# Influence of WRF parameterization on air quality modeling

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**Workshop on Meso and Micrometeorology,**

**03. - 04.11.2014.**

# Agenda

- Motivation
- Test case and  emission data sets
- Modeling systems
- Implementation of new scheme in WRF
- Air quality modeling

# Methodology

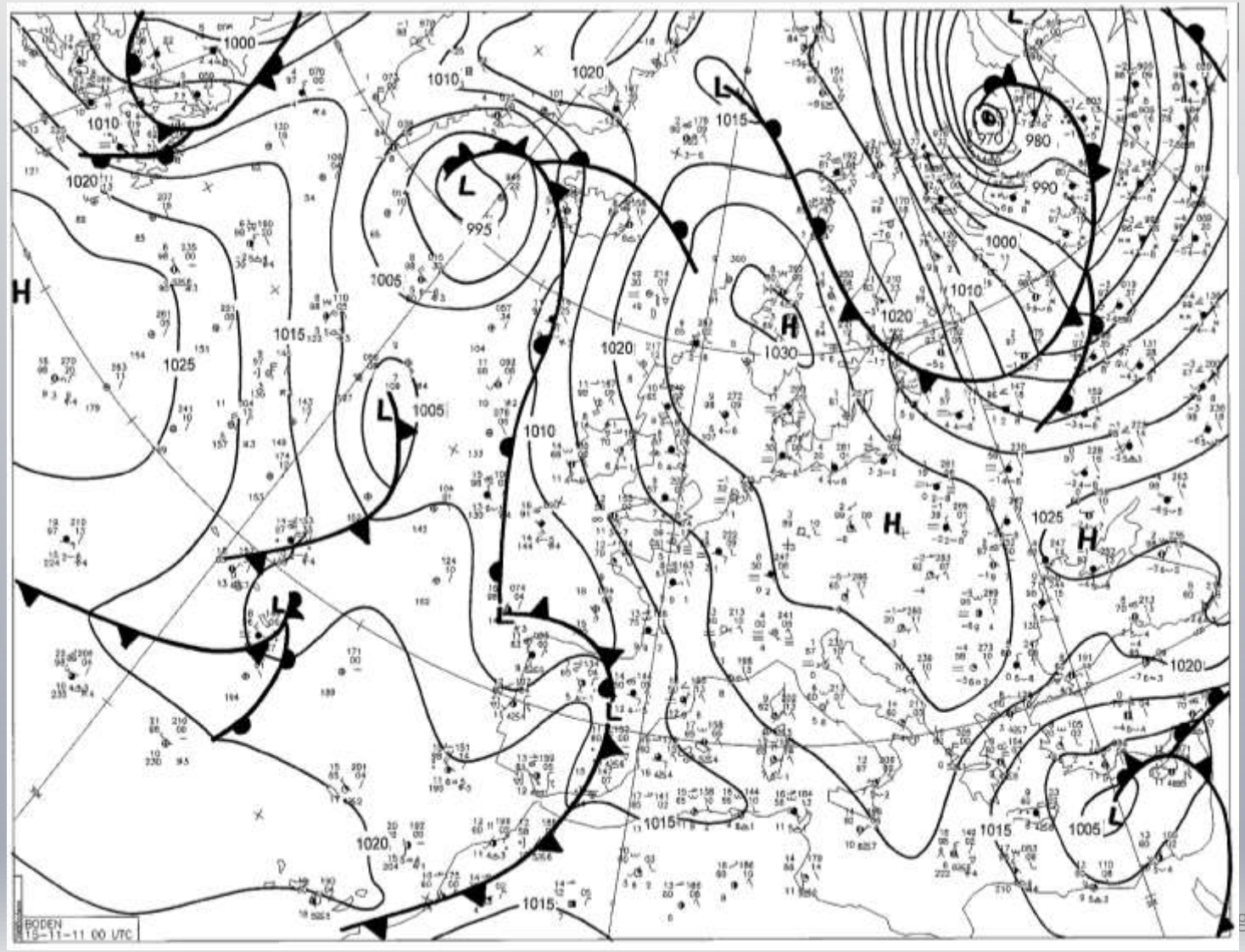
- Air quality modeling systems:
  - EMEP
  - WRF – CAMx
  - *Future works* : WRF Chem, WRF – CMAQ
- Emission data sets
  - EMEP
  - TNO-MACC
- NCEP Final GFS reanalysis
- Simulation period:

01.10.2011. – 30.11.2011. (EMEP)

11.11.2011. – 16.11.2011. (WRF – CAMx)

# Test case

15.11.2011.

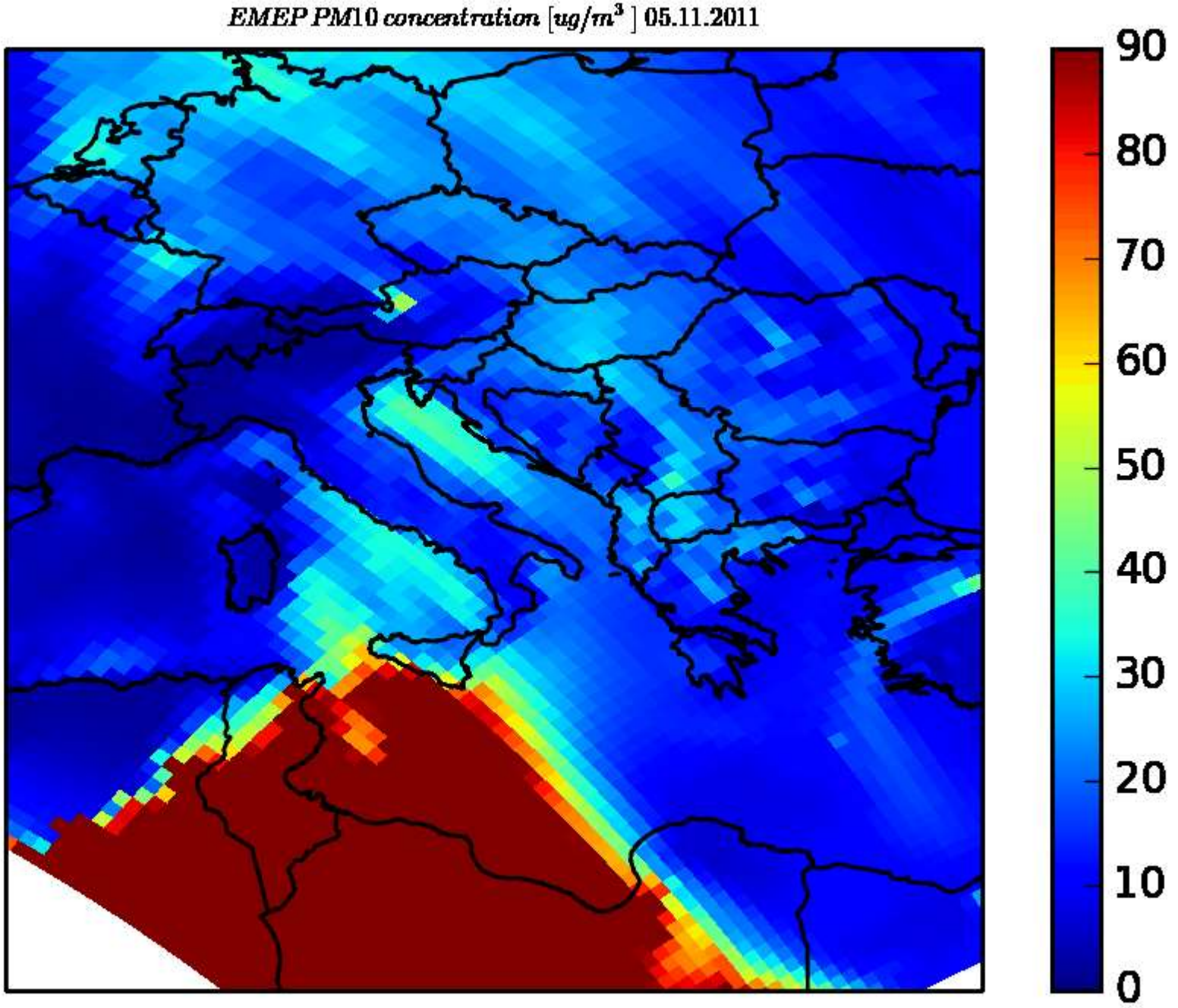


# Unified EMEP model

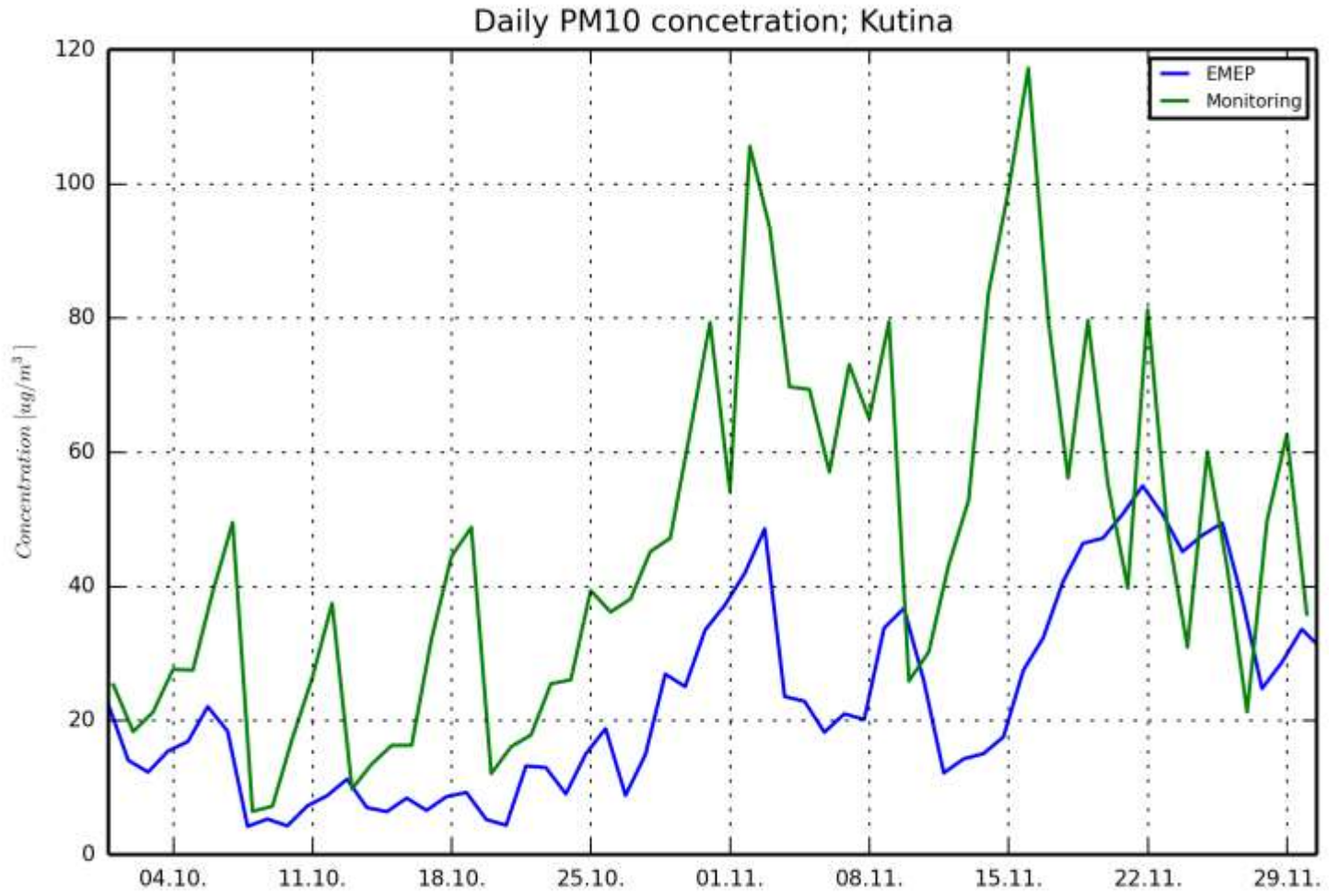
- **PARLAM-PS** meteorology data

  **HIRLAM** (High Resolution Limited Area Model) NWP model

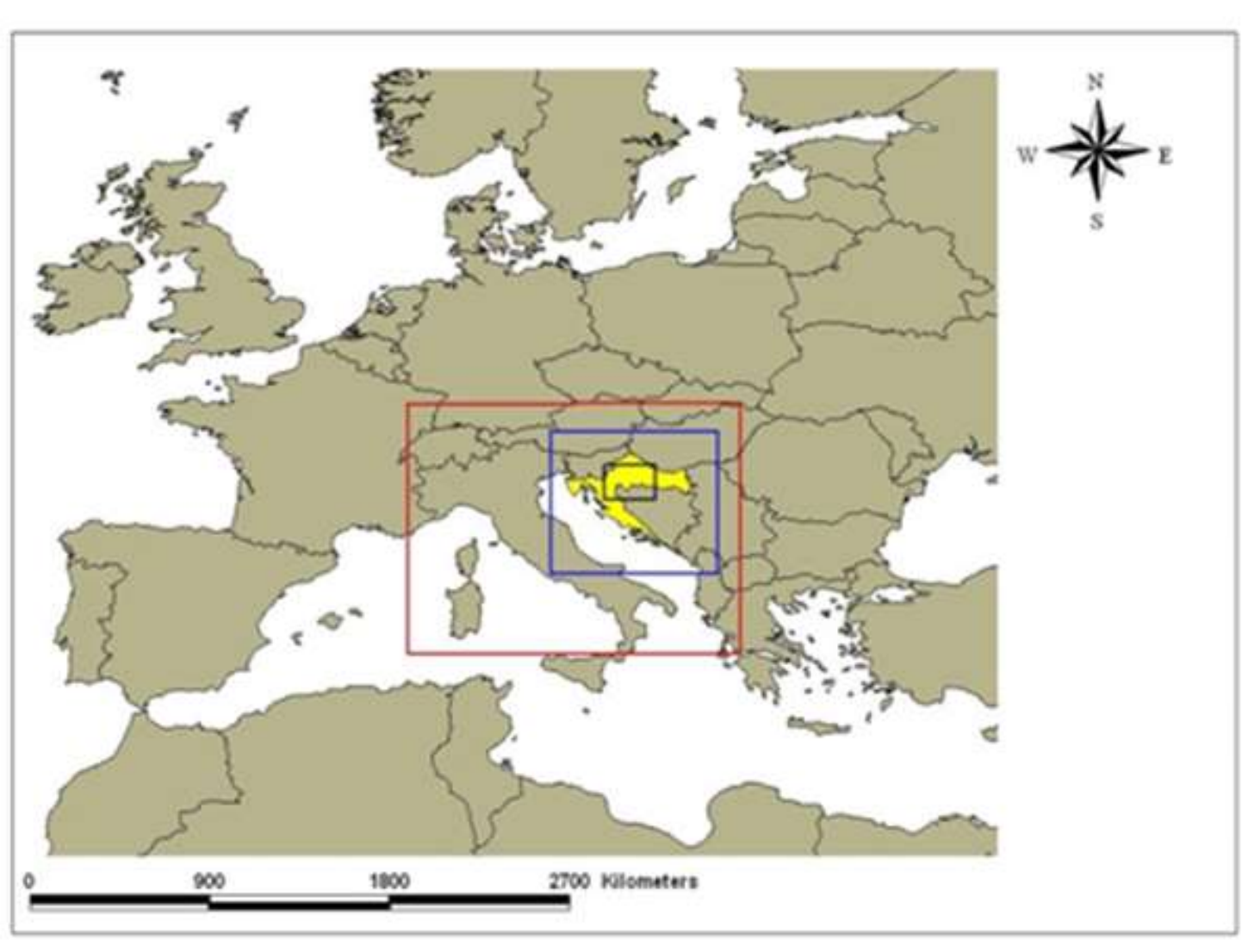
  dt = 3h; vertical levels = 20 levels
- EMISSIONS
  - Anthropogenic (aircraft, shipping, VOC, SO2, NOx, CO, PM)
  - Biogenic (calculated from landuse) – NMVOC, DMS, Lightning, Volcanoes
- Initial/boundary conditions GEOS/ANTHRO


EMEP PM10 concentration [ug/m3 ] 05.11.2011
90
80
70
60
50
40
30
20
10
0

# Unified EMEP model



# WRF model



# ABL modeling

- Turbulent/laminar $$Re = \frac{UL}{\nu}$$

- Turbulent kinetic energy $$TKE = \frac{1}{2}\left(\overline{u'^2} + \overline{v'^2} + \overline{w'^2}\right)$$

$$-\overline{w'u'} = K_M \frac{\partial \bar{u}}{\partial \bar{z}} \qquad -\overline{w'v'} = K_M \frac{\partial \bar{v}}{\partial \bar{z}} \qquad -\overline{w'\theta_v'} = K_H \frac{\partial \overline{\theta_v}}{\partial \bar{z}}$$

- *Mellor–Yamada–Janjic* scheme:

  Kinematic difusivity $$K_M = -lqS_M$$

  Thermal conductivity $$K_H = -lqS_H$$

- Mixing length (*Blackadarova eq.*) $$l = \frac{kz}{1 + \frac{kz}{lo}} \qquad lo = \alpha \frac{\int\left(|z|\sqrt{TKE}\,dz\right)}{\int \sqrt{TKE}\,dz}$$

$$l = \sqrt{\overline{\zeta'^2}}$$

# New mixing length

- Grisogono and Belušić, 2008; Grisogono, 2010;
- Valid in whole atmosphere in neutral and stable conditions

$$\Lambda = const\ \Lambda_0 f(\mathrm{R_i}, \mathrm{P_r})$$

where:

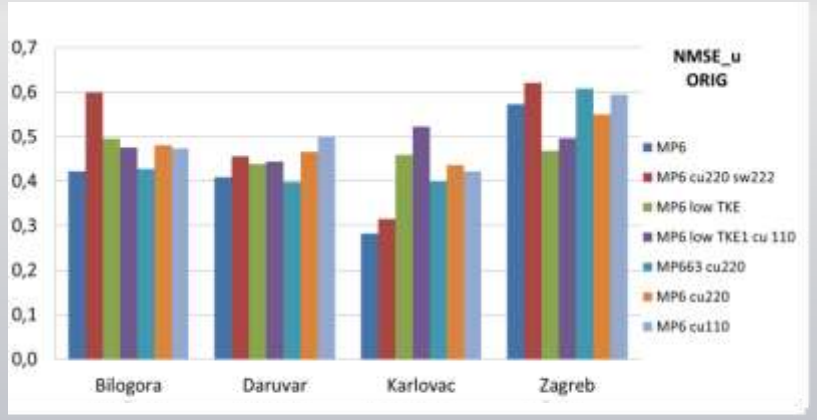
$$\Lambda_0 = \frac{\sqrt{TKE}}{|S|} \qquad const = \sqrt{\frac{b}{a}}$$

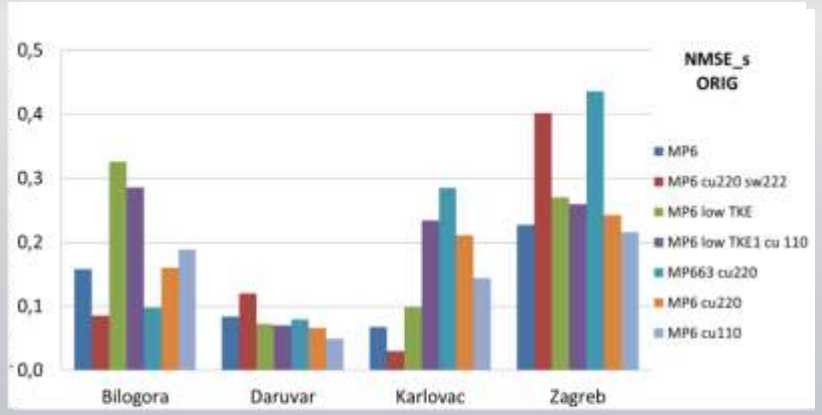
$$f(R_i, P_r) = 1 + \frac{R_i}{2P_r}$$

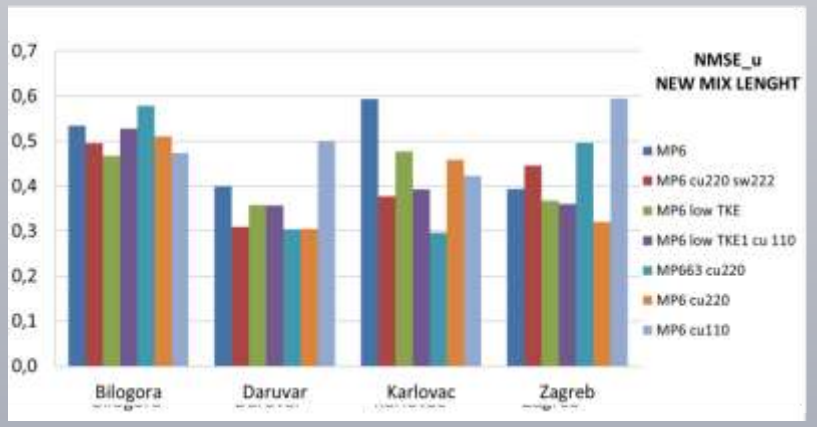
Coefficients of turbulent difusivity:

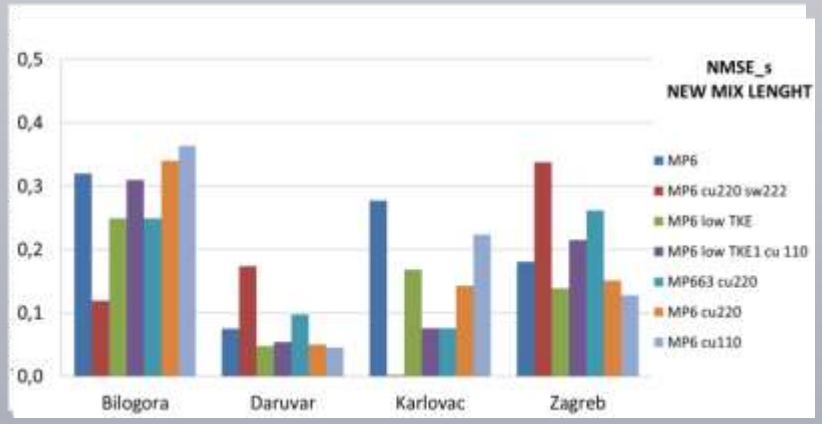
$$K_M = a\Lambda\sqrt{TKE} \qquad K_H = a\Lambda\frac{\sqrt{\mathrm{TKE}}}{\mathrm{P_r}}$$

# WRF comparison



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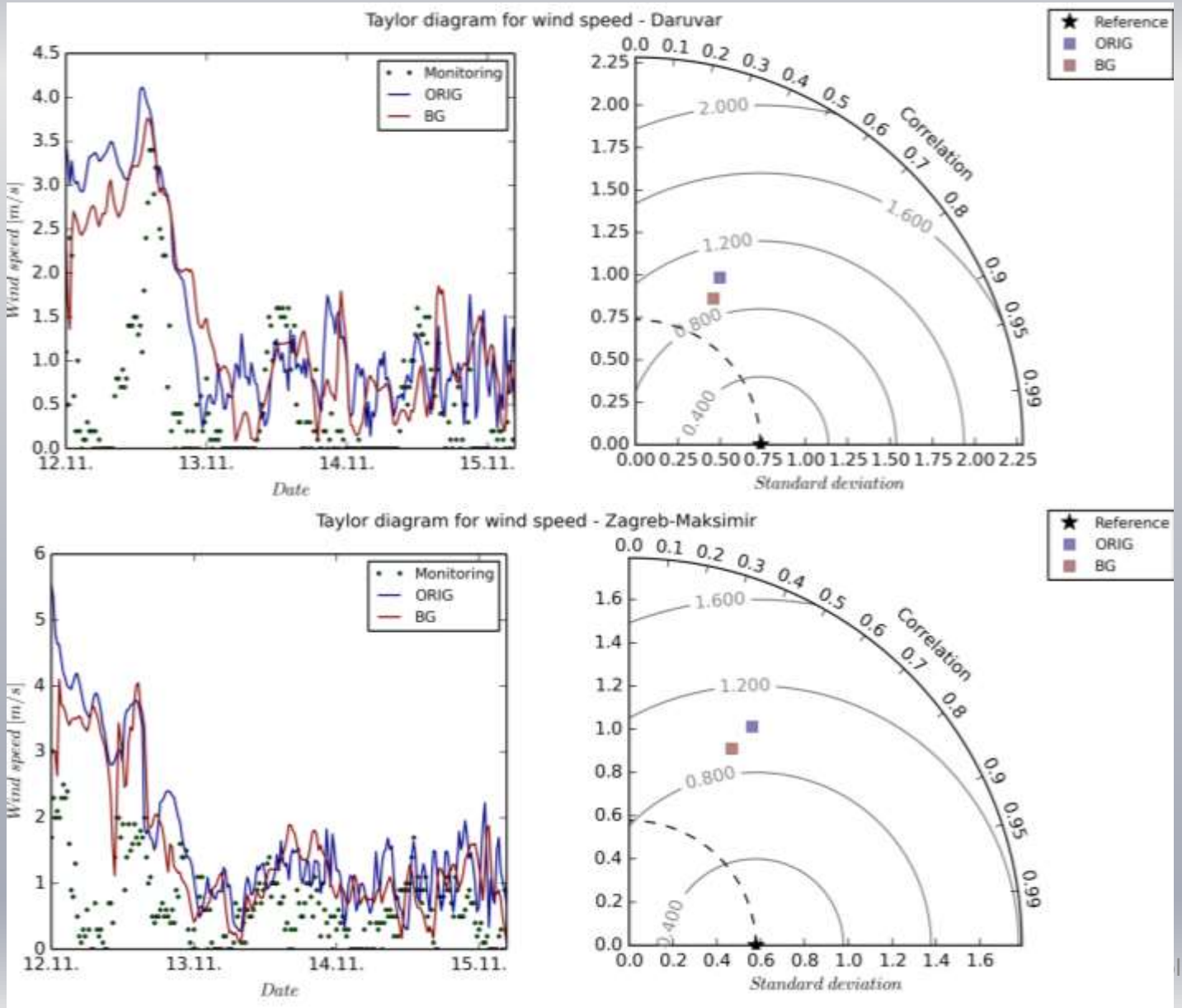
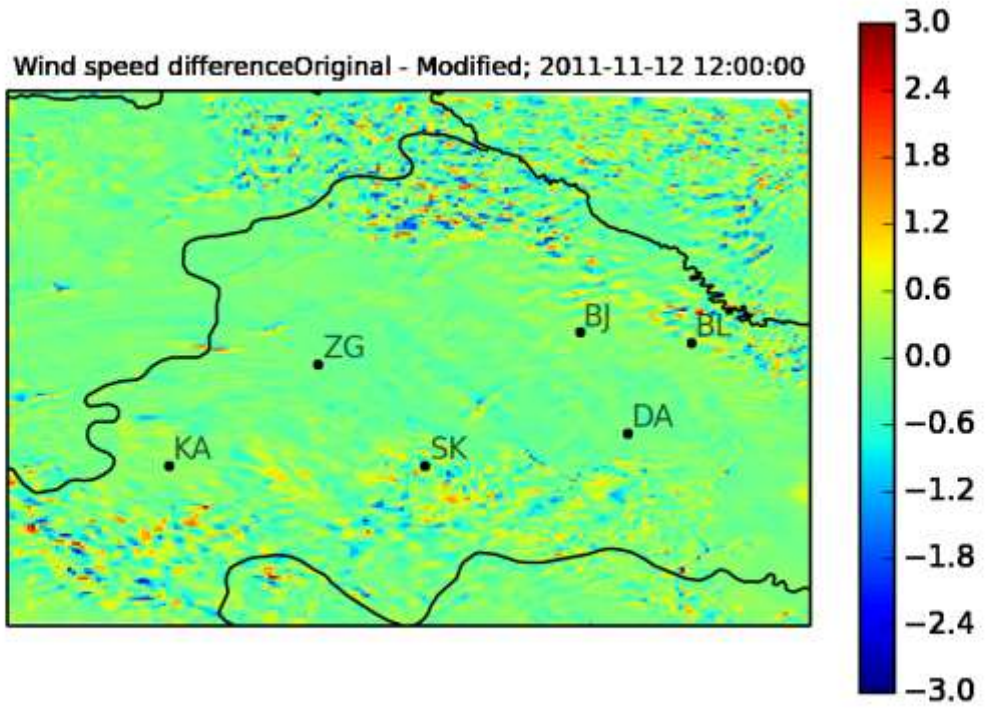
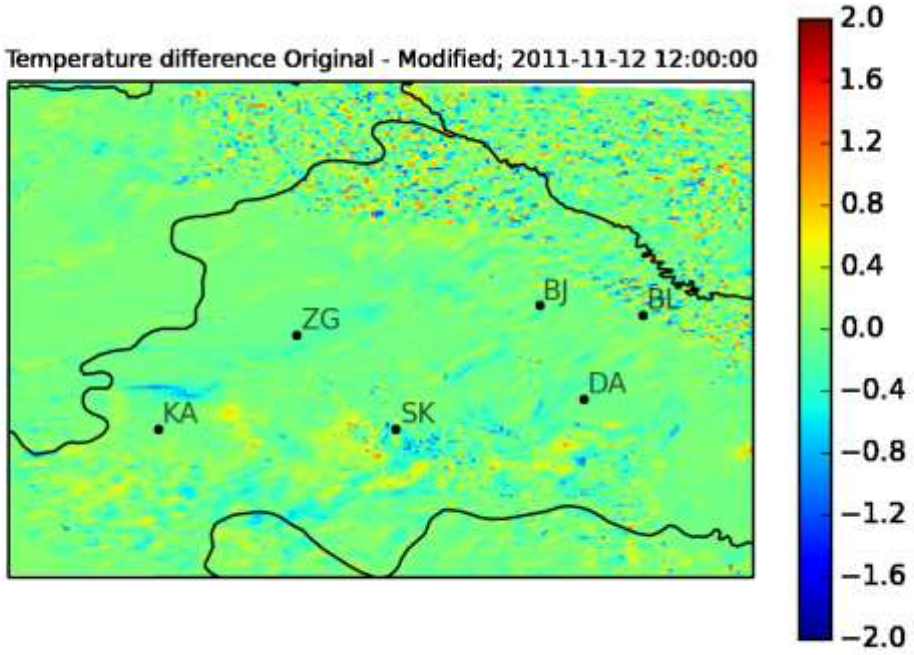


# WRF comparisc

Difference between surface fields for

- 10m wind speed
- temperature at 2m



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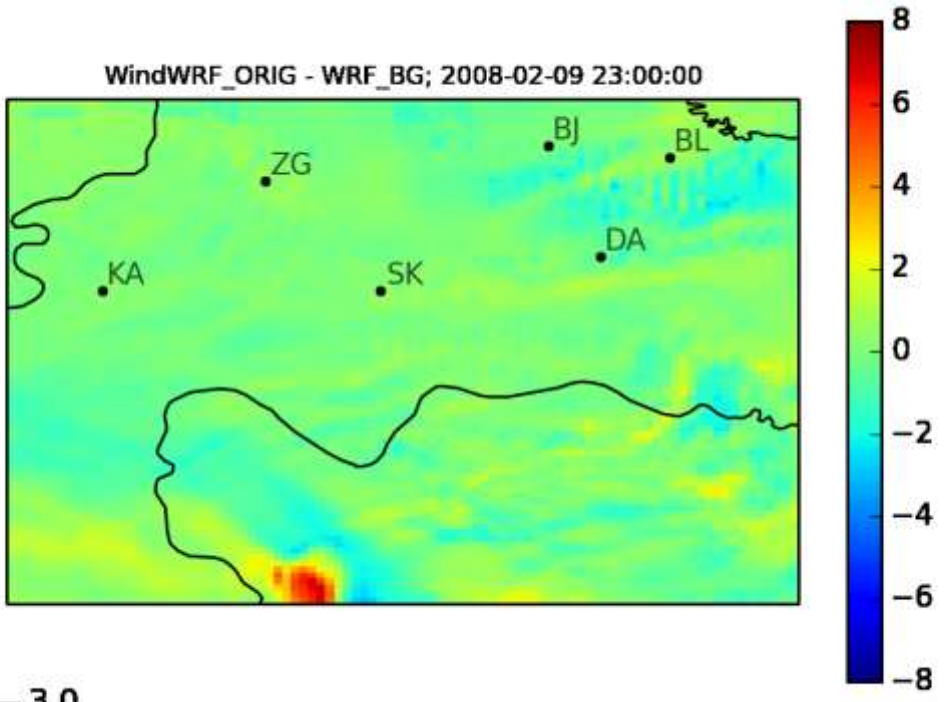
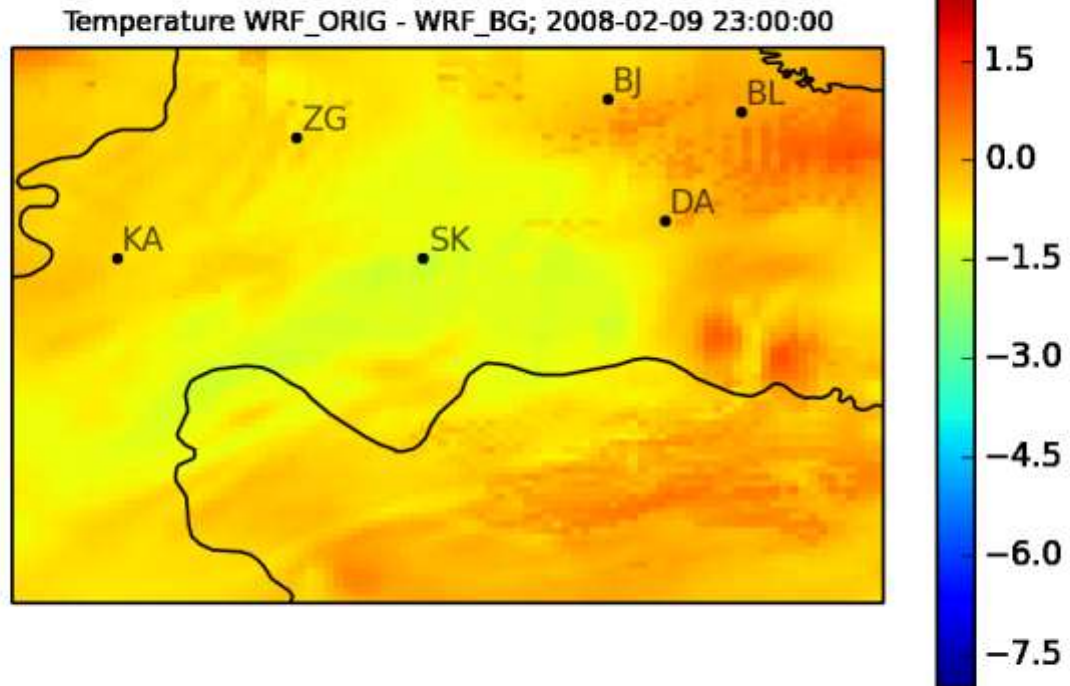
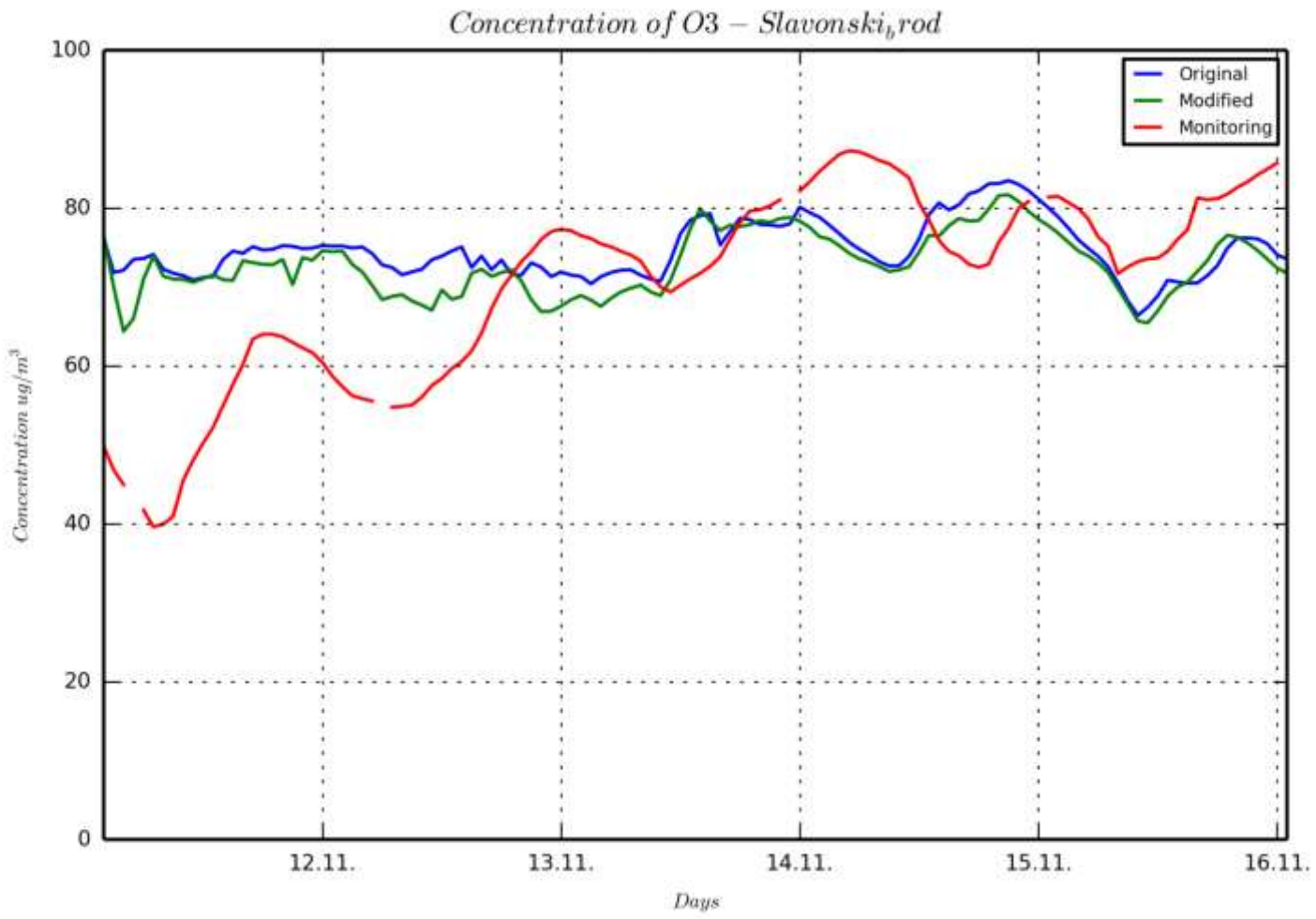


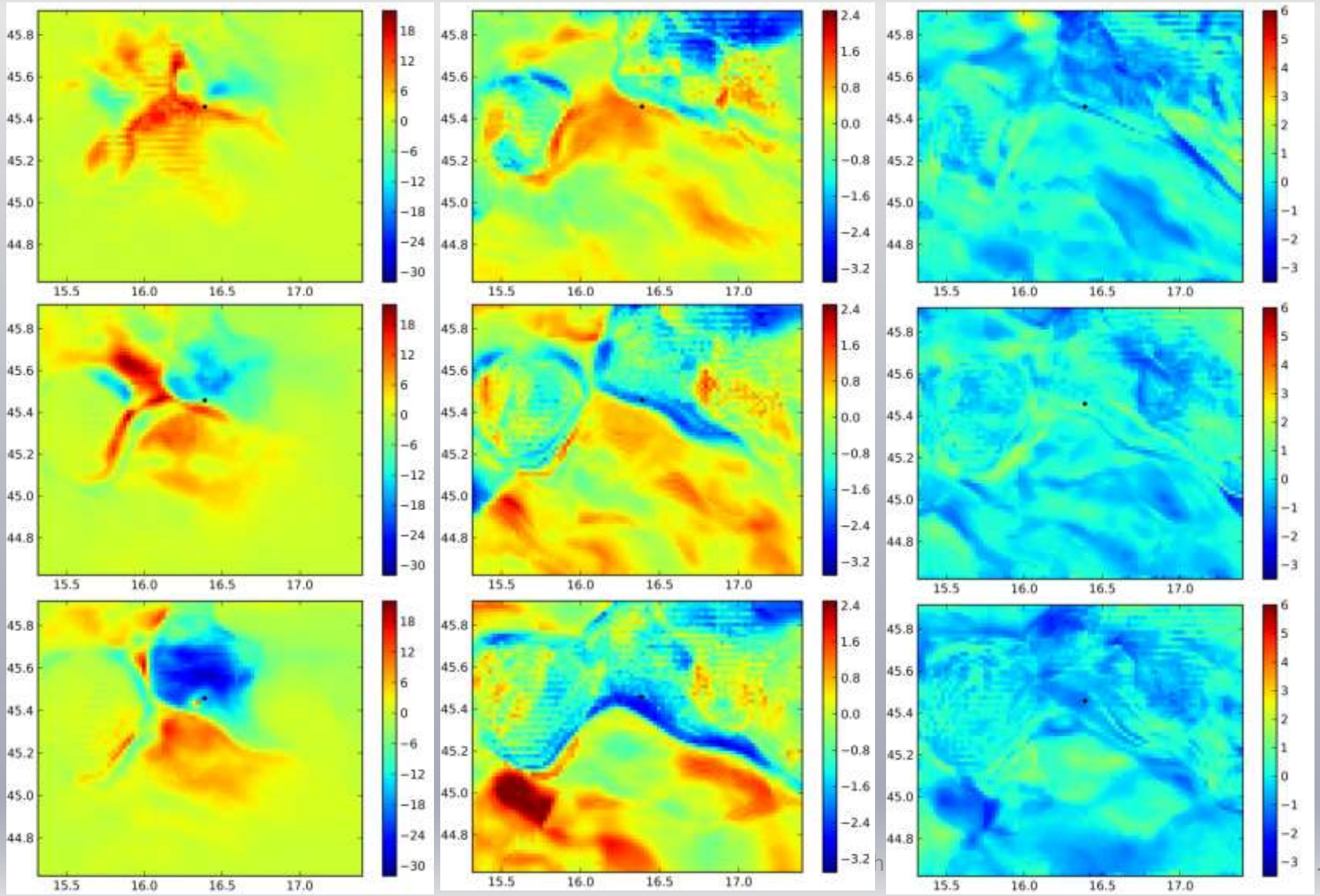
# CAMx model

*$O_3$ example*



# Difference between surface fields, WRF – Modified WRF

*$SO_2$ concentration* *Temperature at 2m* *Wind speed at 10m [m/s]*



# Summary

The WRF model performance is evaluated for 7 different parameterisation schemes.

**Problems:**

- model parameterization
- point representativity
- reproducing stable atmospheric boundary layer conditions

**New mixing length scheme**

- depend on location and time period
- no substantial differences between different parameterisation schemes
- noticeable improvement: reducing model systematic errors

**EMEP:** very good agreement with measurements

**CAMx**

- Dependence on area
- Small differences (WRF – WRF modified) in time series, but larger in surface fields
- Point representativity problem
- Insuficient emission data set

# Thank you for your attention ☺

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