The FAIRMODE CT9 platform

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FAIRMODE CT9 OBJECTIVES

- For a given mitigation scenario (**scen**) and a base case (**bc**), models (**M**) provide different absolute results C^{M}_{scen}
- **BUT, HOW DO THEY BEHAVE ON DELTAS?**

$$\Delta = C^{M}_{scen} - C^{M}_{bc}$$

- What is the order of magnitude of differences? How to evaluate these differences? Which indicators?
- Can we explain the differences, what are the main drivers?

Policy Implication:

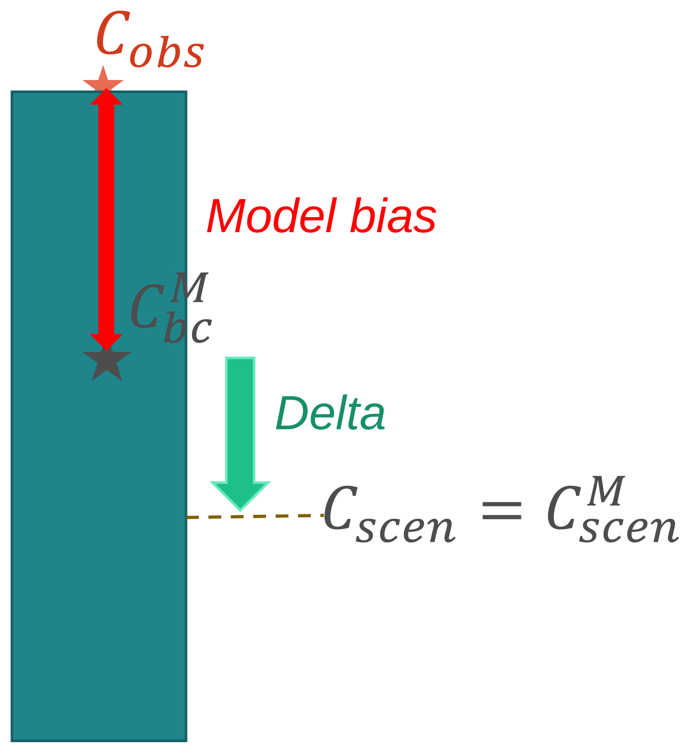
It is important to assess the robustness of deltas for urban air quality policies!

European Commission

FAIRMODE CT9 CONTEXT ➡ TOPIC 2

- Many inter-comparison exercises of air quality models
- No recent exercises to assess the capacity of models to simulate "delta" (Formerly CityDelta, EURODELTA) particularly at more local scale
- **Need to have a long term inter-comparison <u>platform</u> to continually assess model responses**

Mod. only based method



FAIRMODE CT9 CONTEXT ➡ TOPIC 2

- Many inter-comparison exercises of air quality models
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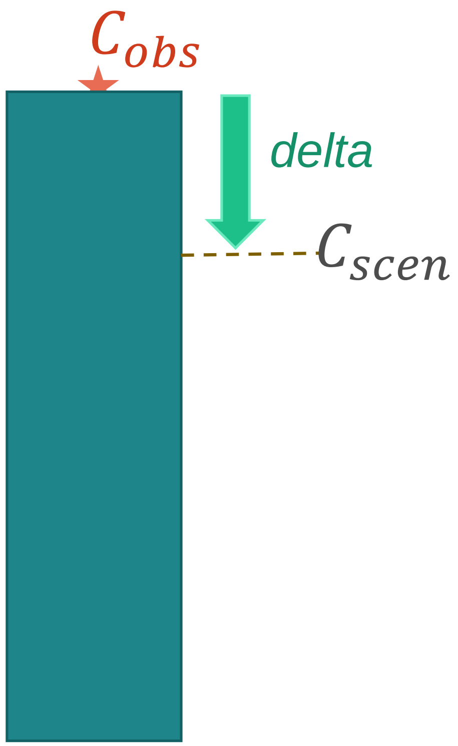
- **Need to have a long term inter-comparison <u>platform</u> to continually assess model responses**

- A Model Concentration Delta can be applied to an observation C_{obs} to evaluate a scenarios based on '*bc*' reference and '*scen*' simulations:
  - Absolute (for O3?): $C_{scen} = C_{obs} + \overbrace{\left(C_{scen}^{M} - C_{bc}^{M}\right)}^{delta}$
  - Relative (for NO2 or PM?): $C_{scen} = C_{obs} \times \left(C_{scen}^{M} - C_{bc}^{M}\right)/C_{bc}^{M}$
  - ***Techniques often used but rarely assessed***

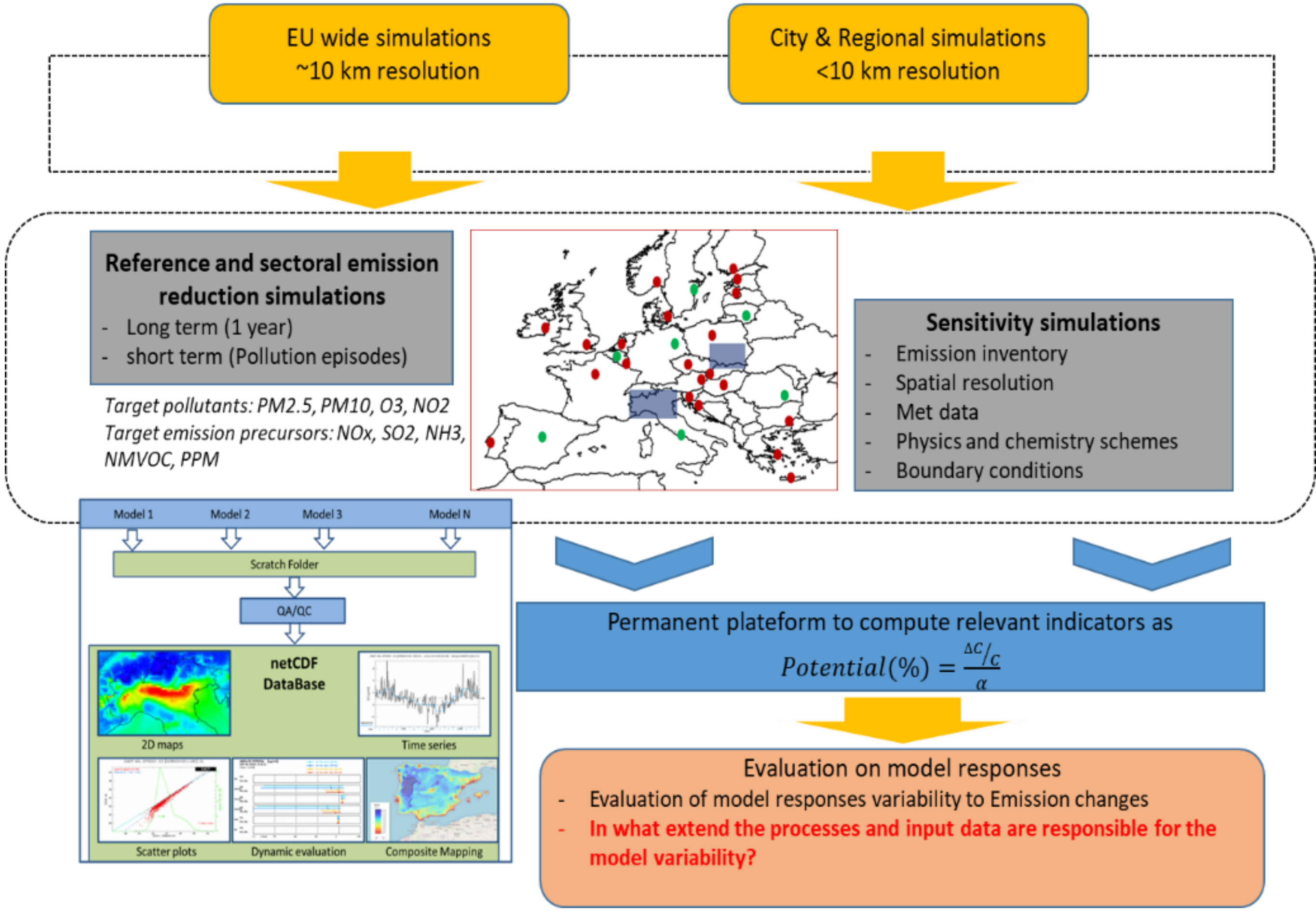
Mod.+obs only based method



Models and teams involved - Overview

Constraints:
-Meteorology 2015
-Emission reductions 25 and 50%
-Target domains, periods (episodes)

Team name - Country	Model Name
JRC (EU)	EMEP
JRC (EU)	EMEP
JRC (EU)	EMEP
JRC (EU)	EMEP
ZAMG (AT)	WRF-Chem
Met Norway (NO)	EMEP
Met Norway (NO)	EMEP + uEMEP
CyI (CY)	WRF-Chem
NKUA (GR)	WRF-Chem
DHMZ (HR)	ADMS-Urban
DHMZ (HR)	LOTOS-EUROS
LMD/IPSL (FR)	WRF-CHIMEREv2020r1
UH-CACP (UK)	WRF-CMAQ
CIEMAT (ES)	IFS-CHIMEREv2017r4
ENEA (IT)	WRF-MINNI
IRCELINE (BE)	CHIMERE + RIO + ATMOSTREET



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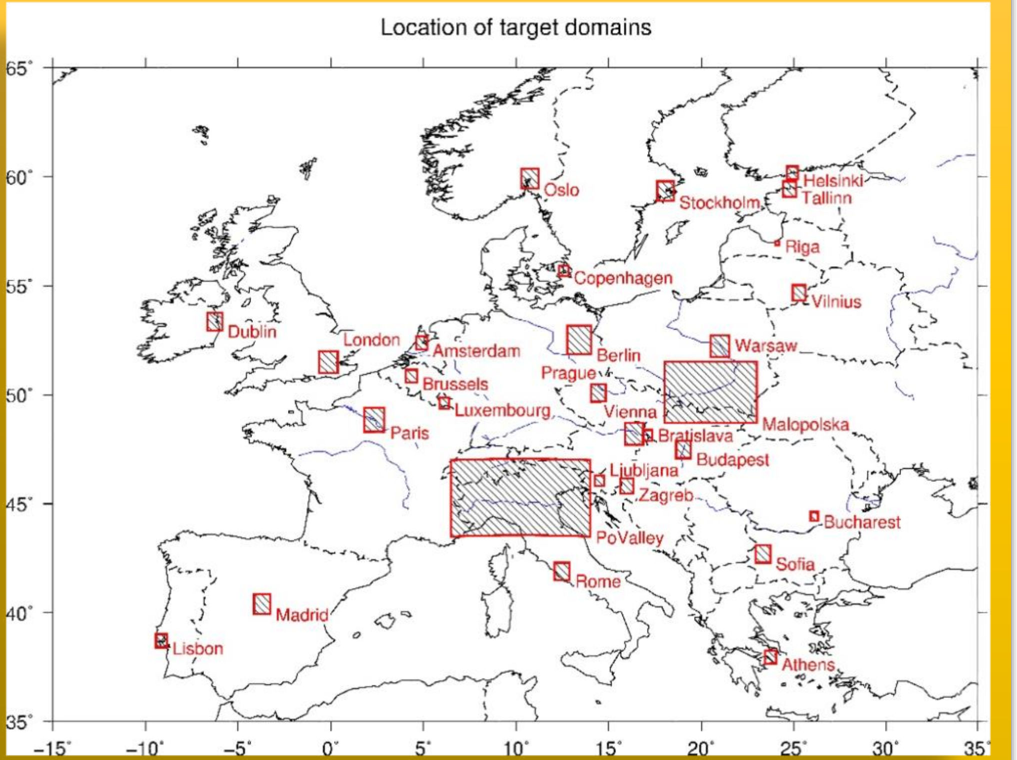
The overall framework

Set-up

- Short term (ST) on episodes
  - *Emissions reduced only during 2015 episodes from 00:00 to 23:00*
- Long term (LT) simulations
  - *Emissions reduced for the whole year 2015*
- Two reductions so far:
  - 25% and 50% from a base case (BC)
- Reduced species depends on target pollutants
  - ***PM10***: *PPM, NOx, VOC, NH3, SO2, **ALL** (All together)*
  - ***Ozone***: *NOx, VOC, **ALL** (All together)*

Domains of emission reductions



The overall framework

Basis Indicators

- **Absolute Potential** defined as the reduction in µg/m^3 scaled by the reduction α of the scenario (25 or 50%) of a precursor from base case BC
  - $APl = (C_{SCEN} - C_{BC})/(\alpha\ )$ ($APl \times \alpha$ is the delta of concentrations)
- **Relative Potential** defined as the reduction in % scaled by the reduction α of the scenario (25 or 50%) of precursor *n* from base case BC and by the BC concentrations.
  - $RPl = (C_{SCEN} - C_{BC})/(\alpha \times C_{BC})$
- **Absolute Potency** in µg/m^3/(ton/day) defined as the derivative of the concentration with respect to the emissions density E of a precursor or in other words the rate with which the concentrations (*C*) will change as a result of an emission density E)
  - $APy = (C_{SCEN} - C_{BC})/(\alpha \times E_{BC})$

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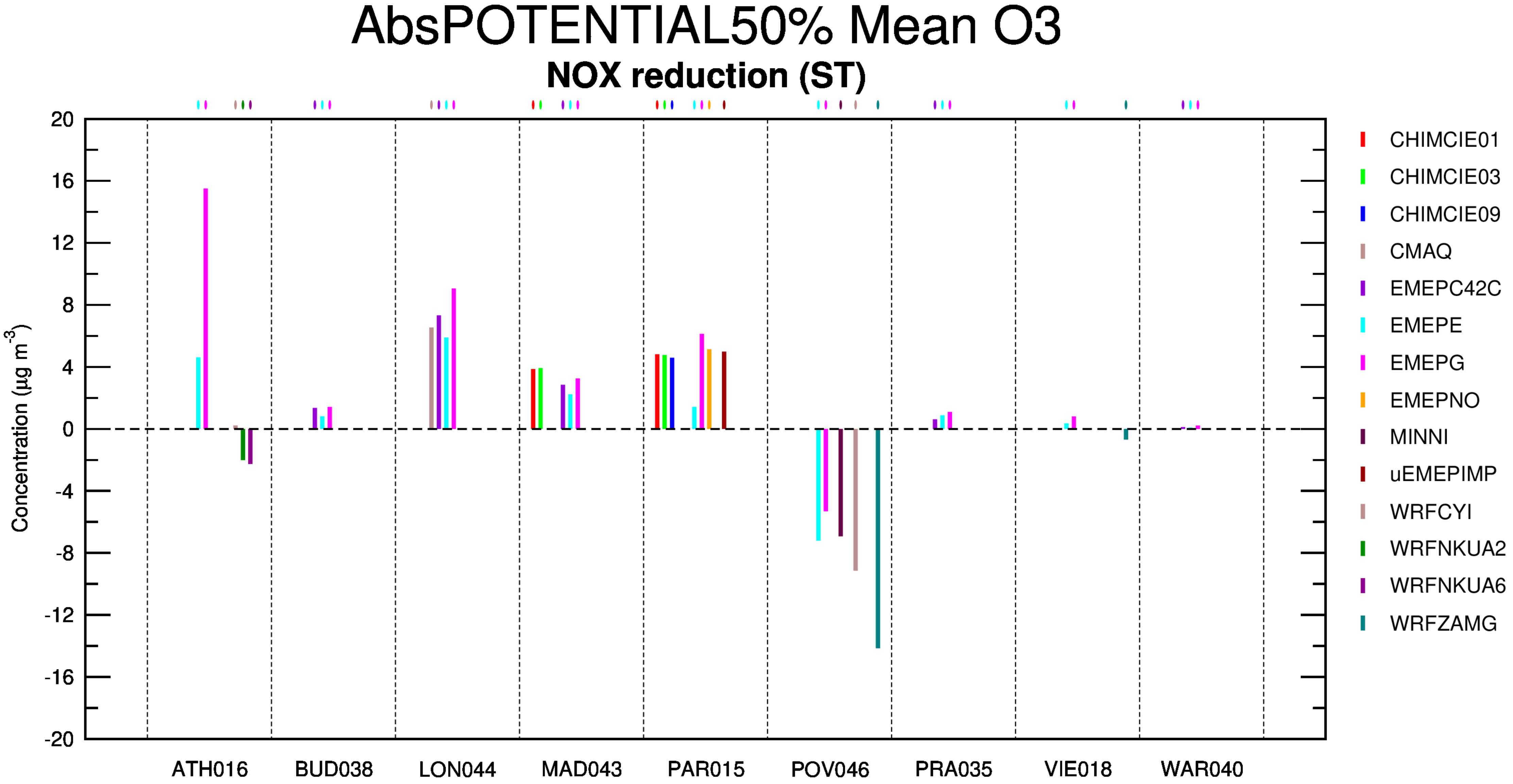
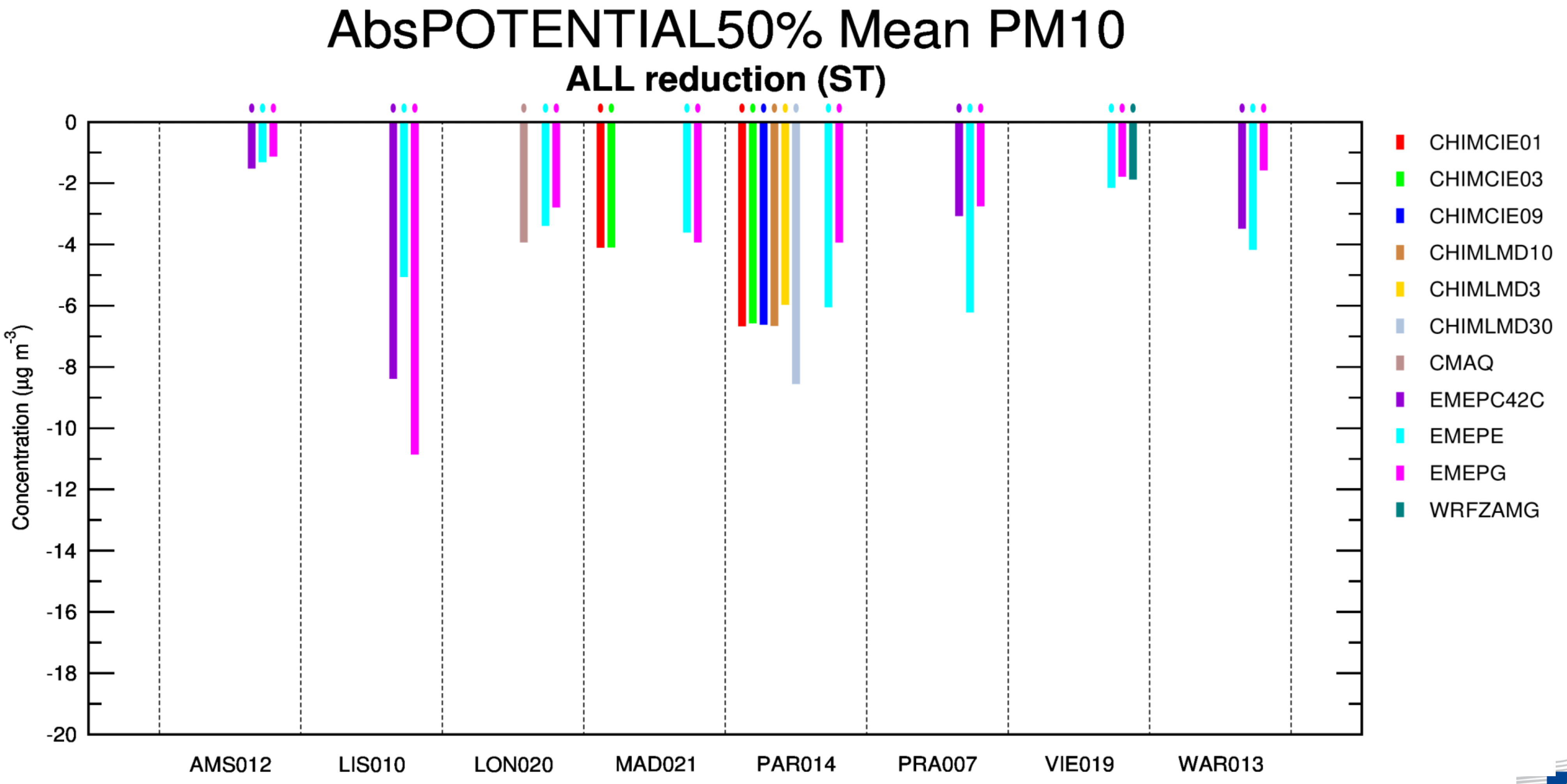
Absolute Potential for O3 for NOx reduction



Absolute Potential for PM10 with ALL pollutant reductions



Other indicators

- **Variability** for each indicator
  - IND = API, RPI, APY

Variability from models M assessed by Norm. Std. Dev.

$$VAR_{IND} = \sqrt{\frac{\sum_{m=1}^{M}(IND_m - \overline{IND})^2}{(\overline{IND})^2}}$$

- Test of linearity using the 50% and 25% runs. **Deviation to linearity for API**

$$100 \times \left(\frac{API50\% - API25\%}{API25\%}\right)$$

- Test of additivity using the ALL scenarios and “ADD” as the sum of individual precursors reductions. **Deviation to additivity for API, RPI**

$$100 \times \left(\frac{IND_{ADD} - IND_{ALL}}{IND_{ALL}}\right)$$

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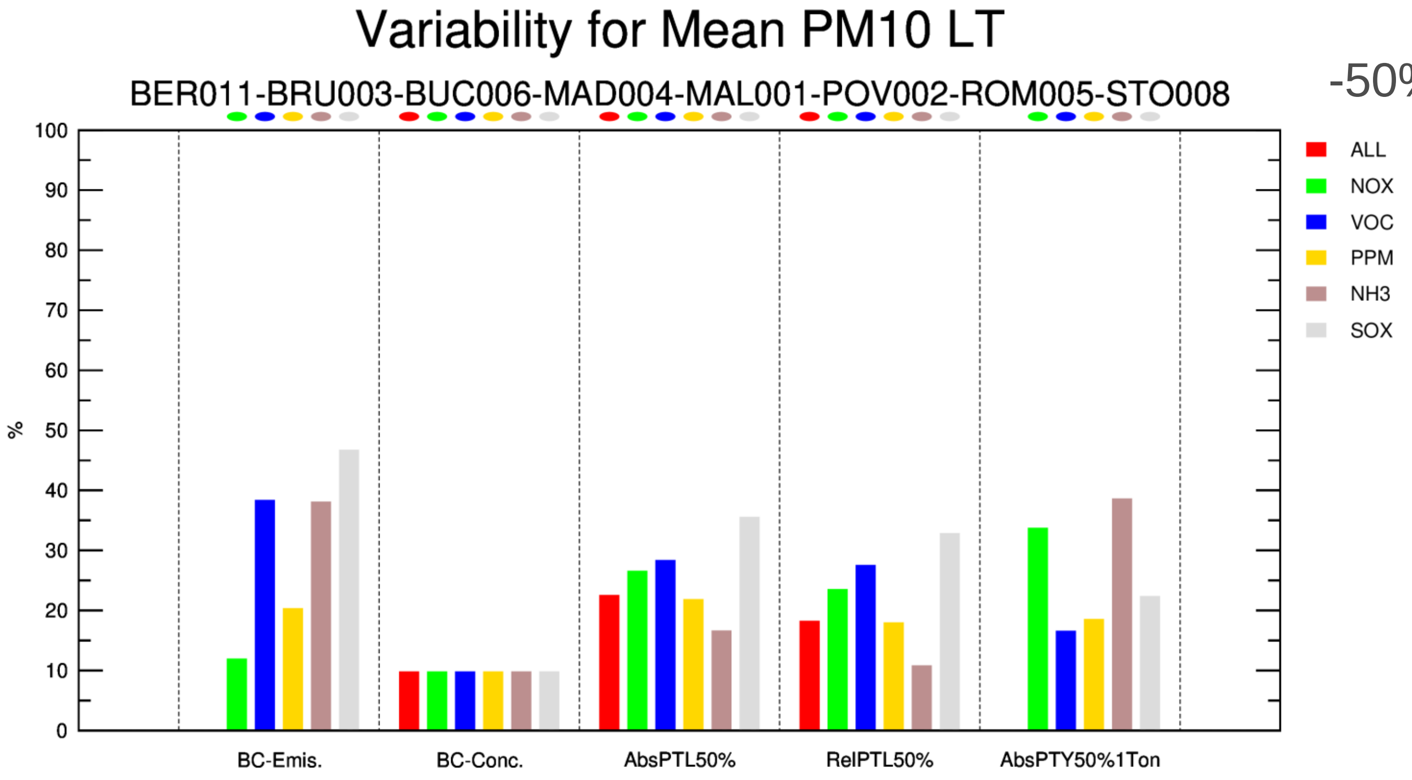

-50% scenario

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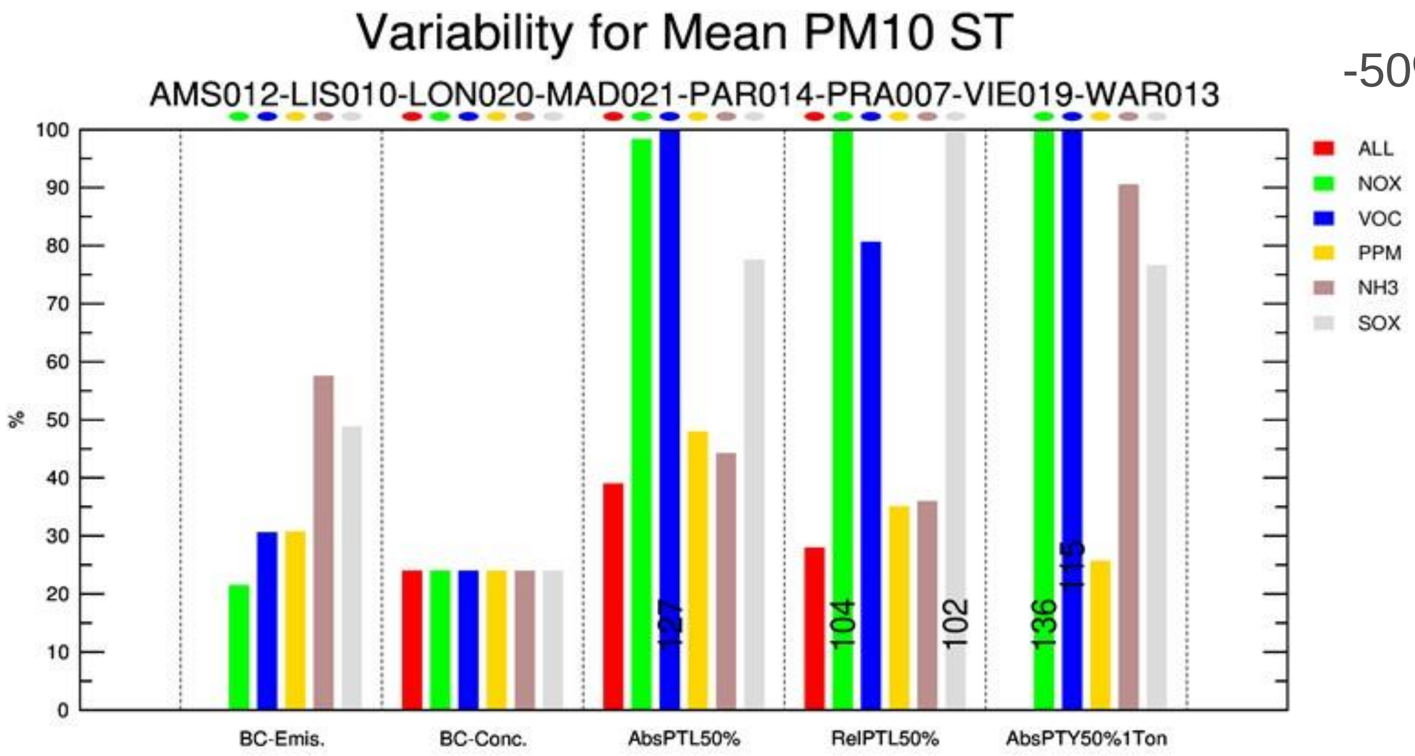

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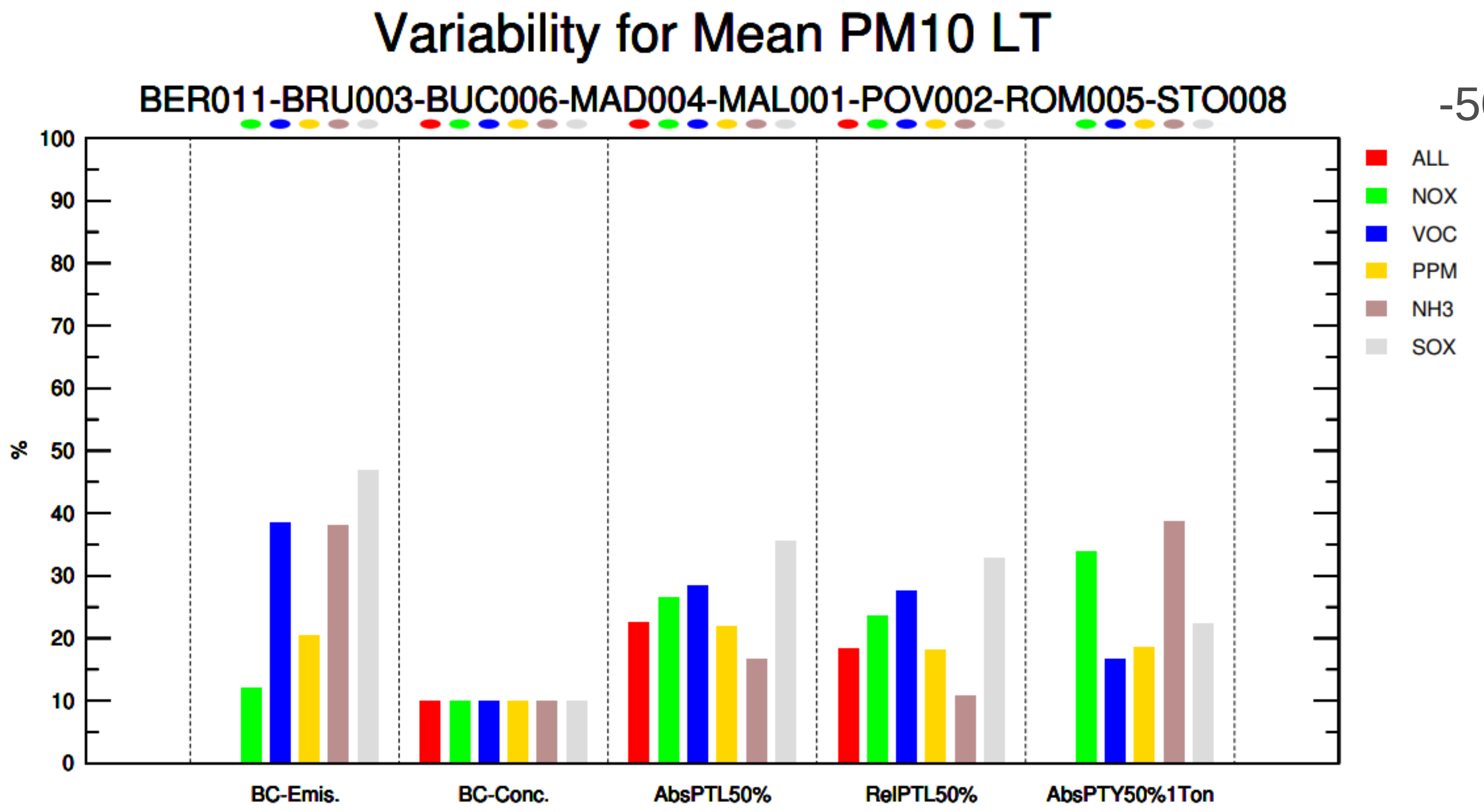
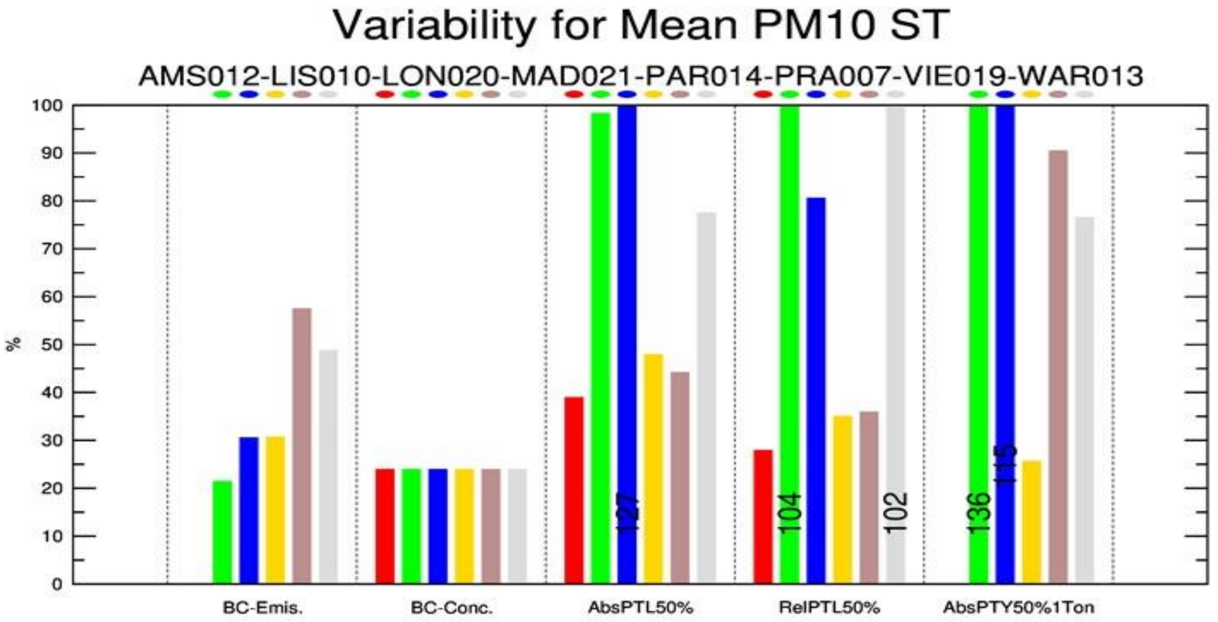


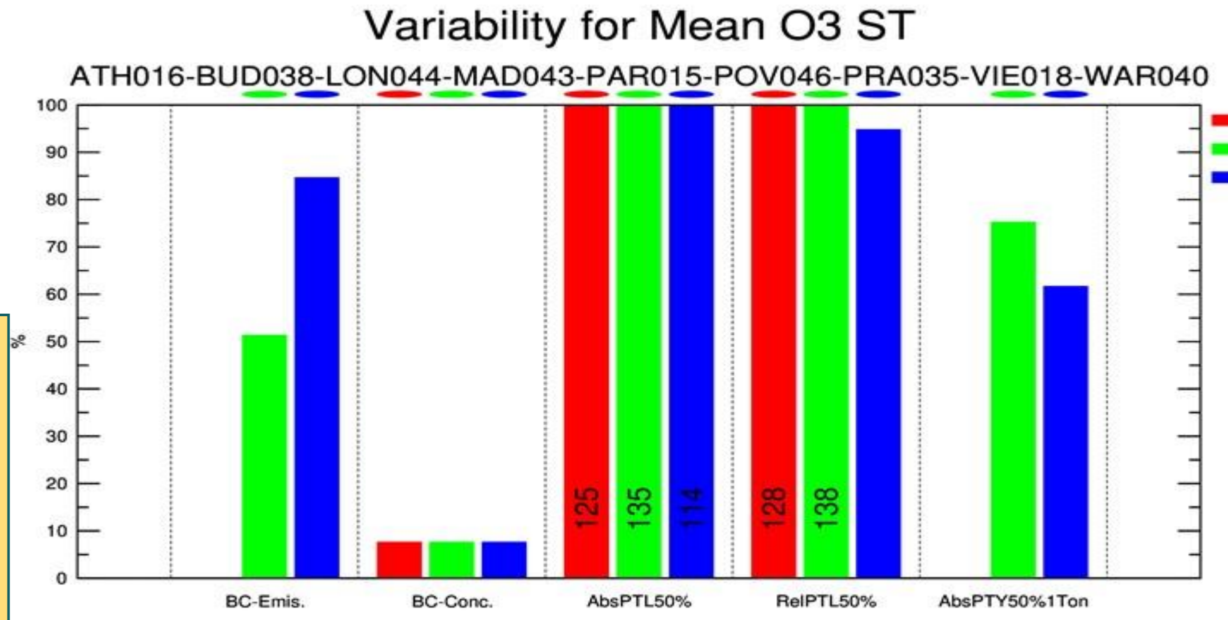
-50% scenario

Results on variability

- Less variability on O3 BC Mean than PM10 BC Mean
  - 6% versus 22%
- Variability of indicators
  - Very high, depending on the indicator
  - Lower variability on Potency (PTY)



-50%



-50%

Variability from models M assessed by Norm. Std. Dev.

$$NSD_{IND} = \sqrt{\frac{\sum_{m=1}^{M}(IND_m - \overline{IND})^2}{(\overline{IND})^2}}$$

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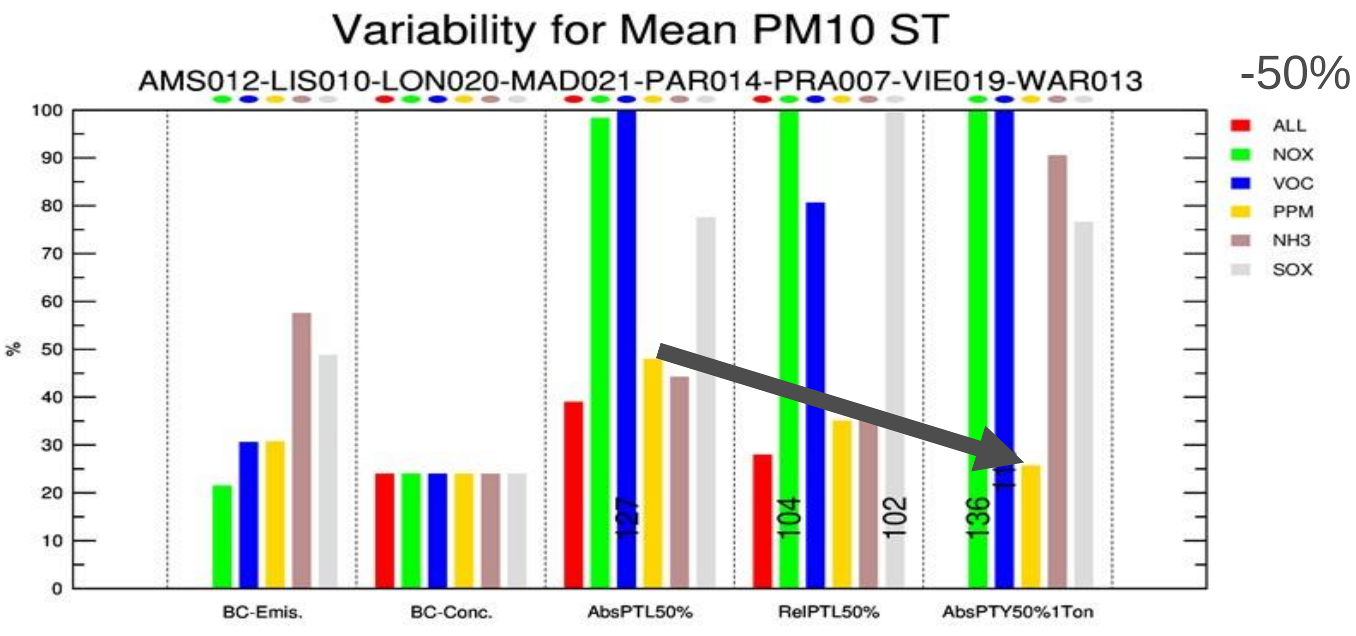

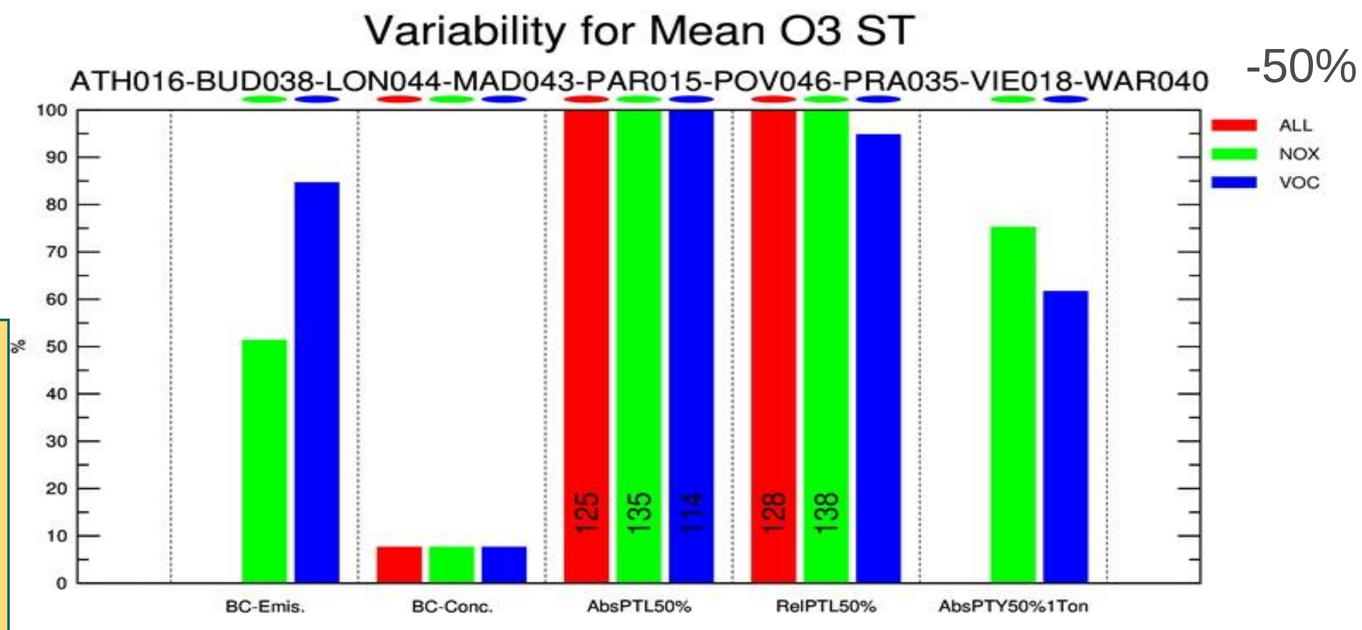

Variability from models M assessed by Norm. Std. Dev.

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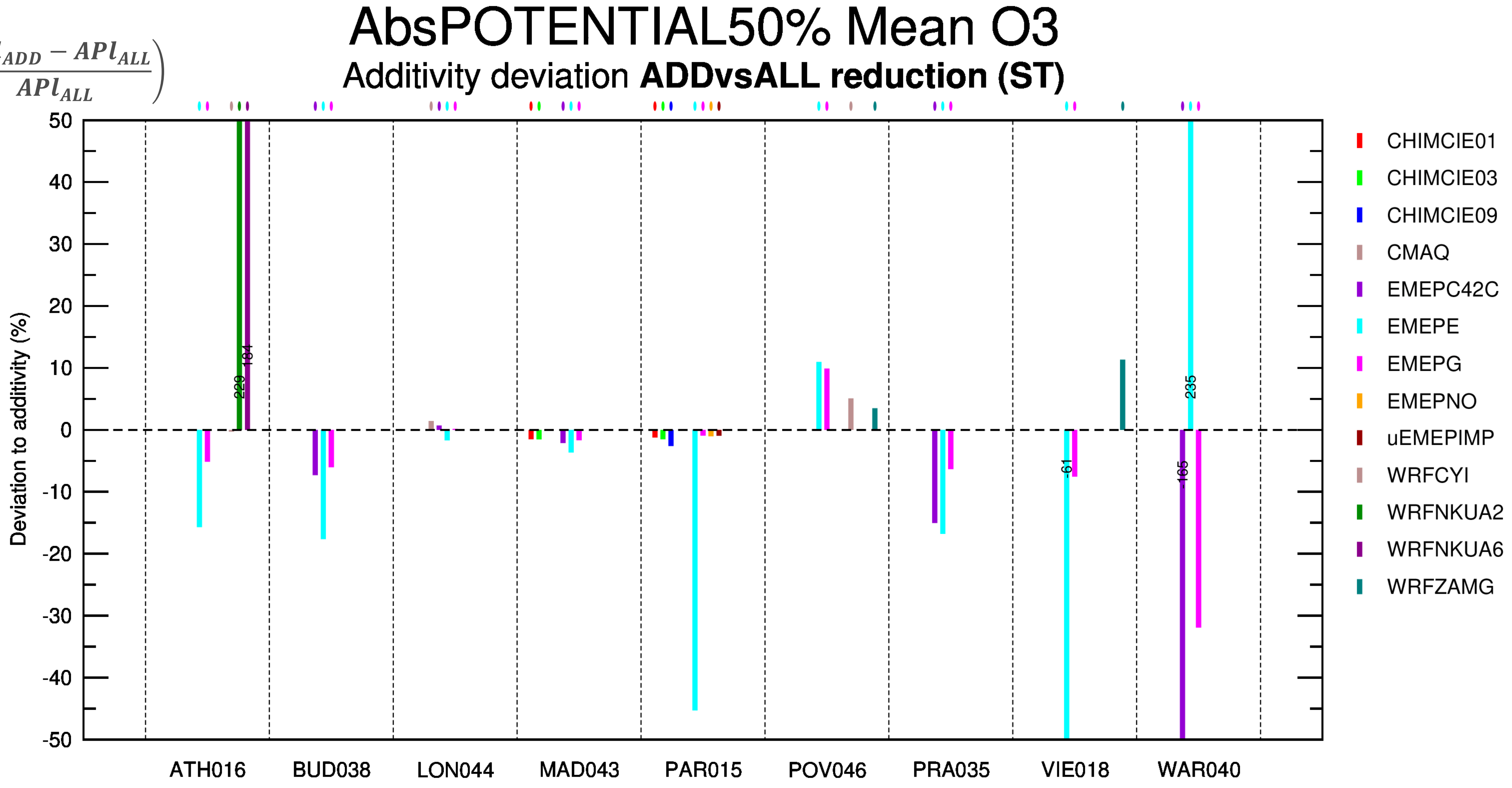
Additivity on O3

Deviation=0% means perfect additivity

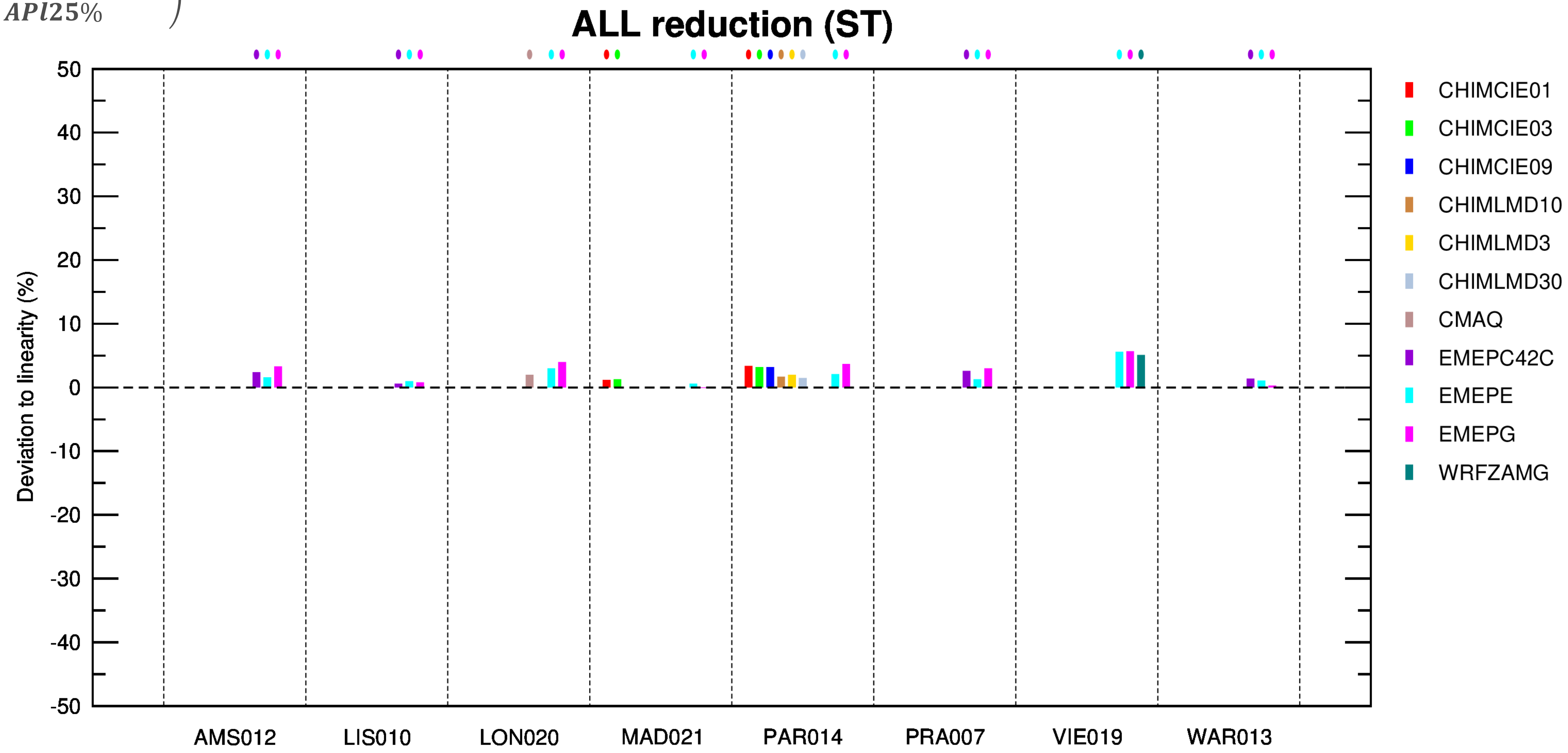
$$100 \times \left(\frac{APl_{ADD} - APl_{ALL}}{APl_{ALL}}\right)$$



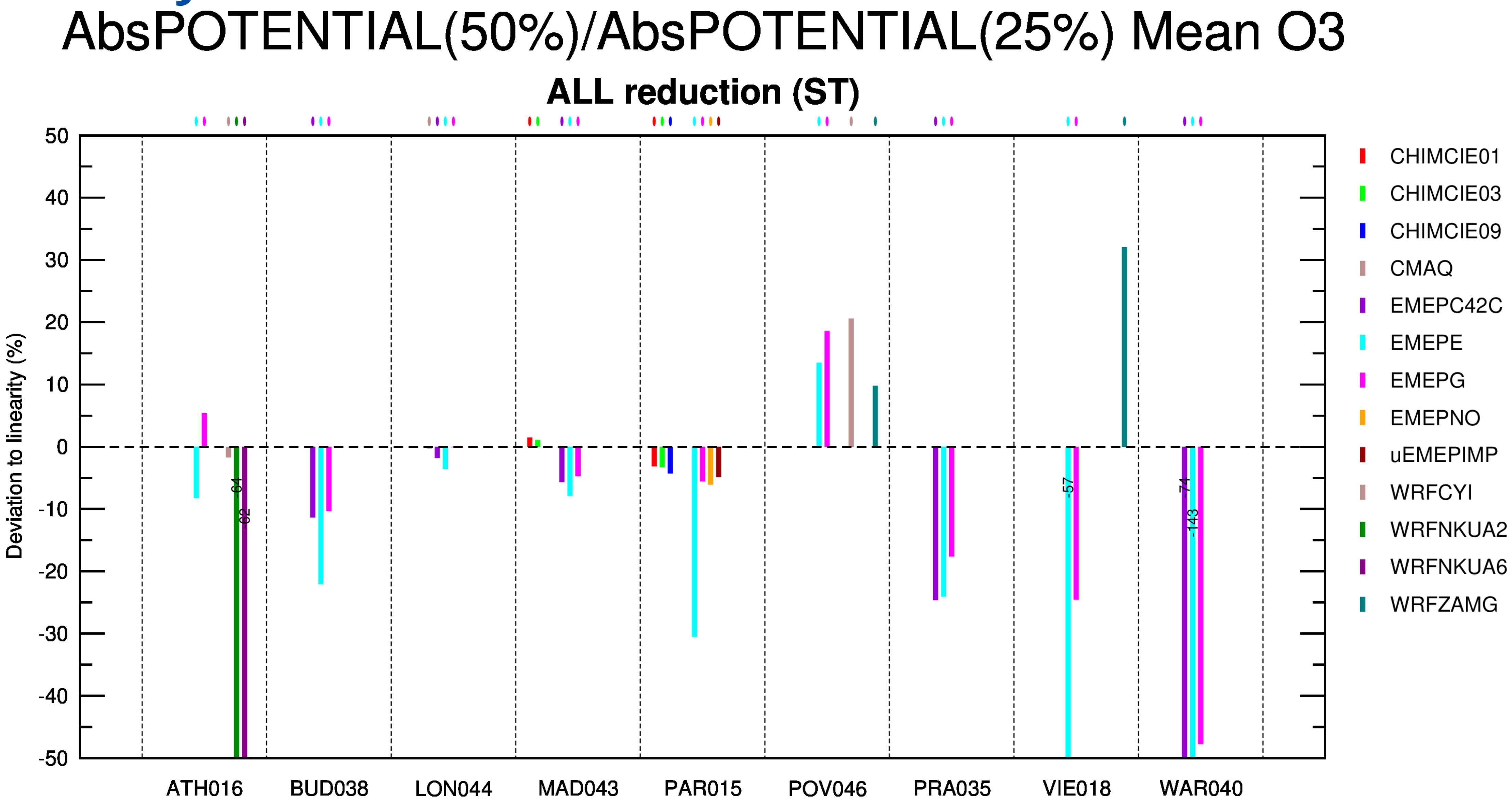
Linearity on PM10

Deviation=0% means perfect linearity

$$100 \times \left(\frac{\boldsymbol{APl50\% - APl25\%}}{\boldsymbol{APl25\%}}\right)$$

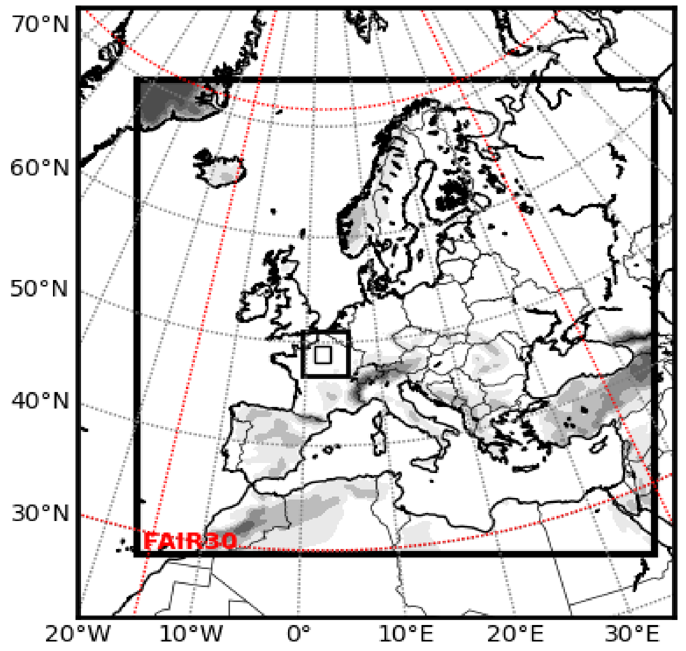


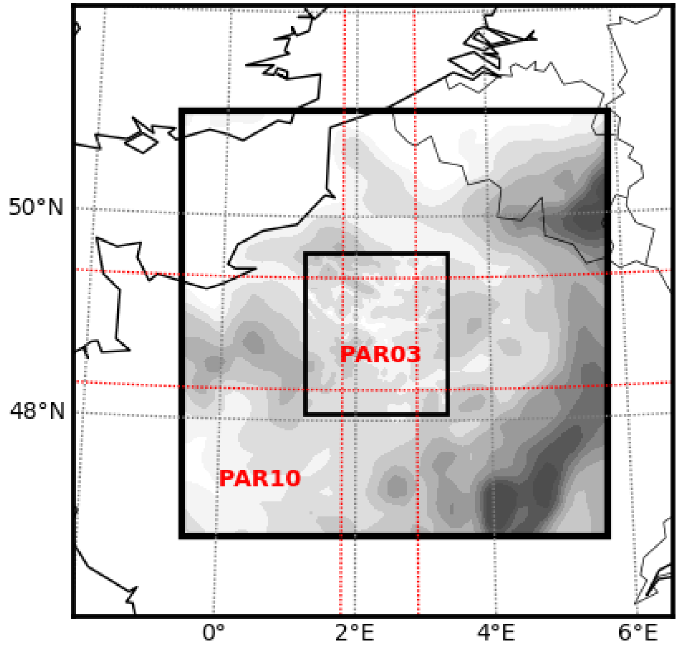
Linearity on O3



Impact of online coupling by LMD (courtesy of Arineh Cholakian)

- Runs : Paris episode 10/02/2015 to 17/02/2015
- (10 days of spinup period for all domains – BC continued to end of the month)
- Triple nesting :
  - FAIR30(30kmx30km)
  - PAR10(10kmx10km)
  - PAR03(3kmx3km)
- Coupled to WRF – no direct/indirect aerosol effects
  - Specific scenarios for aerosol effects
- CAMS-reg anthropogenic emissions
- CAMS global reanalysis Boundary/initial conditions (3-hourly)
- 15 vertical layers: 999hPa to 300hPa





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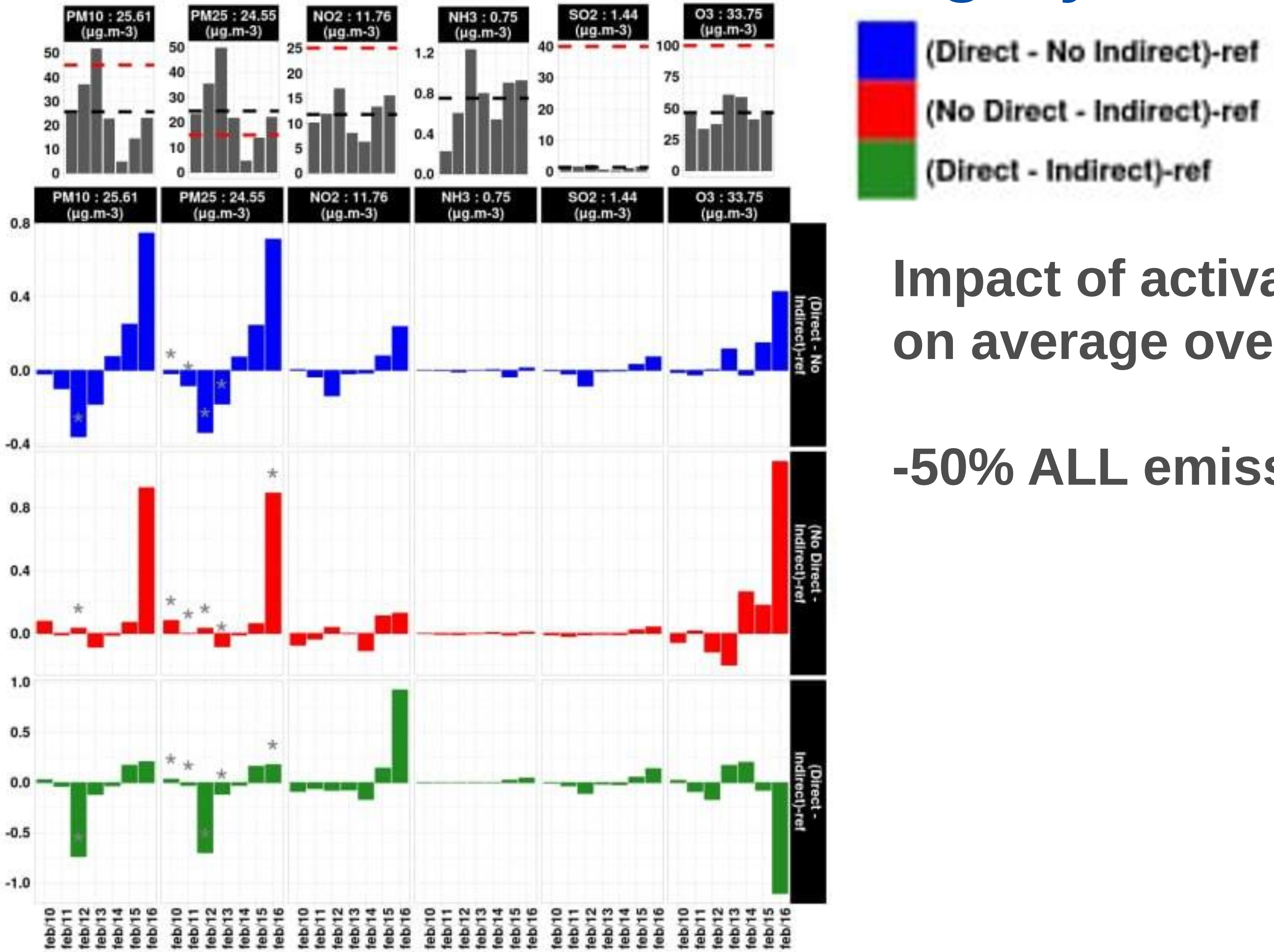
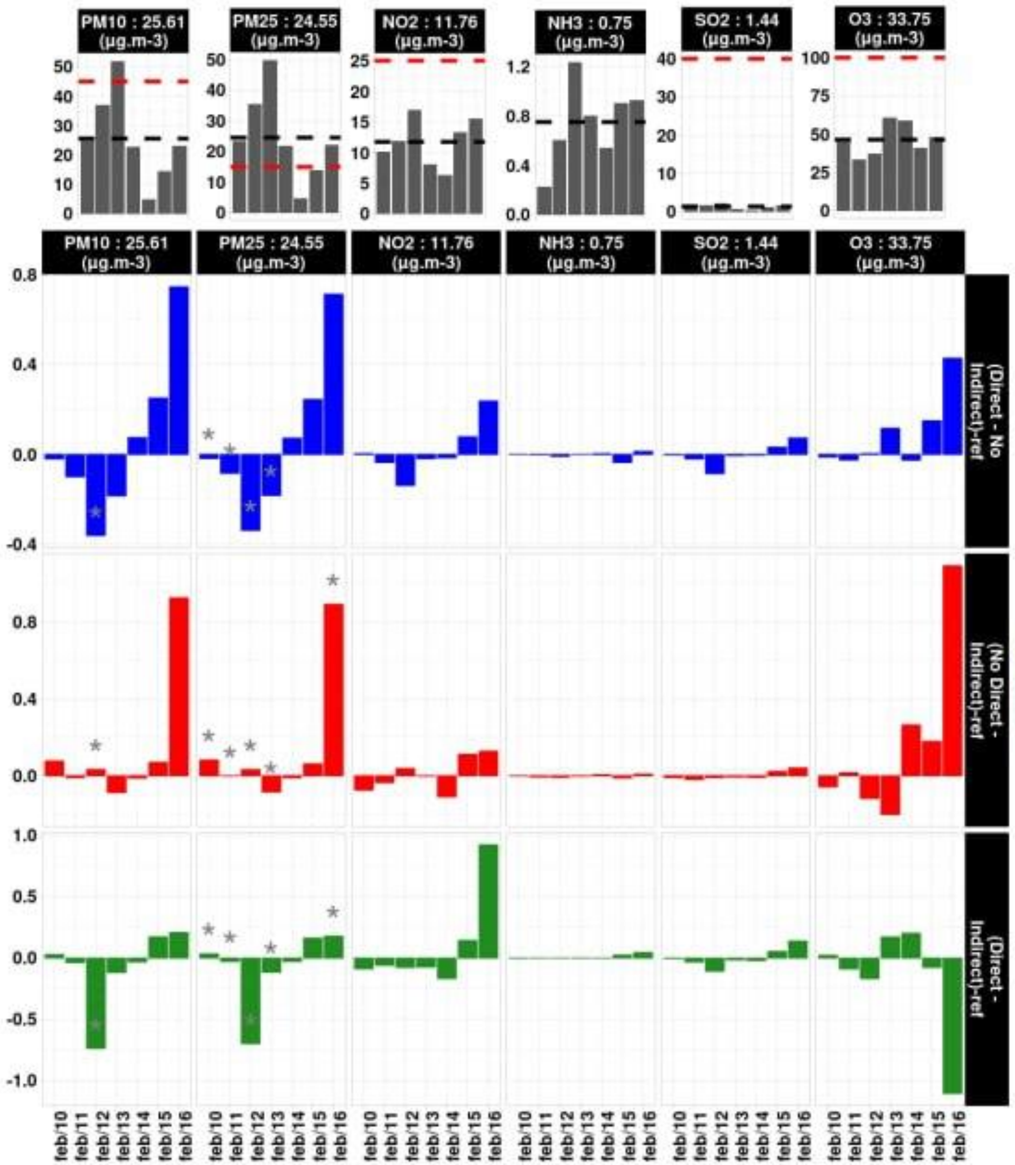


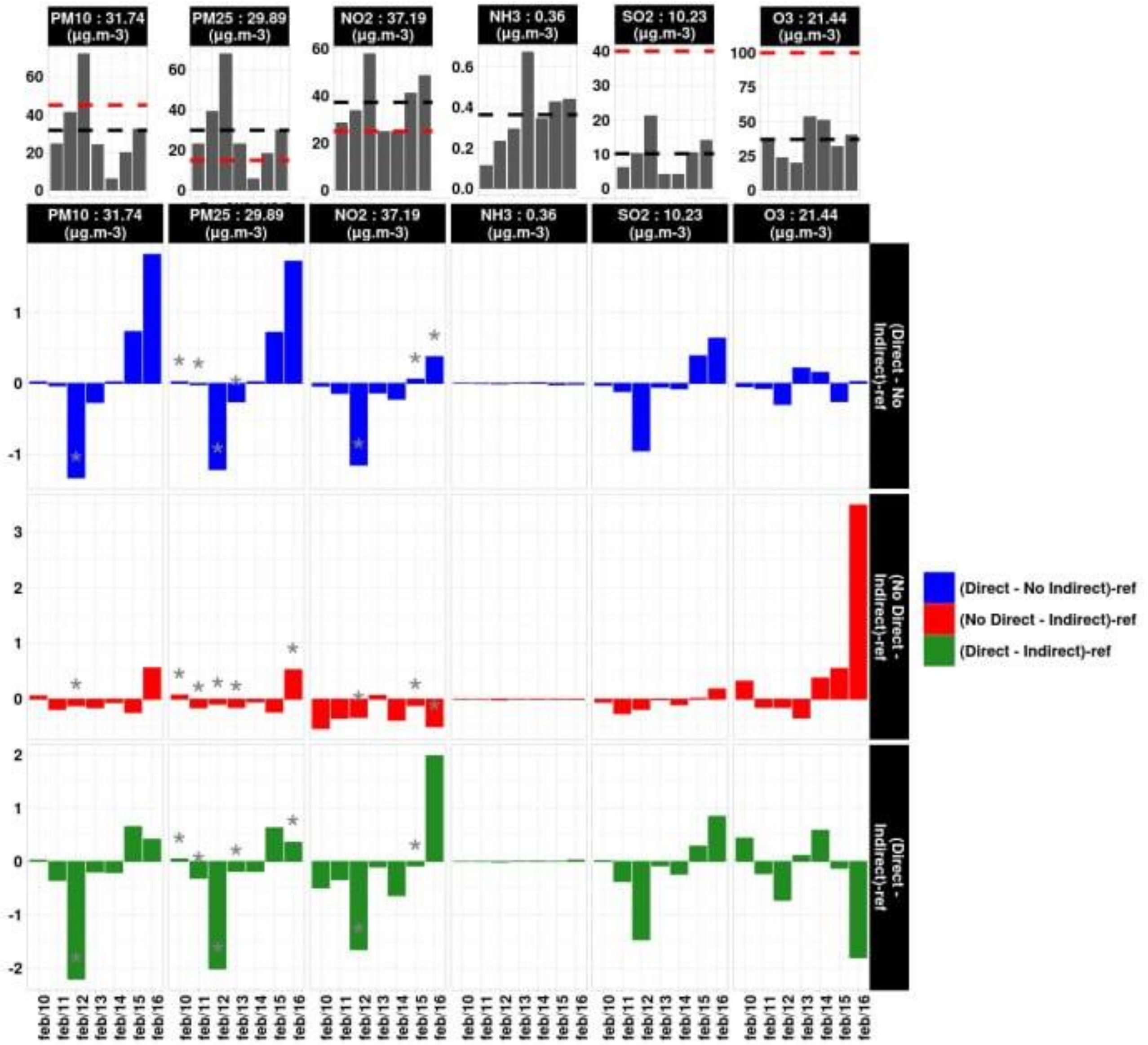
Impact of activation the online coupling on average over the domain

-50% ALL emissions reduced

Over the whole domain



Over urbanized area (>60%)



Conclusions

- **High variability of indicators observed in our first results**
  - Larger variability on model responses to emission reduction than for absolute values!
  - Less variability between models for the Potency compare to Potential
- **Opportunity for dynamic evaluation**
- **Next steps**
  - ✓ In depth work in sub groups on the impact of:
    - *Resolution (CIEMAT, LMD, NKUA)*
    - *Chemistry (CIEMAT, NKUA)*
    - *Emissions on LT (Alexander de Meij – METCLIM/JRC)*
  - ✓ To be discussed in sub-groups (TOPIC1 & TOPIC2)
  - ✓ Newcomers: Amela and Goran from CroatiaControl (focus on Zagreb)

END

Thank you for your attention