COMPARISON OF EMEP AND WRF -CMAQ MODELLING RESULTS FOR DEPOSITION ESTIMATES IN BULGARIA FOR 2016 AND 2017

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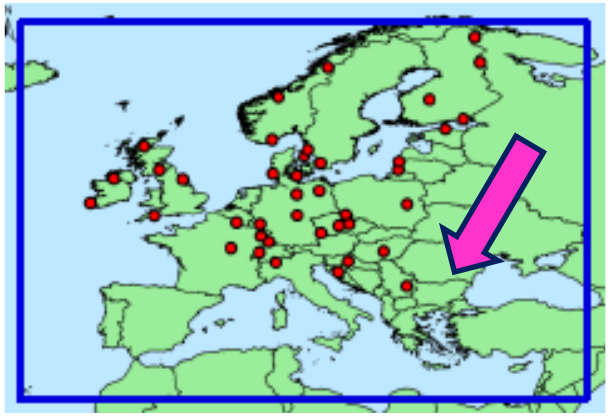
Motivation

EMEP MSC-W model: Annual Reports & validation

https://www.emep.int/mscw/

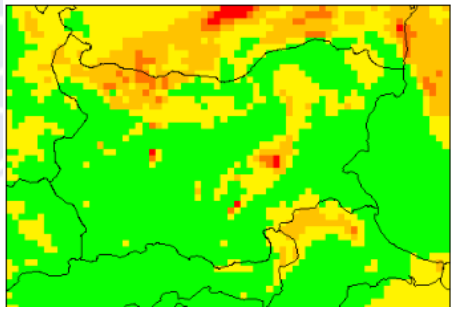


Theobald et al, ACP ,2019

BG Chemical Weather Forecast (WRF-CMAQ)

– **recently set up for deposition estimates**

& new deposition data



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

Goals

Check performance for

S (sulfur), oxN (oxidized nitrogen) and RN (reduced nitrogen)

for the years 2017-2017
seasonal and annul basis

understand model weaknesses and bias

Set-up a methodology for annual deposition calculations in BG using WRF- CMAQ

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Outline

- **Models**
- **Wet depositions of S, oxN and RN**

  seasonal & annual values, and spatial pattern
- **Dry depositions: of S, oxN and RN**
- Comparison to **observations at 3 sites**
- Key Messages

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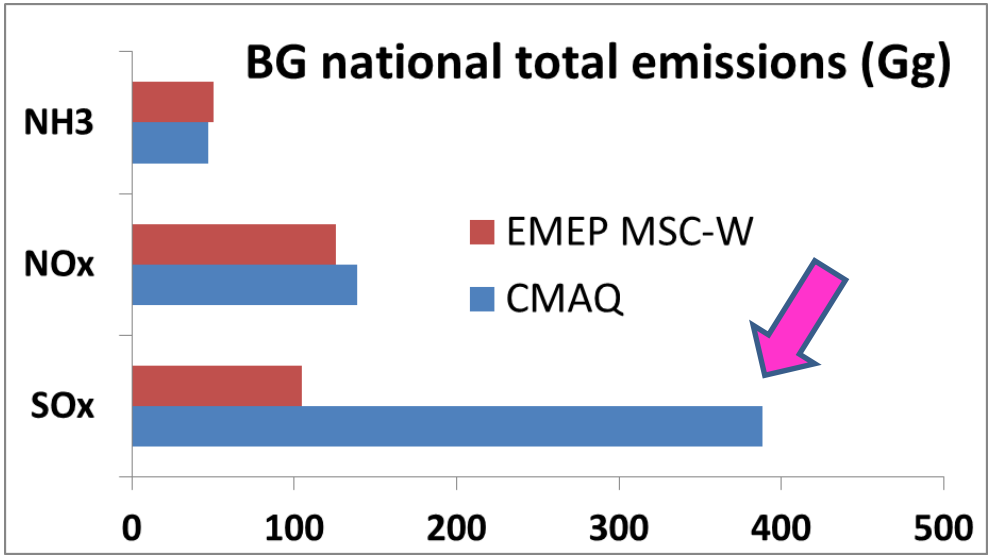
The models

	CMAQ v.4.7	EMEP MSC-W rv.4.17
Grid resolution	81km (EU) → **9km** (BG)	0.1 x 0.1 deg (~**11km**)
Meteorology	WRF (NCEP-GFS)	IFS- ECMWF
Emissions	TNO 2010, BG **2009**	EMEP **2016** (national reporting)
Wet Dep	Chang et al (2007), Byun and Schere (2006)	Simpson et al. (2012)
Dry Dep	Pleim and Xiu(1995), Venkatram and Pleim (1999)	Venkatram and Pleim (1999), Simpson et al. (2012)
Chemical mechanism	CB-IV, Gery et al. (1989)	EmChem09, Simpson et al. (2012)

Emissions – differences

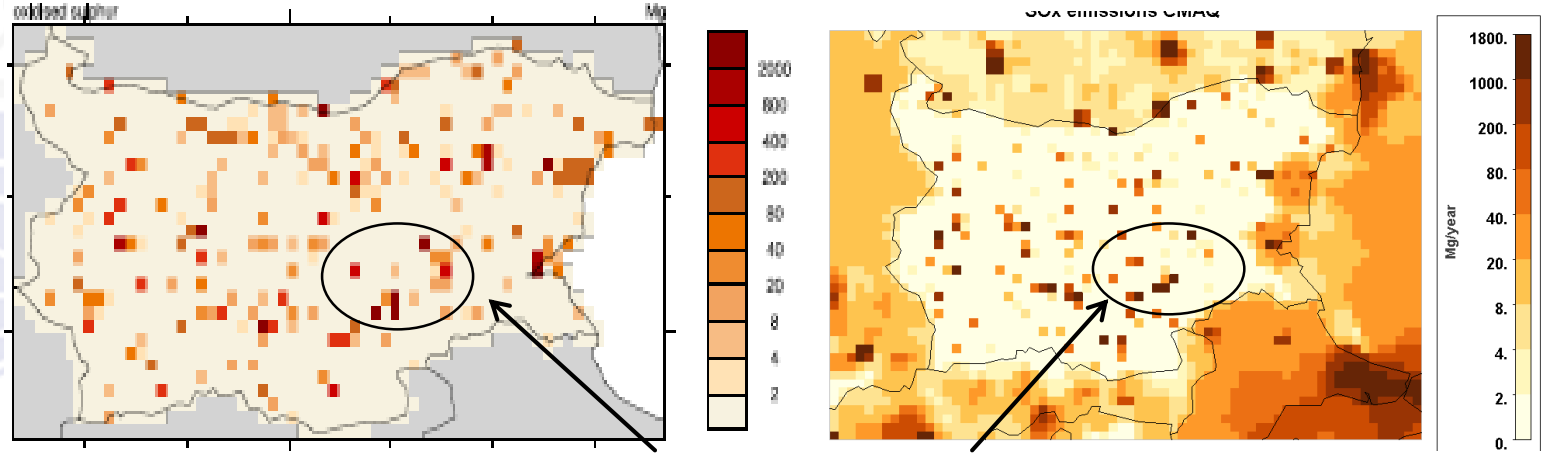
- ***Magnitude***

SOx (CMAQ)>> SOx (EMEP)



- ***spatial pattern***

EMEP ***SOx emissions*** **CMAQ**

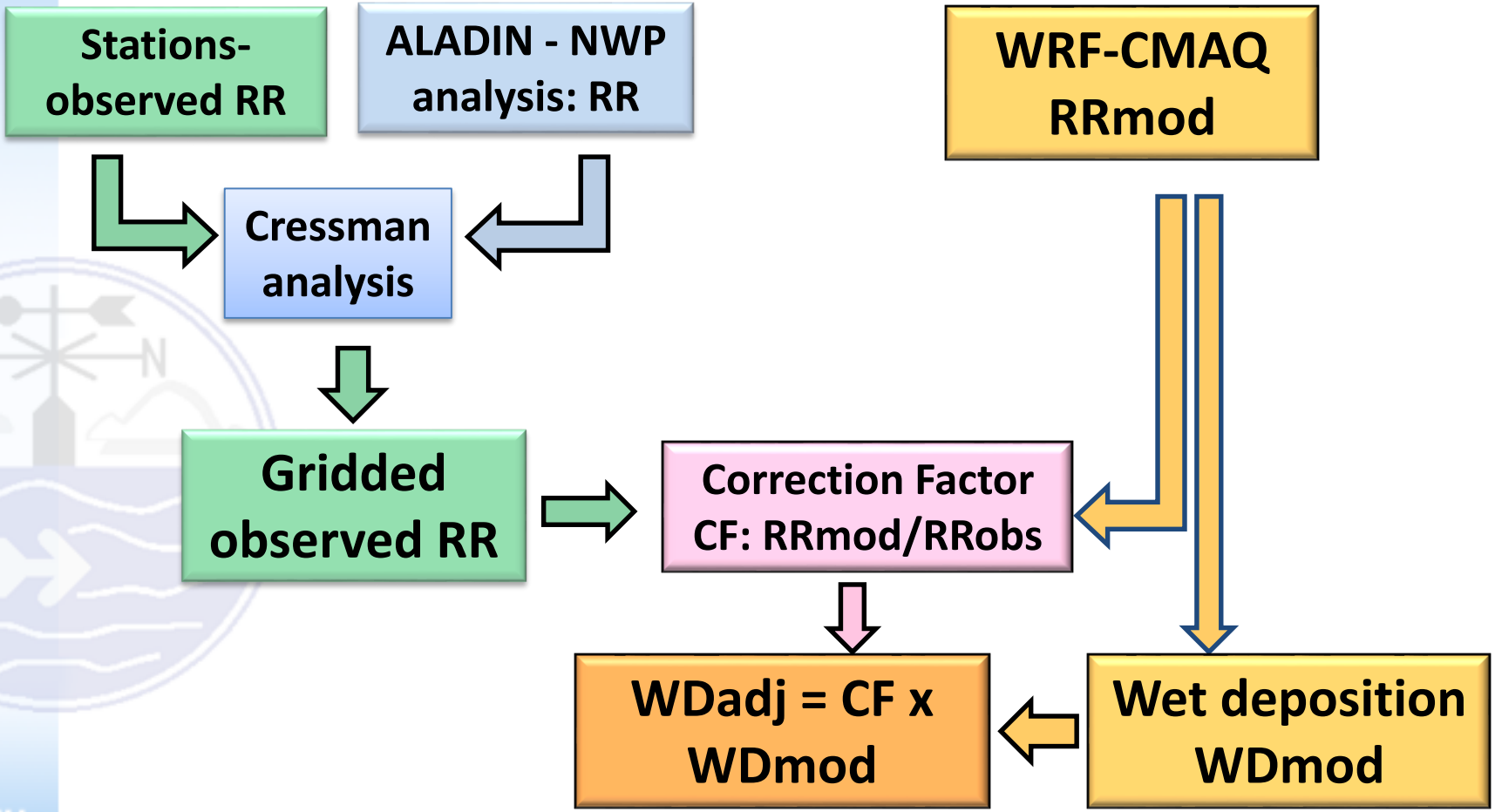


Coal fired TPP "Maritsa East"

Datasource: EMEP/CEIP 2018, Spatially distributed emission data as used in EMEP models
(https://creativecommons.org/licenses/by/4.0/deed.en)

Wet deposition calculations - PBA

Precipitation Bias Adjustment (Appel et al., 2011)



Deposition calculations

Sulfur deposition S:

$$SO_4^{2-} + SO_2$$

CMAQ: includes sea salt sulphate ,
EMEP MSC-W: non-sea salt sulphate

Nitrogen deposition N:

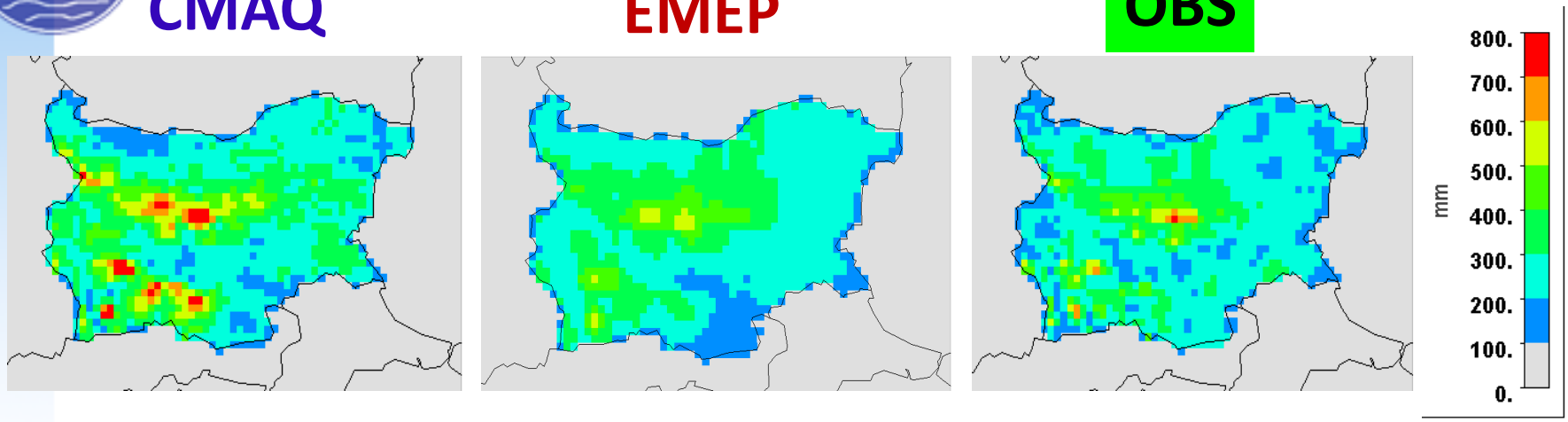
oxidized (N_{oxi}) + reduced (N_{red})

$$N_{oxi} = NO_3^- + NO + NO_2$$

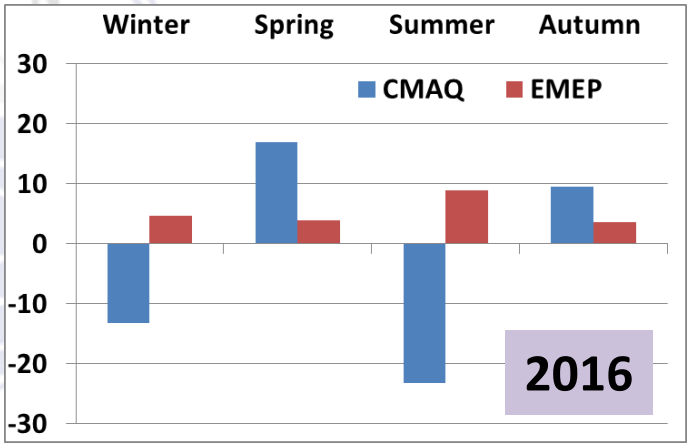
$$N_{red} = NH_3 + NH_4^+$$

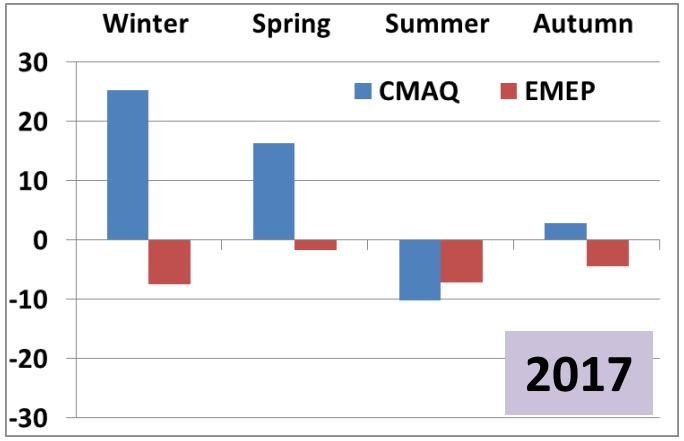
Precipitation - Spring 2016

CMAQ EMEP OBS



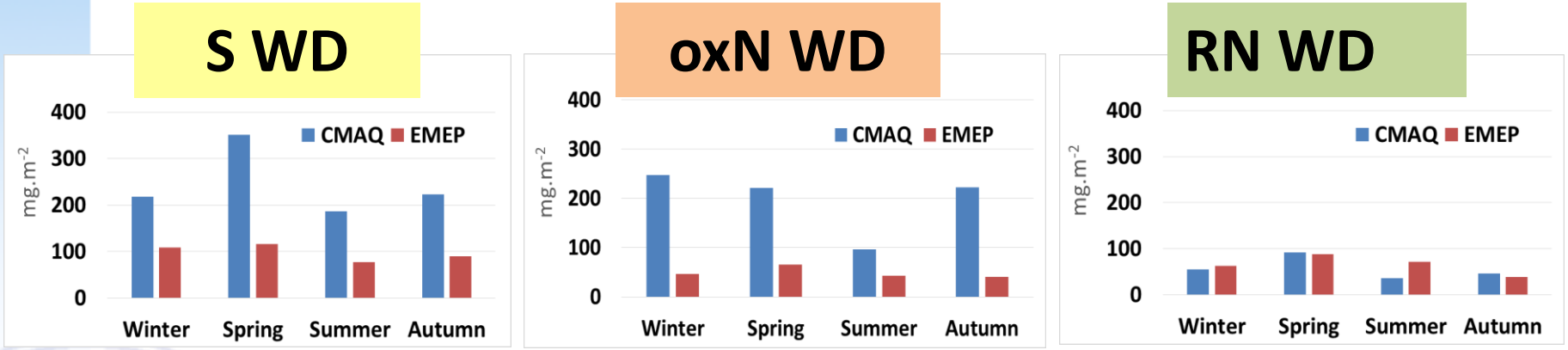
NMB (%) PRECIP: CMAQ overestimation in spring by 17%





NMB (2017) CMAQ: 9%, EMEP: -5%

Wet depositions (mg.m^{-2}) BG- mean by seasons (2016-2017)



CMAQ EMEP

+ Both models: S-WD is prevailing and
+ similar values for RN-WD

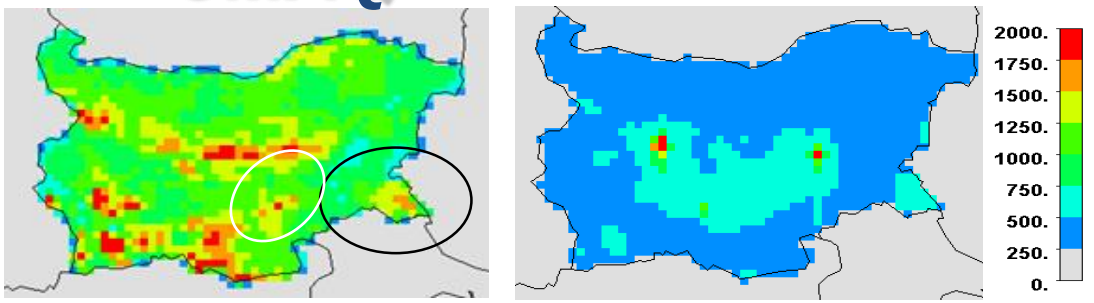
- CMAQ higher values: S-WD (x 2.5), oxN (x 5) on annual basis

2017

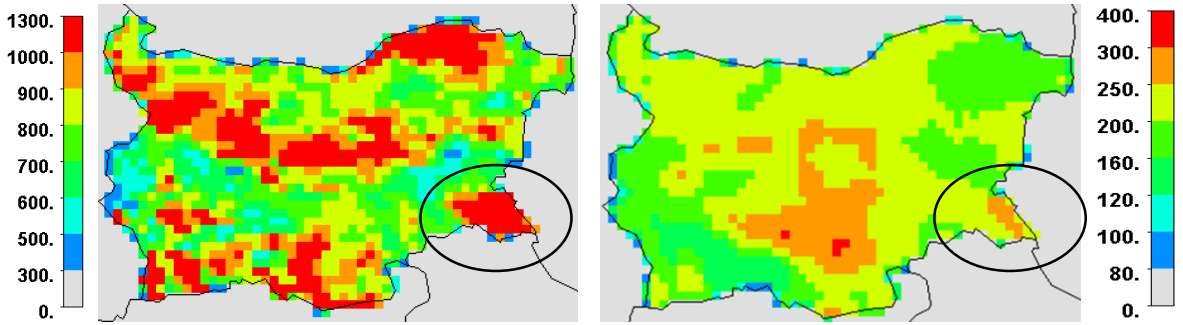
CMAQ

EMEP

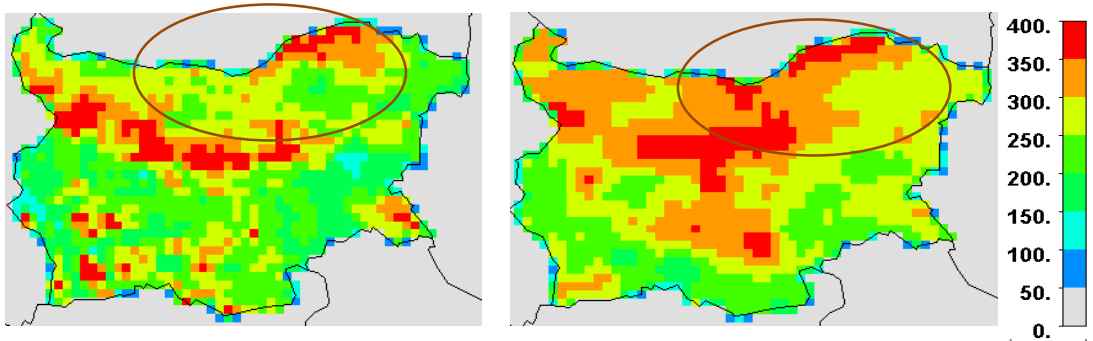
S- WD
mg/m2



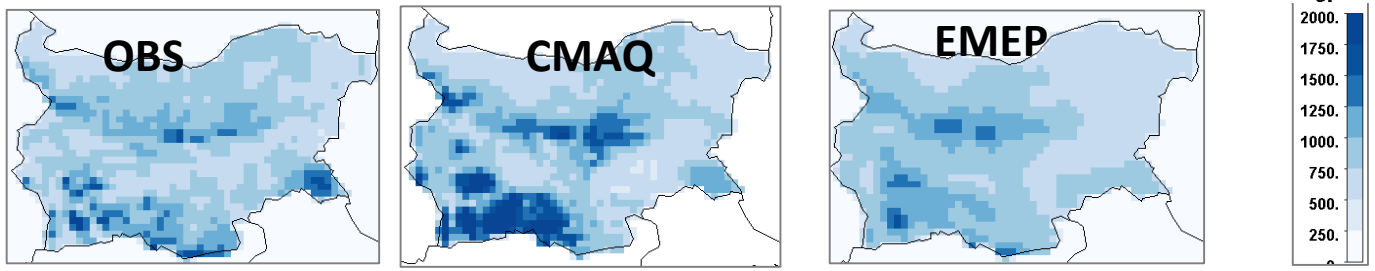
oxN- WD
mg/m2



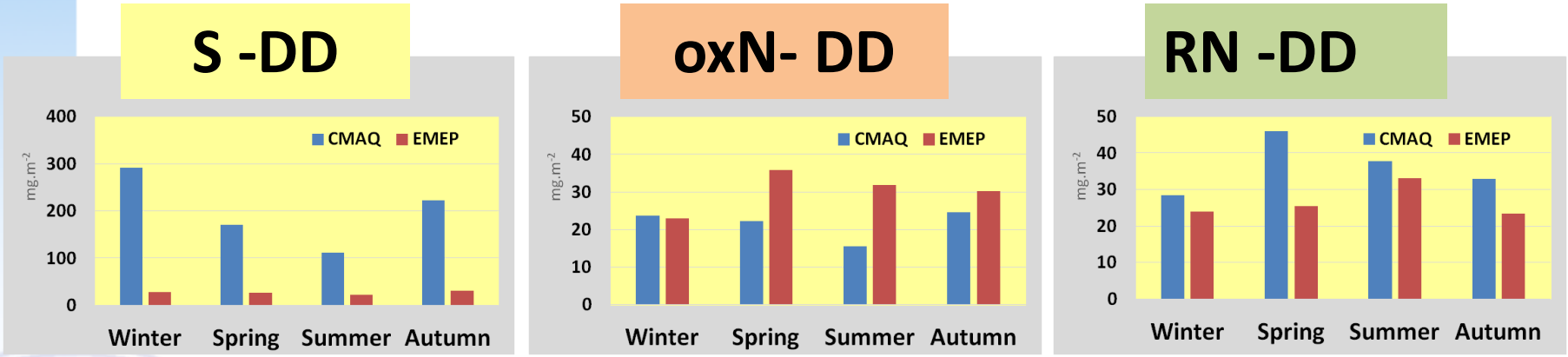
RN- WD
mg/m2



PRECIP
mm



DRY depositions (mg/m2) – BG- mean by seasons (2016-2017)



CMAQ EMEP

- EMEP: similar values for S, oxN and RN
- S-DD: CMAQ: x10 higher than EMEP
- RN-DD: CMAQ higher than EMEP
- oxN-DD: CMAQ lower than EMEP

2017

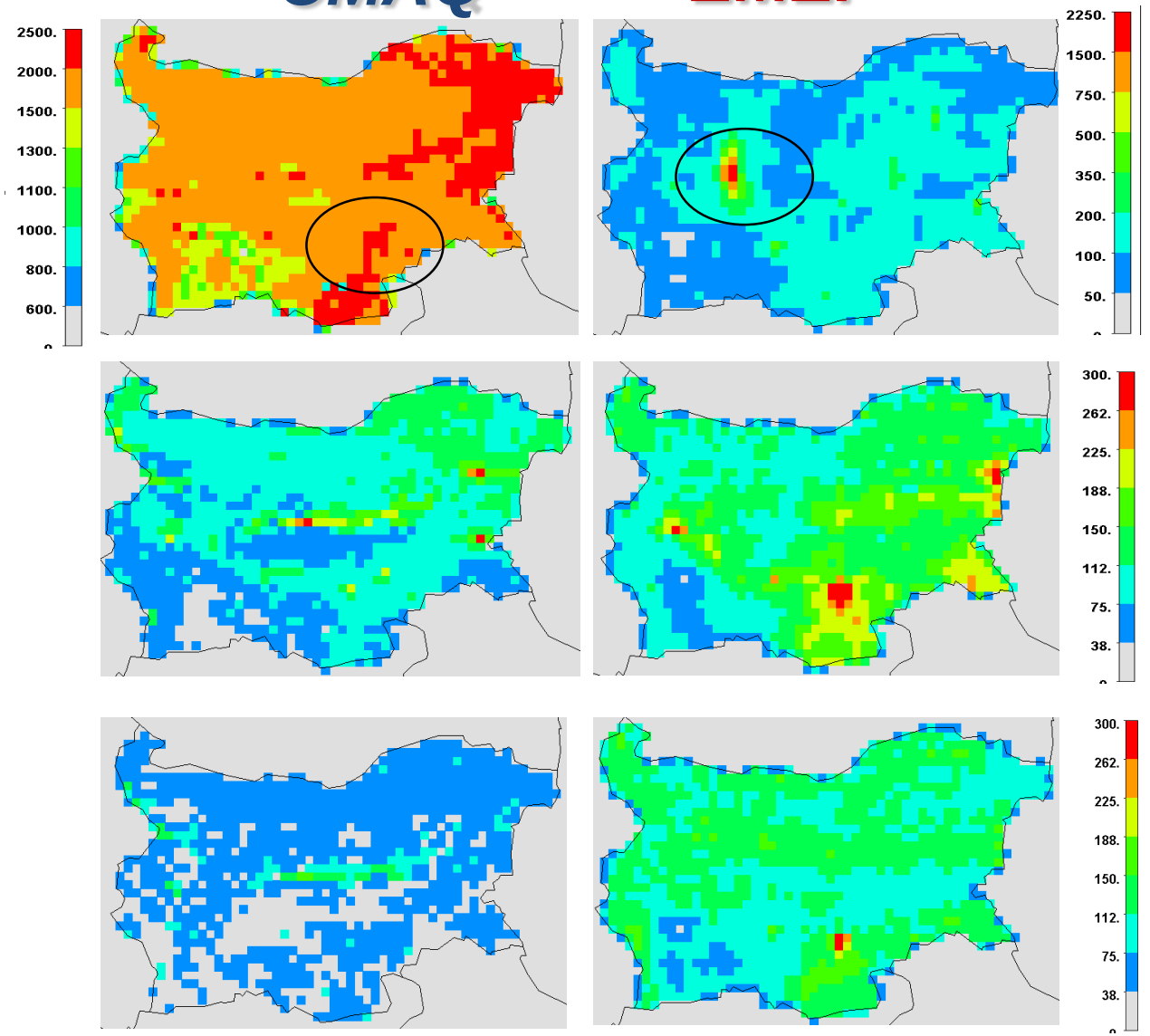
S- DD
mg/m2

oxN- DD
mg/m2

RN- DD
mg/m2

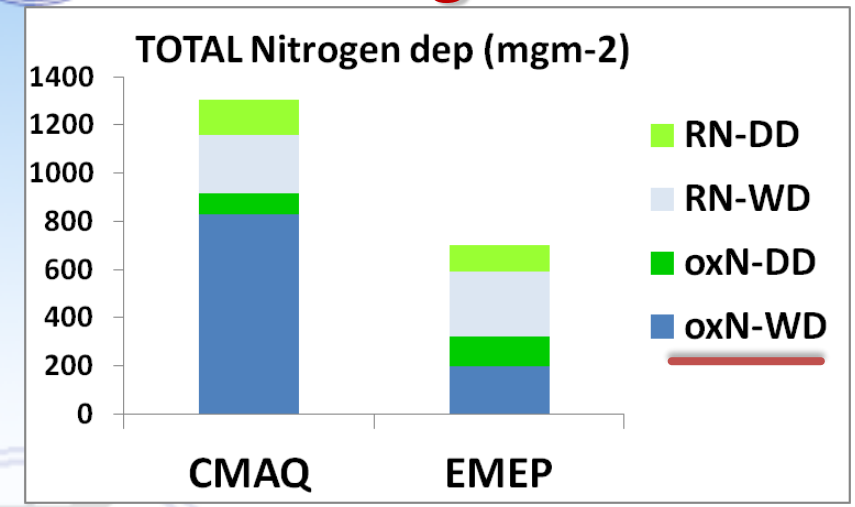
CMAQ

EMEP

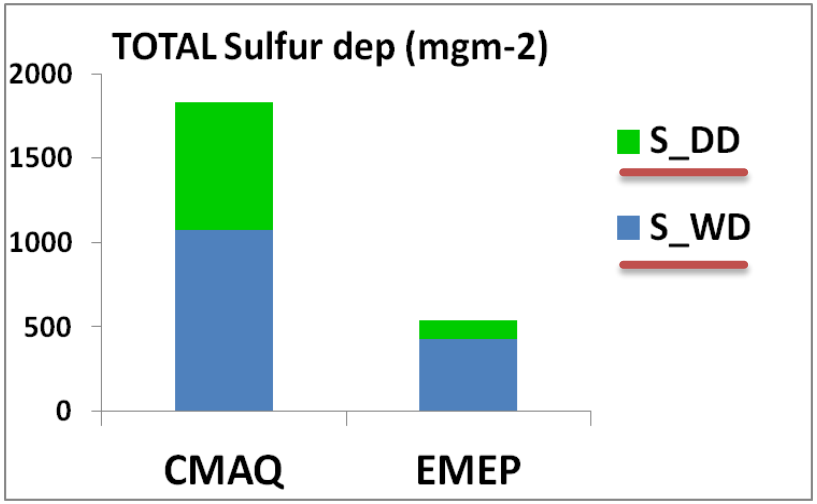


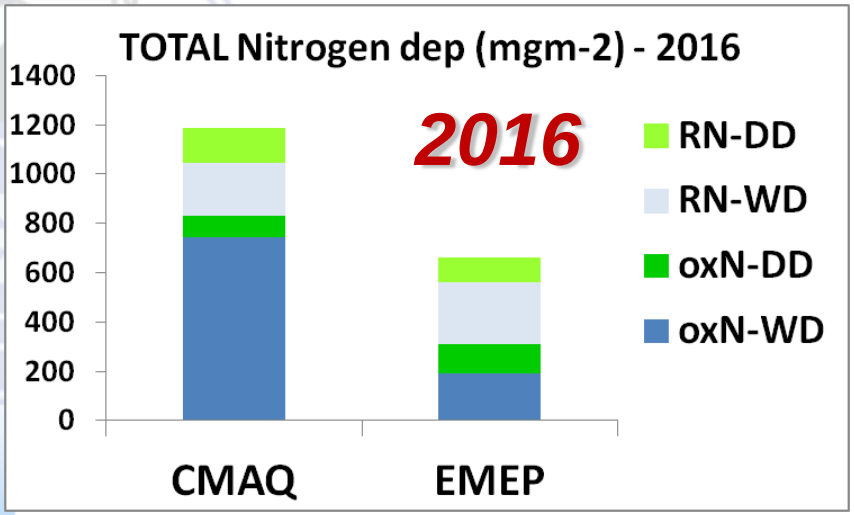
TOTAL DEPOSITIONS

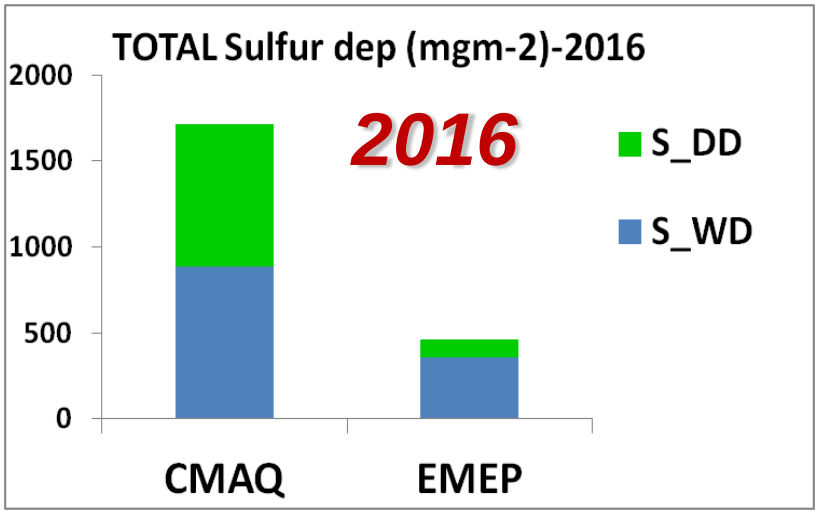
Nitrogen -2017



Sulfur -2017



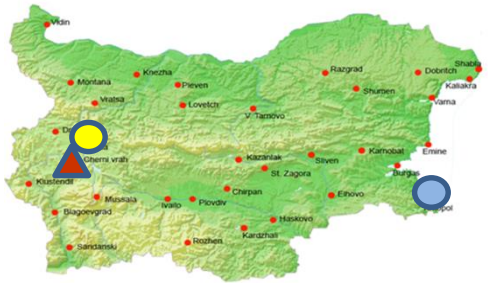




Comparison to observations – WET DEP

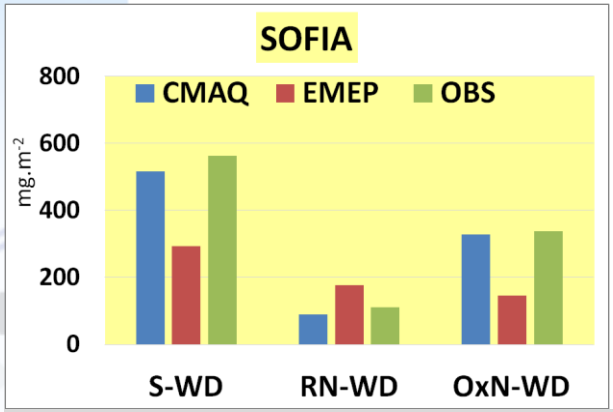
Sofia 570m CherniVruh PEAK (2280 m)

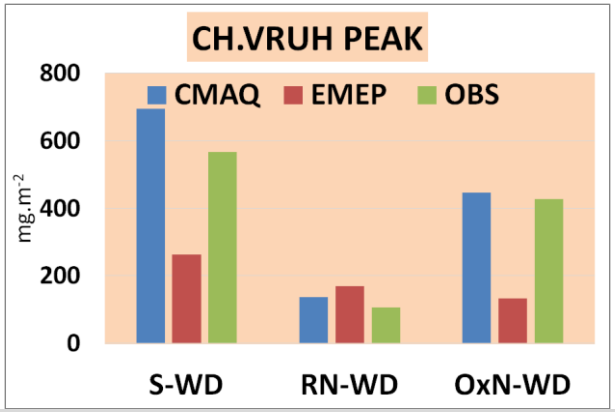
Ahtopol (sea side)

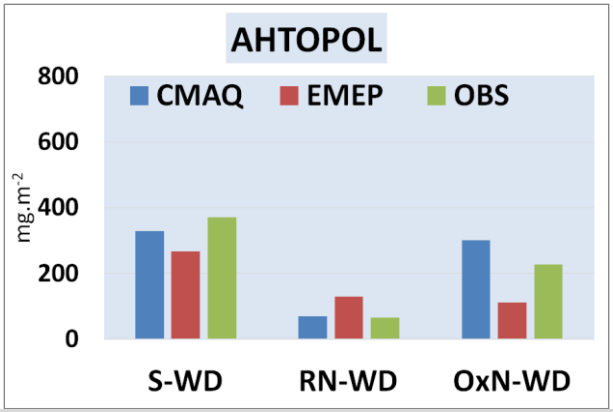


June – November 2017

CMAQ EMEP OBS



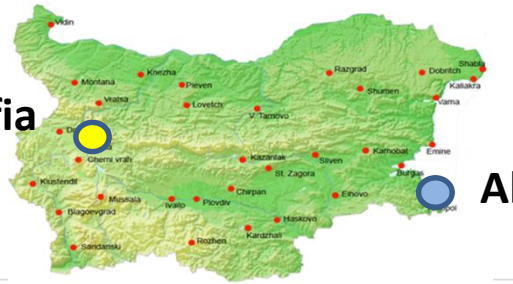




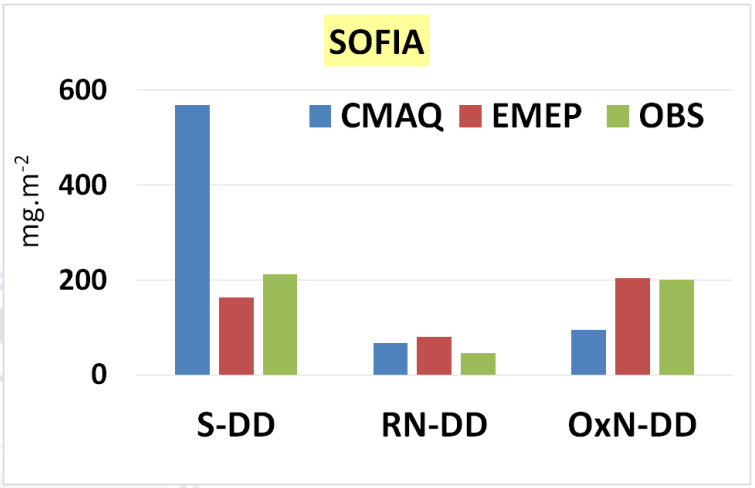
- Both models and observations: S-WD are prevailing at all sites
- CMAQ : more variability in the magnitude from site to site
- EMEP: NMB- RN (≈ +60 to+100%) , oxN (≈ -60%)
- Ahtopol: sea salt contribution to S-WDobs is 31%, EMEP NMB 3% , SOF, CHVRUH: EMEP NMB% ≈ -50 %

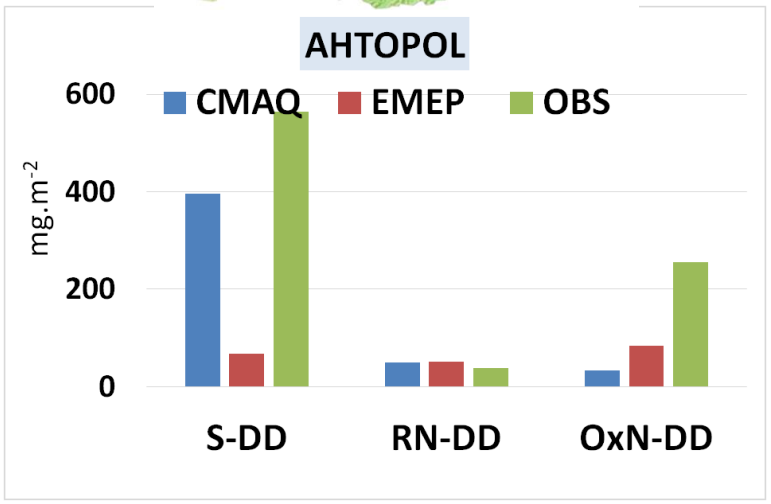
Comparison to observations – DRY DEP

June – November 2017



CMAQ EMEP OBS





- observations: S-DD and OxN-DD are prevailing (higher at Ahtopol site)
- CMAQ : S-DD (SOF) overestimated by x 1.5
- CMAQ diff to EMEP: mainly in S-DD

Key messages

- Despite differences in the models, some common features in model deposition maps are noted (i.e. high depositions in the most SE part of BG)

- Sulfur depositions are prevailing (both in model results and observations)

- Comparison at 3 stations for wet depositions:
  CMAQ: NMB ± 30% , EMEP: NMB ± 50%

- further studies are needed to understand the bias between EMEP and CMAQ results

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Acknowledgments

- **EMEP team and MET Norway** for the EMEP MSC-W data
- **TNO** for the emissions
- **U.S. EPA (CMAS)** for the codes WRF-CMAQ

This study was realized with the financial support from the BG National Science Fund through Contract N.04/4 15.12.16

Additional information in poster H19-147

THANK YOUR FOR THE ATTENTION !