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Do local urban emissions influence ambient meteorology?

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1. Introduction – aerosol impact on meteorology

- In time average, the effect of urban aerosols is negligible – e.g. Huszár et al. (2016) – temperature change up to 0.1 K
- In special episodes (dust advection, wildfires, near sources), the effects can be more significant (Baró et al., 2017)
- Makar et al. (2015): Direct aerosol effect mainly in summer, indir. also in winter
- => Effects of urban emission on meteorology could be significant (in Prague urban area)

Aims of study:

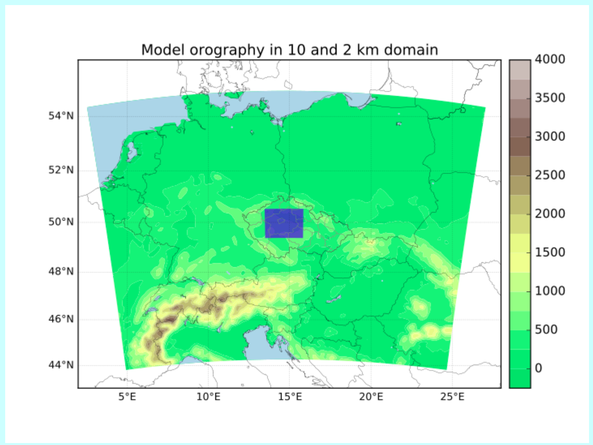
1. How significant is the effect of urban emitted aerosols on weather?
2. Study based on annihilation approach (Baklanov et al., 2016)
3. Chosen special episodes – summer, summer convection and winter

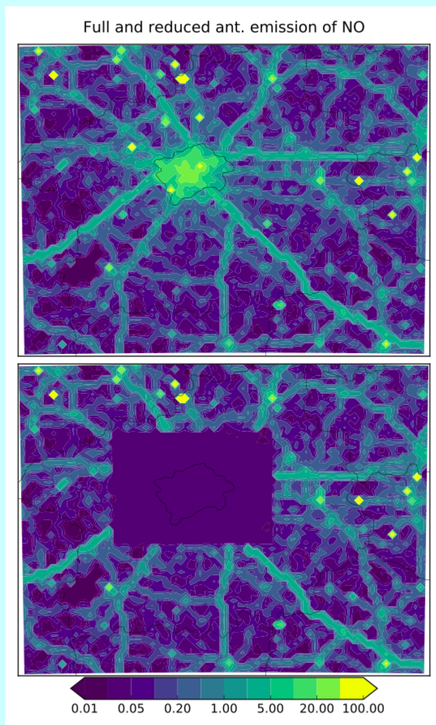
2. Model setup

- WRF-Chem 3.8.1, non-hydrostatic v., SLUCM urban parametrization
- Domain 10+2 km: 160x120 + 86x66 grid-boxes, 30 levels
- Era-interim + MOZART data for boundary conditions
- Land-use data derived form CORINE
- **Chemical and aerosol modules** (full aerosol chemistry):
- CBMZ–MOSAIC 8bin – **CM8** simulation, RADM2 and MADE/SORGAM – **RMS** simulation
- Parameterization: RRTMG (radition), Morrison (micro-physics), Noah LSM, Eta (surface layer), MYJ PBL, Grell-3D (convection,only in 10 km)
- Biogenic emission – MEGAN
- No dust, sea salt and wildfire emission
- Anthropogenic emission – FUME preprocesor, based on TNO (EU), REZZO (CZ), ATEM (Prague)
- Simulation with full AE – **FULL_AE**, reduced on backround level (25th percentile of space distribution)– **RED_AE** simulation
- **Episodes:** (2-day spin-up)

1. **SUM**: 1.–17. August 2015 (high ozone and PM levels, low precipitation)
2. **SUMCONV**: 3.–19. August 2017 (more rainy)
3. **WIN**: 10.–26. January 2017 (high PM levels)

- Data for validation: MODIS AOD (10+3 km)





3. Results

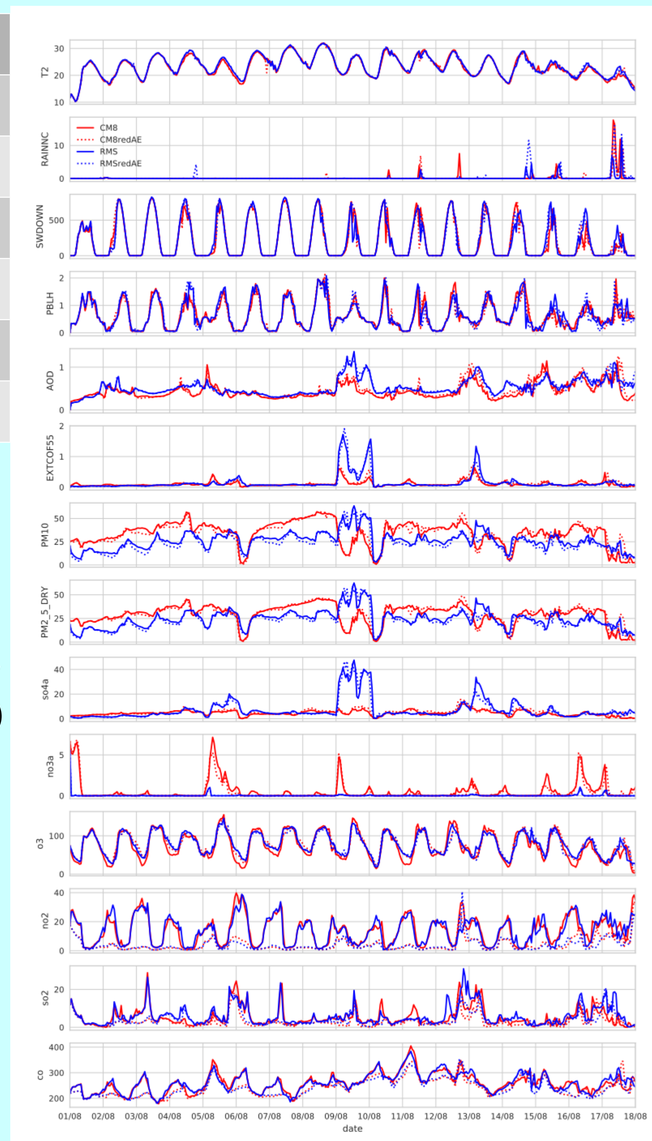
a) Validation of AOD (important in view of aerosol radiative effects)

- Correlation better in space only, values of corr. coef. lower for 2 km domain
- Problem with data availability (mainly the WIN episode and inner domain)

AOD 10 km	SUM		SUMCONV		WIN	
Time+ space	CM8	RMS	CM8	RMS	CM8	RMS
Bias	0.059	0.095	0.127	0.151	0.146	0.107
Corr. Coef..	0.42	0.45	0.44	0.33	0.33	0.33
Space	CM8	RMS	CM8	RMS	CM8	RMS
Bias	0.066	0.102	0.136	0.160	0.146	0.101
Corr. Coef.	0.59	0.67	0.35	0.45	0.23	0.51

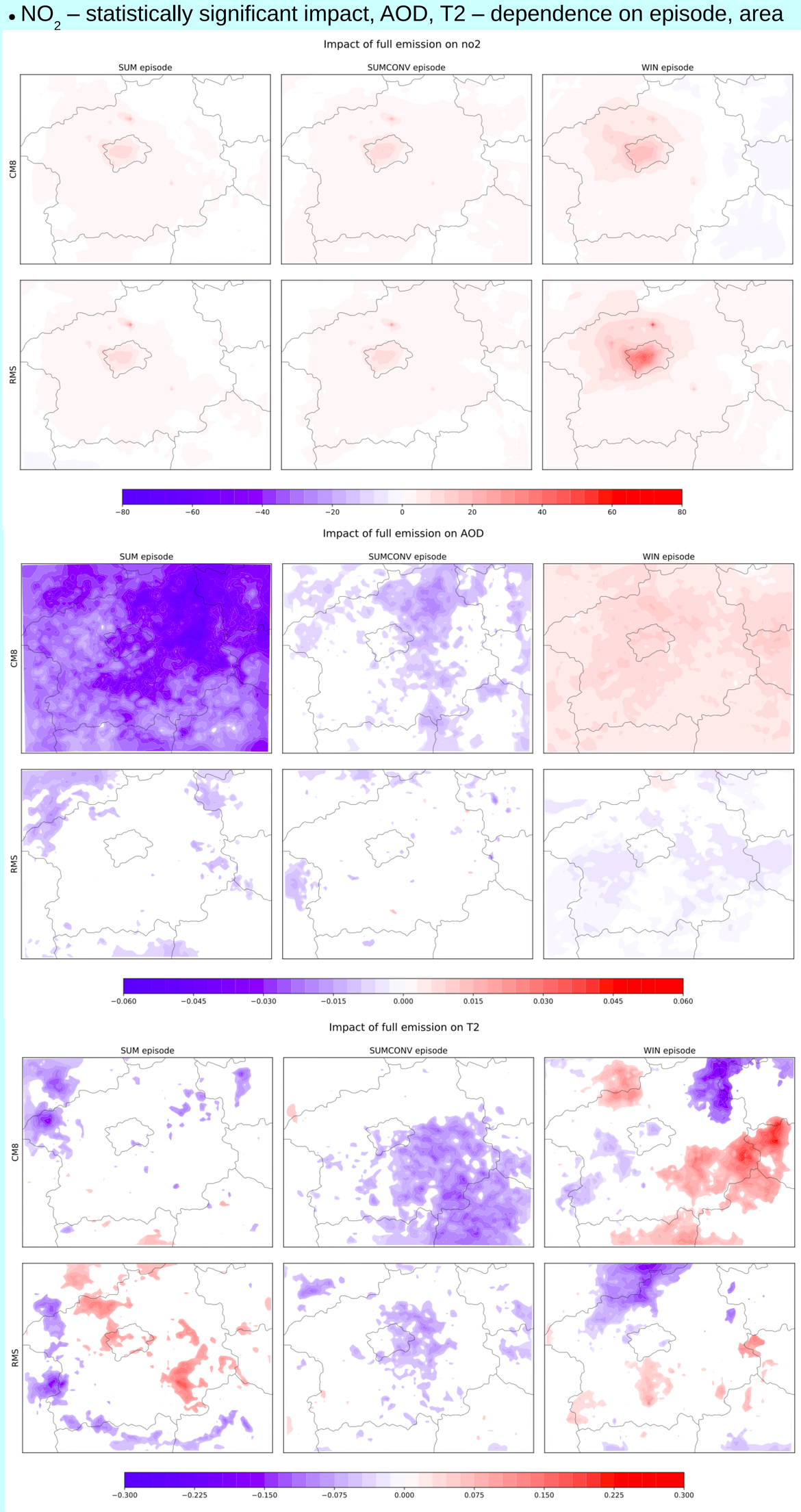
b) Impact in time series – SUM

- CM8 sim. = red line, RMS = blue
- FULL_AE = solid, RED_AE=dotted
- Impact of reduction on meteorology low (T2, RAINC, SWDOWN, PBLH)
- Impact on aerosol concentraions also low (AOD, EXTCOF55, PM10, PM25, SO_4 and NO_3 aer.)
- Impact on primary gas pollutants – positive (mostly on NO_2)
- In **SUMCONV** and **WIN** episodes – qualitatively similar



c) Spatial distribution of impact

- Red color = positive effect of full emission, white color = non-significant
- NO_2 – statistically significant impact, AOD, T2 – dependence on episode, area



4. Summary

- Impact of AE reduction clear and signifcant only on primary pollutants
- AOD modified only partly in CM8 simulation, not in RMS => impacting of meteorology also not clear
- Impact of AE reduction on rain, PBLH, SWDOWN non-significant
- Impact on 2-metre temperature – unclear
- **Impact of urban emissions seems to be not significant on meteorology in Prague urban area (in chosen episodes)**

References

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