# Investigating the urban climate characteristics of Budapest with SURFEX/TEB land surface model

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#### Motivation

Conclusions and future plans

## Outline



- Introduction
  SURFEX/TEB
  - Experimental design
- 3 Results
  - Added value of SURFEX to ALADIN-Climate
  - Validation of temperature results
- 4 Conclusions and future plans
  - Conclusions
  - Future plans

In Hungary, urban impact studies have been based on either regional climate models or microscale models (in better case) until now.

 ORIENTGATE project: vulnerability studies for a district in Budapest (13 km<sup>2</sup>) and town of Veszprém (127 km<sup>2</sup>) based on 10 and 25 km resolution RCM outputs.

• UHI project: adaptation investigations were based on ENVI-MET model. E.g. impact of settling trees in a street.

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However with fine resolution RCMs and specific physical parameterization schemes, adequate dynamical impact studies can be performed for the entire city.

SURFEX/TEB Experimental design

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## SURFEX Land Surface Model

- tiling approach [natural land, inland water, sea, town]
- simulates turbulent heat and moisture exchange between surface and atmospere
- may be coupled to an atmospheric model in online or offline mode
- physiography information from ECOCLIMAP database (1 km resolution, 243 different types of surfaces)



Source: http://www.cnrm.meteo.fr/surfex/

SURFEX/TEB Experimental design

## Scheme over town tiles: TEB

- Town Energy Balance scheme
- cities represented as canyons
- surface energy and soil moisture budget for three types of surfaces: road, wall and roof
- antropogenic heat and moisture release from traffic, industry and households



Based on Masson (2000)

SURFEX/TEB Experimental design

## Experimental design



- LBC of ALADIN-Climate: ERA-40
- SURFEX in offline mode
- Period: 1991-2000

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#### Summer mean 2-m temperature in ALADIN and SURFEX

Fraction of town by ECOCLIMAP

- ALADIN results interpolated → temperature pattern follows topography



3

0.5

-1

-2

-3

-0.5

Added value of SURFEX to ALADIN-Climate Validation of temperature results

## Diurnal evolution of summer UHI



$$UHI_i = T_i - \overline{T}_{rur}$$

- average daily cycle of UHI seems realistic
- objective validation is limited, because available observation datasets are
  - CARPATCLIM (gridded, 10 km resolution, 1961–2010)
  - 2 for this period only one observational site in the city core

Added value of SURFEX to ALADIN-Climate Validation of temperature results

### 2-m temperature bias. Reference: CARPATCLIM



#### CARPATCLIM

- its 10 km resolution is coarse for us
- impact of cities cannot be detected (in Budapest only 2 urban stations were taken into account)
- Daily mean temperature:  $avg(T_{max}, T_{min})$

- SURFEX heats the ALADIN results → larger overestimation
- bias field is spatially variable

Added value of SURFEX to ALADIN-Climate Validation of temperature results

#### 2-m temperature bias in urban and rural gridpoint

Reference: observational station measurements

Temperature bias









Urban site

Suburban site

- ALADIN underestimates 2-m temperature in every month
- larger negative bias over the inner gridpoint
- in ECOCLIMAP: both gridpoints have the same class (temperate suburban, [*F<sub>town</sub>*=0.6])!!!
- Result: UHI is negative (in reality 0.5–1  $^{\circ}$ C)
- in ideal case: taking the temperature difference → eliminates the bias

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- Urban impact studies are performed with SURFEX land surface model coupled to ALADIN-Climate RCM
- Thanks to TEB, SURFEX is able to perform the theoretical pattern and diurnal evolution of UHI
- But! exact validation is difficult classical tecniques can be applied on a limited extent (e.g. only few observational sites in the city, shorter time series)
- Plan: usage of satellite data
- Achilles' heel of impact studies: garbage in garbage out (?)
- It is very important to improve the RCMs as well as the impact models



- 2 Long term urban climate simulations
  - for the past validation
  - for the future projection
- Final aims: collaborate with urban planners and stakeholders. But it is still in infancy in Hungary.



- Detailed sensitivity study with SURFEX, and its interaction with the forcing  $\rightarrow$  proper settings of the model
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  - for the past validation
  - for the future projection
- Final aims: collaborate with urban planners and stakeholders. But it is still in infancy in Hungary.

## Thank you for your attention!