)^2}}{\sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(O_{i-j} - O_i\right)^2}}$$

j - forecast time length (day)

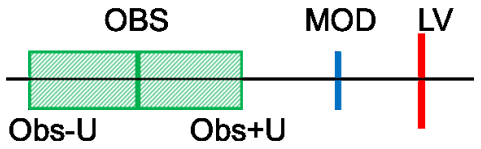
M* - transformed model value to account for measurement uncertainty (U)

MQI = 1: model is as good as a persistent model
MQI < 1: better than the persistent model
MQI >1: poorer performance

DELTA forecast parameters & input

- False alarms FA, missed alarms MA
- False alarm ratio FAR=FA/(FA+GA+)
- Probability of detection DP = GA+/(MA+GA+)
- Composite exceedance indicator CEI = 0.5(DP+1-FAR)

	Observations		Model (M*)		DELTA
	relation to LV	Alarm?	relation to LV	Alarm ?	
	O_+<LV	No	M*<LV	No	GA-
	O_+<LV	No	M*≥LV	Yes	FA
	O_-<LV O_+≥LV	1: Yes, conserv. 2: No, cautious 3: Same as model	M*<LV	No	MA GA- GA-
	O_-<LV O_+≥LV	1: Yes, conserv. 2: No, cautious 3: Same as model	M*≥LV	Yes	GA+ FA GA+
	O_-≥LV	Yes	M*<LV	No	MA
	O_-≥LV	Yes	M*≥LV	Yes	GA+



input parameters:

1. **Limit value (LV) (PM10 -50, O3 -120)**
2. **Uncertainty (fixed%, or variable)**
3. **Flexibility option for uncertainty behavior (conservative, caution, same as model)**
4. **Forecast time (D+1, D+2..)**

Sensitivity to input parameters

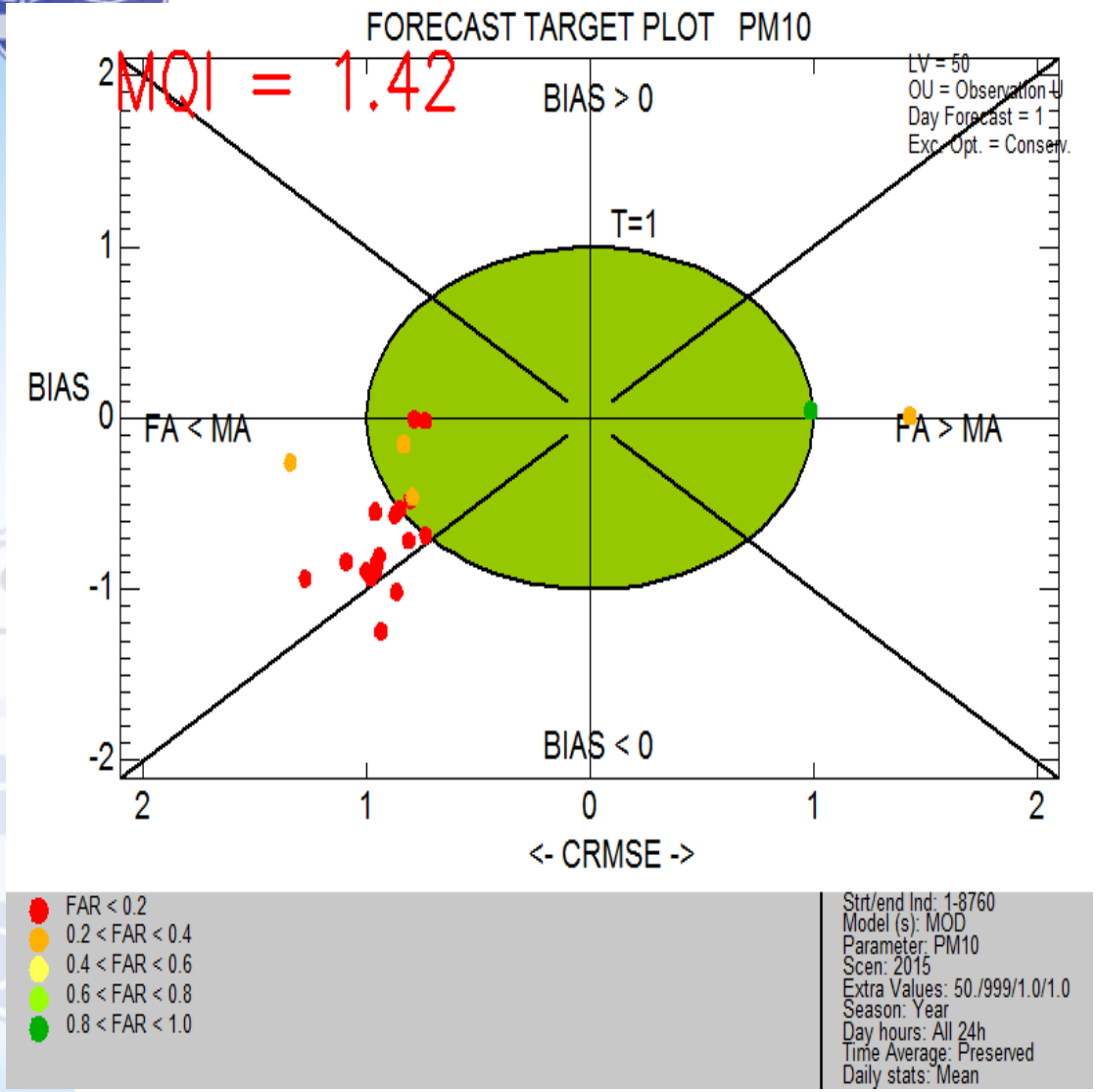
1.Uncertainty | 2. Flexibility | 3. Time lag

	10%	50%	Variable	conserv	caution	as model	d+1	d+2
MQI	1.82	0.96	1.42	1.42	1.42	1.42	1.42	1.05
FAR %	27	2	9	9	26	9		
POD %	14	32	21	21	38	43		

- Improvement with higher U
- Flexibility changes FA, MA, not MQI; best with “as model”
- MQI improves with time lag

Selected options:
U – variable, flexibility –conservative, Day+1

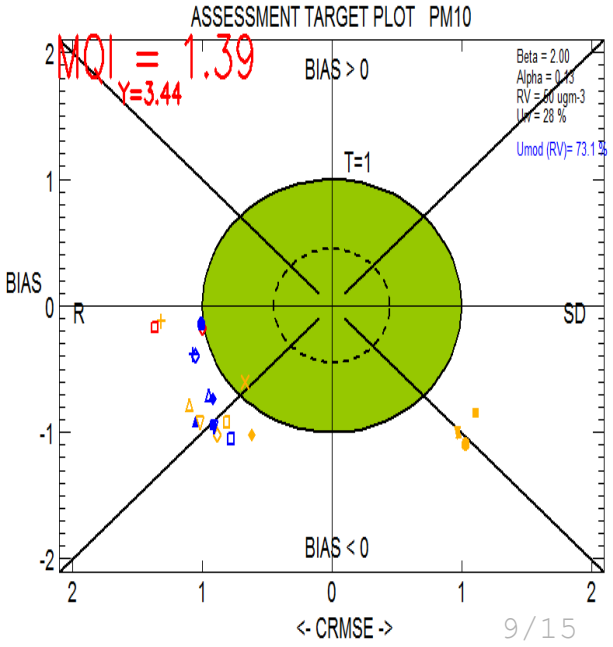
Forecast Target plot PM10



- MQI >1
- MA > FA

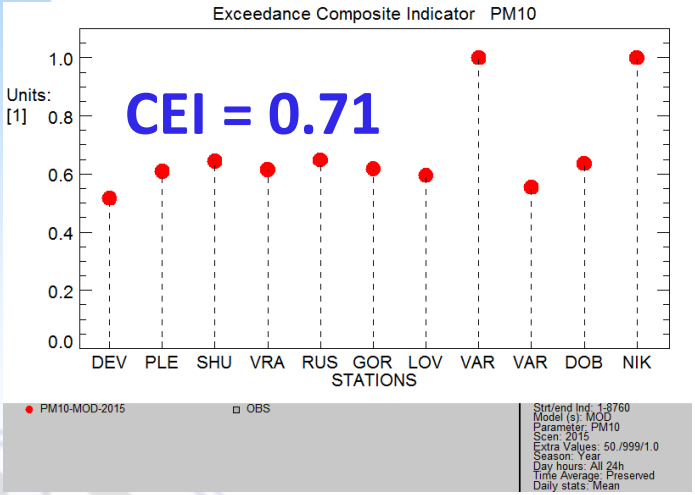
- BIAS < 0,

Mean OBS =35.5 μgm^{-3},
mean MOD=24.2 μgm^{-3}

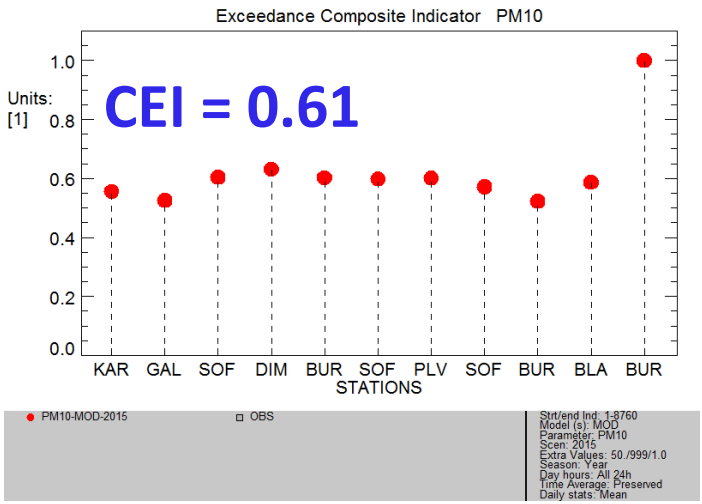


Regional plots – PM10

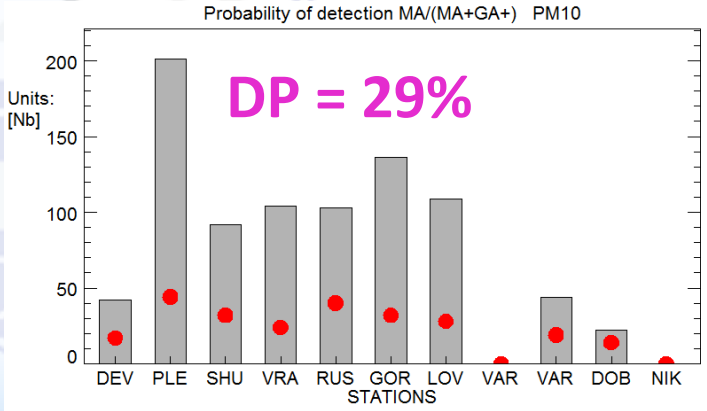
North Bulgaria

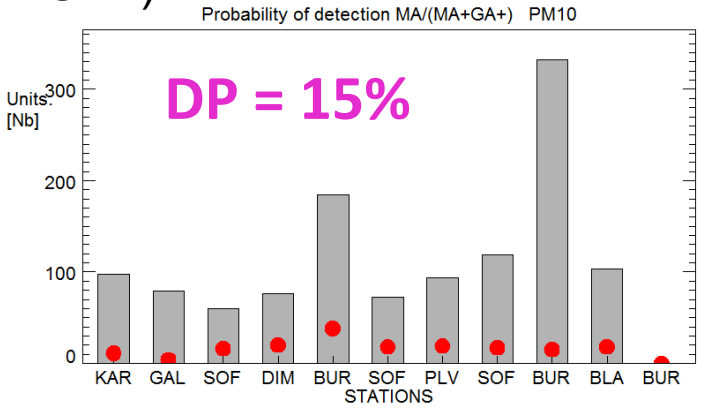


South Bulgaria



DP = GA+/(MA+GA+)

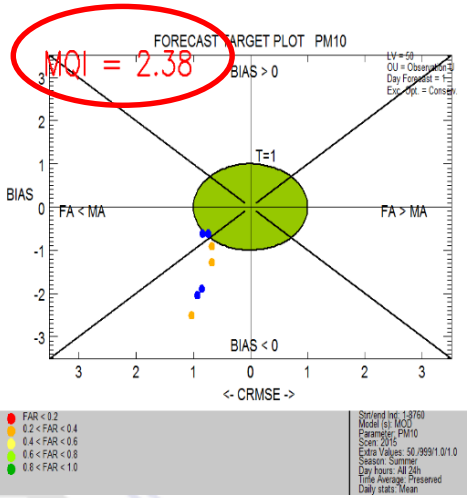


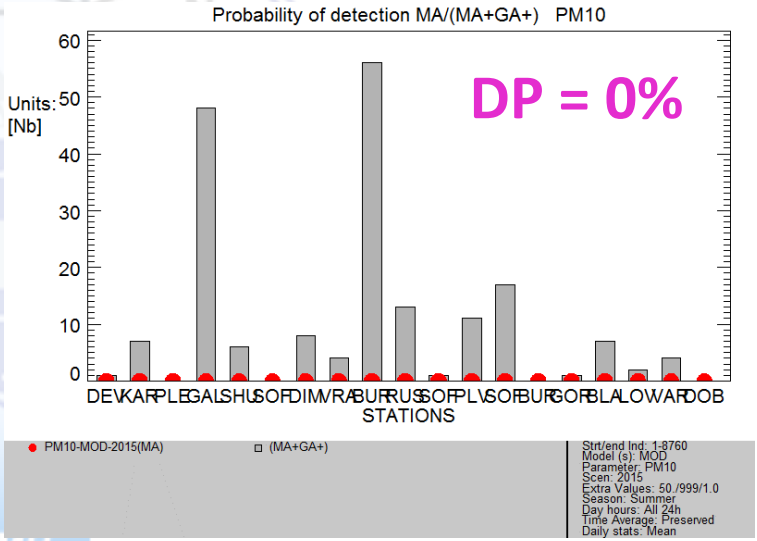


The first (Figure 3) for the probability of detection plots GA+ as red dots and (MA+GA+) as grey column for each station. A good model capability would see all red dots on top of the column.

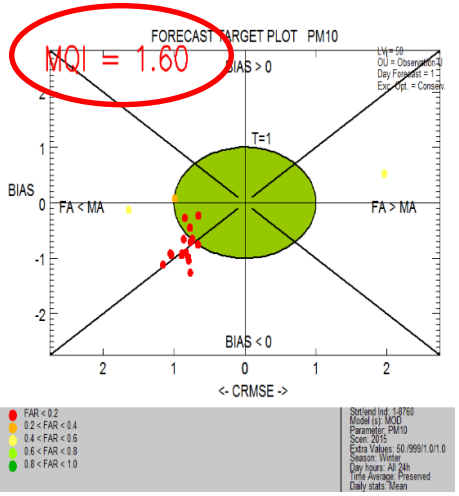
Seasonal plots – PM10

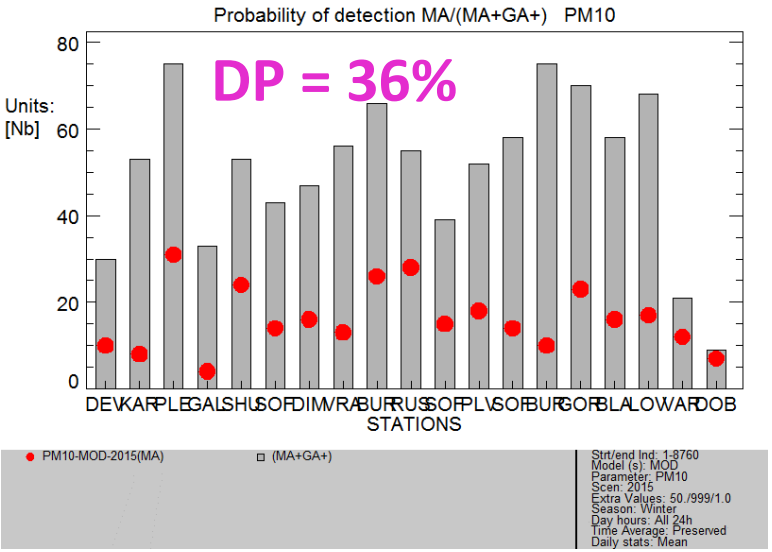
summer



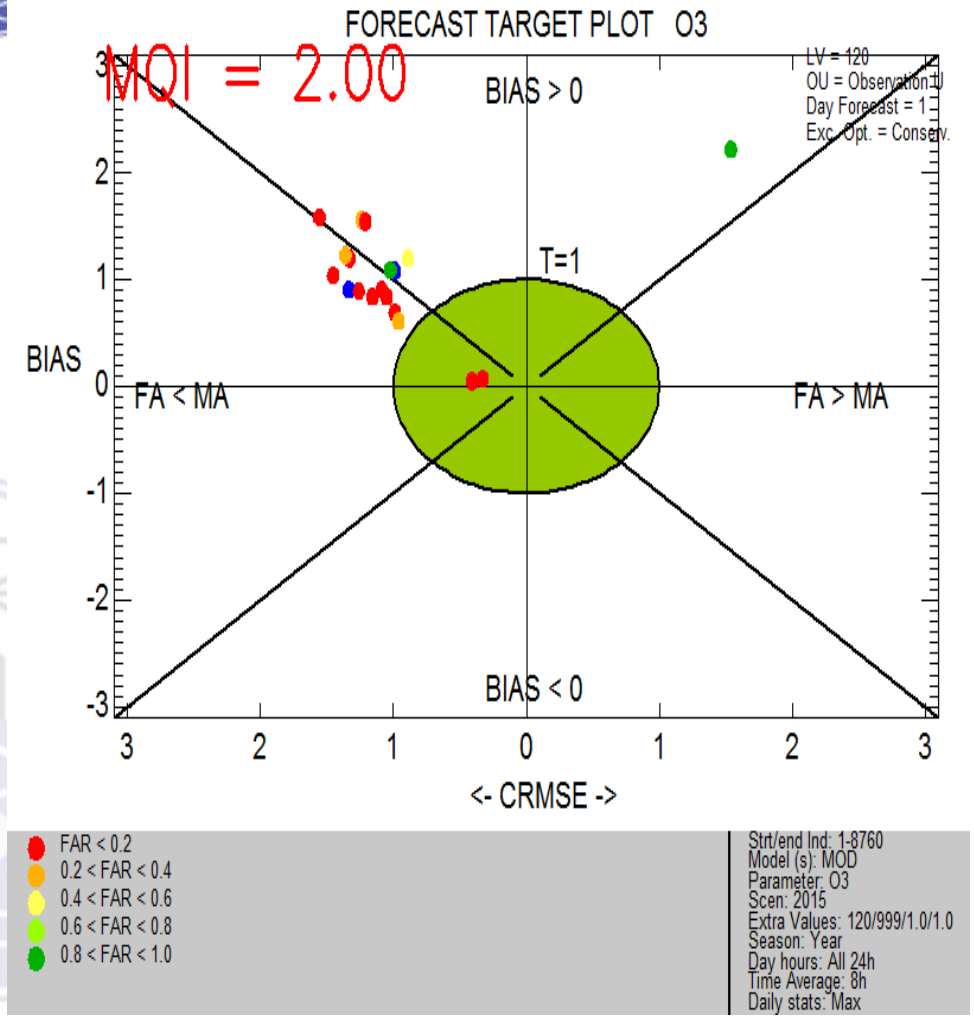


winter



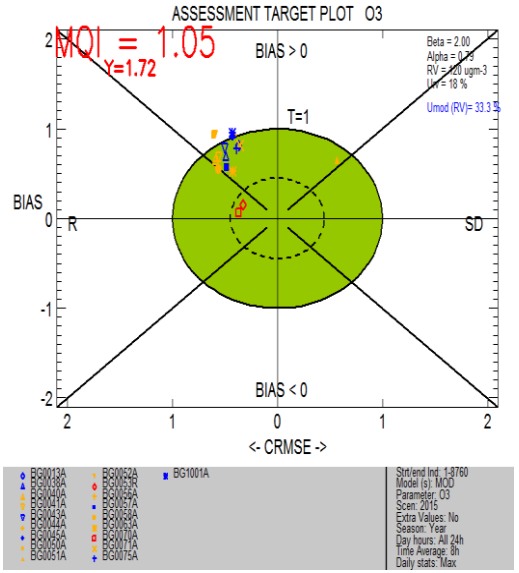


Forecast Target plot O3 8hDMAX



- MQI >1
- MA > FA
- Overestimation

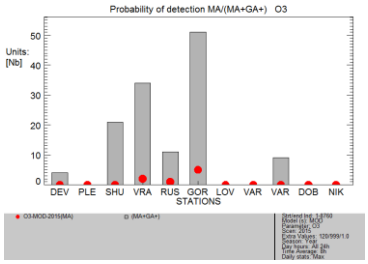
mean OBS =69.2 μgm^{-3},
mean MOD =95.3 μgm^{-3}



Regional plots – Dmax 8h O3

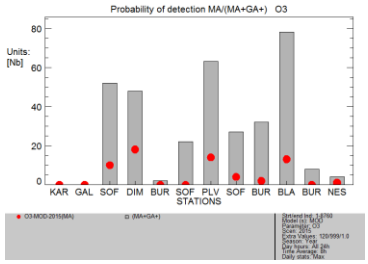
North BG

DP = 6%



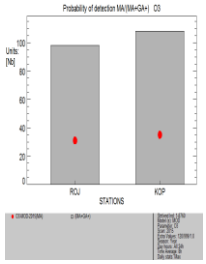
South BG

DP = 18 %

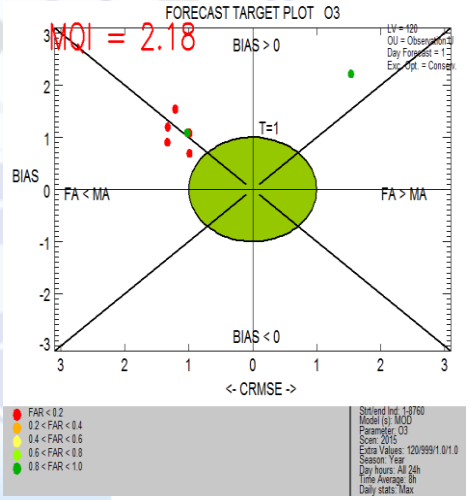


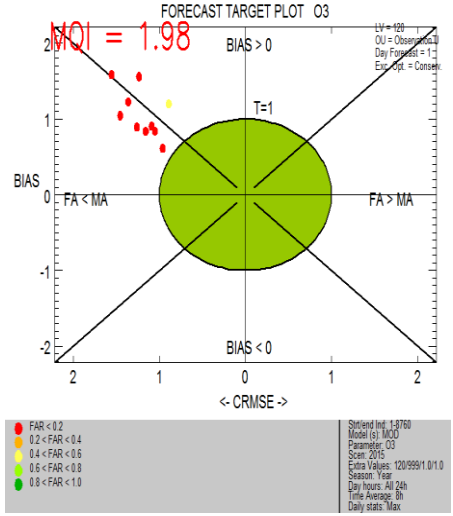
MOUNT

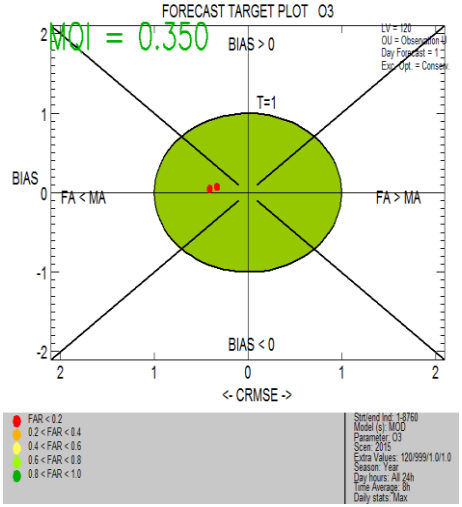
DP =31%



DP = GA+/(MA+GA+) **Red dots:** GA+, **grey bars** :MA+GA+

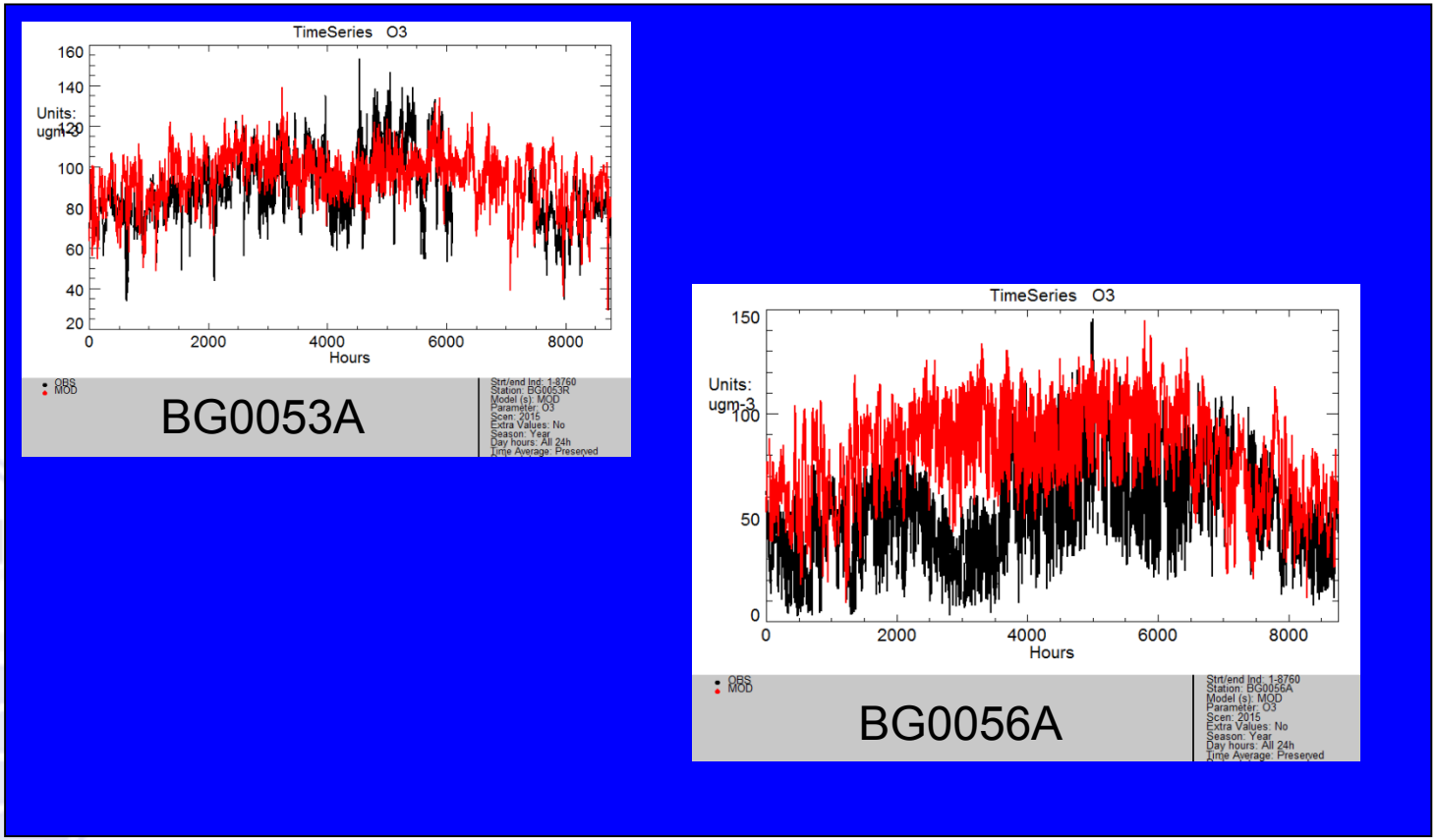






O3 hourly – time series

OBS —— MOD ——



The model overestimates night-time values

Conclusions

- MQI (forecast) : The modelling system performs worse than the persistent model
- The probability of detection of C>LV is ~20%
- PM10 – OBS near LV, tolerance on the threshold ?
- Spatial performance – North BG for PM10 and South BG MNT for O3
- Seasonal performance – PM10 in winter O3 in summer
- DELTA tool – Useful, but sensitive to measurement uncertainty & flexibility input – not easy to interpret, technical errors
- Meteorological variables – add to DELTA forecast