European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

New Sensing Technologies for Indoor Air Quality Monitoring: Trends and Challenges

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PERFORMANCE OF THE BULGARIAN WRF-CMAQ MODELLING SYSTEM FOR THREE SUBDOMAINS IN EU

E. Georgieva, D. Syrakov, M. Prodanova, E. Etropolski, K. Slavov

Emilia Georgieva

WG Member

National Institute of Meteorology and Hydrology – BAS / Bulgaria

emilia.georgieva@meteo.bg

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability

Outline

- **Why are we interested in model evaluation ?**

- **Which is the basis for our study ?**

- **Results - O3, PM10, PM2.5 speciation**

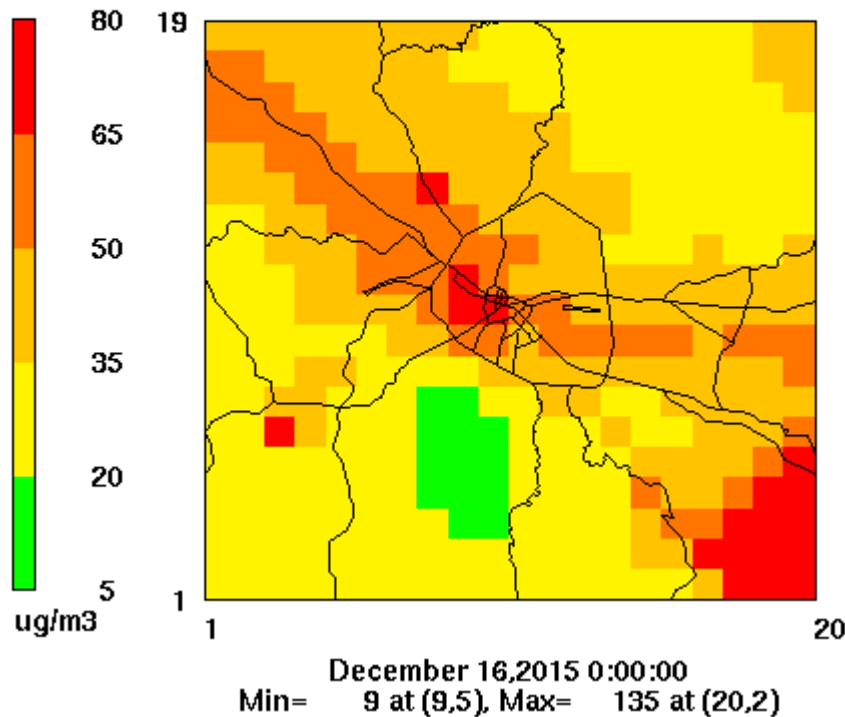- **Comment on meteor. drivers**

- **Summary & future steps**

cost
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Motivation - 1

WRF-CMAQ: Operational chemical weather forecast system

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

Surface PM10

dx = dy = 3 km.

December 16,2015 0:00:00
Min=   9 at (9,5), Max=   135 at (20,2)

Measurements: PM10 above EU Daily limit value **(50 µgm^{-3})** e.g. 1-3 times **higher** for the foggy period of 6-8.12.15 in Sofia

PM10 (µgm^{-3}) - daily mean - Sofia stations

BG0052A   BG0073A   BG0040A   BG0050A   BG0070A

06-dic   07-dic   08-dic
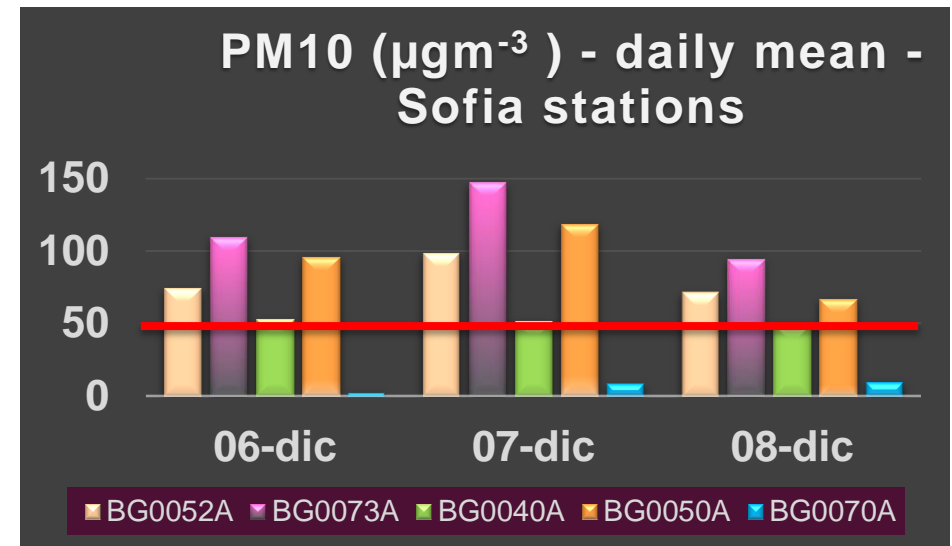
BG0070 – Vitosha mountain 1320 m asl.

Motivation – 2

BG one of the EU "hot-spot regions" for PM exceedances
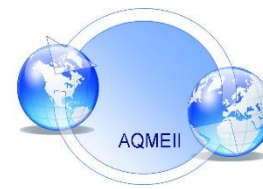
OBS. PM10 mean annual in EU

2012　　　　　　　　　　　　　　　　　　　　　　　　**2013**
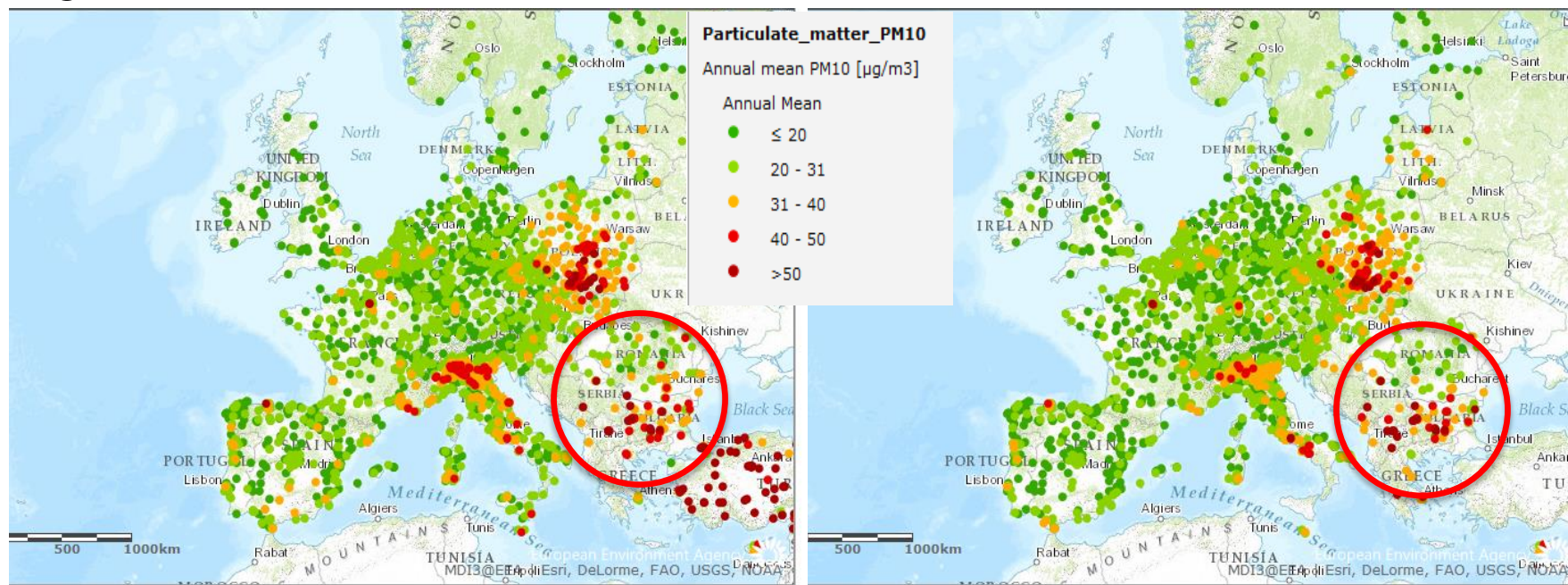
Source: European Environmental Agency interactive maps

http://www.eea.europa.eu/themes/air/interactive/pm10

The basis: AQMEII - 2

- **NIMH participated in A**IR **Q**UALITY **M**ODELLING **E**VALUATION **I**NTERNATIONAL **I**NITIATIVE – **II**

- **1 year** – **2010, simulations for EU and NA**

- Focus on '**on-line'** coupled MET- CHEM (8 models)

- NIMH's WRF-CMAQ system is <u>uncoupled</u>

- Huge amount of **observational data sets**

- Web based model **evaluation platform ENSEMBLE** (EC-JRC)

The basis: WRF - CMAQ runs (BG2)

- **EU domain, horizontal grid step 25 km**

WRF v.3.3 - Driven by NCEP/GFS , Analysis nudging, *27 vertical levels*

CMAQ v. 4.6 - **CB4 mechanism,**   14 vertical levels (7 below 1000 m)

Emissions - provided by AQMEII team

   TNO-MACC inventory 2009 ~ 7-8 km resolution

Emission processing (e.g. disaggegation)

   by individual groups

Operational model evaluation - regions

- rural surface stations bellow 1000 m asl.
- Data availability > 75% & 3 sub-regions

REG1

REG2

REG3

Stations EMEP
O3: 65
PM10daily: 43
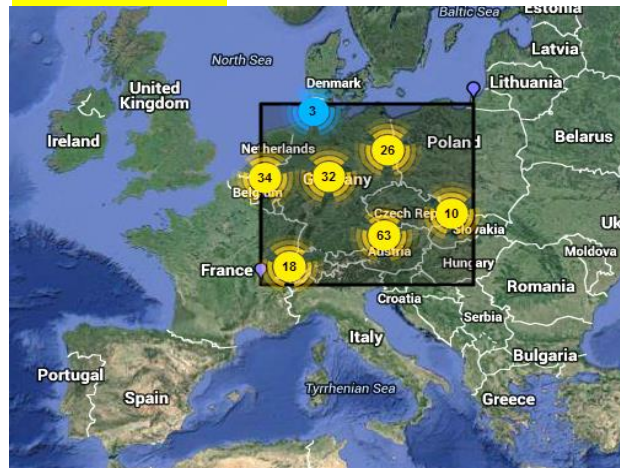
Stations AIRBASE
O3: 217
PM10daily: 139
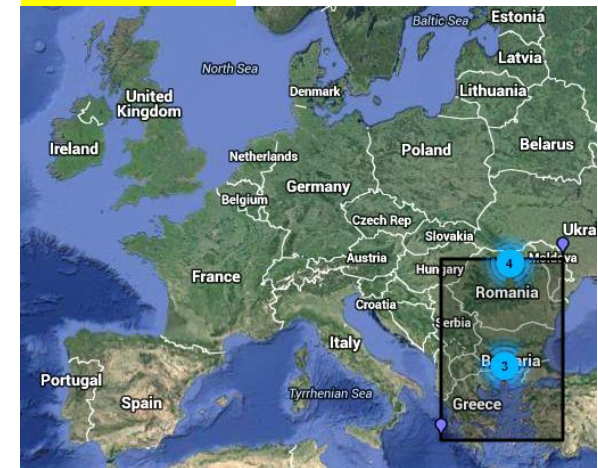
Stations AIRBASE
O3: 7
PM10daily: 7

Ozone

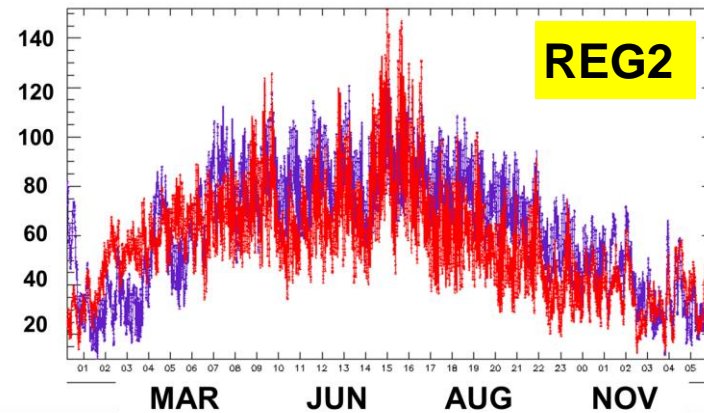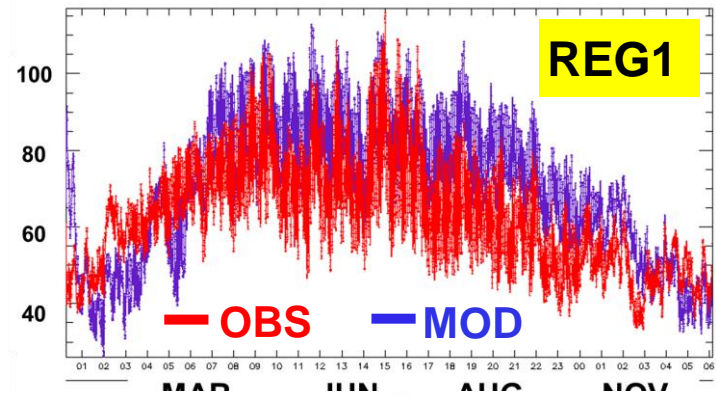**O3 is overestimated in all regions, esp. REG3**

NMB:	REG1	REG2	REG3
Annual:	14%	9.6%	87%
PCC:	0.76	0.76	0.33

Coupled models:
EU wide NMB: - 8%
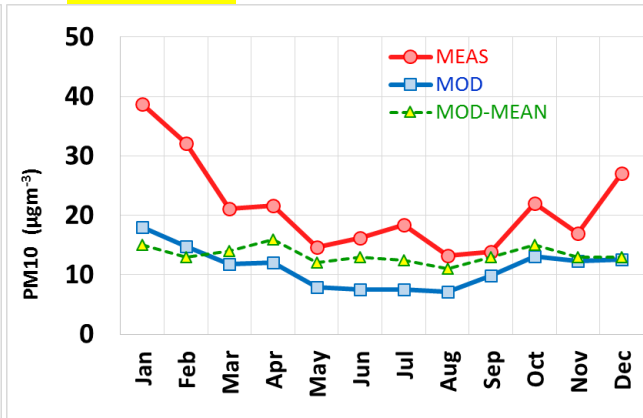**PCC = 0.86**

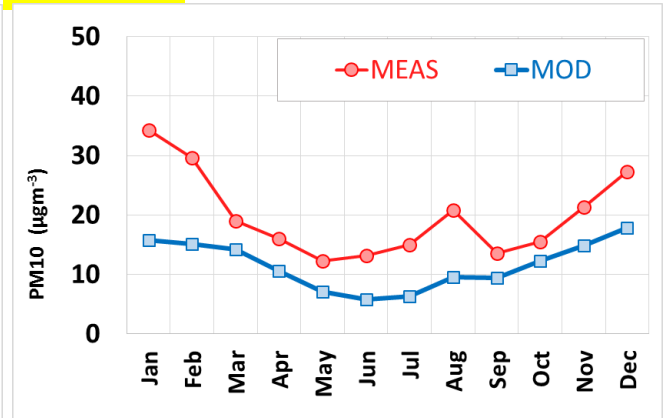*Im et al, 2015: Atm, Env, 115, 404-420*
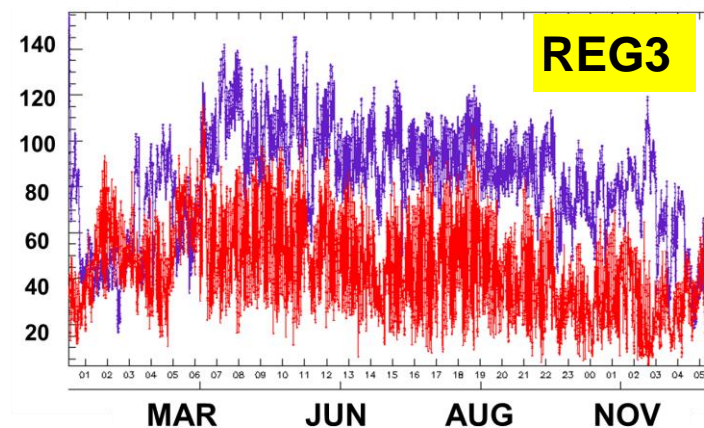
PM10 monthly variation
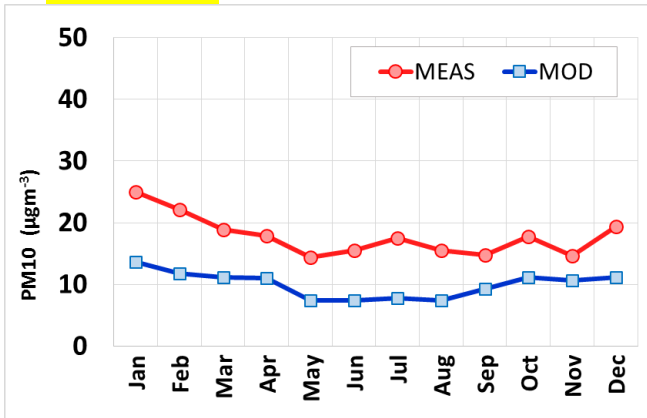
- **underestimation** especially in winter
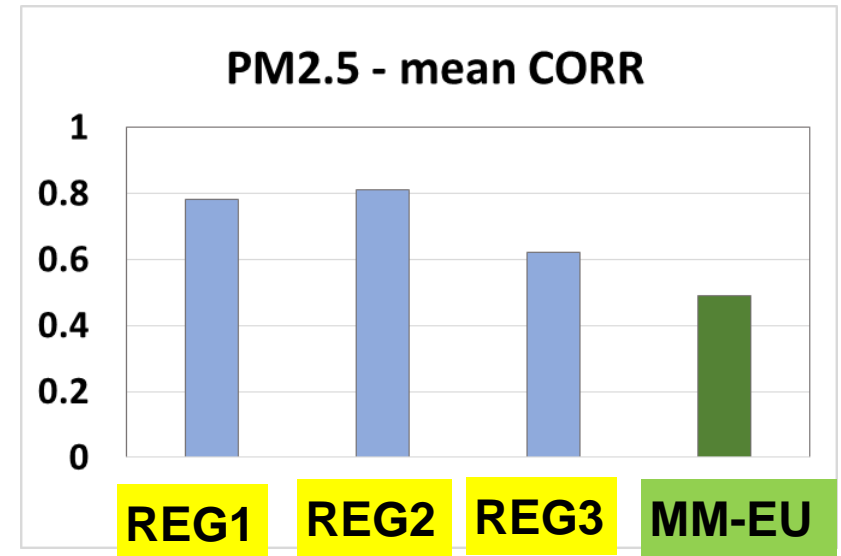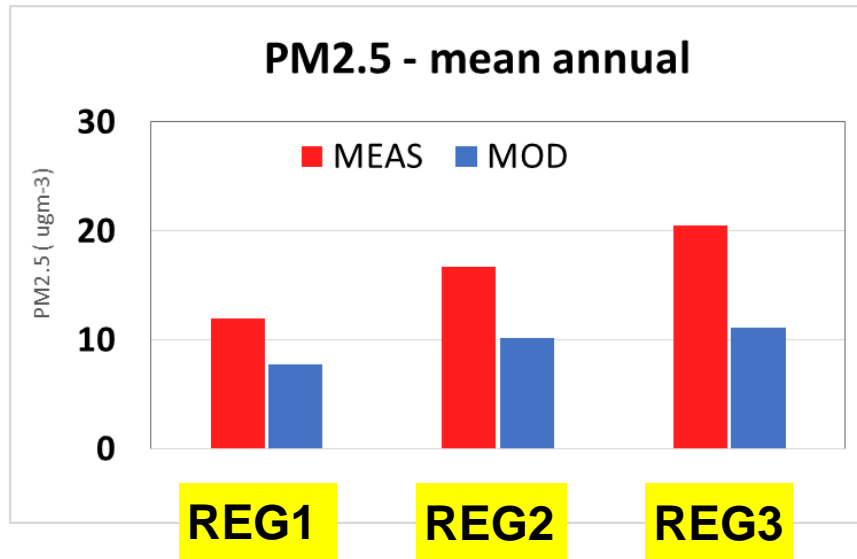
NMB: - 43.3%   - 47.3%   - 41.2%

PCC: 0.71   0.78   0.61

Within values by coupled models *Im et al, 2015*

- **NMB: - 40.3%   PCC = 0.64**

Im et al, 2015: Atm, Env, 115, 421-441
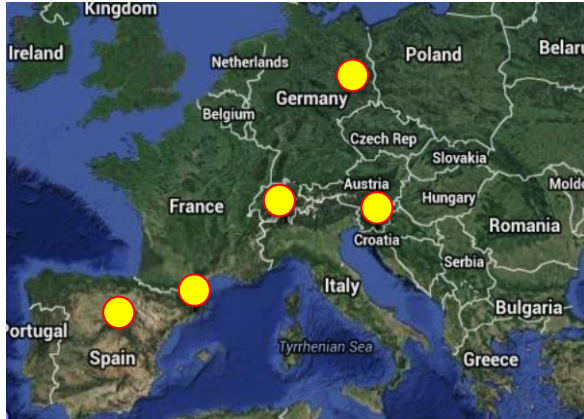
PM2.5 mean annual values

- **Underestimation:** **mean NMB: -37% (REG1&2) vs. NMB: -27% MM EU**; **REG3 – underestimation by factor 3**

- **PCC (mean 0.78)** **better than "online coupled"** - **0.49** for **MM EU** (model mean over EU rural stations, *Im et al, 2015*)
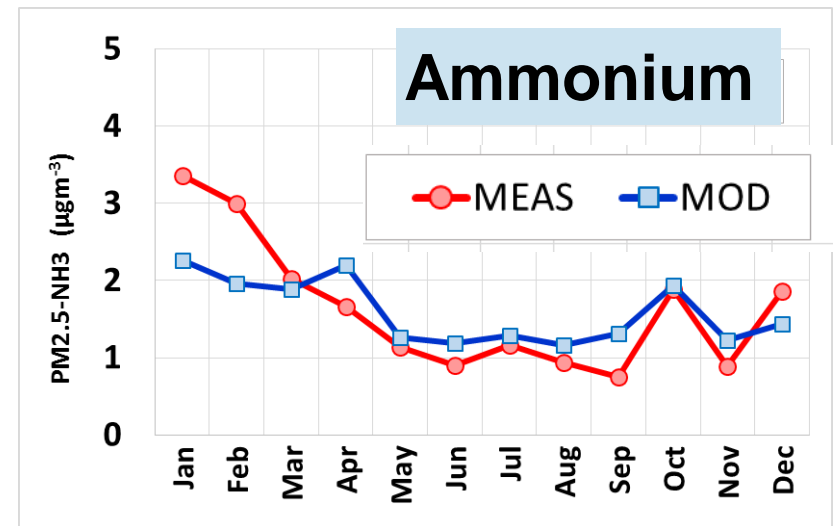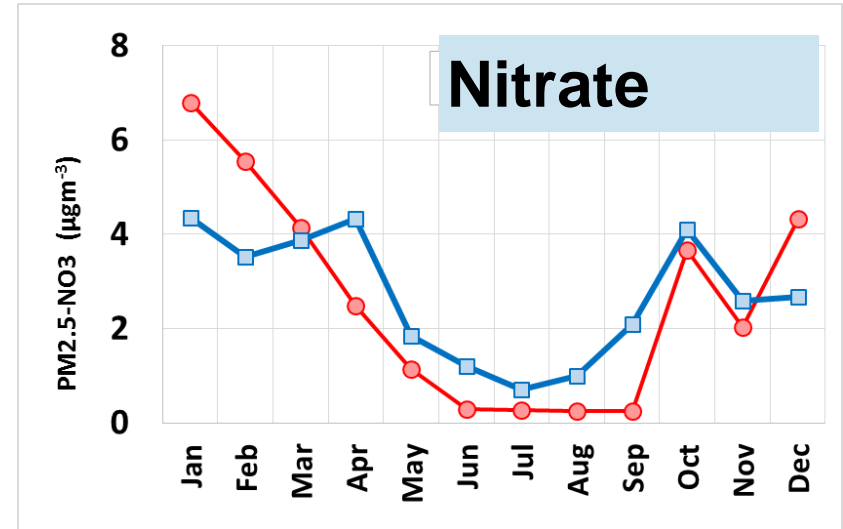
Im et al, 2015: Atm, Env, 115, 421-441

PM2.5 speciation monthly means - 1

- Based on 5 **EMEP stations**

- **Overestimation:** NO3 32%, NH4 19%
- PCC: (0.55 and 0.65)
- *coupled models* (*Im et el, 2015*): Overestimation NO3 by 20-75%,
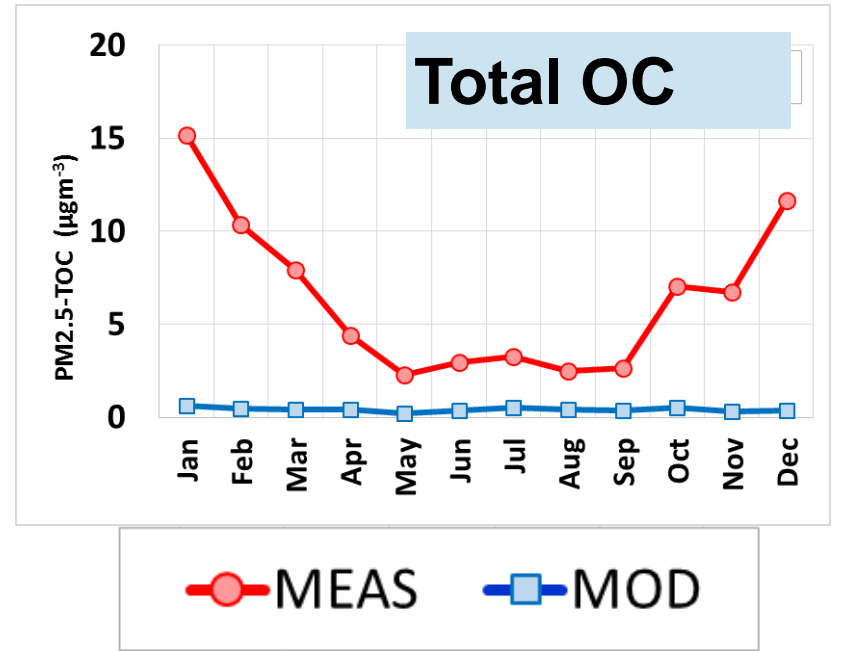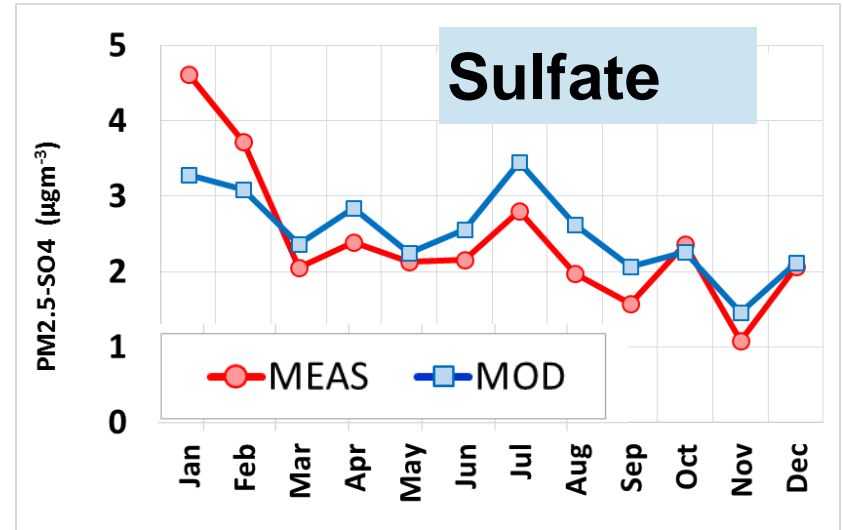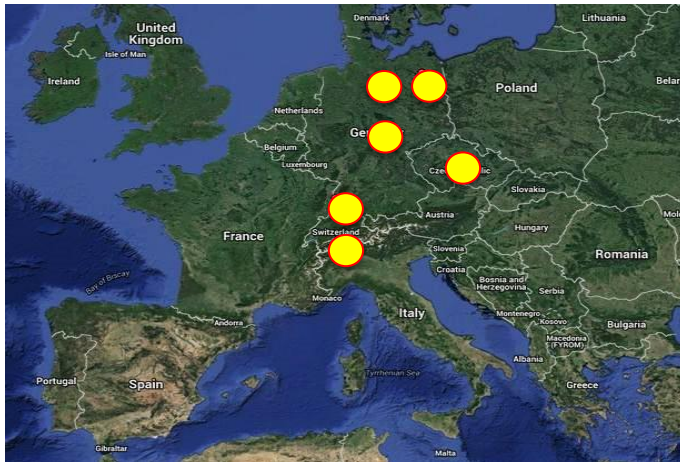

Nitrate

Ammonium

PM2.5 speciation monthly means - 2

SO4 Overestimation: 7%, CORR – 0.57

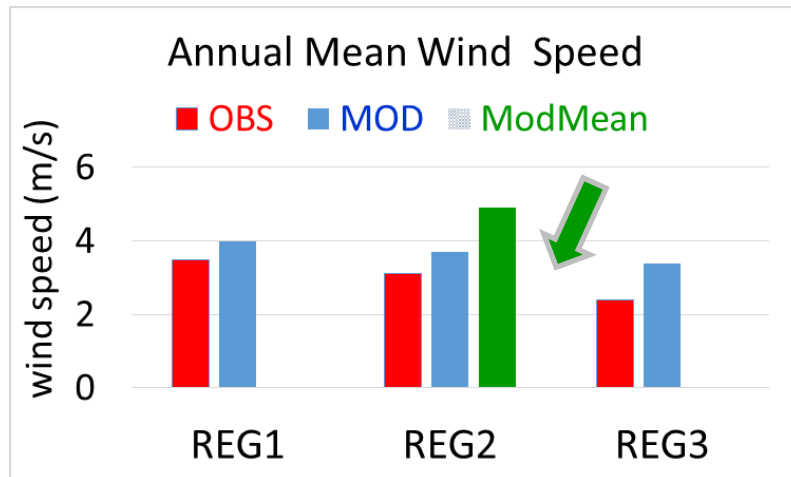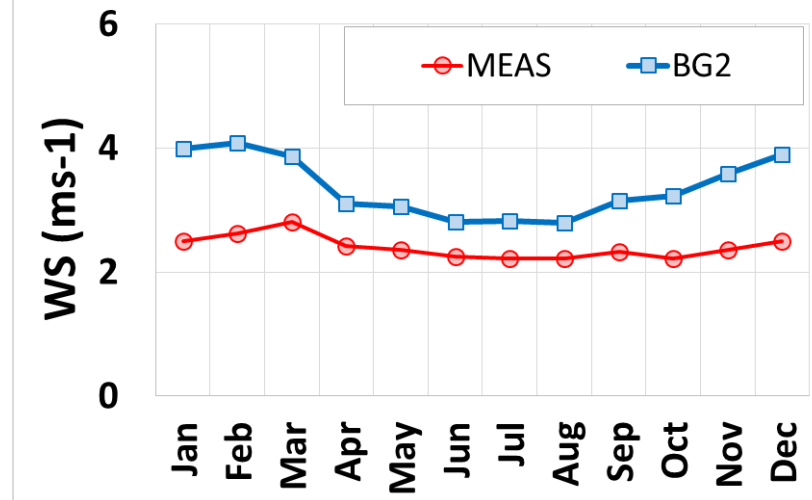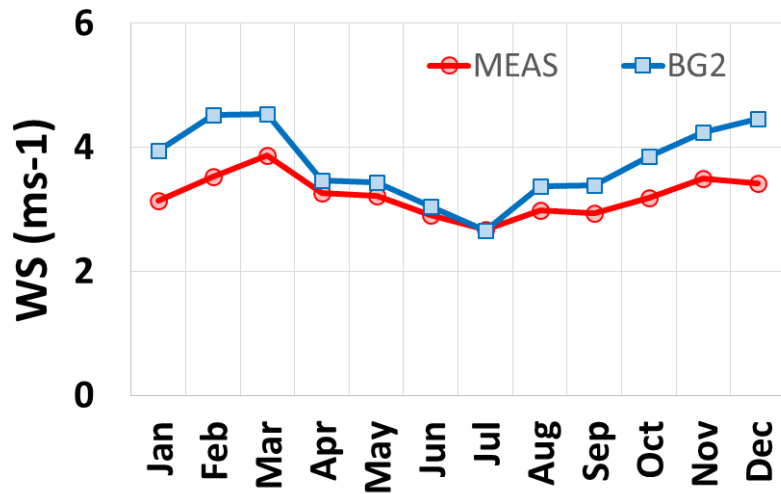- *coupled models* (*Im et el, 2015*): majority of the models underestimate SO4 by 22-64%

Total organic carbon : underestimation by **factor 5**, no variability
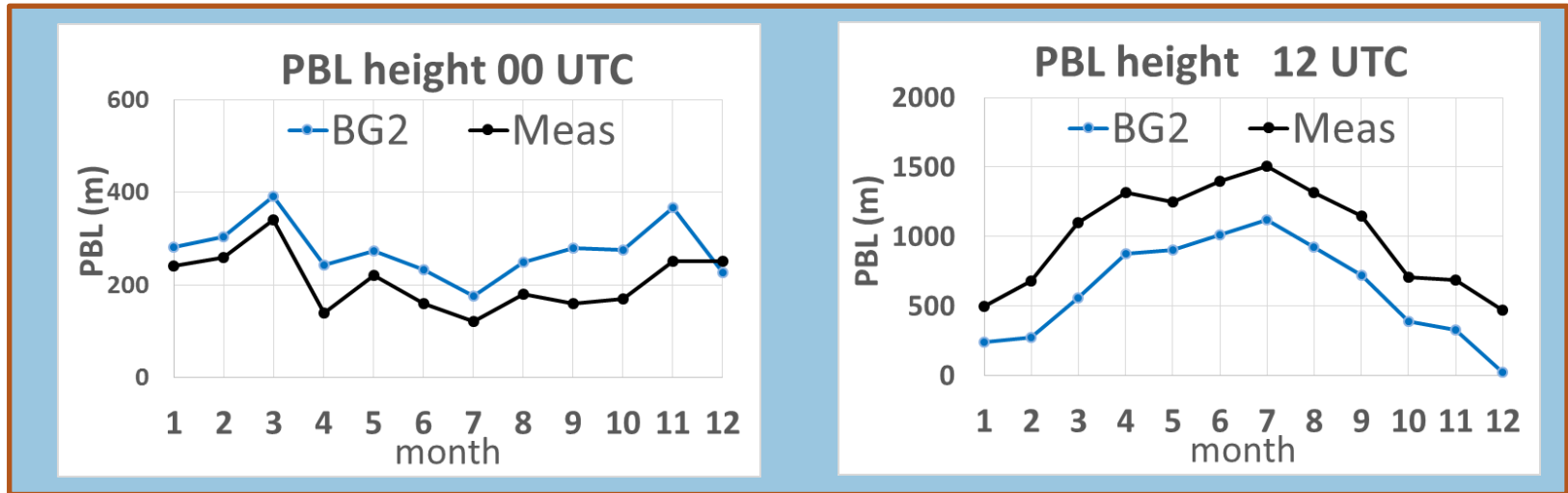

Sulfate

Total OC

10m - Wind speed (WS10)

- WS10 is overestimated in winter by 25% - 60%

- WS10 overestimated also in summer in REG3

- Results for REG2 comparable to ModMean of coupled models *(Brunner et al, 2015)*

PBL height   in REG2

Mean monthly values at 00UTC and 12UTC

- **MEAS** – from sounding sites *(see Brunner et al, 2015)*
- **Overestimated at night-time**
- Underestimated at   noon-time

Brunner et al, 2015: Atm, Env, 115, 470-498

Summary

Preliminary *operational model evaluation*:

- **Ozone is overestimated, PM underestimated**

- **Model performance decreases from REG1 to REG3 (Balkan) (***No. stations, emiss. Inventory, dx)*

- **Better performance for PM2.5 than PM10**

- **WRF-CMAQ (uncoupled) – similar results to coupled models**

- **Model-intercomparison: very useful for detecting weaknesses in different modules of the AQ systems**

Acknowledgments: ENSEMBLE team at EC- JRC , AQMEII Community

THANK YOU FOR YOUR

KIND ATTENTION !