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

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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 mean PM$_{10}$, daily max of 8h running mean O$_3$

Compare to previous evaluations
Outline

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

<table>
<thead>
<tr>
<th>No.stations</th>
<th>O3</th>
<th>PM10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background with data &gt;75%</td>
<td>19</td>
<td>22</td>
</tr>
</tbody>
</table>

Urban, suburb

Rural (MNT) mountain 1750 m and 1325m
DELTA v5.5 – Forecast mode

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

\[ Target_{\text{forecast}} = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (M^*_i - O_i)^2} \]

\[ \sqrt{\frac{1}{N} \sum_{i=1}^{N} (O_{i-j} - O_i)^2} \]

- \( j \) - 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 \( \text{FAR} = \frac{\text{FA}}{\text{FA} + \text{GA} +} \)
- Probability of detection \( \text{DP} = \frac{\text{GA} +}{\text{MA} + \text{GA} +} \)
- Composite exceedance indicator \( \text{CEI} = 0.5(\text{DP} + 1 - \text{FAR}) \)

**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

<table>
<thead>
<tr>
<th></th>
<th>10%</th>
<th>50%</th>
<th>Variable</th>
<th>conserv</th>
<th>caution</th>
<th>as model</th>
<th>d+1</th>
<th>d+2</th>
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<tbody>
<tr>
<td>MQI</td>
<td>1.82</td>
<td>0.96</td>
<td>1.42</td>
<td>1.42</td>
<td>1.42</td>
<td>1.42</td>
<td>1.42</td>
<td>1.05</td>
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<td>FAR %</td>
<td>27</td>
<td>2</td>
<td>9</td>
<td>9</td>
<td>26</td>
<td>9</td>
<td></td>
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<td>POD %</td>
<td>14</td>
<td>32</td>
<td>21</td>
<td>21</td>
<td>38</td>
<td>43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 2. Flexibility

- 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

CEI = 0.71

DP = GA+/ (MA+GA+)

DP = 29%

South Bulgaria

CEI = 0.61

DP = 15%

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
- NQI = 2.35
- DP = 0%

Winter
- NQI = 1.60
- DP = 36%
Forecast Target plot O3 8hDMAX

- MQI > 1
- MA > FA
- Overestimation

mean OBS = 69.2 $\mu$gm$^{-3}$, mean MOD = 95.3 $\mu$gm$^{-3}$
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+

MQI = 2.18

MQI = 1.98

MQI = 0.350

Harmo18, Bologna, Italy, 9-13 Oct 2017
The model overestimates night-time values

O3 hourly – time series

OBS ——— MOD ———

BG0053A

BG0056A

Harmo18, Bologna, Italy, 9-13 Oct 2017
MQI (forecast): The modelling system performs worse than the persistent model.

- The probability of detection of C>LV is \( \sim 20\% \).
- 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.