WCRP CORDEX
Coordinated Regional Climate Downscaling Experiment

# Klima Prahy

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# Od URBI PRAGENSI k mezinárodnímu kontextu

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# Motivation

World:

- From 1995 - more than 50% of the world's population living in cities (UN, 2009)
- 2030 – more than 60% expected
- Adaptation committee UN FCCC – $1.8 trillion investment in 2020-2030 benefit of $7.1 trillion, cities one of critical issues

Europe:

- 2008 - 73% of the population in cities
- mid 21th century - 84%, representing a rise from 531 to 582 millions (UN, 2008)

Clearly:

- Quite many atmospheric effects on population through the urban environment
- Especially extreme weather effects like heat wave and air-quality threshold exeedances

Moreover:

- Significant increase of the models resolution where large city‘s (megacities) scale achieved, thus urban infrastructures – atmosphere interactions processes can be resolved and should be considered
- Improvement of urban infrastructures data availability

# Projekt URBI PRAGENSI

- Urbanizace předpovědi počasí
- Urbanizace předpovědi kvality ovzduší napojená na urbanizovanou předpověď počasí
- Urbanizace scénářů klimatické změny, nástroje pro zhodnocení účinnosti adaptačních či mitigačních opatření (např. pro strategické plány rozvoje města
- Mikroměřítkové simulace hot-spotů

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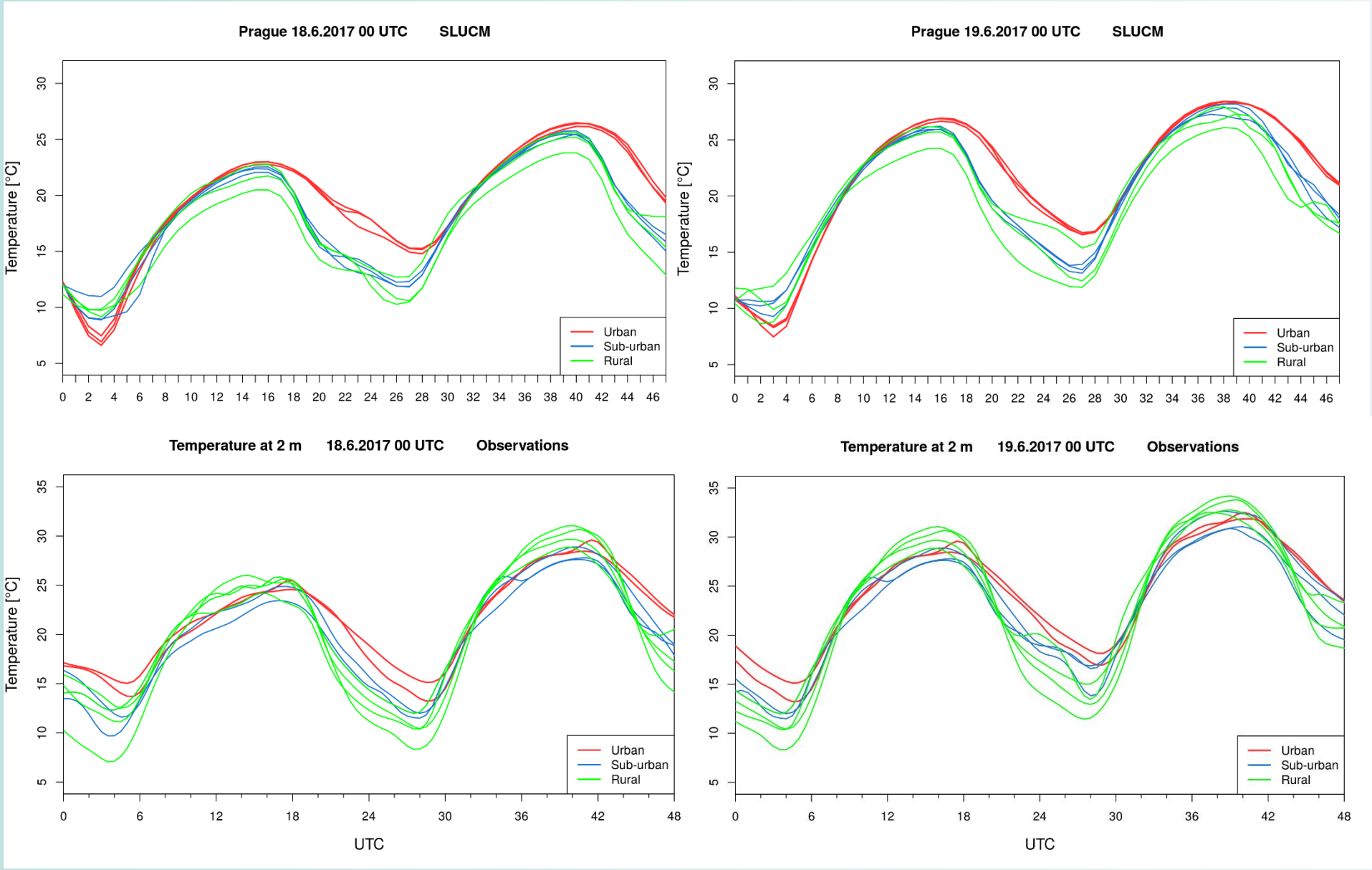
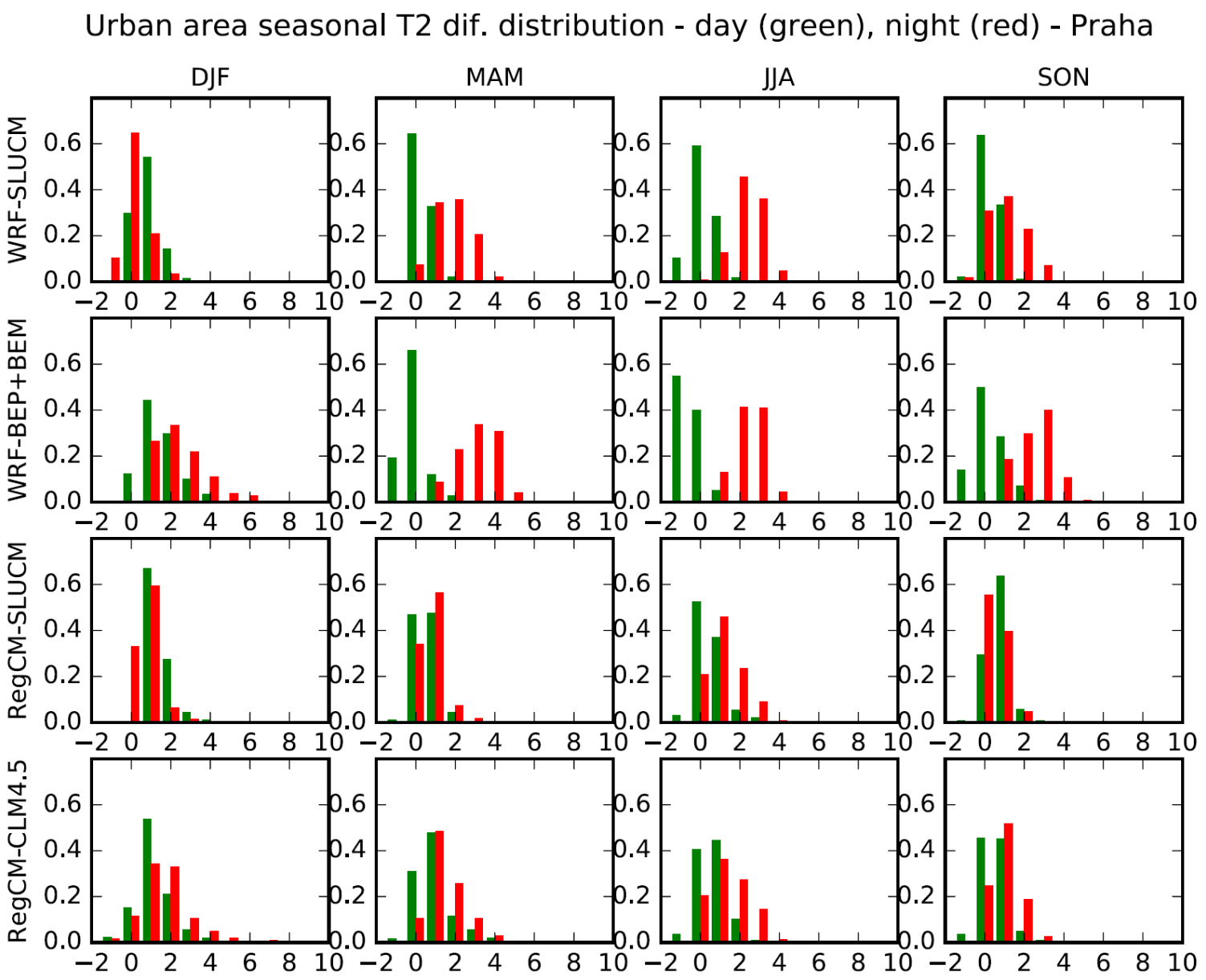
ČESKÝ HYDROMETEOROLOGICKÝ ÚSTAV

INSTITUTE OF COMPUTER SCIENCE
The Czech Academy of Sciences

# URBI PRAGENSI - WRF forecast with SLUCM (3km)



# URBI PRAGENSI - UHI intensity in Prague (day vs. night)




Karlicky et al. (ACP, 2018)

Climate simulations:
10 years
resolution 10km
Central Europe

# Short introduction FPS URB-RCC

URB-RCC

***Understand the effect of urban areas on the regional climate, as well as the impact of regional climate change on cities, with the help of coordinated experiments with urbanized RCMs***

**Main Objectives:**

- *Understanding and assessing urban climate change impacts.*
- *Investigating interactions of urban environment with local/regional climate for (mega)cities based on coordinated ensemble using urbanized RCMs in CORDEX experiments.*
- *Assessing options for urban parameterization (UP) schemes in high-res RCM simulations for further use in CORDEX.*
- *Better understanding the urban environment's vulnerability under CC and providing the urban CC science to underpin climate services for cities.*

# Phases

***Phase 1: (started May 2021)***

- Overview of urban effects/parameterization schemes incorporated
- Analysis of available simulations outputs to understand CC impacts in different big cities
- Co-developing simulation protocols and criteria for city(ies) selection for coordinated (convection permitting (CP)) experiments.

***Phase 2:***

- Coordinated (CP) experiments - validation
- Identify urban processes needed to be included in future RCM simulations

***Phase 3 (for selected experiments):***

- Coupling to Chemical Transport Models
- Include urbanization scenarios

***Phase 4:***

- Coordinated (CP) experiments with full complex urban effects under future scenarios
- Comparison and added value assessment of urban effects in regional/local CC
- Assessment of knowledge on urban regional climate and CC impacts, and connection to climate services development

# End to end perspective/potential to support local/regional needs (expected impact)

Share of population living in urban areas is projected to reach about 70% of the world population up to 2050

→ Urban environments are vulnerable to climate change

URB-RCC

***Improved scientific understanding and robust assessment of CC impacts in the urban environment supports:***

- ***urban climate services development,***
- ***risk management,***
- ***city planning,***
- ***development and proposing adaptation or mitigation measures to minimize e.g. the health effects, air-pollution exceedances, ...***

Demonstrated connection to end-users will play important role for city selection

# Applicant groups/Partners

- 30 partners, about 2/3 EURO-CORDEX (/MedCORDEX) partners, some overlap with FPS Convection and LUCAS, which are close to the topic
- 9 partners outside of Europe (Africa, N/S-America, Australia, Asia)
- Remains open to additional partners, especially for Phase 1 and for coordinated experiments
- Mainly RCM community, complemented with urban climate community to add expertise in the subject

# Phase 1

- **Models overview** - urban schemes included (Google Table – 26 inputs)
- **Science topics:** CORDEX-CORE, EuroCORDEX0.11, FPS, EUCP, coordinated simulations
  - urban climate change signal
  - extremes in the cities
  - regional effect of urbanized areas
  - sensitivity on city size and density
  - urbanization development effects
  - role of individual urban – atmosphere interaction processes
  - effects on precipitation – convection, aerosols interaction
  - Reliability of the urban impacts information based on CORDEX-CORE
- **Coordinated urbanized simulations:**
  - Simulation protocol (coordinated experiment vs.individual cities of partners interest)
  - City selection

# Models Overview

- Google.docs Table – 26 inputs
- **Models:** RegCM, WRF, WRF-Chem, REMO, WRF-CMAQ, RegIPSL, CCAM, CCLM, HMS-ALADIN5.2, ALARO, COSMO-CLM, AROME, WRF-AUTH, WRFV381, HCLIM-AROME, COSMO & COSMO-CLM, possibly COSMO-ART (work on COSMO + ART + TERRA_URB coupling is onoing), transition to ICON is planned for next few years,
- **Urban schemes:** SLUCM-BATS (own implementation), SLUCM in CLM with RegCM, bulk, SLUCM, MLUCM (BEP-BEM) with WRF, Urban tile (to be implemented), UCLEM, TERRA-URB (Urban Parametrization, Wouters et al., 2016) - Bulk scheme - Tile approach, online: bulk scheme (rock), tile approach; offline: TEB (Masson, 2000), tile approach, TEB+BEM, inline : ISBA (bulk), offline : TEBoffline + urban signature, UCM, Urban canopy model, BEP Building Environment Parameterization, BEM Building Energy Model, Slab model at sub-regional scales (16-4 km), Urban tile (to be implemented), Single layer UCM, CLMU
- **Many other characteristics of implementation and simulations**

# Cooordinated City Selection

- **Candidate Cities:** Paris, London, Shangai, Buenos Aires, Johannesburg, Beijing
- **Supporting characteristics:** available measurement campaigns, other data, urban infrastructure data, urbanization trends, other studies for comparison, specific climate features

- Potential „satellite“ cities of individual interest of participating groups
- Preliminary results, for some of the cities we can achieve quite reasonable number of simulations to get more robust results

# EC Horizon Europe - FOCI

Non-CO2 Forcers and their Climate, Weather, Air Quality and Health Impacts

Goal: **to improve our knowledge of individual and cumulative contribution of non-CO2 radiative forcers and their precursors.**

- to assess the impact of key radiative forcers, where and how they arise, the processes of their impact on the climate system
- to find and test an efficient implementation of these processes into global ESMs and into RCMs, eventually coupled with CTMs, down to urban scales, and to use the tools developed to investigate mitigation and/or adaptation policies incorporated in selected scenarios of future development targeted at Europe and other regions of the world
- to target species with the greatest uncertainty in determining their impact on climate change and the associated influence on weather patterns (e.g., atmospheric and ocean circulation and extreme weather events), air pollution episodes and health impacts
- To focus on the radiative forcing properties of PM2.5/PM10, CCN and their components (e.g., POA, SOA, BC/EC, SIA, dust), O3(and its precursors NOx, VOCs, SO2, carbon monoxide (CO)), CH4, and N2O in the wider context of the warming potential of all key GHGs.

# EC Horizon Europe – new project

New project is getting ready to start, with overarching goal „ to improve the quality, accessibility and usability of near-term climate information and services at local to regional scales – where impacts are most keenly felt and on-the-ground adaptation is implemented“

Developed in some specific urban related objectives

- Develop novel methods to downscale predictions to local scales
- Improve assessments of hazards and translate this into usable information for local risk assessments
- Make advances towards the goal of end-to-end seamless climate services
- Through transdisciplinary co-production approaches develop fit-for-purpose "Adaptation support packs" at municipal scales through our so-called urban Demonstrators (Prague included)
- Prague – test to infrastructure characteristics setting (urban zones vs. direct values), air quality effects

# Shrnutí

- Významný efekt městského prostředí na atmosférické podmínky a klima, jehož význam s rostoucím podílem populace žijící ve městech roste
- Současné technologie umí tento vliv dobře zachytit, tepelný ostrov je jasně identifikován v modelových simulacích v souladu s pozorováním, tedy především v létě a noční době, a zvláště za významných termických extrémních situací, tj. především v tzv. horkých vlnách
- Vysoké rozlišení současných numerických modelů dosáhlo měřítka města, nelze je nadále ignorovat, možnost lokalizovaných simulací, předpověď počasí pro města realitou, scénáře klimatické změny s vyhodnocením adaptačních a mitigačních opatření
- Pro zachycení všech procesů, zvláště pro účely modelování kvality ovzduší, je třeba komplexnějších parametrizací

„Proof of concept“ a další zhodnocení v rámci projektu URBI PRAGENSI a jeho udržitelnosti, tématika vnesena do mezinárodní aktivity CORDEX – FPS URB-RCC, EC Horizon Europe projekt FOCI, nový projekt připravován, WMO koordinace

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