

PMinter

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Modelling air pollution episodes in Slovenia



Rahela Žabkar, Luka Honzak, Marko Rus

Univerza v Ljubljani

Fakulteta za *matematiko in fiziko*



University of Ljubljana,
Center of Excellence SPACE-SI



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AND TECHNOLOGY



LAND KÄRNTEN





Outline

- 1) Short overview of two Air Quality (AQ) modelling systems (WRF/Chem and ALADIN/CAMx)
- 2) Towards AQ forecasting
- 3) Understanding air pollution (O_3 and PM10) episodes with the help of AQ modelling
- 4) Model evaluations





Air Quality modelling



Meteorology



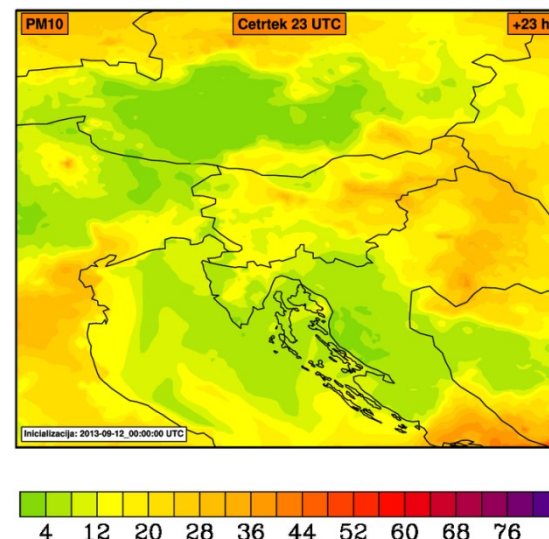
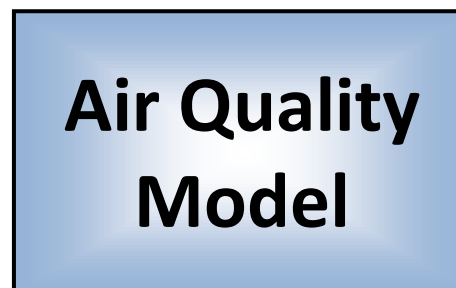
Emissions



Geographical data



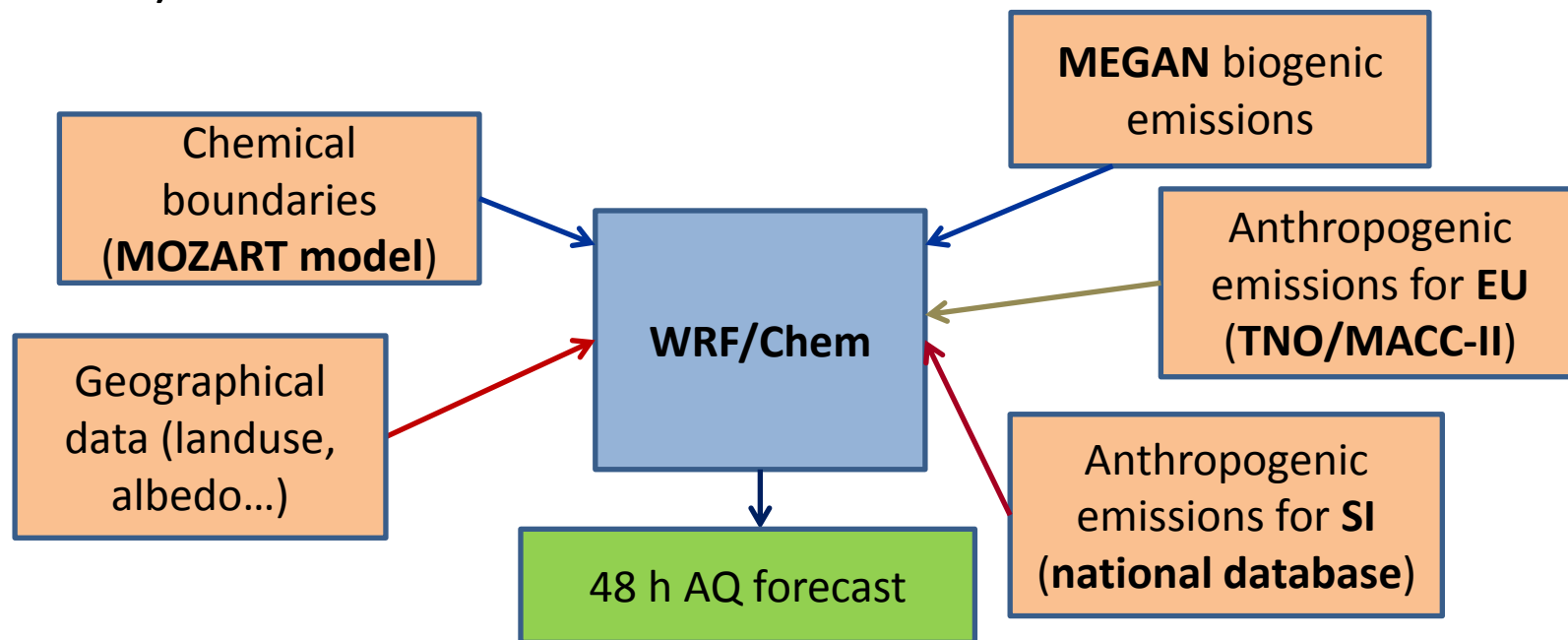
Atmospheric composition



Air pollutant concentrations

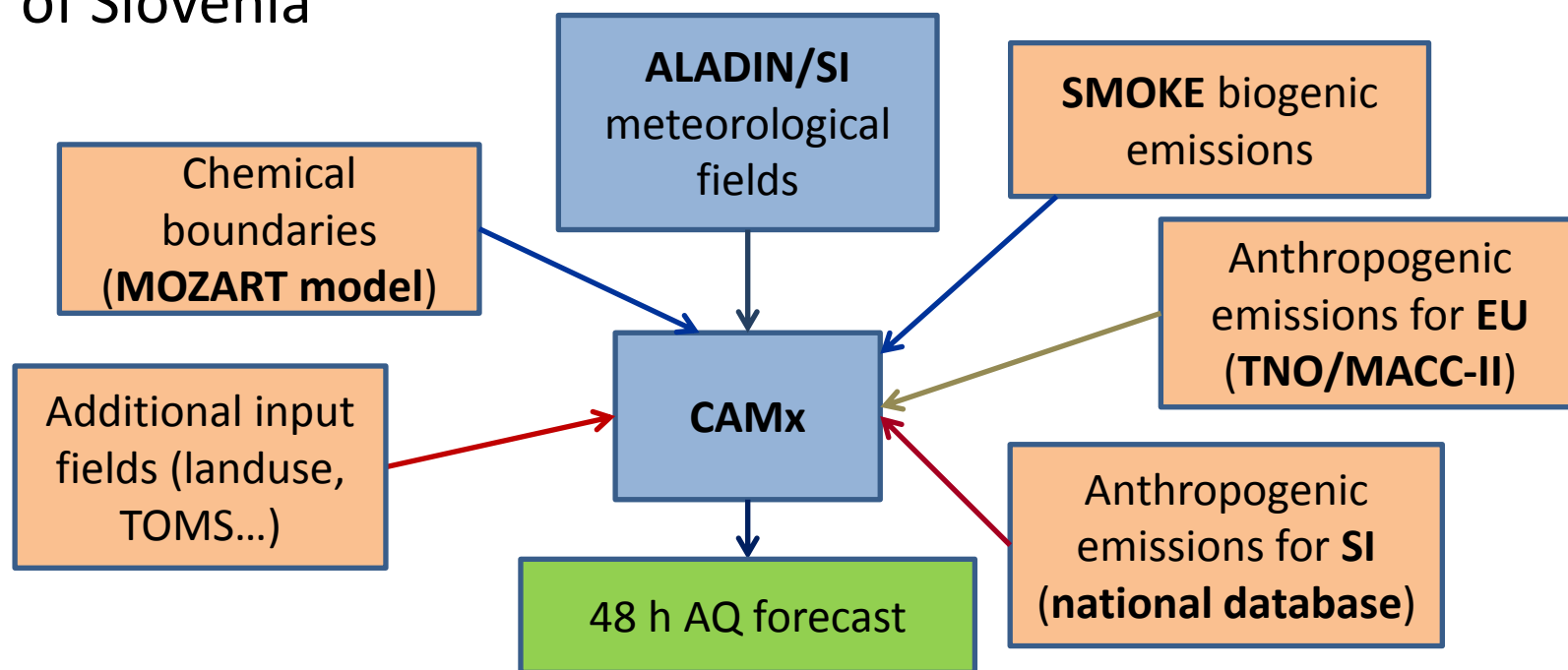
WRF/Chem model

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



ALADIN/CAMx

- 1) Off-line coupled meteorological (ALADIN) and chemical transport model (CAMx; ENVIRON, 2011)
- 2) Running (almost operationally) at Environmental Agency of Slovenia



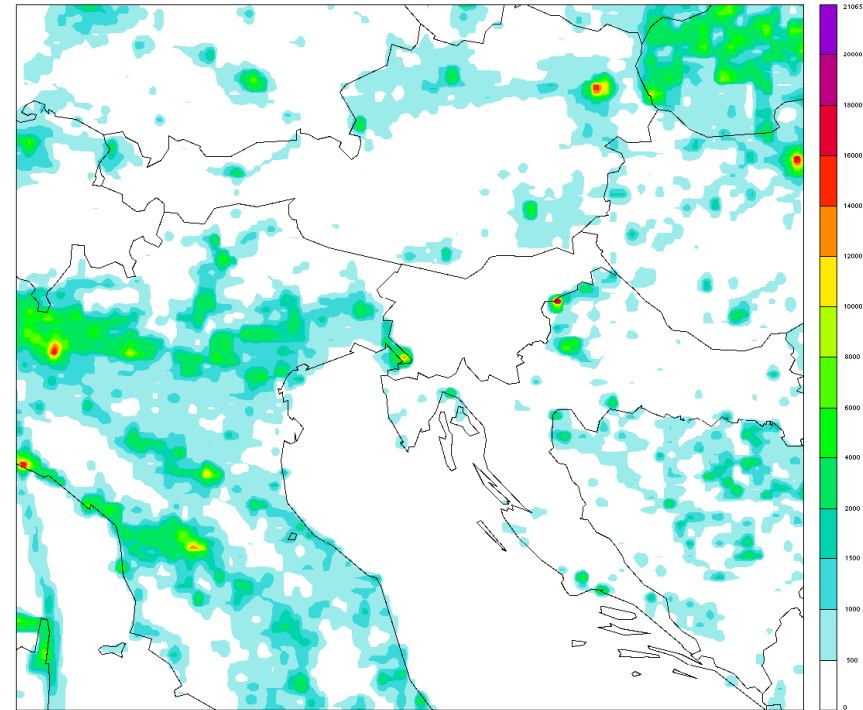
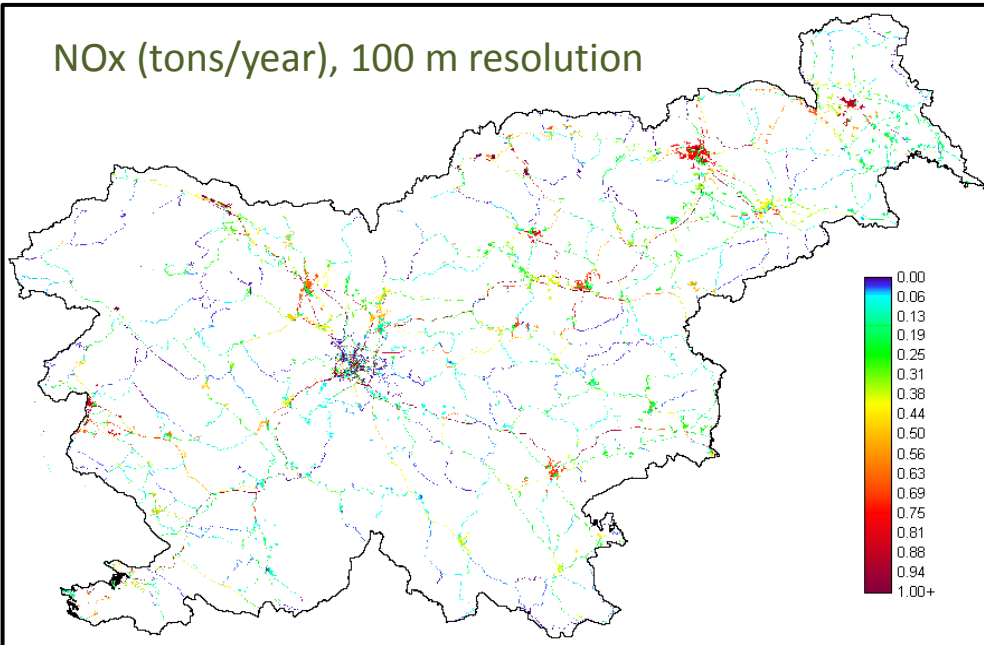


Anthropogenic emissions

- 1) Detailed database for Slovenia for 2009 (source: Slovenian Environmental Agency)
- 2) Outside Slovenia: TNO/MACC-II for year 2009

TNO/MACC II: PM_{2.5} (g/hour)

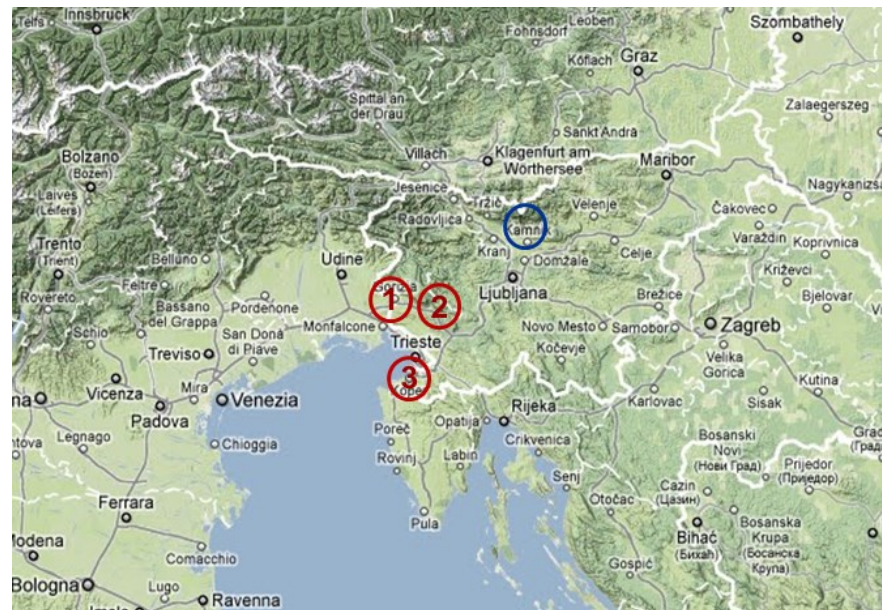
NO_x (tons/year), 100 m resolution





High ozone episodes

Number of days with measured ozone daily maximum (per year) above **160 $\mu\text{g}/\text{m}^3$** for measuring sites in Slovenia (ARSO):



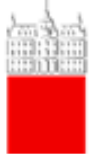
year	NG	KOP	OTL	KRV	LJ	MB	CE	MS	TRB	ZAG	HRA	IS
2010	13	7	13	8	-	-	1	2	2	1	4	-
2011	16	4	15	1	2	-	2	2	2	-	2	1
2012	22	12	12	11	4	-	4	1	2	1	3	2

Mediterranean
stations

Elevated
site

Urban interior stations

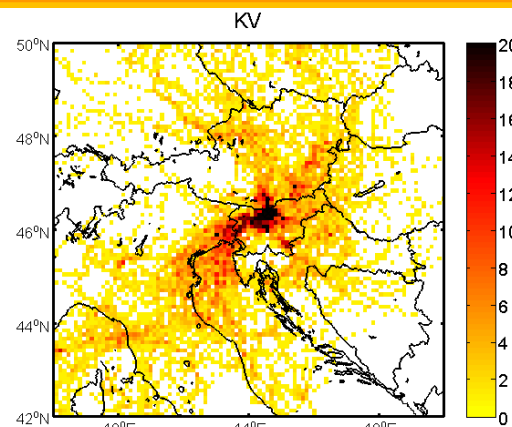
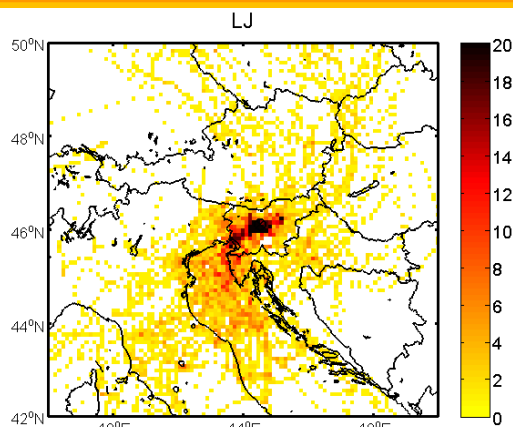
Rural
background



High ozone episodes

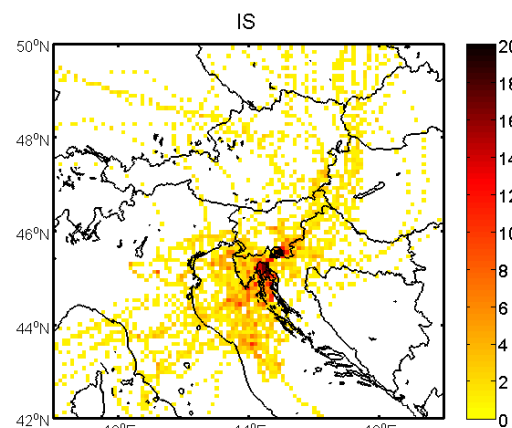
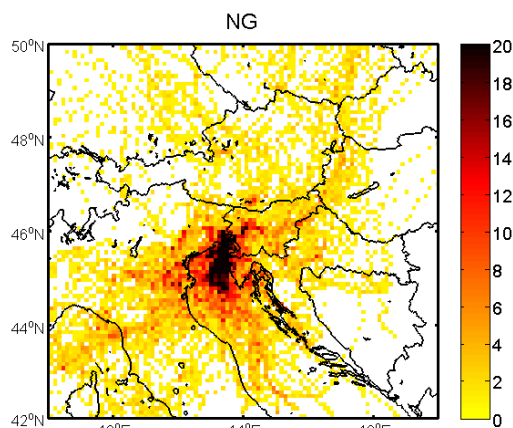
NUMBER DENSITY of polluted backward trajectories
with 3 h maximum above $160 \mu\text{g}/\text{m}^3$

Ljubljana



Krvavec
(Elevated
Alpine site)

Nova Gorica
(Mediterranean
site)



Iskrba
(Rural
background)



High ozone episodes

Model: ALADIN/CAMx

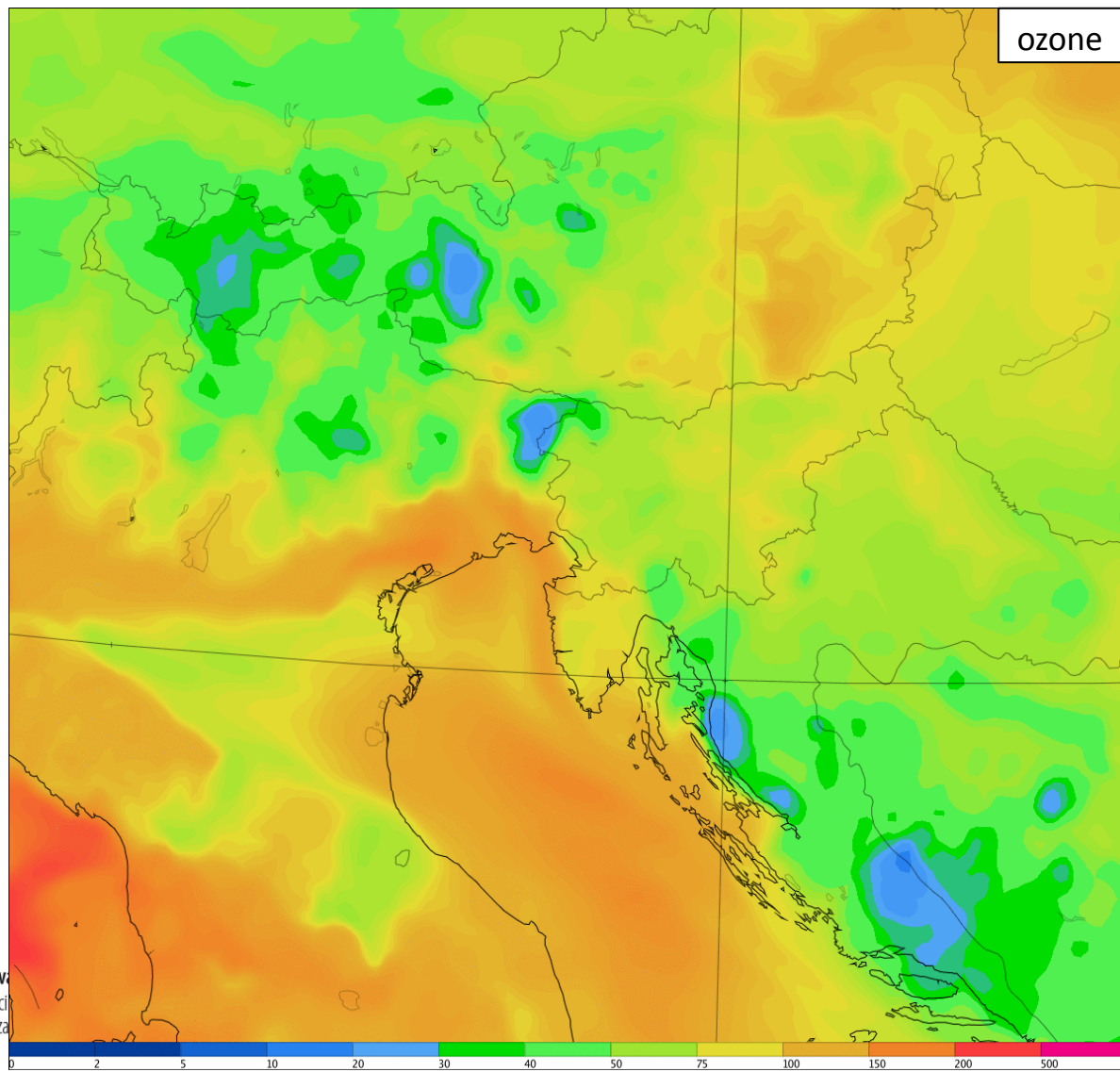
Results for 2 days
during high ozone episode
(August 12 – 24, 2011)

High ozone daily levels
simulated above Adriatic
Sea and coastal regions

In Slovenia highest ozone
levels measured at
Mediterranean stations



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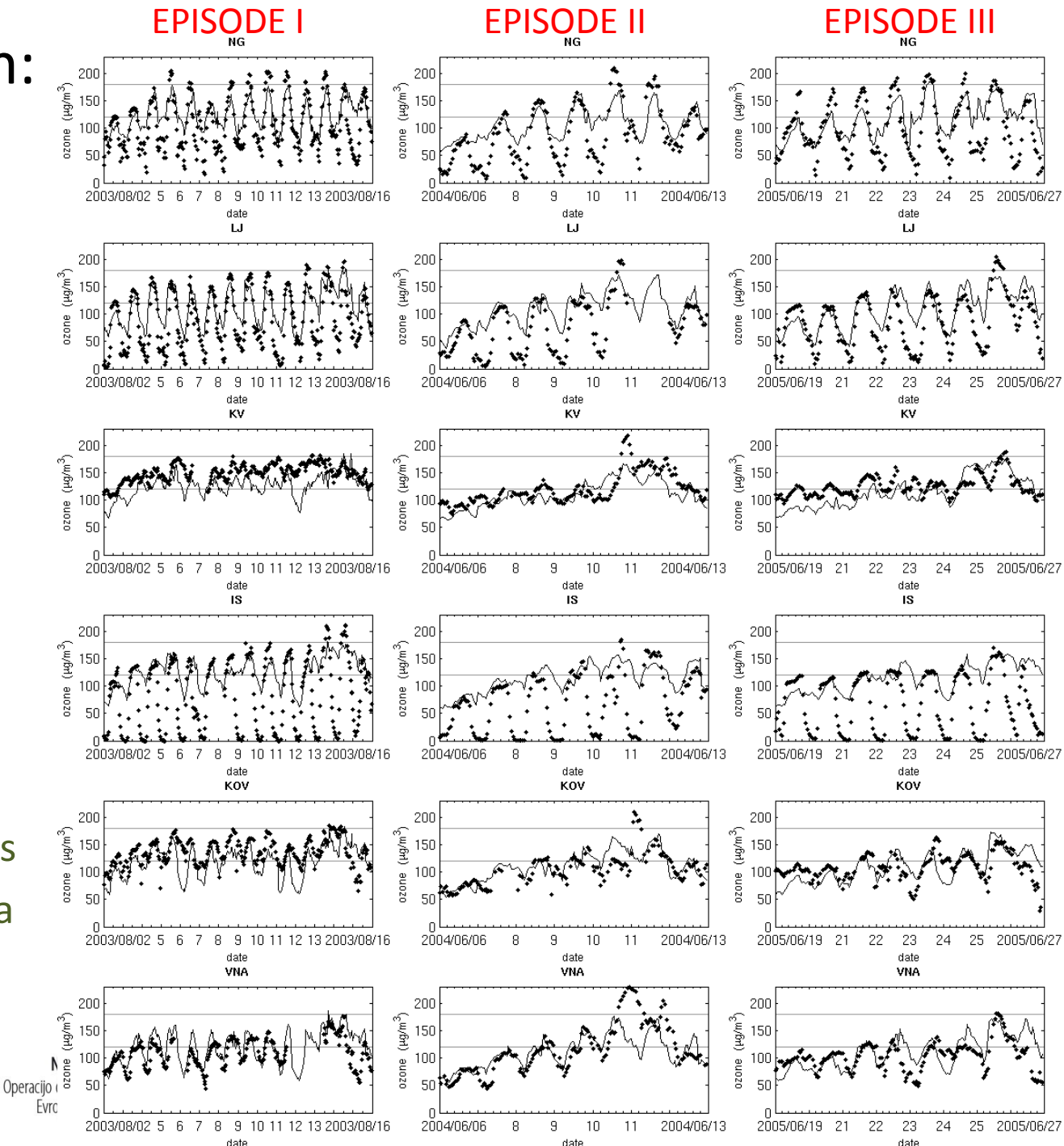


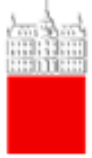
Model evaluation: ozone

3 high ozone episodes,
7 stations

Dots – measurements
Lines – model

Under/Over-estimations
of daily maxima/minima

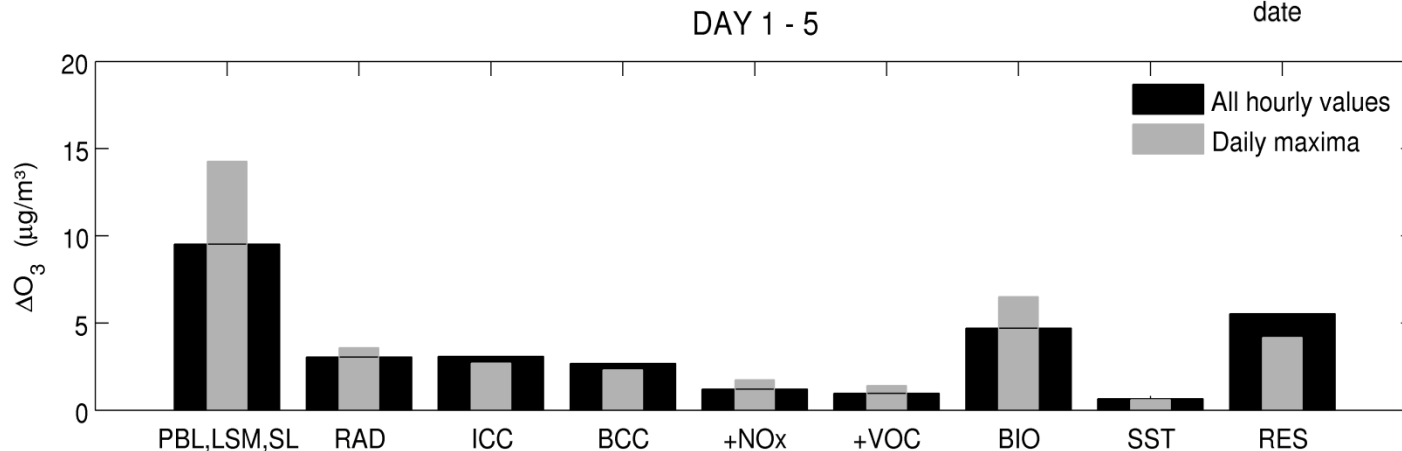
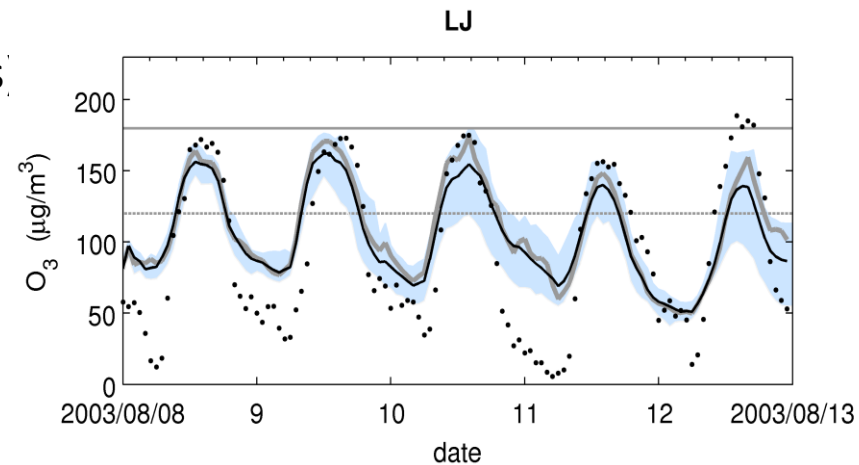




WRF/Chem ozone sensitivity study

- 1) August 2003 high ozone episode, 51 plausible simulations
- 2) Comparison of model sensitivities to:

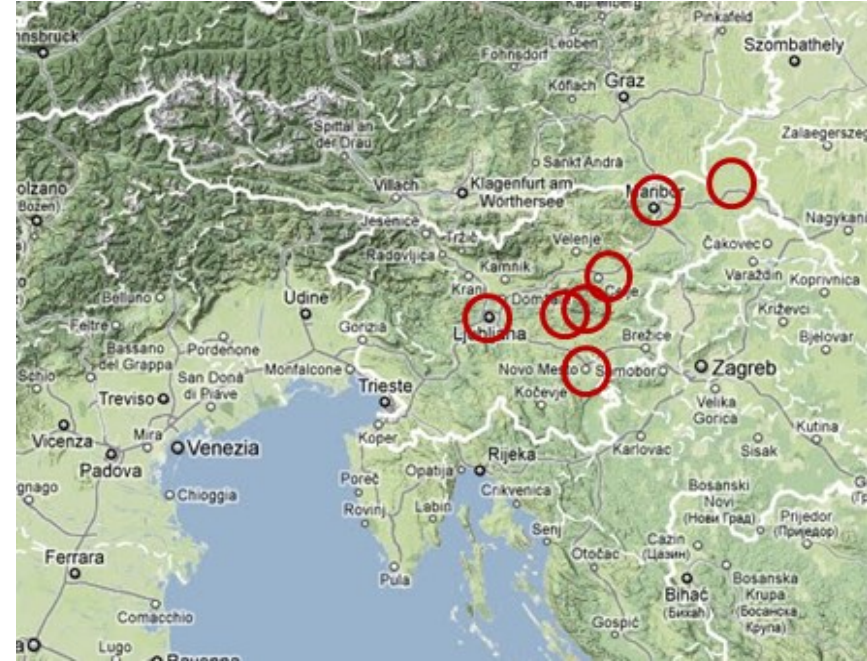
ICC (initial conditions), **BCC** (boundary conditions),
PBL,LSM,SL (physical parameterisations),
RAD (radiation scheme), **RES** (model resolution),
BIO (biogenic emissions),
+NO_x, +VOC (30% increased emissions)





High PM10 episodes

Number of days (per year) with
measured average daily
PM10 above 50 $\mu\text{g}/\text{m}^3$
(35 allowed):



year	LJ	MB	CE	MS	TRB	ZAG	NG	KOP
2010	43	47	58	52	64	68	27	15
2011	63	64	73	71	68	75	28	21
2012	27	34	55	44	65	62	19	23

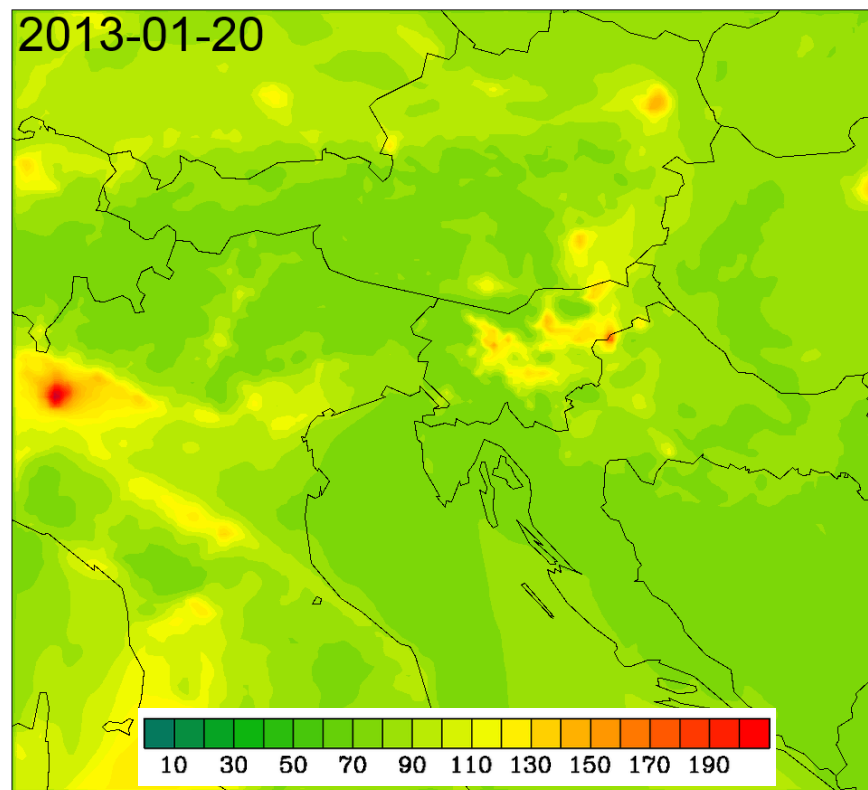
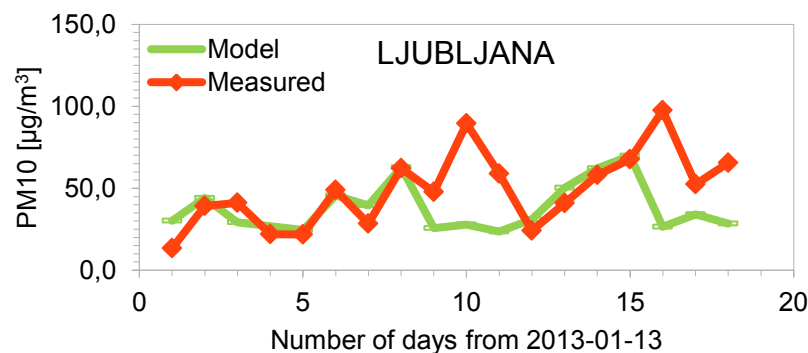
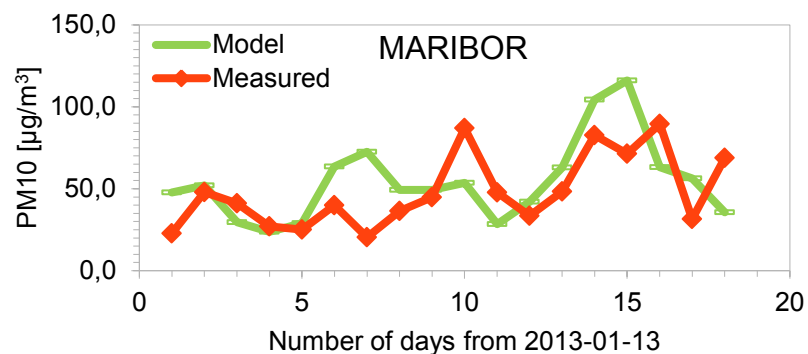
Mediterranean stations

Interior urban stations

High PM10 episodes

Geographical location of Slovenia in the lee side of Alpine barrier: blocked predominant westerly flows

Complex terrain with cities and towns located in basins and valleys: frequent calm conditions with temperature inversions and suppressed vertical mixing

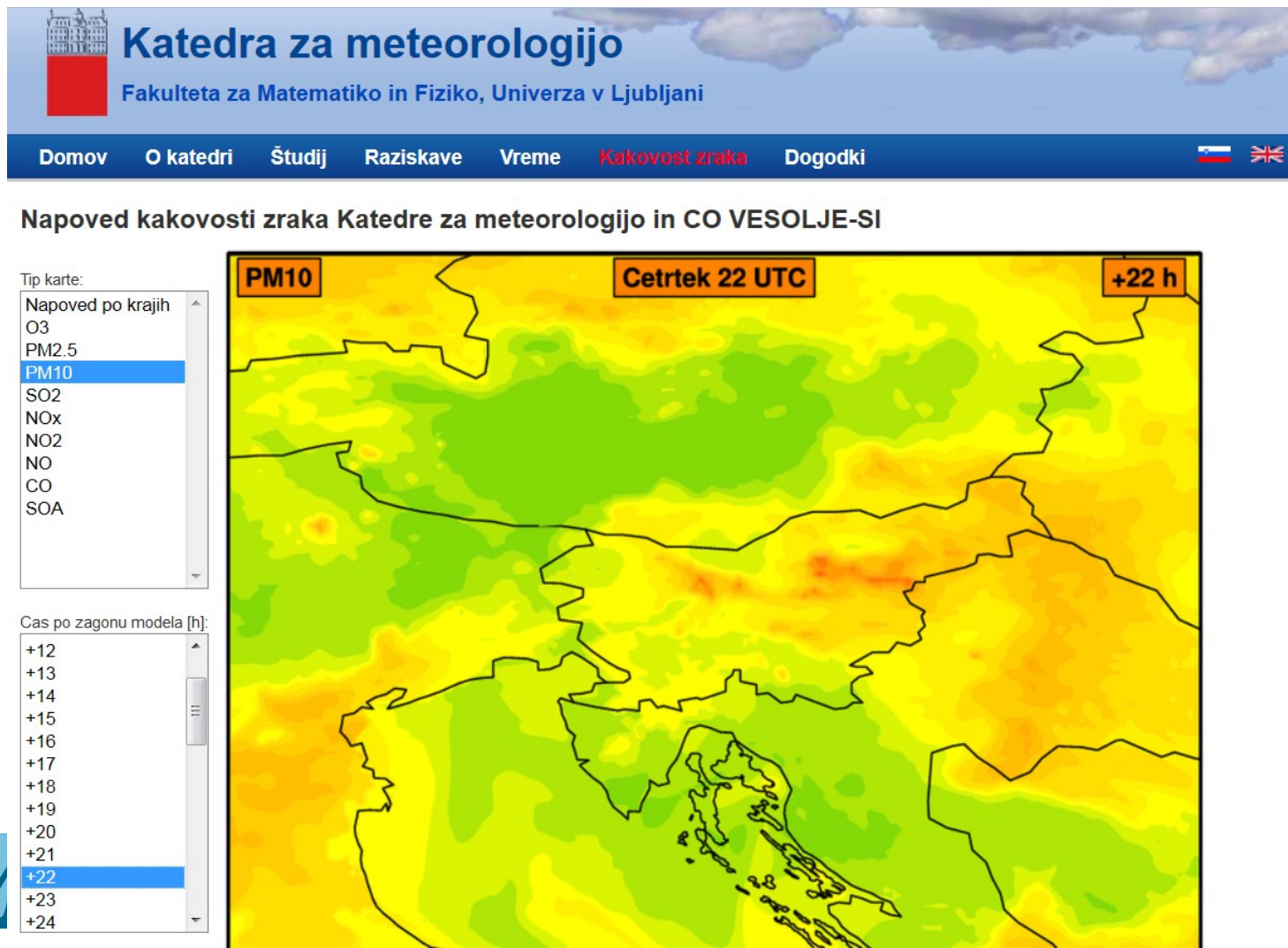




Experimental AQ forecast

WRF/Chem model, running operationally at UL, 48 h AQ forecast

<http://meteo.fmf.uni-lj.si/onesnazenje>





To sum up...

- Models well reproduced general (main) observed characteristics of air pollution episodes
- Model uncertainties and limitations (gridded atmosphere, uncertain input fields, many parameterizations, approximations...)
- Meso-scale meteorological conditions in complex terrain during air pollution episodes generally challenging for models
- Many further investigations needed (related to modelling both high O₃ and PM10 episodes...)
- To improve model predictions of hourly values (and high pollution episodes): necessary to combine model results with measurements



Thank you!

rahela.zabkar@fmf.uni-lj.si



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