WCRP CORDEX
Coordinated Regional Climate Downscaling Experiment

FPS URB-RCC
WCRP CORDEX

IMPETUS 4 CHANGE

FOCI

Klima a kvalita ovzduší Prahy v mezinárodních aktivitách modelování urbanizace a poskytování klimatických služeb

Funded by the European Union

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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, expected IPCC AR7 cycle Special Report on Cities

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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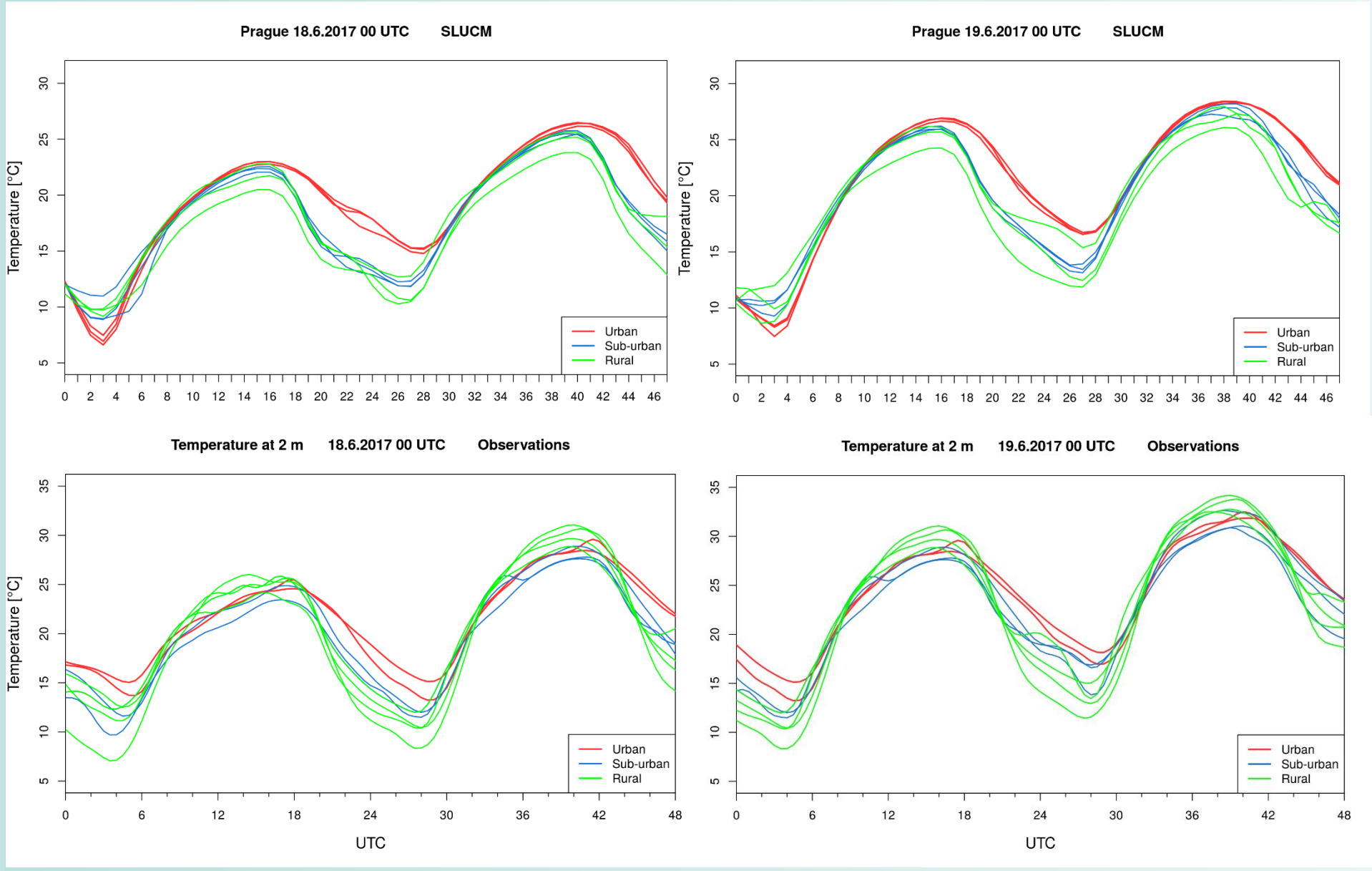
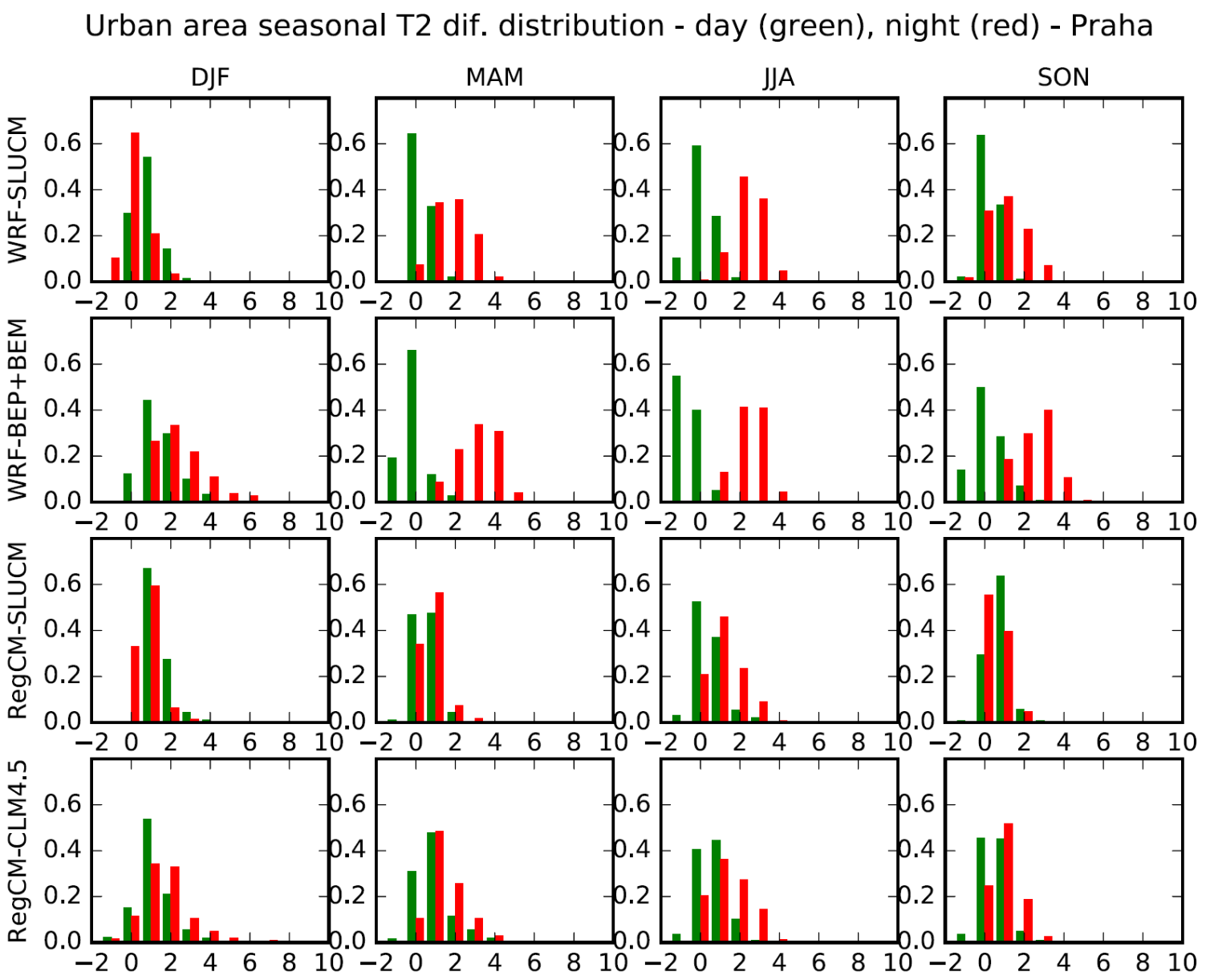
ČESKÝ HYDROMETEOROLOGICKÝ ÚSTAV

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

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

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

„Geohazards“
Natural and anthropogenic georisks

Project number: **CZ.02.01.01/00/22_008/0004605**

WP2

Modelling, Prediction and Projection of Atmospheric and Climate Risks with Their Impacts

Co-funded by the European Union

MINISTRY OF EDUCATION, YOUTH AND SPORTS

WP2 – Modelling, Prediction and Projection of Atmospheric and Climate Risks with Their Impacts

- Modelling of future scenarios, impacts, local optimization, solutions
- Significantly inter/multi-disciplinary
- Cooperating partners: IAP CAS, CzechGlobe CAS, ICS CAS
- Affiliate institution: CHMI
- Cooperating departments from Faculty of Mathematics and Physics: Dept. Of Atmospheric Physics, Dept. Of Chemical Physics and Optics, Dept. of Applied Mathematics, Dept. of Information Theory and Theoretical Logics, Dept. of Distributed and Dependable Systems, Dept. of Probability and Mathematical Statistics, Institute of Formal and Applied Linguistics

WP2 – Modelling, Prediction and Projection of Atmospheric and Climate Risks with Their Impacts

Aims

- Climate change projections
- Climate change impact, risk phenomena
- Analysis of their causes
- Assessment of their consequences in selected areas of human activity

Methods

- Based on the analysis of available model simulation data
- Supplemented by our own model results
- Especially in terms of the extreme characteristics and indices, which are easier to interpret in the research of the impacts consequences in follow-up studies of selected areas.

Connections

- International cooperation envisaged in the ongoing activities (Horizon Europe FOCI, Horizon Europe IMPETUS4CHANGE, CORDEX FPS URB-RCC, EuroCORDEX)
- local big projects PERUN, SEEPIA (TACR, Ministry of Environment „Environment for Life“

WP2 – Modelling, Prediction and Projection of Atmospheric and Climate Risks with Their Impacts

Objectives:

1. Preparation and analysis of available model data and model development
2. Analysis of output uncertainties and their impact on projections of climate change and risk events
3. Construction of climate change and risk scenarios for the selected area
4. Analysis of climate prediction options using currently available resources
5. Climate change projections for selected large cities with emphasis on risk phenomena
6. Assessment of the consequences of climate change and risk phenomena in selected sectors (health, agriculture, forestry, socio-economic), their prevention and warning
7. Benefit-risk analysis of sulphur aerosol-based geoengineering

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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.

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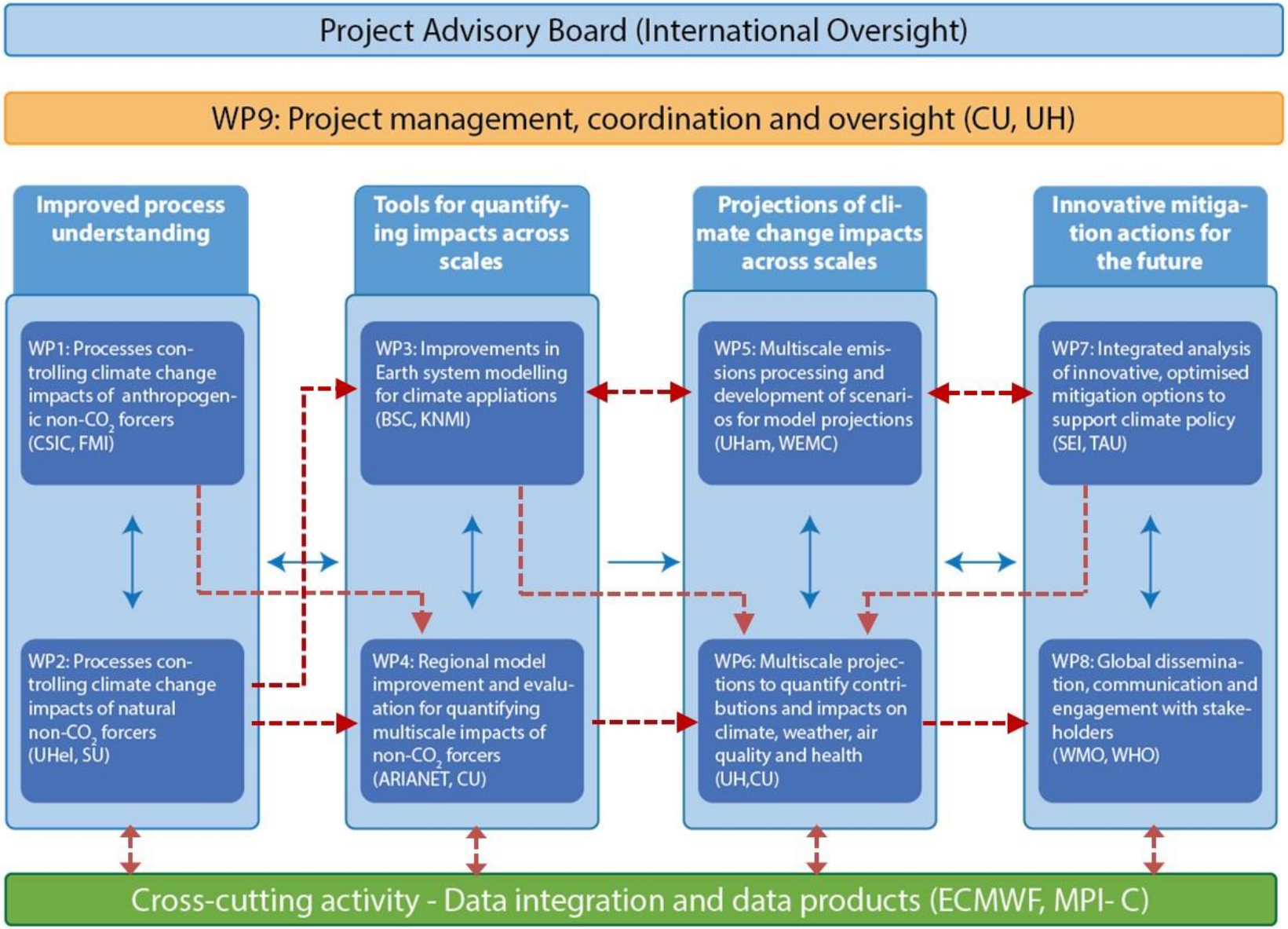
FOCI - Scheme



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EC Horizon Europe – IMPETUS4CHANGE

Improving NearTerm Climate Predictions for Societal Transformation

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 urban Demonstrators (Prague included)
- Prague – test to infrastructure characteristics setting (urban zones vs. direct values), air quality effects

ADAPTALAB in I4C

- important part of the process of developing climate services with a real impact
- participants from different disciplines and sectors
- collaborating to develop innovative solutions for a specific problem

Adaptalab I: Paris, 29/11-1/12, 2023

creating mock-ups for the climate services that I4C is developing.
working groups exploring the services, reviewing their format, content, target audience, visual presentation, and usability

Adaptalab II: Barcelona, Feb/March, 2025

Adaptalab III: Prague 2026 ???

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Hazard Indices

IMPETUS 4CHANGE

- Worked with demonstrators from start of project to develop list of hazard indices
- 19 general indices and 4 demonstrator-specific indices
- All calculated indices will be available through an online toolkit
- Details of indices given in Deliverable 4.1 report (delivered in June 2023)

1. EURO-CORDEX - full European domain
2. Existing convection permitting climate model (CPCM) simulations – various domains
3. Calculate from simulations and emulations from WP3 – three domains

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Simulated outputs

IMPETUS 4CHANGE

out_name	frequency	units	long_name	priority	priority-urb	priority-conv	comment
vas	1hr	m s-1	Northward Near-Surface Wind	I4C-CORE	URB-CORE	CONV-CORE	T33 WP6
vas	day	m s-1	Northward Near-Surface Wind	I4C-CORE	URB-CORE		T33 WP6
uas	1hr	m s-1	Eastward Near-Surface Wind	I4C-CORE	URB-CORE	CONV-CORE	T33 WP6
uas	day	m s-1	Eastward Near-Surface Wind	I4C-CORE	URB-CORE		T33 WP6
tas	1hr	K	Near-Surface Air Temperature	I4C-CORE	URB-CORE	CONV-CORE	T33 WP4 WP6
tas	day	K	Near-Surface Air Temperature	I4C-CORE	URB-CORE		T33 WP4 WP6
snw	1hr	kg m-2	Surface Snow Amount	I4C-CORE			WP6
sfturf	fx	%	Percentage of the Grid Cell Occupied by Urban Area	I4C-TIER2	URB-CORE		T33 WP4 WP6 not in CMIP or in CF
sftlf	fx	%	Percentage of the Grid Cell Occupied by Land	I4C-CORE	URB-CORE	CONV-CORE	T33 WP4 WP6
sfcWind	1hr	m s-1	Near-Surface Wind Speed	I4C-CORE	URB-CORE		T33 WP6
sfcWind	day	m s-1	Near-Surface Wind Speed	I4C-CORE	URB-CORE		T33 WP4 WP6
rsds	1hr	W m-2	Surface Downwelling Shortwave Radiation	I4C-CORE	URB-CORE	CONV-CORE	T33 WP6
rsds	day	W m-2	Surface Downwelling Shortwave Radiation	I4C-CORE	URB-CORE		T33 WP6
rlds	1hr	W m-2	Surface Downwelling Longwave Radiation	I4C-CORE	URB-CORE	CONV-CORE	T33 WP6
rlds	day	W m-2	Surface Downwelling Longwave Radiation	I4C-CORE	URB-CORE		T33 WP6
ps	1hr	Pa	Surface Air Pressure	I4C-CORE	URB-CORE		WP6
pr	1hr	kg m-2 s-1	Precipitation	I4C-CORE	URB-CORE	CONV-CORE	T33 WP4 WP6
pr	day	kg m-2 s-1	Precipitation	I4C-CORE	URB-CORE		T33 WP4 WP6
orog	fx	m	Surface Altitude	I4C-CORE	URB-CORE	CONV-CORE	T33 WP4 WP6
mrso	1hr	kg m-2	Total Soil Moisture Content	I4C-CORE			WP6 The mass of water in all phases per unit area, summed over all soil layers.
mrros	1hr	kg m-2 s-1	Surface Runoff	I4C-CORE		CONV-CORE	WP6
mrro	1hr	kg m-2 s-1	Total Runoff	I4C-CORE		CONV-CORE	WP6
huss	1hr	1	Near-Surface Specific Humidity	I4C-CORE	URB-CORE	CONV-CORE	T33 WP6
hurs	1hr	%	Near-Surface Relative Humidity	I4C-CORE	URB-CORE		T33 WP6

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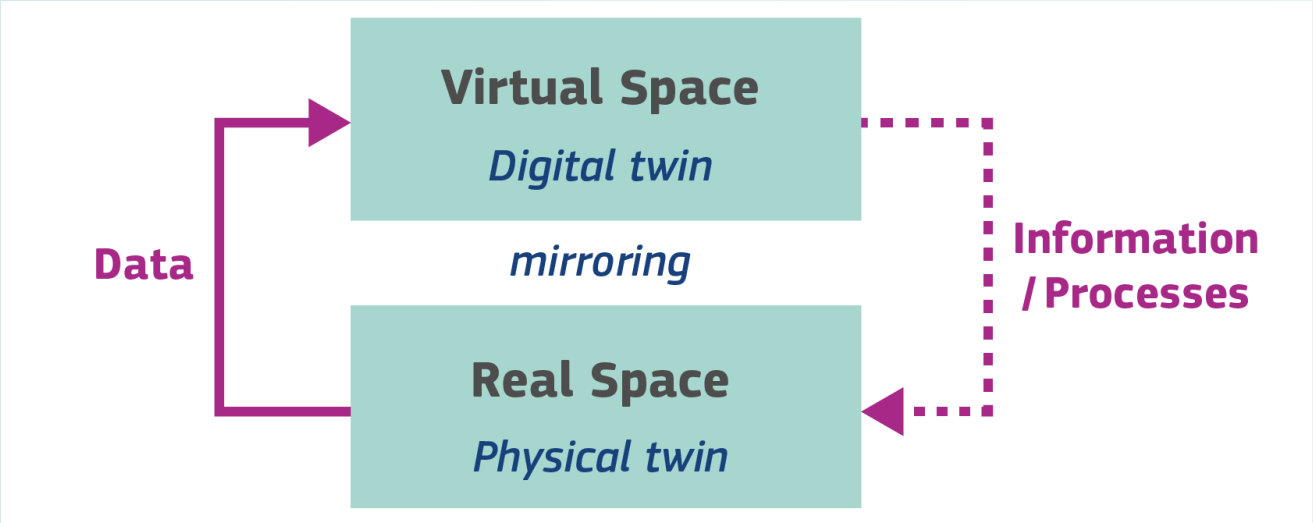
EC Project – Destination Earth (DestinE)

Destination Earth – Digital Twins Concept

Overarching goal „ to develop a highly accurate digital model of the Earth (a ‘digital twin’) to monitor and predict environmental change and human impact to support sustainable development“

Why:

- Evidence-based policy development
- Contribution to the European Green Deal
- Accessing data and benchmarking models
- User-Specific and Actionable Predictions



Main Partners:
European Space Agency (ESA),
European Centre for Medium-Range Weather Forecasts (ECMWF)
European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)

Funded by the European Union

DestinE – Urban Digital Twin

URBAN HEAT USE CASE

virtual representation of a city's environment: buildings, streets, parks, and trees

Using cutting-edge technologies such as cloud storage and HPC, they integrate real-time data through sensors (e.g. traffic signals, power grids) for use by city departments and policymakers through real-time visualisations to:

- improve urban planning and infrastructure management
- manage urban traffic
- predict extreme weather events
- improve waste collection
- reduce energy consumption

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, EC Horizon Europe projekt IMPETUS4CHANGE, WMO koordinace, IPCC AR7 cyklus – Speciální zpráva k městům, projekt PERUN – TAČR/MŽP Prostředí pro život

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PRA G

Akce

- Adaptalab 2026???
- IMPETUS4CHANGE Project Meeting 2025
- Air Quality – Science and Applications (former Urban Air Quality) 2026 Praha

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