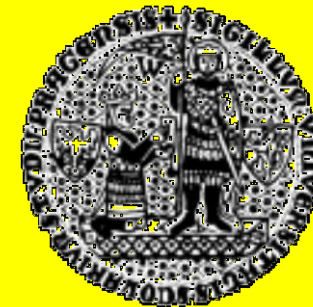




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URBANIZOVANÁ PŘEDPOVĚĎ PRO PRAHU - PROJEKT URBI PRAGENSI

Tomáš Halenka & URBI PRAGENSI team



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Operační program Praha – pól růstu ČR

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Motivation

World:

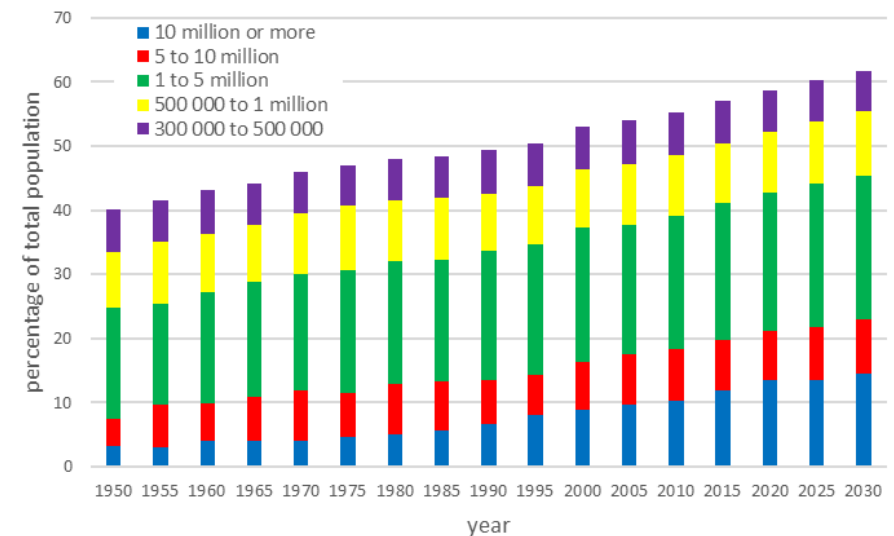
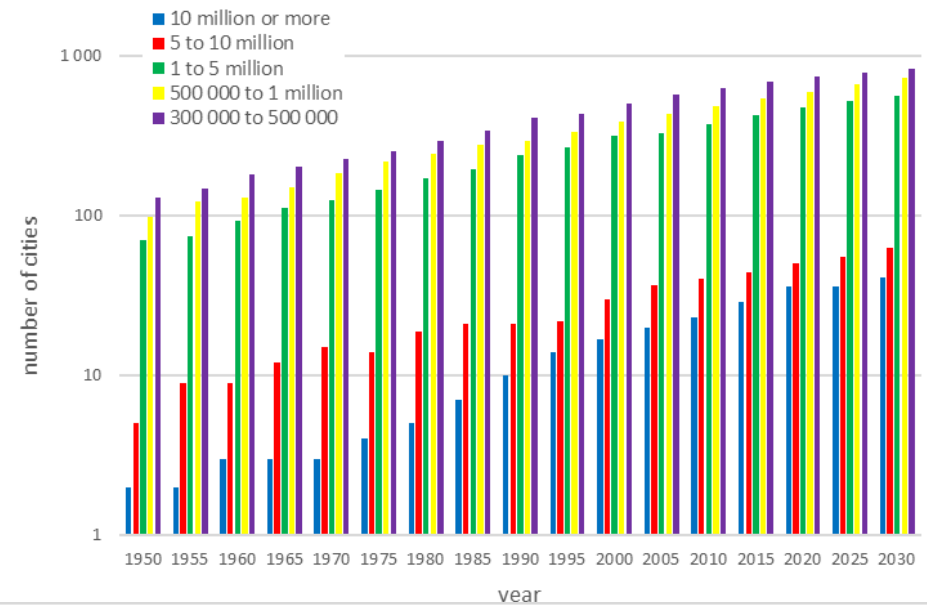
- From 2009 - more than 50% of the world's population living in cities (UN, 2009)
- less than 0.1% of the Earth's surface

Europe:

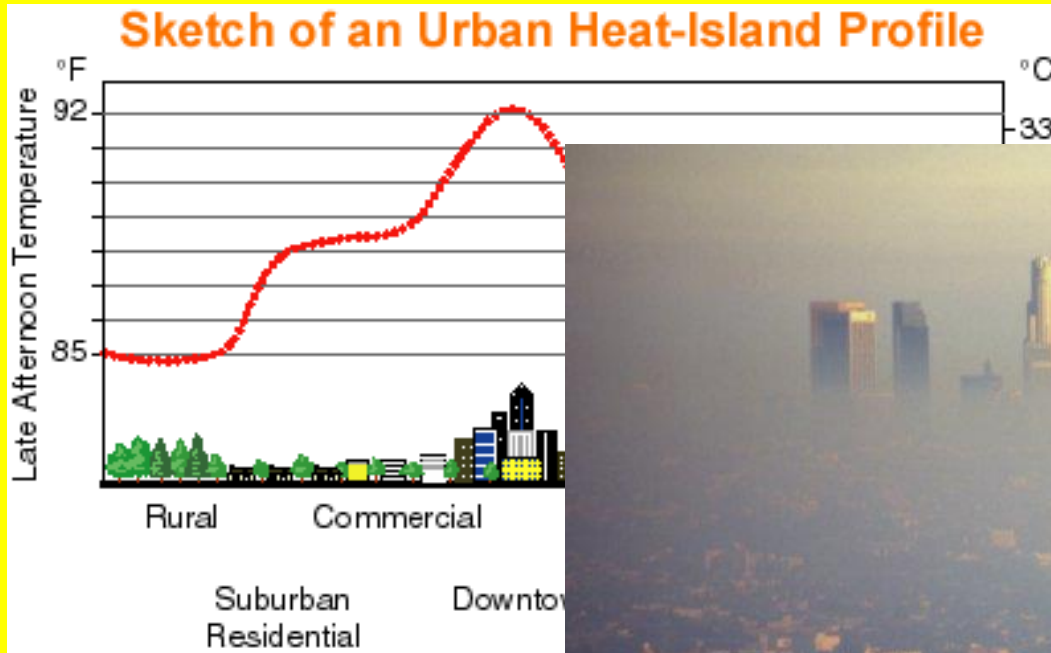
- 2008 - 73% of the population in cities
- mid 21th century - 84%, representing a rise from 531 to 582 millions (UN, 2008)
- in the Czech Republic, a similar change from 73.5% to 83% is projected by the Czech Statistical Office.

Clearly:

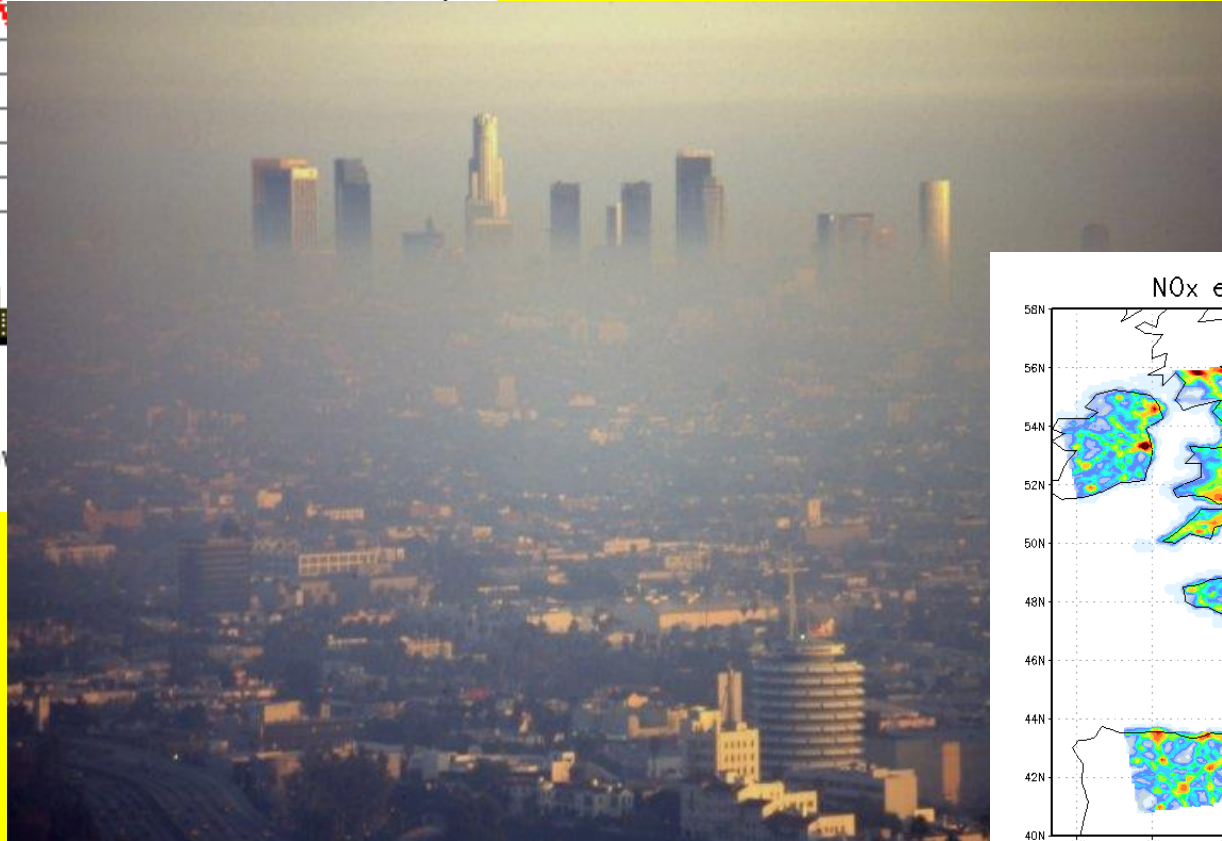
- Quite many atmospheric effects on population through the urban environment
- Especially thermal extreme weather effects like heat wave



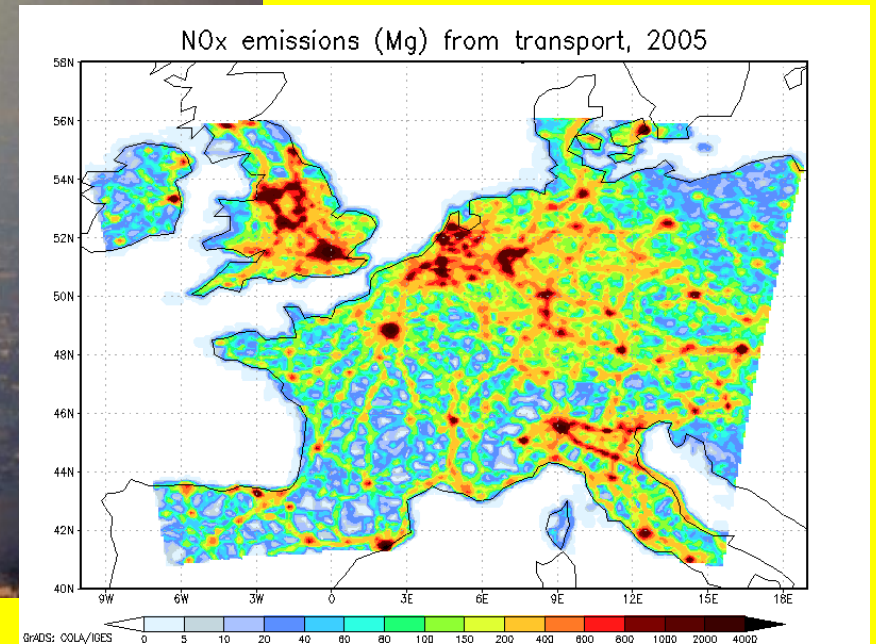
What we are (not) talking about ...



Solecki et al ., 2004



Los Angeles smog and California climate change policy



MEGAPOLI TNO NO_x emissions [Mg], 2005 from transport (S7)

UHI Project - Development and Application of Mitigation and Adaptation Strategies and Measures for Counteracting the Global Urban Heat Island Phenomenon

Within framework of EC
Operation Programme
Central Europe
(3CE292P3)
18 partners, coordinated
by ARPA, Italy (Paolo
Lauriola)



Connection to the City
Authority, decision makers,
Institute for City Planning and
Development

8 of the most relevant
metropolitan areas and
Metropolitan European
Growth Areas (MEGAs) of
CE area



EUROPEAN UNION
EUROPEAN REGIONAL
DEVELOPMENT FUND

Project PoC CUNI

OP-Prague the Pole of Growth:
Proof of Concept CUNI – Assessment of
research results commercial potential
at Charles University

KK2:
Climate change impacts on Prague,
potential of adaptation and mitigation
options

01/2017 – 12/2018



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City of Prague
~ 1.5 M of population



Project URBI PRAGENSI



- Urbanization of weather forecast
- Urbanization of air-quality forecast (connected to the above)
- Urbanization of climate change scenarios, the tool for efficiency assessment of adaptation or mitigation measures in strategic development plans
- Hot-spots simulations



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ČESKÝ
HYDROMETEOROLOGICKÝ
ÚSTAV

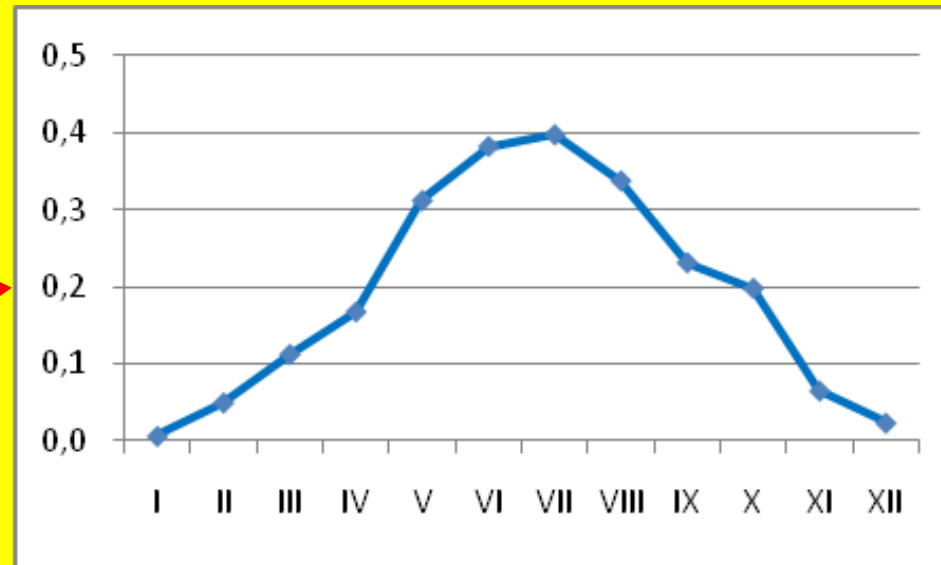


INSTITUTE OF COMPUTER SCIENCE
The Czech Academy of Sciences

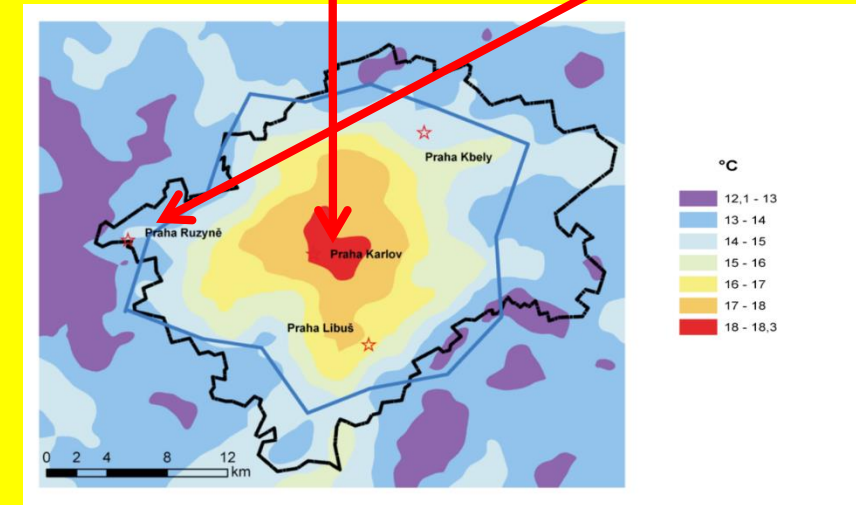


Prague heat island

period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	YEAR
1961-2009	2,2	2,3	2,2	2,2	2,2	2,4	2,3	2,2	2,0	2,0	2,2	2,2	2,2
1961-1990	2,2	2,3	2,2	2,1	2,1	2,2	2,2	2,0	1,9	2,0	2,2	2,2	2,1
1991-2009	2,2	2,3	2,3	2,3	2,4	2,6	2,6	2,4	2,1	2,2	2,2	2,2	2,3
Difference new - standard	0,01	0,05	0,11	0,17	0,31	0,38	0,40	0,34	0,23	0,20	0,07	0,02	0,19

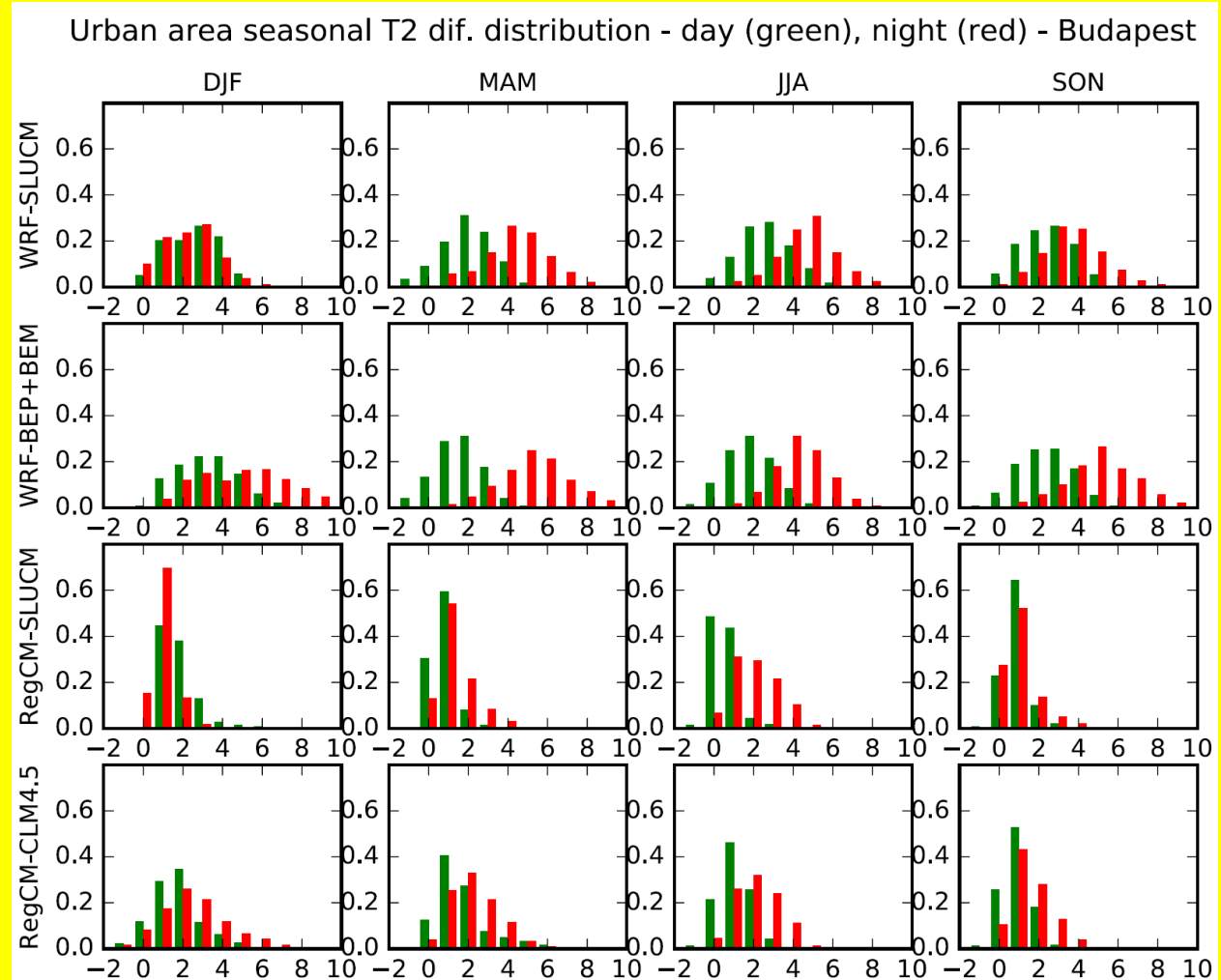
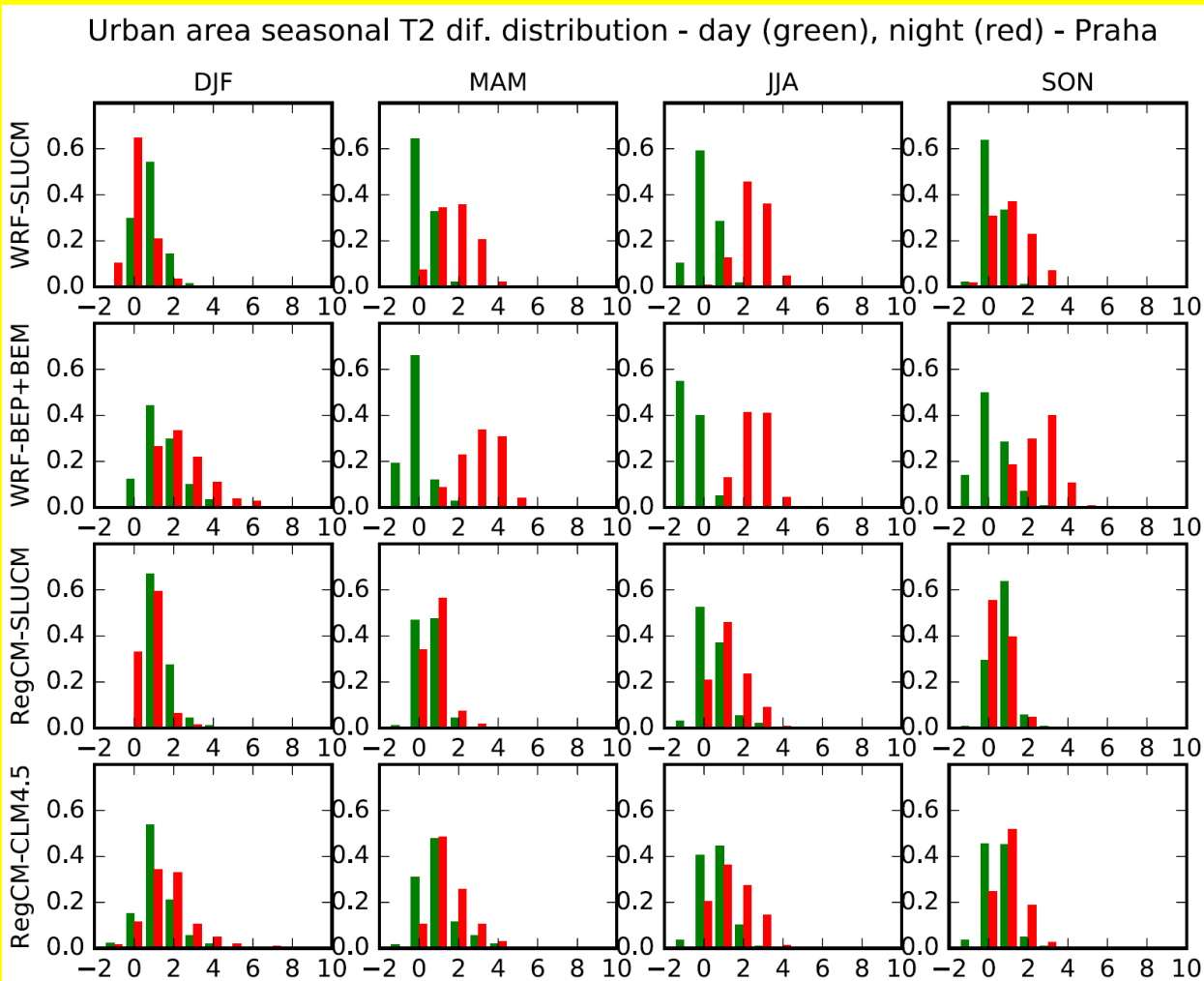


Klementinum vs. Ruzyne



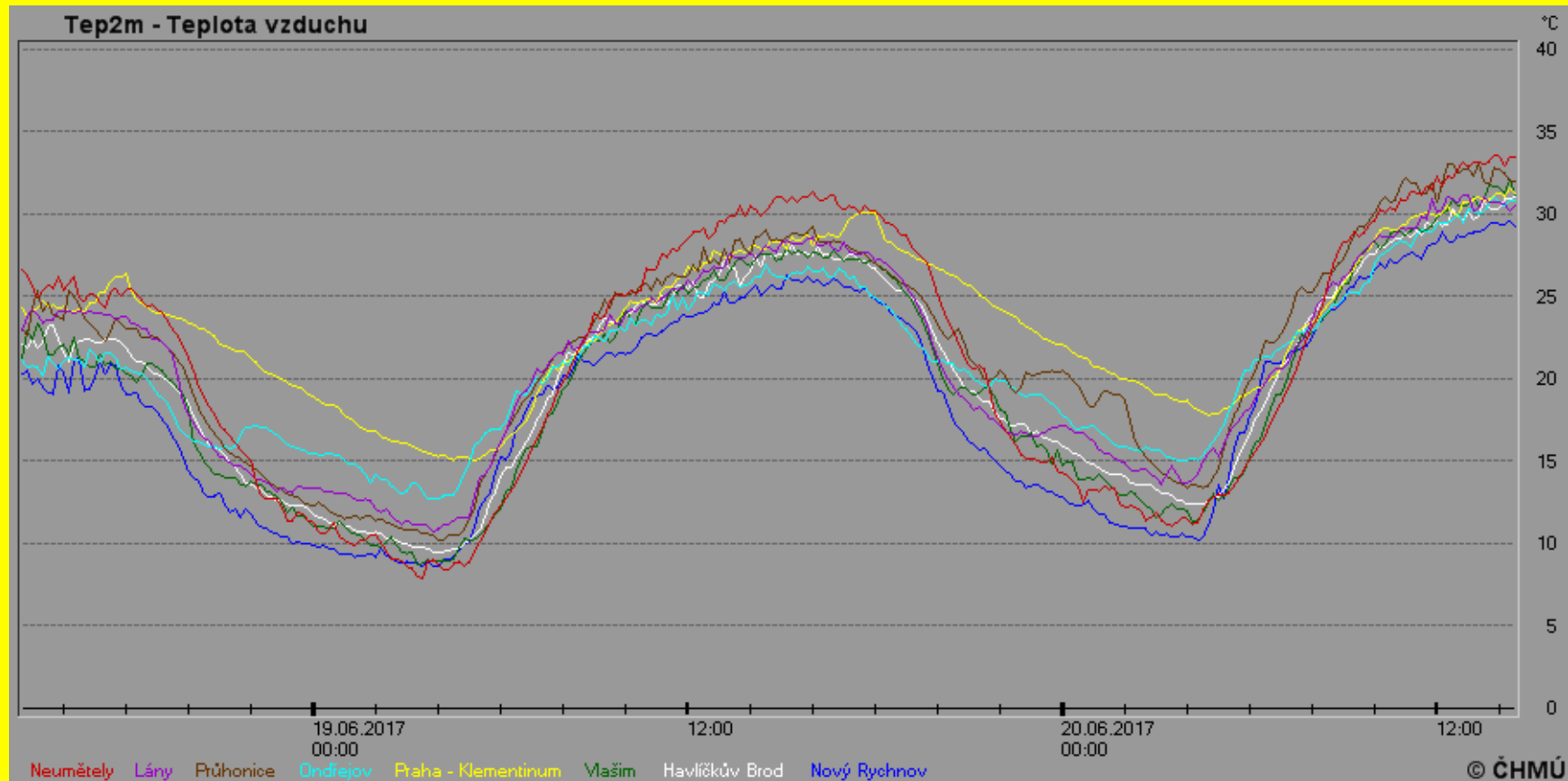
Pretel (2010)

UHI intensity Prague (day vs. night)



Karlícky et al. (ACP, 2018), you can see our poster here as well (Halenka et al., A21L-2878, this morning)

Example June 18-21, 2017



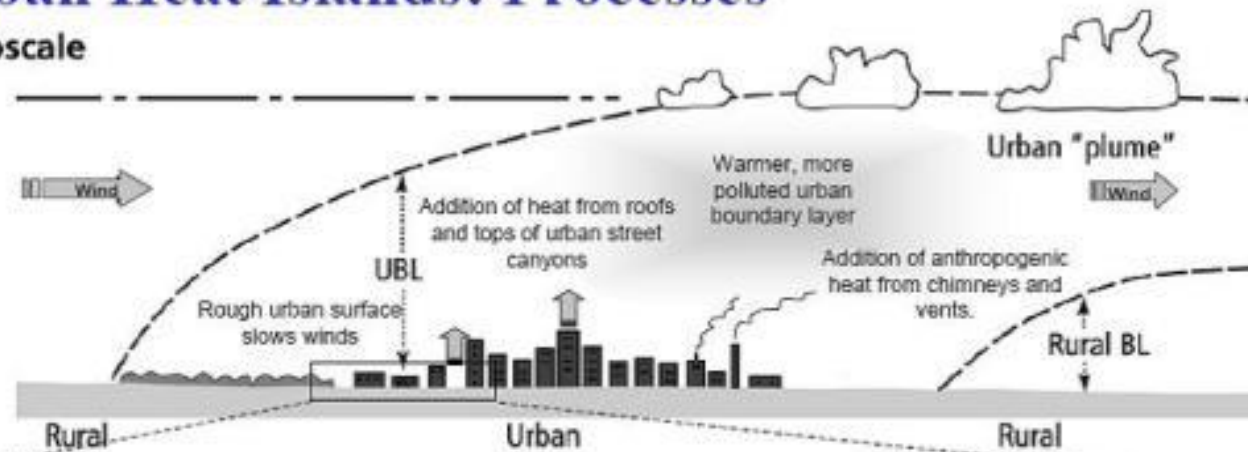
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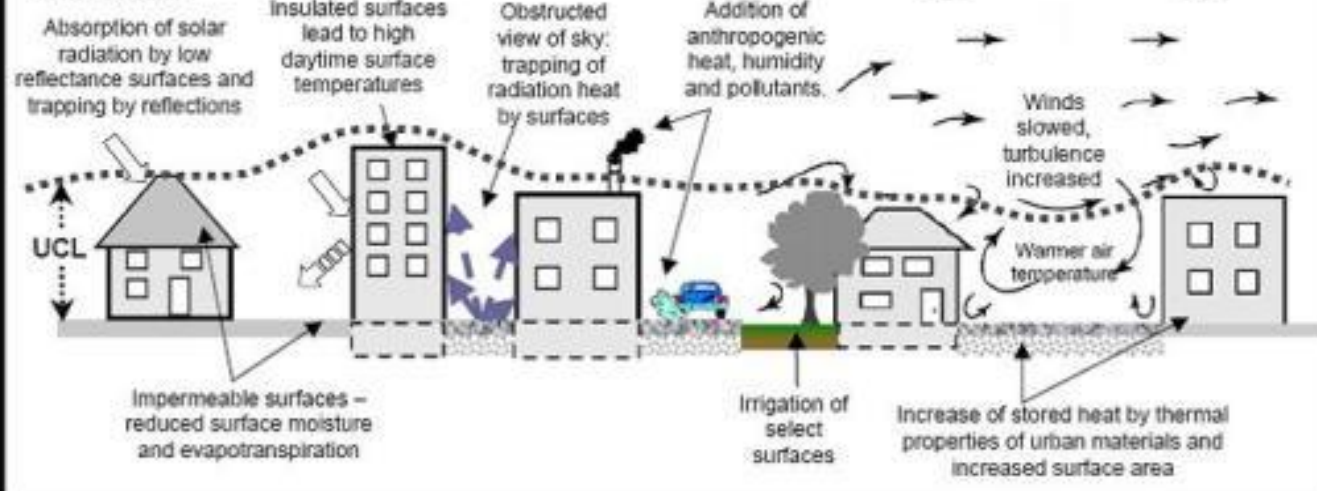
Atmospheric processes in urban canopy layer

Urban Heat Islands: Processes

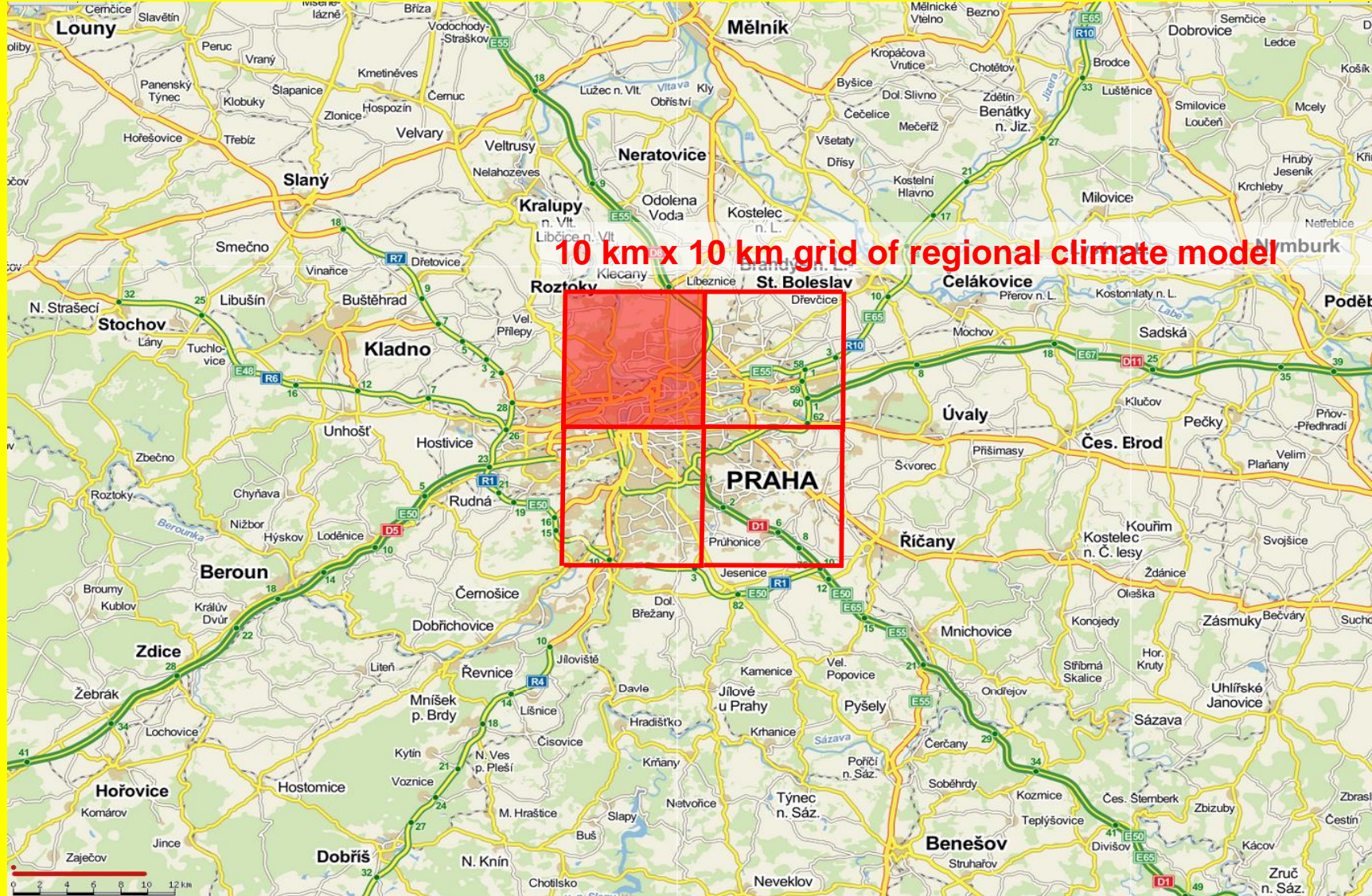
Mesoscale



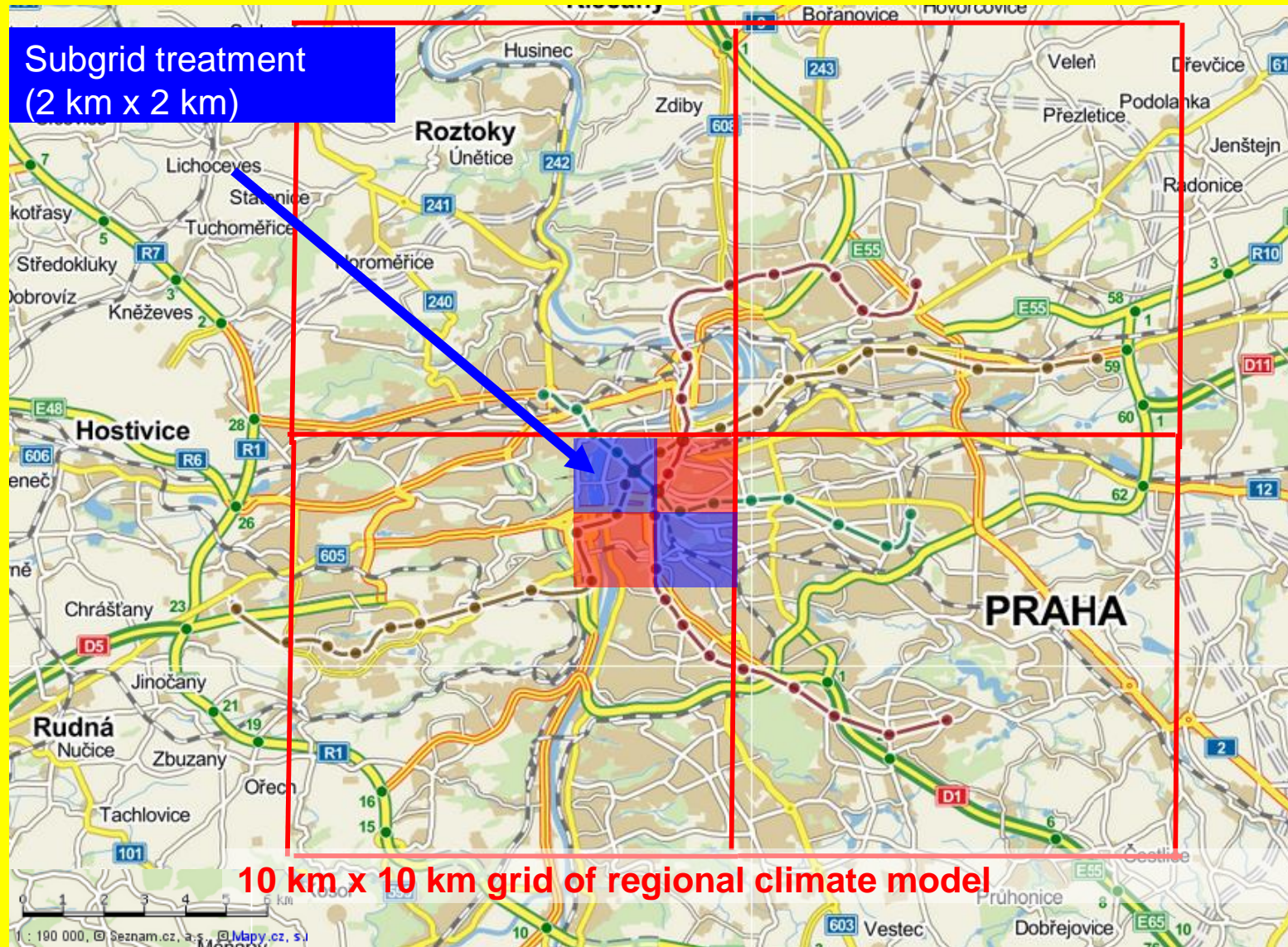
Microscale



Why urban parameterizations



Even further in very high-resolution



1 km resolution for
weather and air
quality forecast in
URBI PRAGENSI

Modeling atmospheric process in urban canopy

- BULK – no special parameterization, but recognizing the land-use type (albedo, emissivity and other land surface parameterizations)
- SLUCM – single-layer urban canopy model
- MLUCM – multi-layer urban canopy model
- BEP-BEM – building environment parameterization – building energy model

Experiments

Central European domain **10 km x 10 km** (160 x 120 grid points)
23 vertical levels up to 50 hPa, inner domain 3.3 km x 3.3 km

Summer episode (18-23 June 2017)

Winter episode (17-23 January 2017)

April 2018

GFS data

- **Simulations:**

WRF – BULK

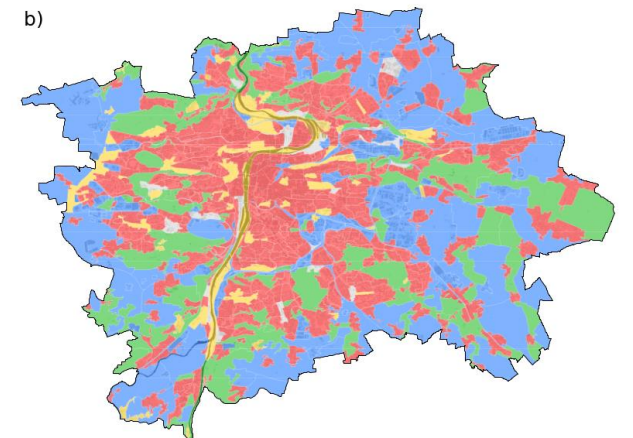
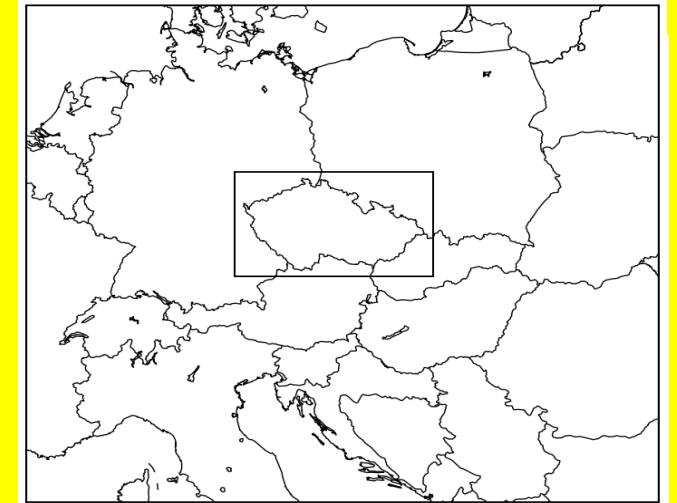
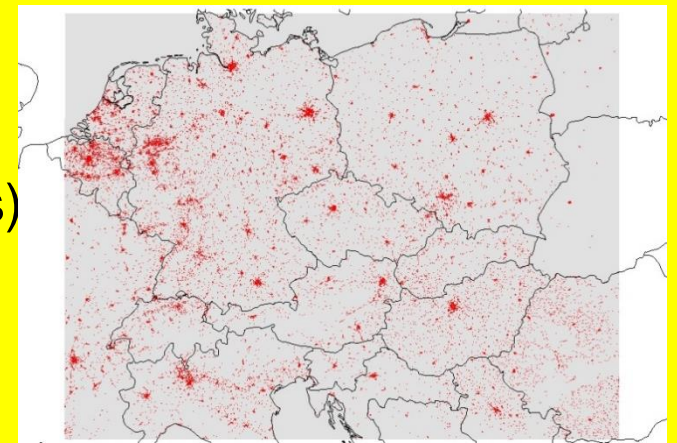
WRF – SLUCM

WRF – BEP-BEM

- **Test (for SLUCM):**

Mosaic land use

Dominant land use



Urbanization of weather forecast



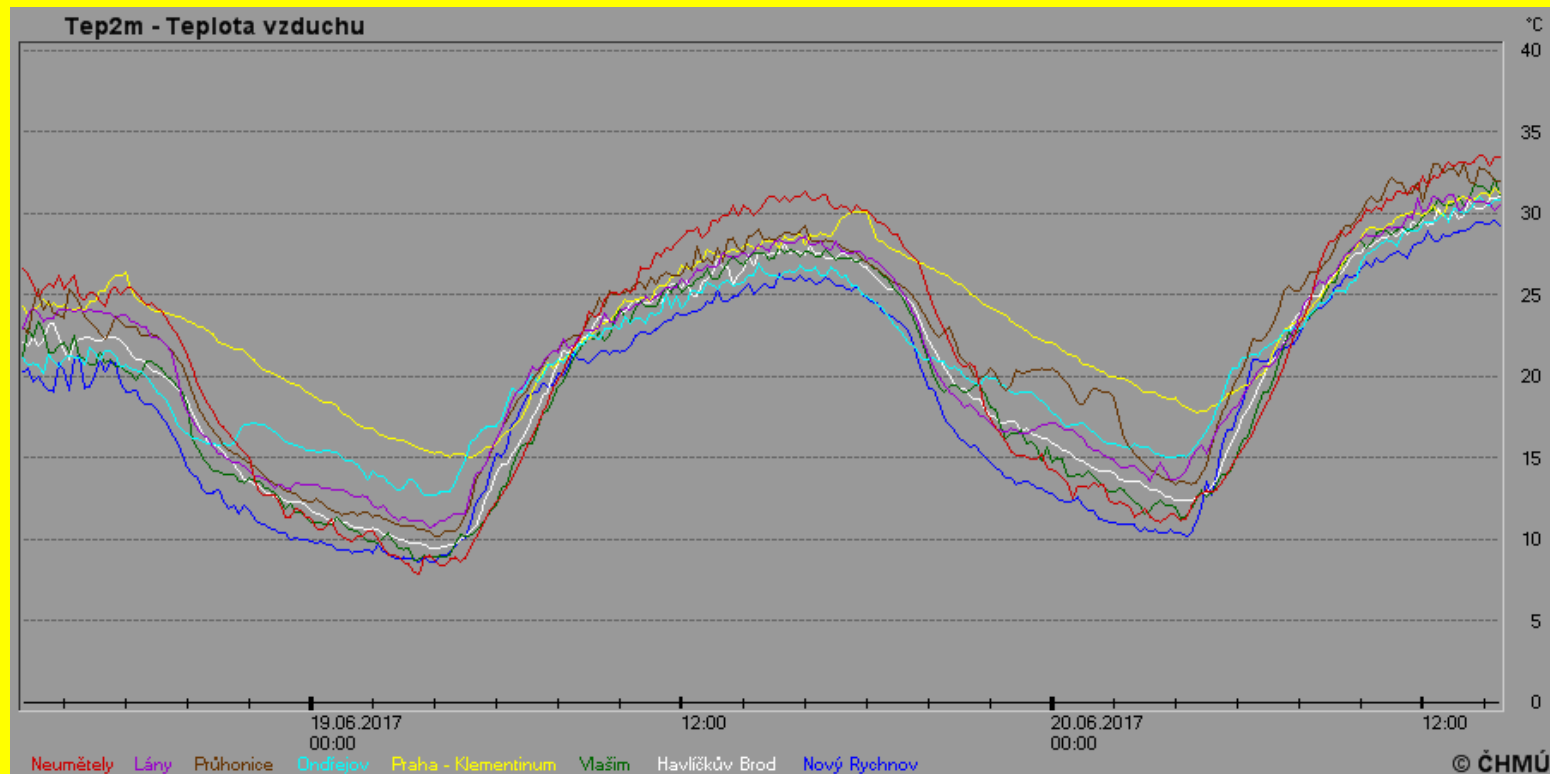
- urbanized weather prediction based on very high resolution simulations (WRF, 1 km) with localised urban parameters for individual parts of the city
- to provide more detailed information for warnings, planning of the activities of population, planning of the services to adapt and mitigate the effects of urban heat island
- to provide the tool for the assessment of the potential of measures for adaptation and mitigation adopted in Strategic City Development Plan in selected case studies



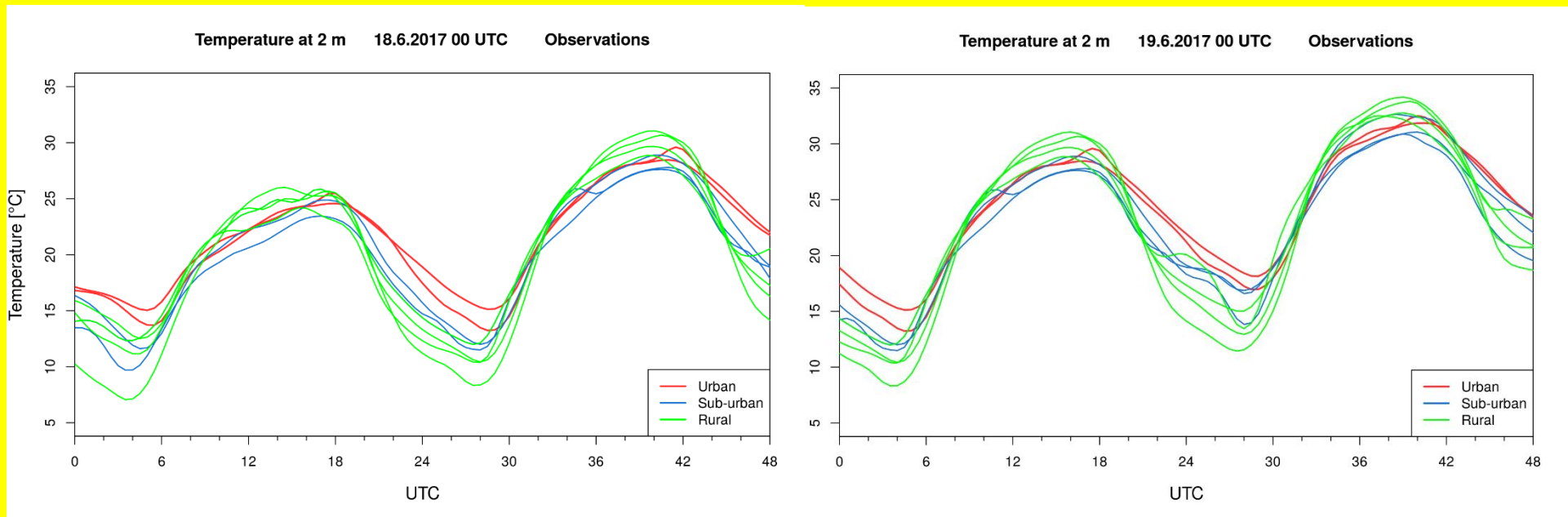
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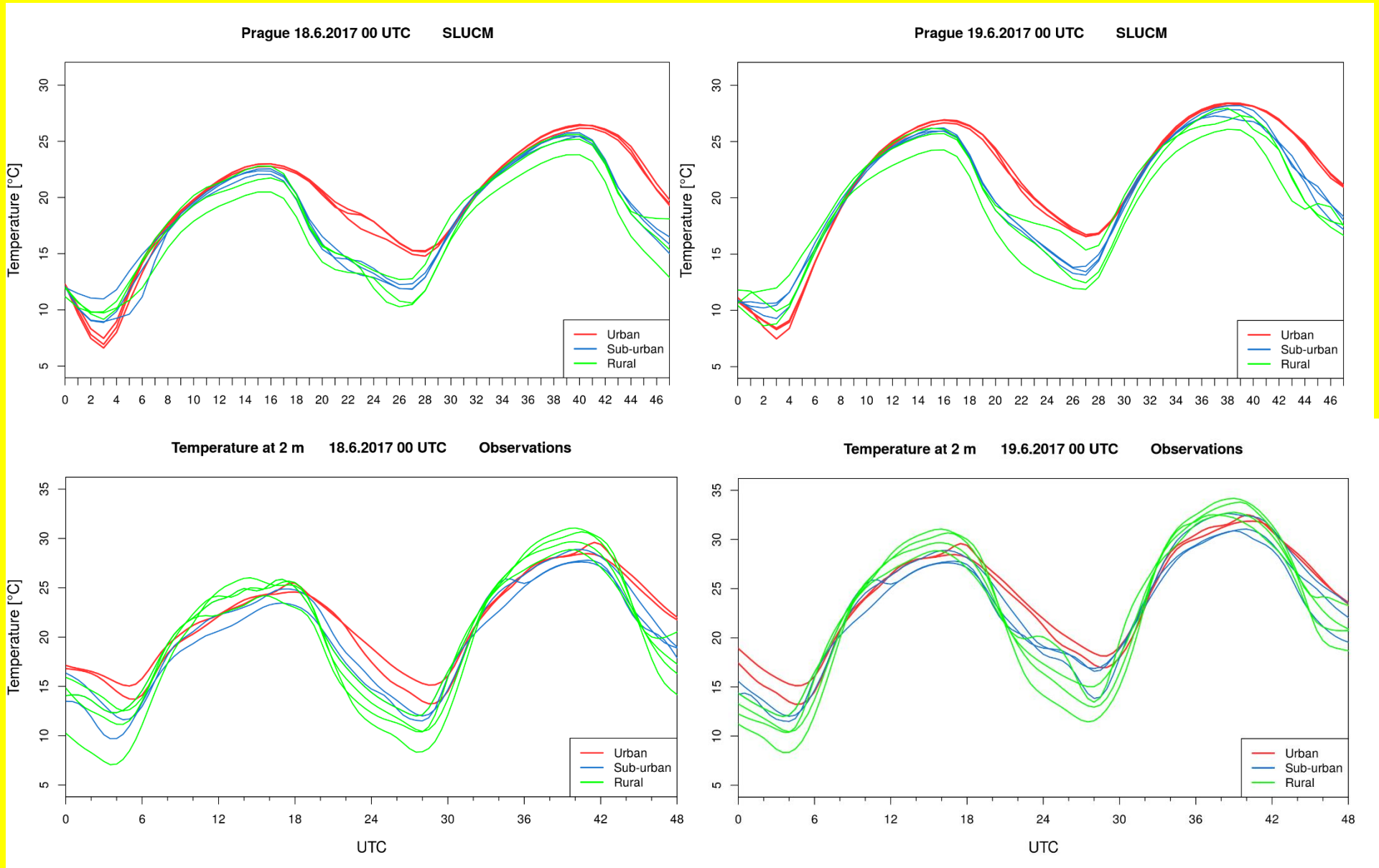
WRF forecast mode with SLUCM (3km)



WRF forecast mode with SLUCM (3km)

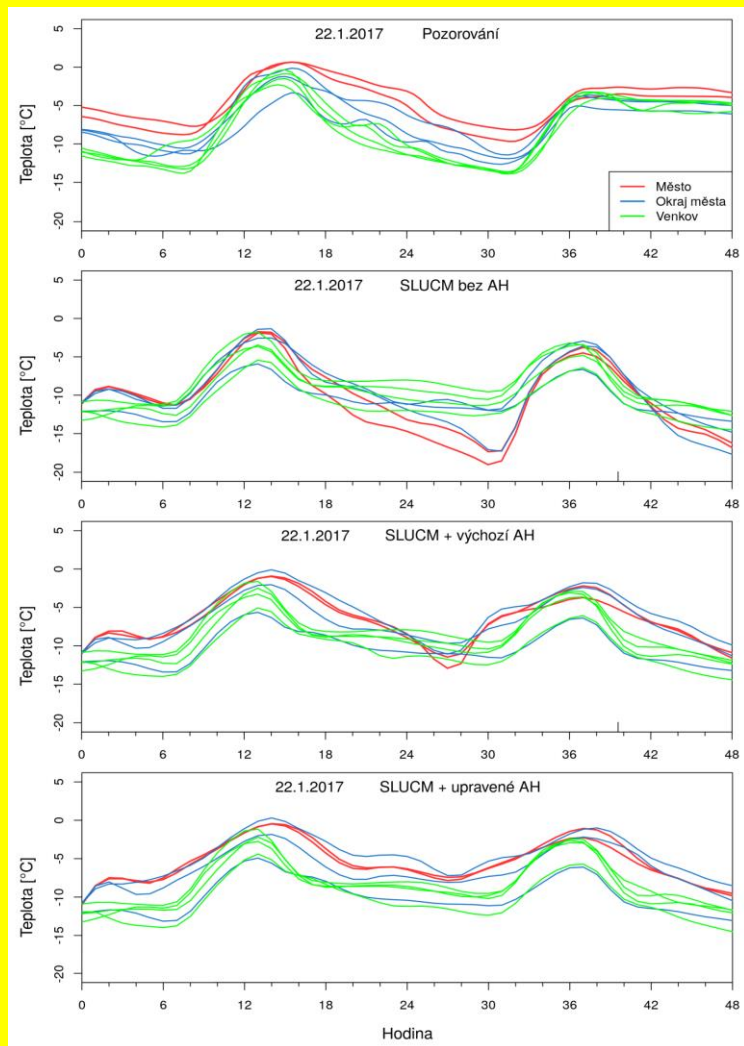


WRF forecast mode with SLUCM (3km)

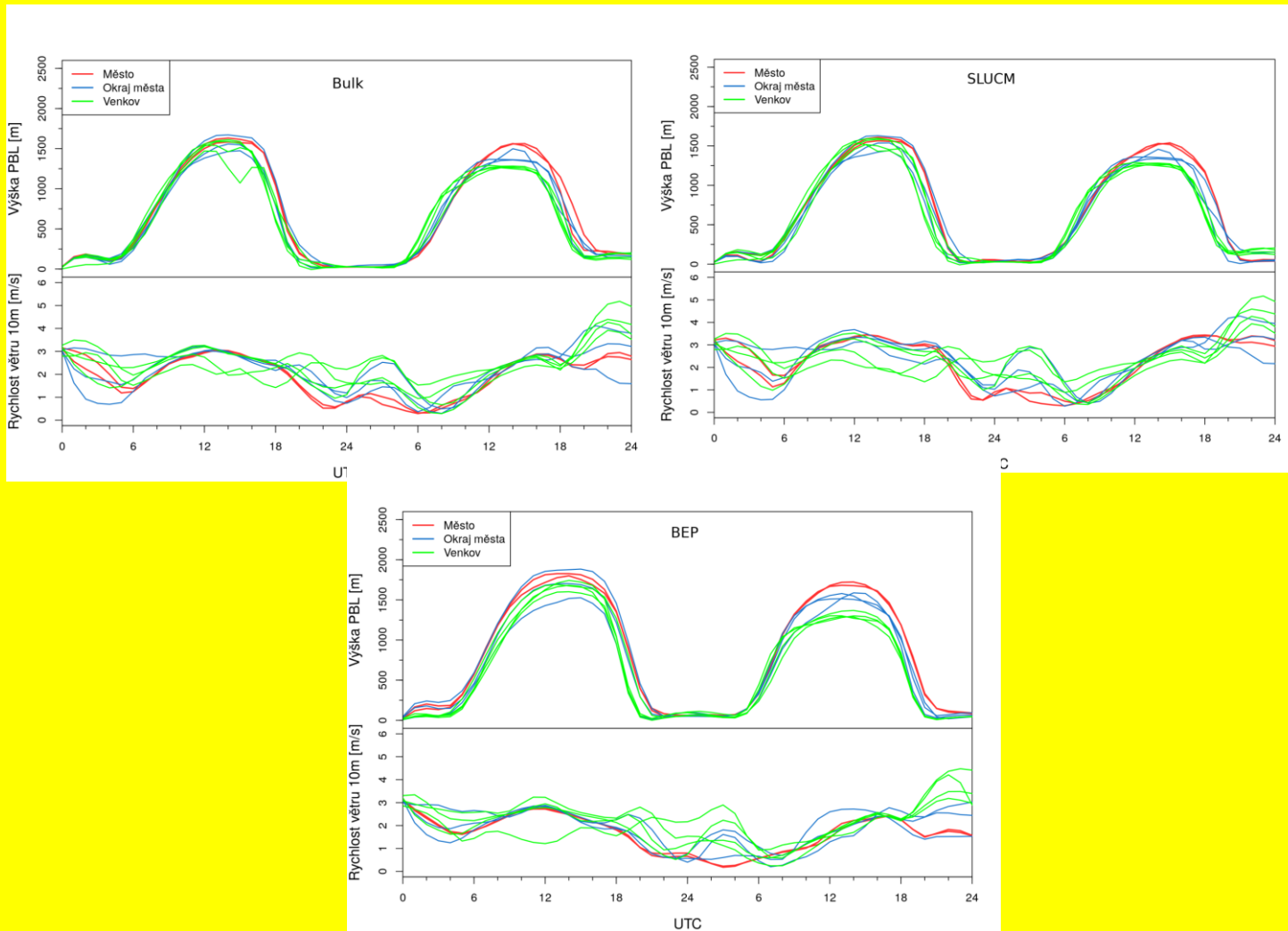


Winter case study

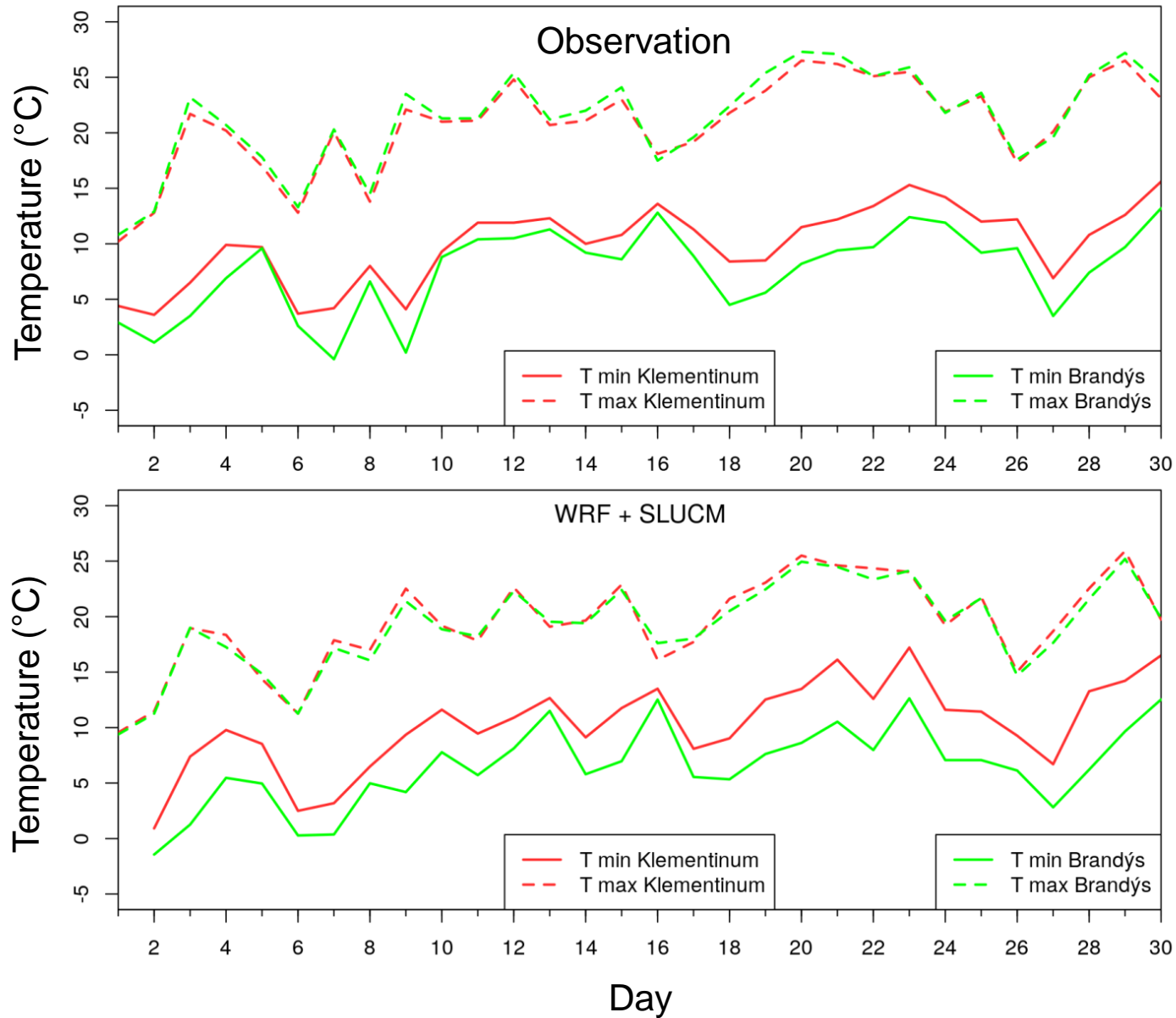
Anthropogenic heating sensitivity



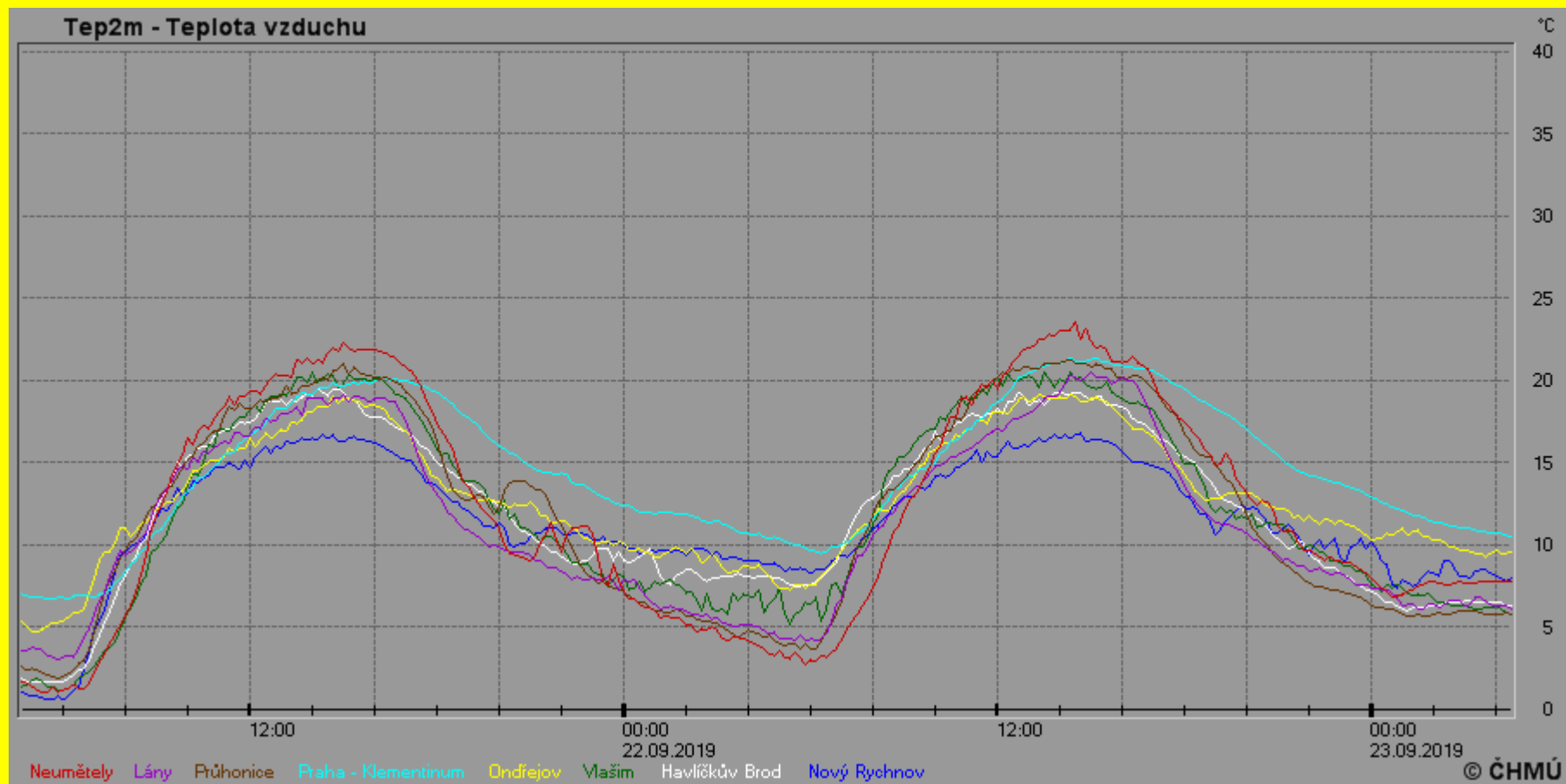
Wind and mixing layer relative change



April 2018 – observation comparison



Present situation

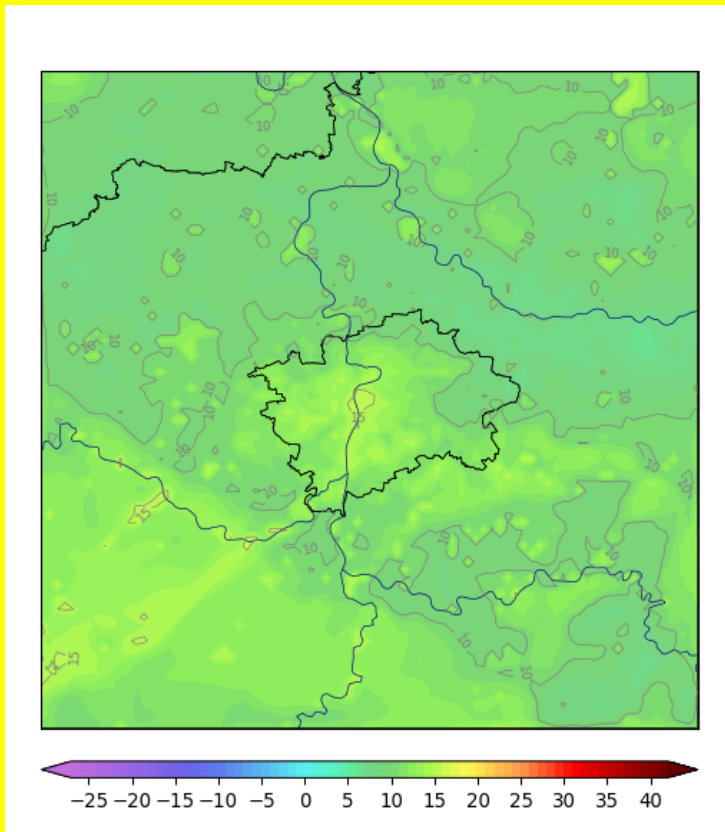


Předpovědní systém Libuše

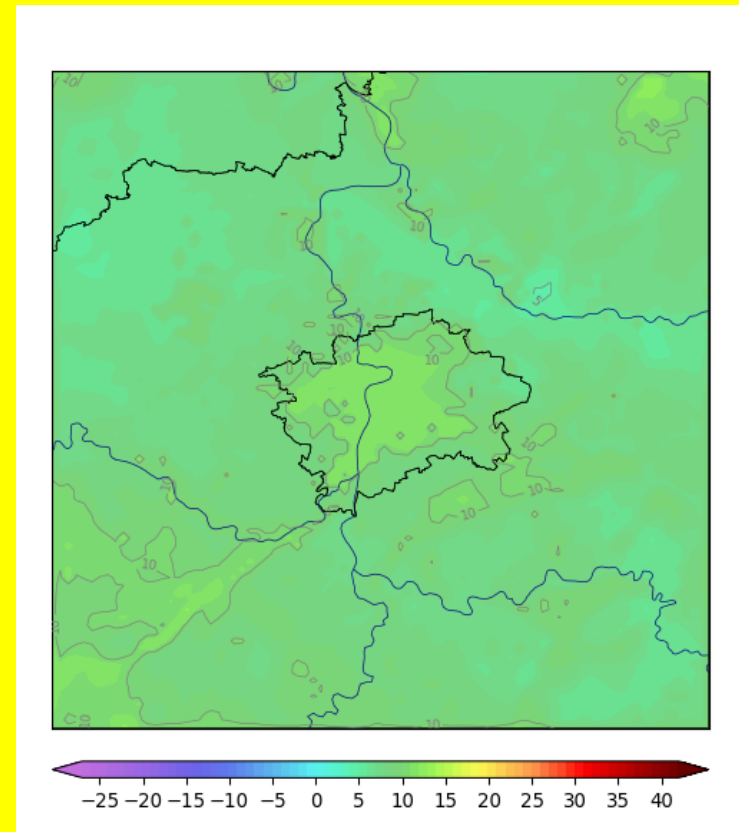


Present situation 05:00

S městem



Bez města



Urbanization of air-quality forecast



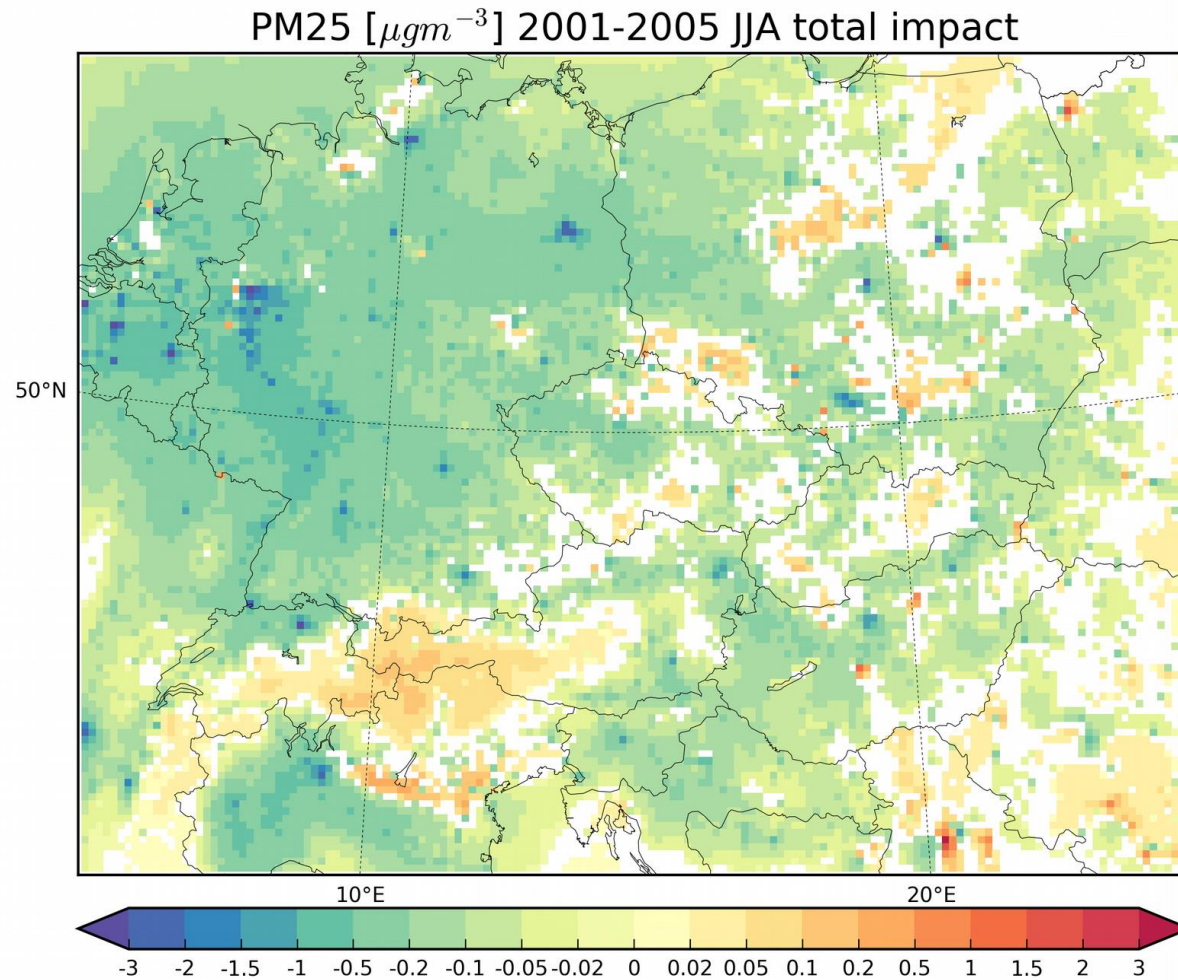
- air quality prediction based on urbanized weather forecast (role of mixing layer height, wind velocity, temperature, etc) using coupled simulations of WRF and CTM in very high resolution simulations of 1 km with localised urban emissions
- to provide more detailed information for warnings, planning of the activities of population, planning of the services to adapt and mitigate the effects of urban environment
- to provide quasi-operationally the tool for the assessment of the potential of regulatory measures, esp. for transportation, for mitigation of concentration exceedances



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PM2.5 urban effect



Urbanization of climate change scenarios



- urbanization of climate change scenarios results from CMIP and EuroCORDEX available simulations
- urbanized simulations for dynamical downscaling of selected climate change scenarios simulations in very high resolution simulations (3 km) with localised urban parameters for individual parts of the city
- to provide the tool for the assessment of the potential of measures for adaptation and mitigation adopted in Strategic City Development Plan in long term perspective, together with air-quality issues



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Hot-spots simulations



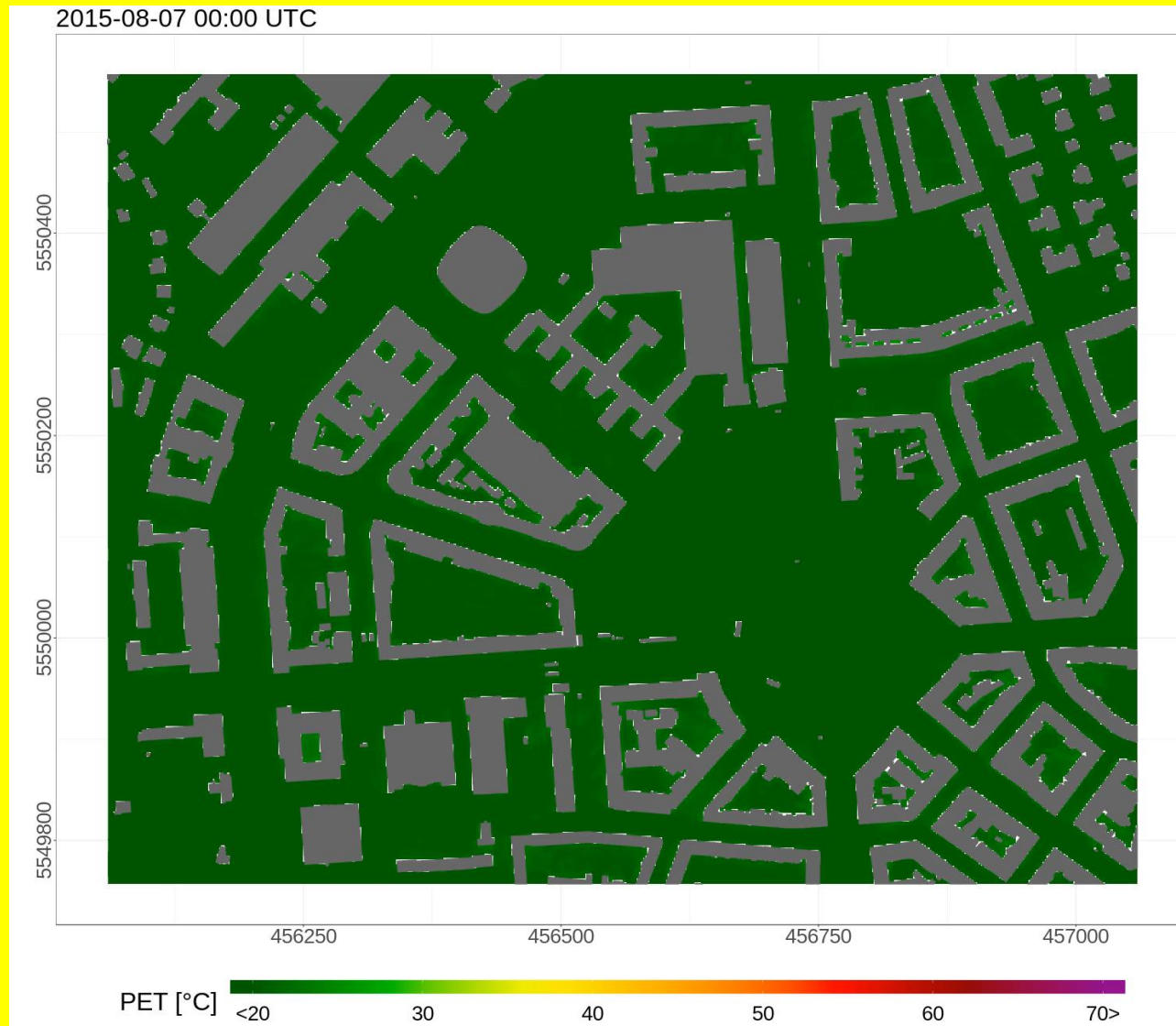
- LES tools for more detailed assessment of selected hot-spots in the city (PALM), at scale of individual streets, blocks, ...
- connected with air-pollution transport, option to run quasi-operationally connected to urbanized weather and/or air-quality prediction
- to provide the tool for the assessment of the potential of measures for adaptation and mitigation the harmful effects at selected locations



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PET – PALM simulation



Conclusions

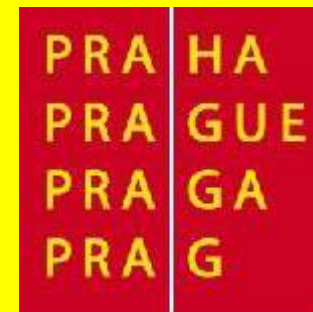


- Urban surfaces have significant impact on the meteorological conditions and climate in Central Europe, with increasing effects on population and up-to-date science can capture it
- Urban heat island effect clearly identified in simulations as well, mainly during summer and nighttime, especially significant under extreme weather like heat wave
- High-resolution achieved the city's scale, no excuse to neglect it, localized simulations, weather prediction for cities, with extreme events for adaptation or mitigation options can be done
- Higher complexity parameterization necessary to capture the effects fully, which might be important e.g. for air-quality issues

Proof of concept and further more detailed assessment within the project URBI PRAGENSI, topic taken to CORDEX activity platform – possibly planning FPS



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Acknowledgement



The work recently supported within OP-PPR URBI PRAGENSI - Urban Heat Island (UHI) weather forecast, air quality prediction and climate scenarios for Prague CZ.07.1.02/0.0/0.0/16_023/0000383, OP-PPR project Proof of Concept UK, CZ.07.1.02/0.0/0.0/16_023/0000108, Ověřování praktičnosti a komerčního potenciálu výsledků výzkumu Univerzity Karlovy, started under support of EC FP7 Project "Development and Application of Mitigation and Adaptation Strategies and Measures for Reducing the Global Urban Heat Island Phenomenon" within the framework of EC Operation Program Regional Development (3CE292P3), using the previous development achieved under EC FP6 STREP Grant agreement no.: 212520.

THANKS FOR YOUR ATTENTION !



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