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

COST Action TD1105

INTERNATIONAL WG1-WG4 MEETING on

New Sensing Technologies and Methods for Air-Pollution Monitoring

European Environment Agency - EEA

Copenhagen, Denmark, 3 - 4 October 2013

Action Start date: 01/07/2012 - Action End date: 30/06/2016 - Year 2: 2013-2014 (*Ongoing Action*)

AIR QUALITY MODELLING IN SLOVENIA: FORECASTING AIR POLLUTION AT REGIONAL AND LOCAL SCALE

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SPACE-SI
SLOVENIAN CENTRE OF EXCELLENCE FOR SPACE SCIENCES AND TECHNOLOGIES

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Background

Why models?

- complete spatial coverage of air quality (limited spatial coverage of monitoring)
- can be applied prognostically
- provide improved uderstanding of the sources, causess and process

Model limitations

- require extensive input data
- due to many uncertainties extensive validations needed
- remain a representation of reality

Current activities

Air quality modelling within meteorology group at University of Ljubljana, Slovenia:

- **Investigating dynamics of air pollution episodes (together with evaluations, verifications of AQ models)**
- **Studying feedback effects of aerosols on meteorology (AQMEII initiative, WRF/Chem model)**
- **AQ forecasting (WRF/Chem, ALADIN/CAMx, statistical ozone model)**

Involved in EuNetAir COST Action as member of WG3 (Environmental measurements and air pollution modelling)

WRF/Chem forecast

- Weather Research and Forecast (WRF) model **online coupled** with chemistry (WRF/Chem)
- Experimental operational AQ forecast at UL (**started in spring 2013**)

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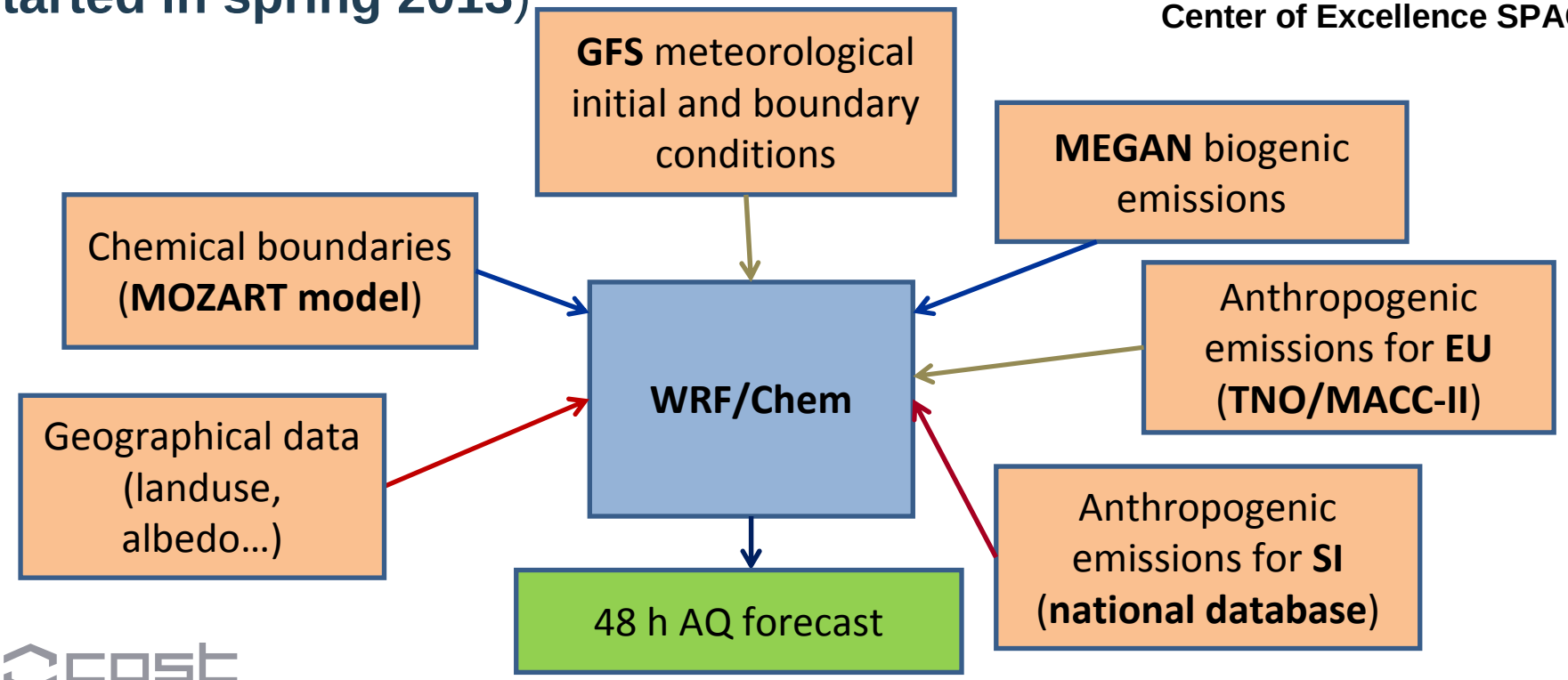
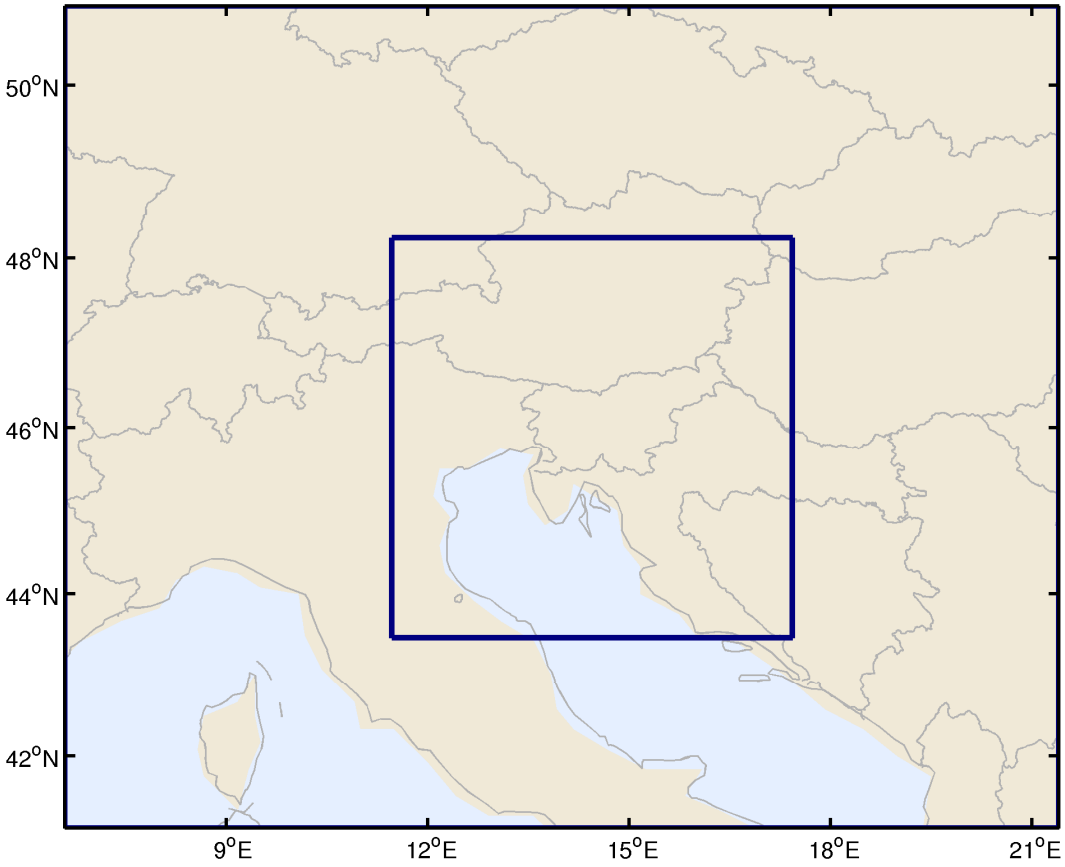


WRF/Chem forecast

- Model version 3.4.1
- Two nested domains, horizontal grid spacing (grid points) 11.12 km (151x100) and 3.7 km (181x145)
- 42 vertical model levels
- Integration once per day: 00 UTC
- Integration time 48h
- Aerosol direct effect included
- Parameterization schemes:

  Morrison microphysics,
  RADM2-MADE/SORGAM,
  YSU PBL, RRTMG radiation,
  Noah LSM, G3 cumulus,
  Fast-J photolysis…

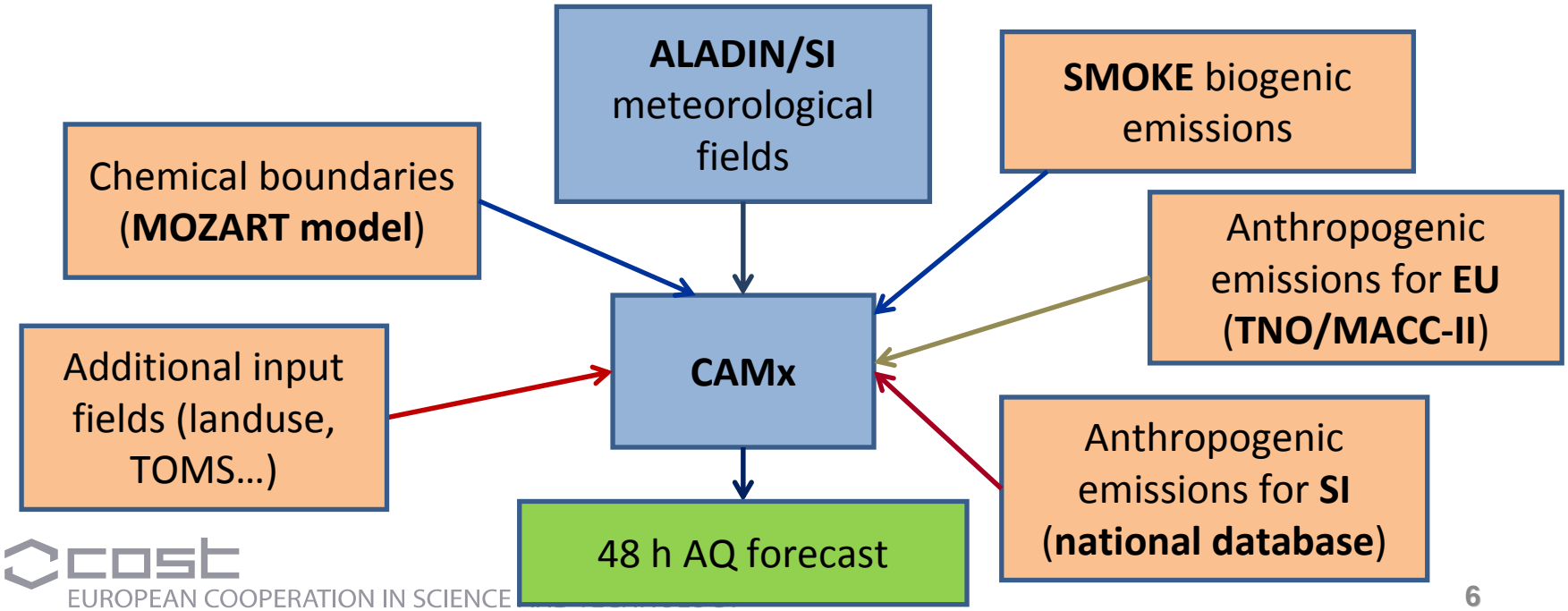


Available : http://meteo.fmf.uni-lj.si/onesnazenje

ALADIN/CAMx forecast

- **Off-line coupled** meteorological (ALADIN) and chemical transport model (CAMx)
- Running (almost operationally) at Environmental Agency of Slovenia

Environmental Agency of Slovenia



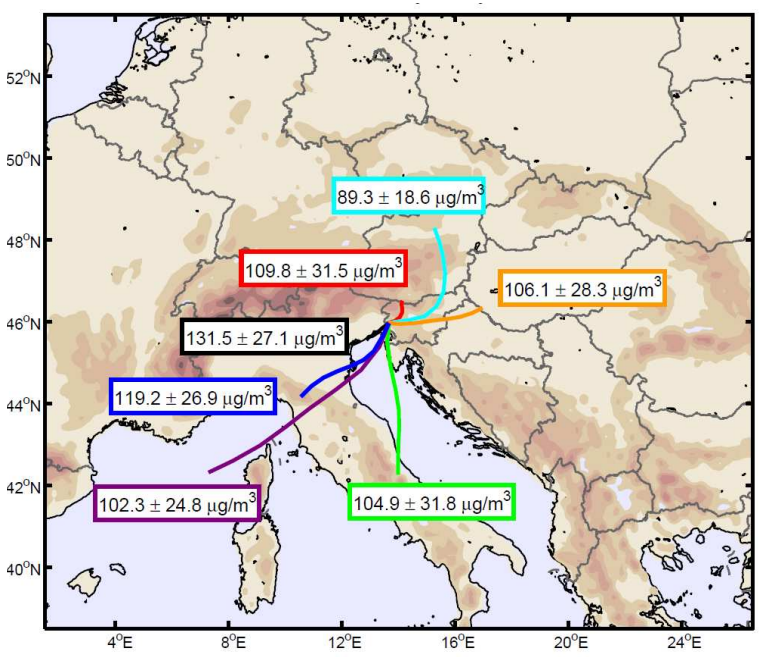
Statistical ozone forecast

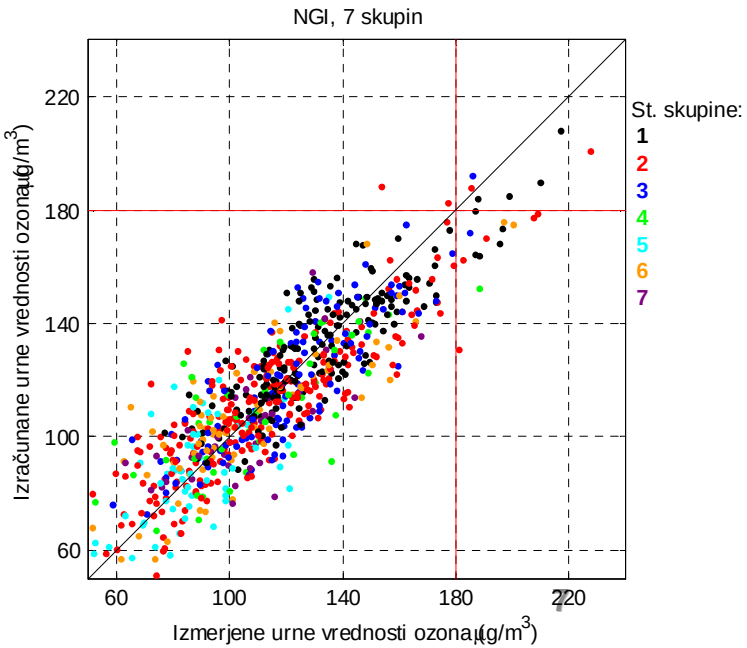
- 2-day **ozone daily maximum** forecast at Slovenian Environment Agency for **8 measuring sites**
- **Regression type model**: meteorological and air quality **measurements** (yesterday, today early morning), **ECMWF forecast for meteorological variables** and **trajectories** at 925 and 850 hPa
- Important feature: O_3 prediction depends on predicted trajectory cluster (k-means clustering)

Example:
Nova Gorica

Left:
Ozone statistics for trajectory clusters

Right:
measured / forecasted ozone daily maximum

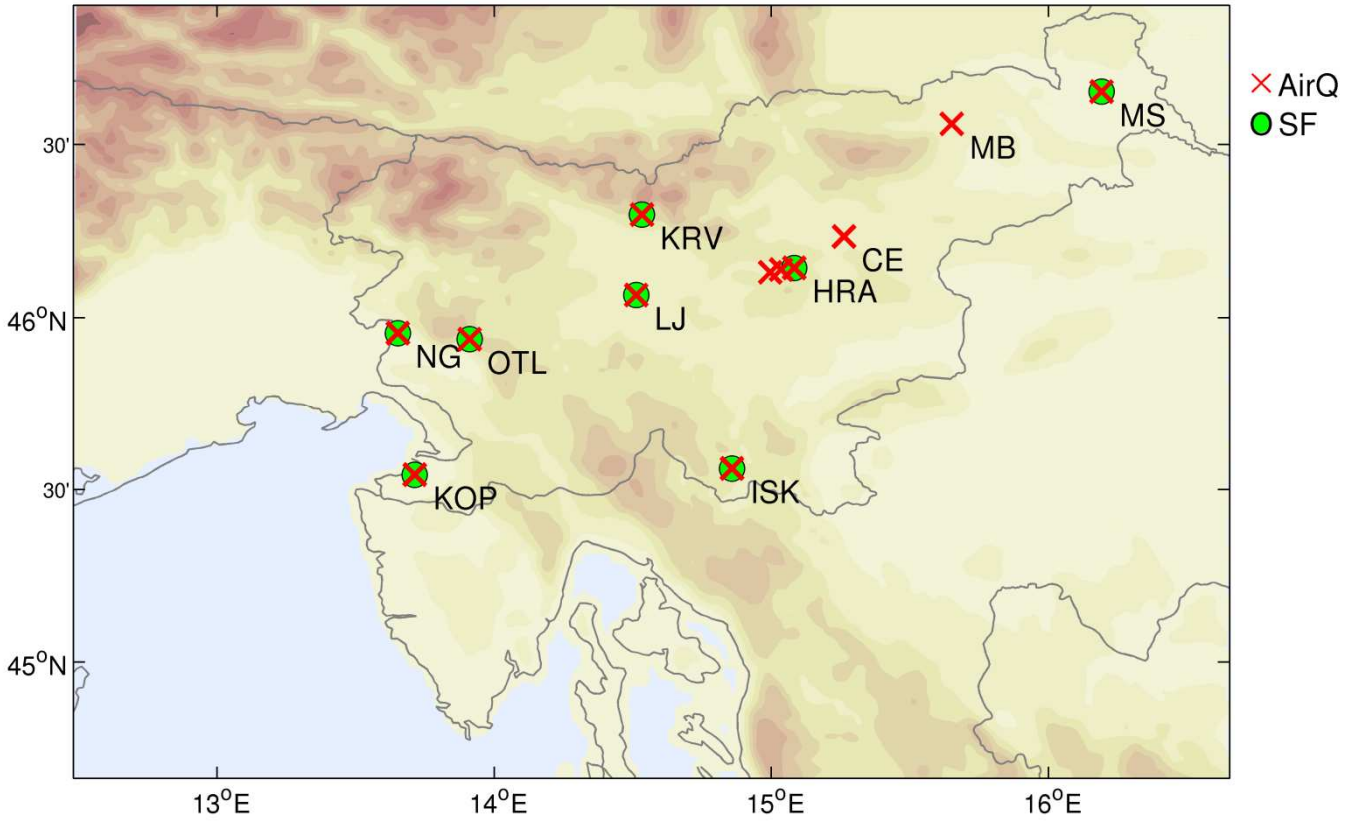




Verification of model predictions

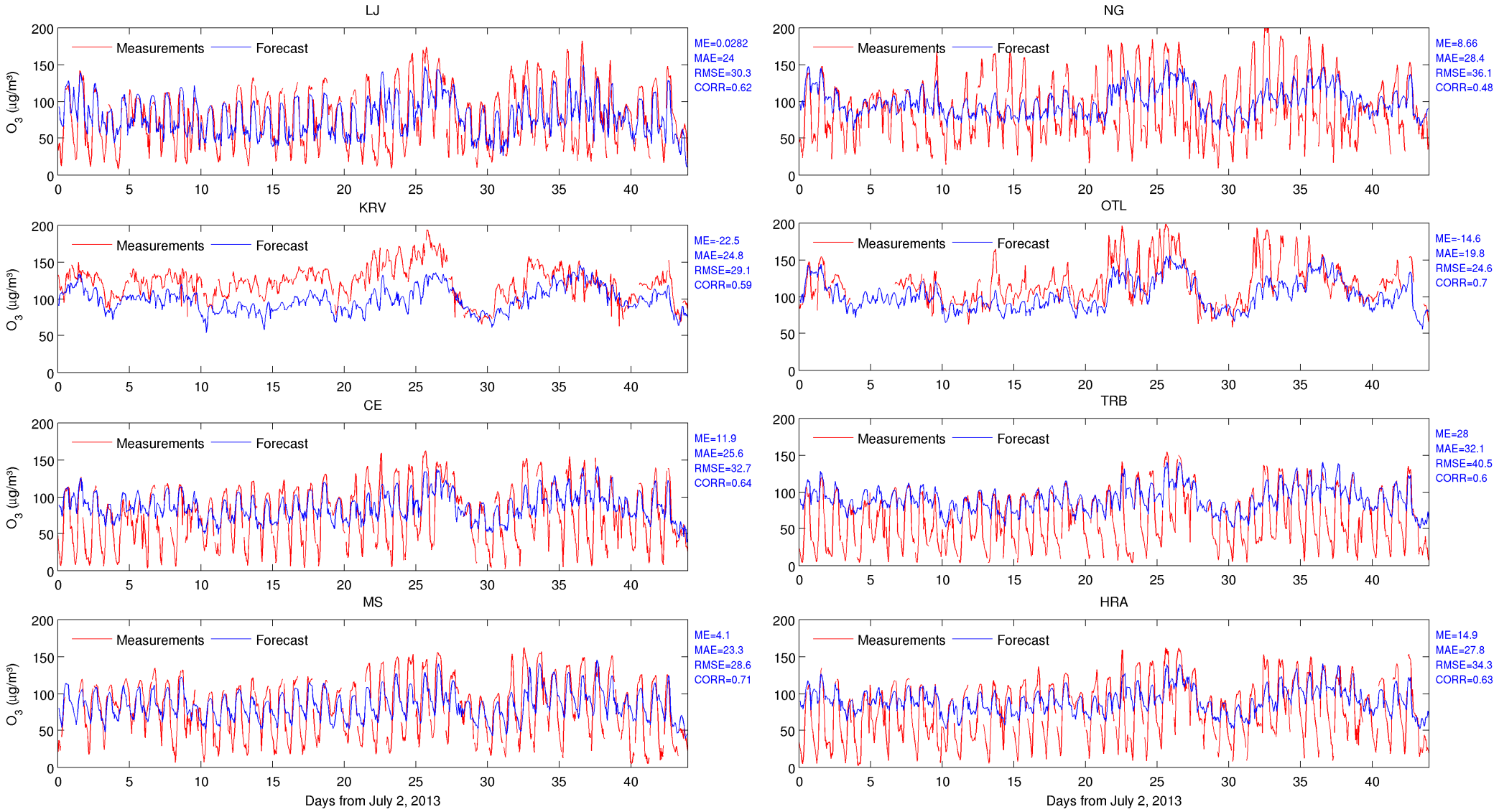
- July & August 2013 - focused especialy on O_3
- Measurements from 12 monitoring stations (**AirQ**; national network) for WRF/Chem forecast (O_3, PM10, SO_2, CO, NOx, NO_2)
- For 8 monitoring stations statistical ozone daily maximum forecast (**SF**)

KOP – urban, background
NG – urban, background
OTL – rural ,background
LJ – urban, background
ISK – rural, background
KRV – rural, background
HRA – urban, background
TRB – suburban, background
CE – urban, background
MB – urban, traffic
MS – rural, background



ozone (hourly values) - July&August 2013

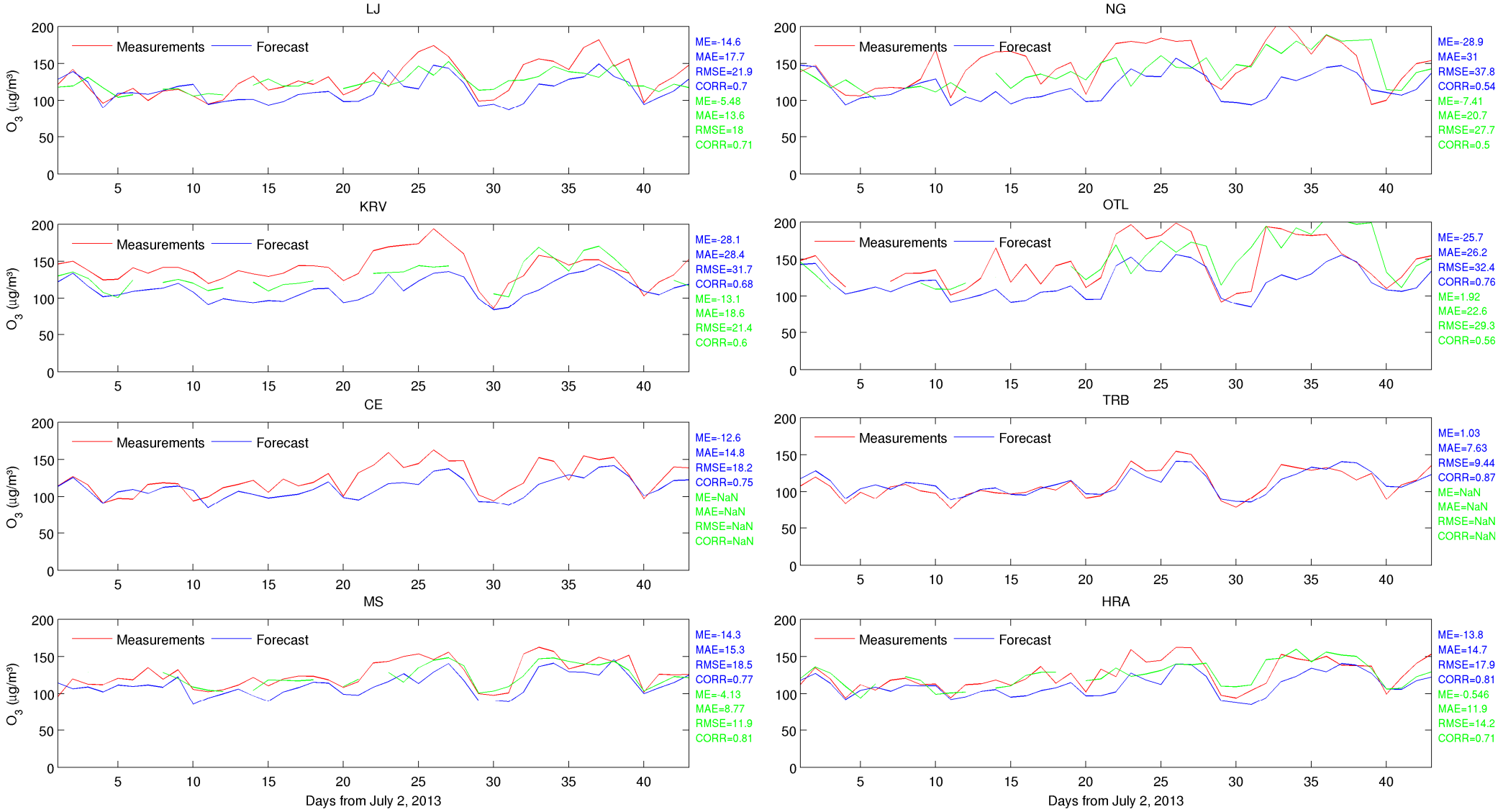
WRF/Chem: ME: -22 to 28 µg/m³; RMSE: 24 to 40 µg/m³; CORR: 0.48 to 0.71



ozone (daily maxima) - July&August 2013

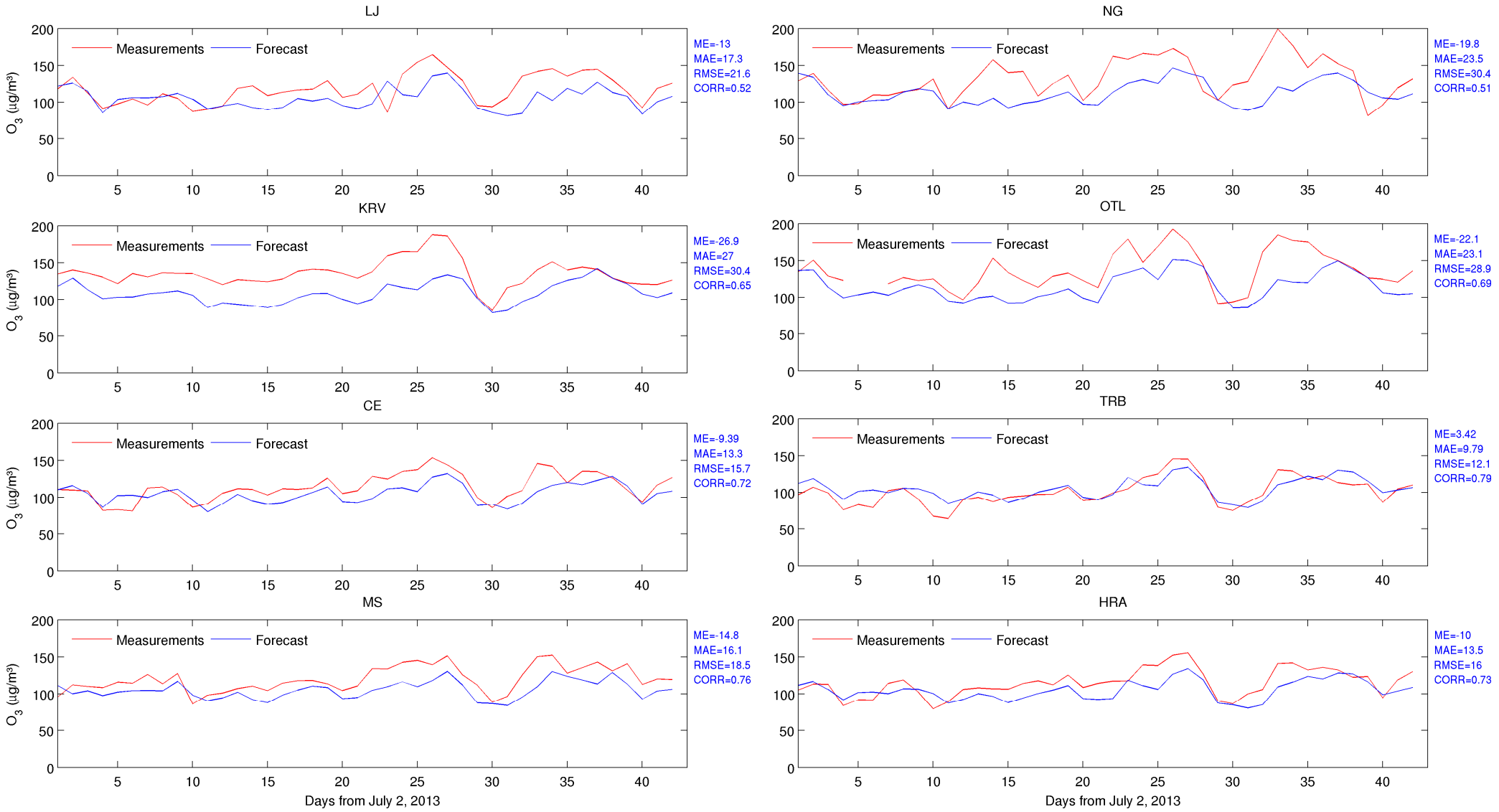
WRF/Chem: ME: -28 to 1µg/m³; RMSE: 9 to 37 µg/m³; CORR: 0.54 to 0.87

Statistical model: ME: -13 to 2 µg/m³; RMSE: 12 to 29 µg/m³; CORR: 0.5 to 0.81



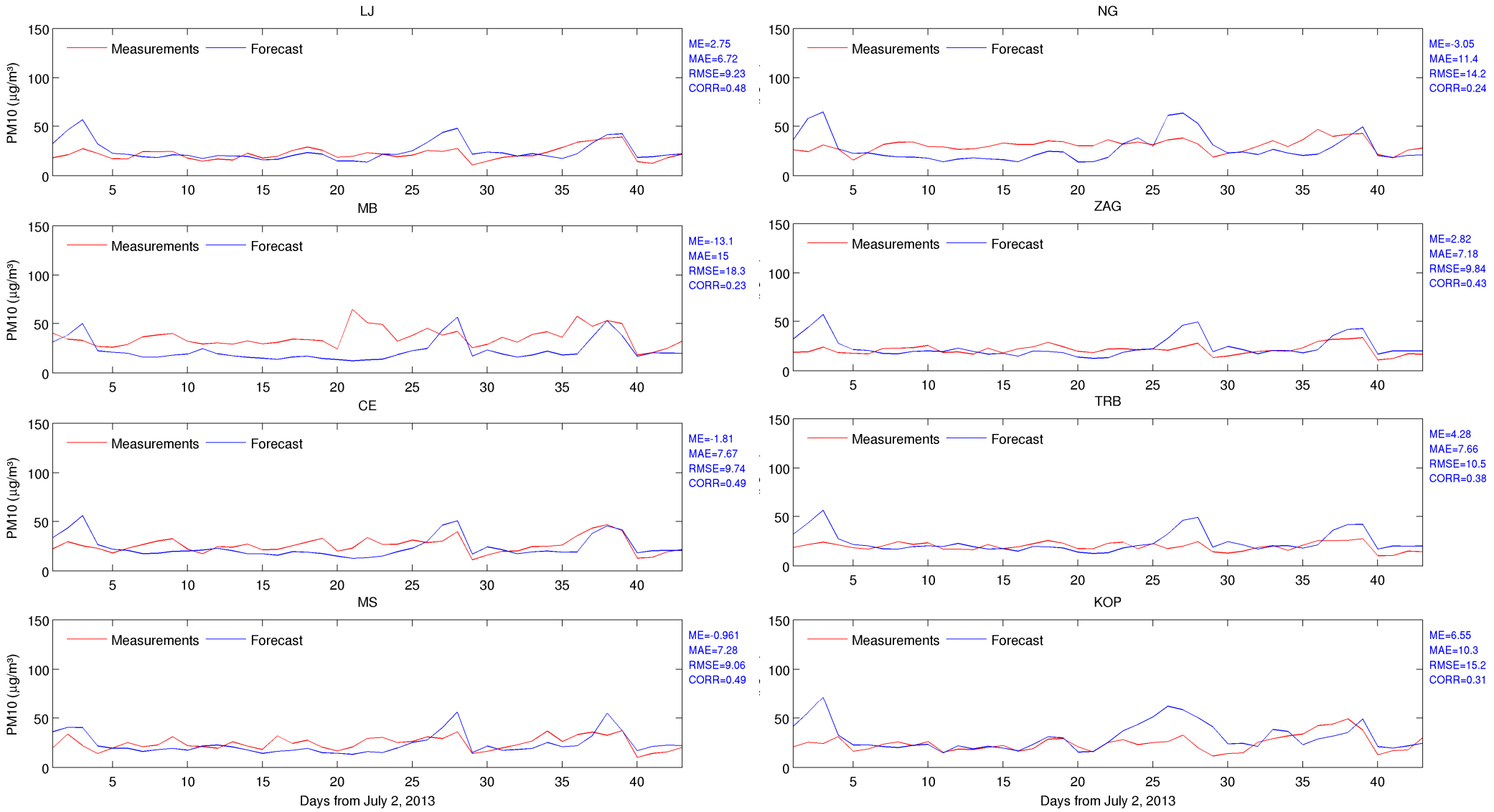
ozone (8h maxima) - July&August 2013

WRF/Chem: ME: -26 to 3 µg/m³; RMSE: 12 to 30 µg/m³; CORR: 0.51 to 0.79



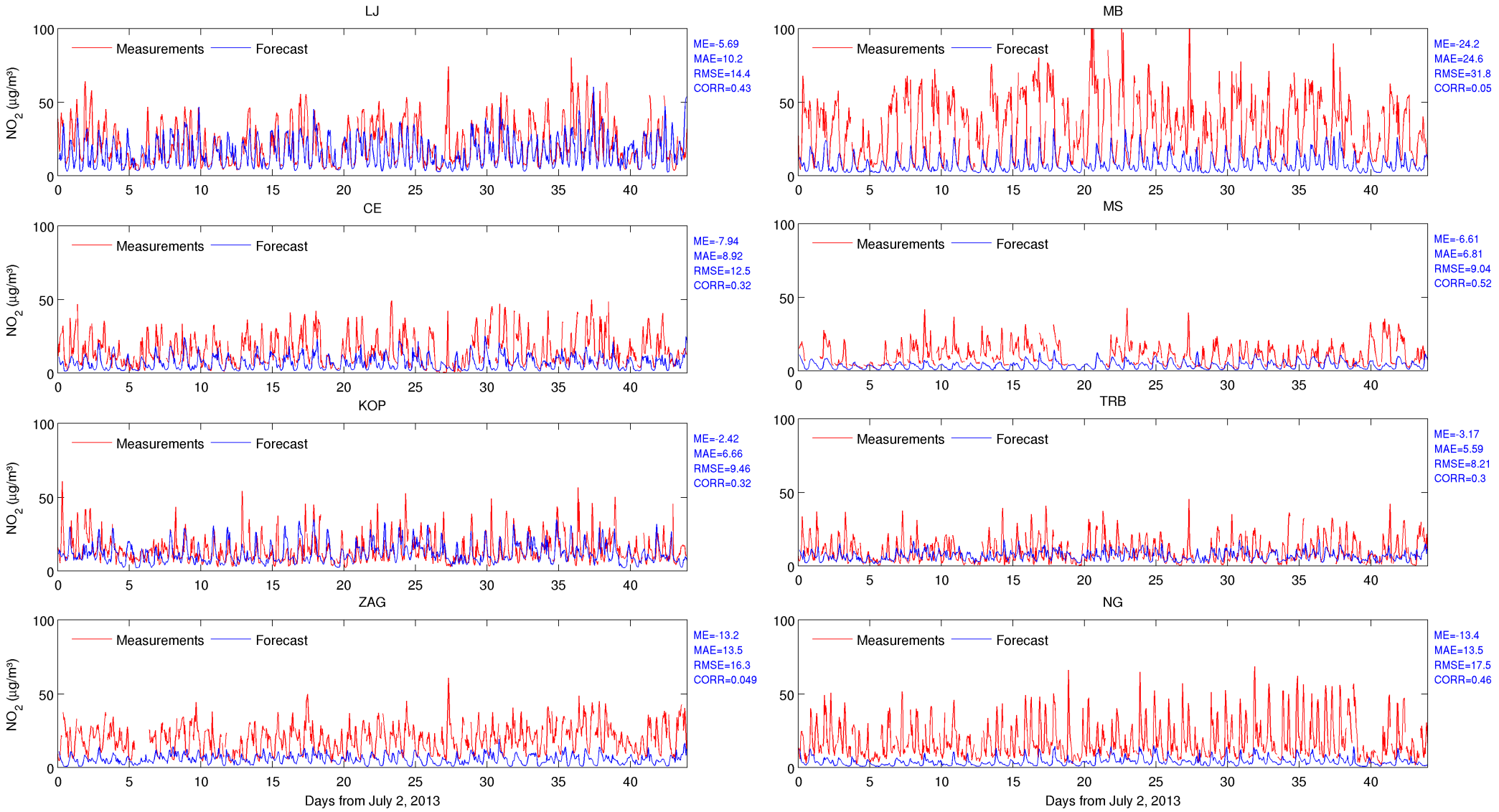
PM10 (daily values)- July&August 2013

WRF/Chem: ME: -3 (-13) to 6 µg/m³; RMSE: 9 to 18 µg/m³; CORR: 0.23 to 0.49



NO2 (hourly values) - July&August 2013

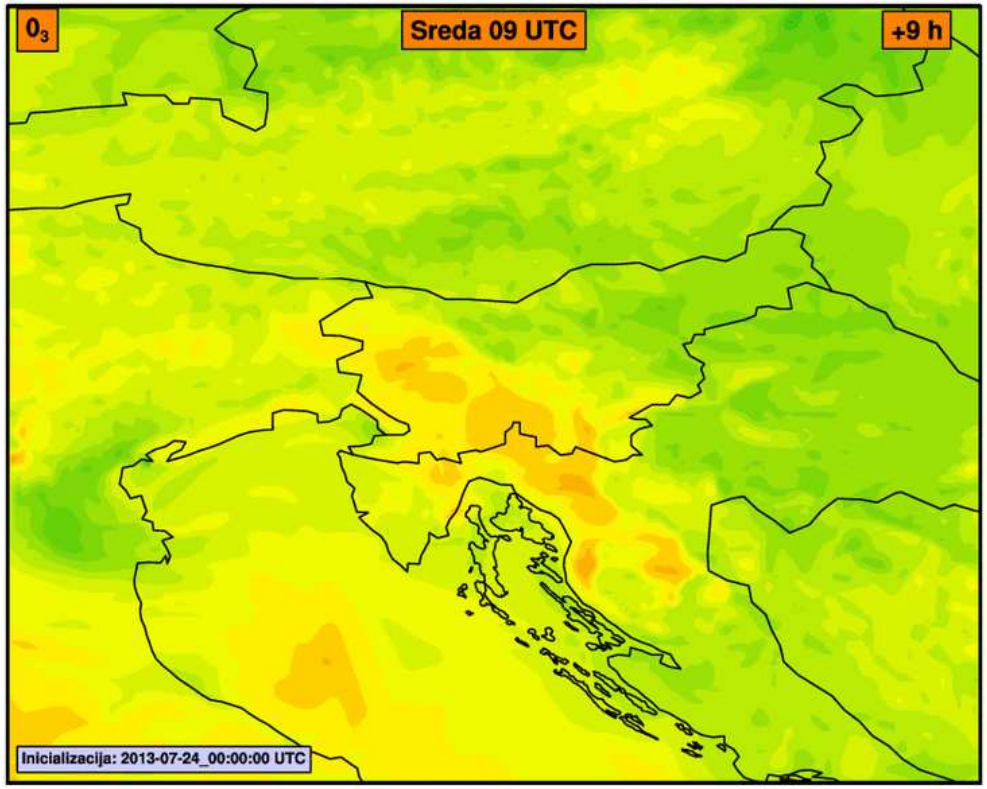
WRF/Chem: ME: -24 to 6 µg/m³; MAE: 5 to 24 µg/m³; RMSE: 8 to 31 µg/m³

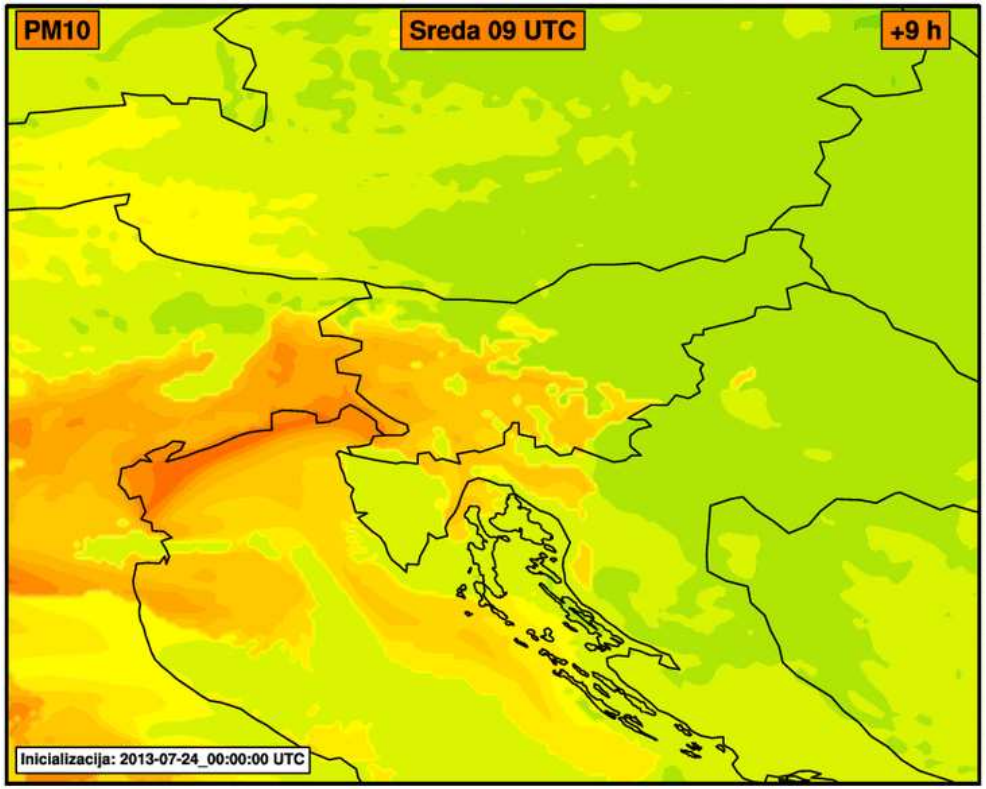


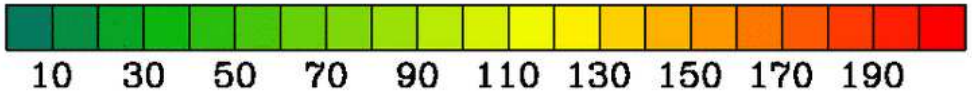
Air pollution above the sea

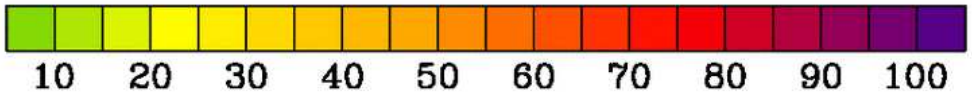
Example of 48h forecast for July 24, 2013

Measurements needed to verify model results above the sea









Future plans

- Further model evaluations and verification with additional measurements (spatial, temporal, also stations from neighbouring contries…)
- Comparison of WRF/Chem forecast with ALADIN/CAMx results
- Studying the impact that have aerosol feedbacks in coupled model approach on meteorological and AQ forecast (PM concentrations not underestimated as in other studies)
- Consider possibilities for (off-line) assimilation of measurements to improve AQ forecast…

Summary of the results and the conclusion

- WRF/Chem AQ forecast succesfully implemented
- Generally good (qualitative) agreement between model and measurements
- Model (quantitative) performance depends on pollutant and station representativness, location…
- O_3: simulated maxima/minima underestimated/overestimated, bias corrections needed for most (not all) stations, WRF/Chem forecast competitive to statistical model
- PM10, PM2.5: concentrations almost without bias (!), exception MB urban traffic station
- To improve model predictions of hourly values (and high pollution episodes) necessary to combine model results with measurements

Summary of the results and the conclusion

- High O_3 levels above the sea explain higher measured O_3 at Mediterranean station in Slovenia
- Are high PM concentrations above Adriatic realistic, or model artifact?
- Measurements (AQ, but also meteorological) needed to verify model results above the sea

Thank you!

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