

SENSITIVITY OF THE SURFEX LAND SURFACE MODEL TO FORCING SETTINGS IN URBAN CLIMATE MODELLING

Gabriella Zsebeházi

PhD supervisor: Gabriella Szépszó

Regional Climate Modelling Group, Hungarian Meteorological Service
Budapest (Hungary)



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Outline

1. Motivation
2. Models and background
3. Sensitivity test
4. First results
5. Conclusions and future plans

Motivation

- High demand to estimate **exposure of cities to climate change**
→ essential for proper **adaptation strategies**
- Regional climate models (RCMs)
 - detailed information about background climate
 - coarse resolution → cities: bare rocks / substituted by neighbouring land cover
- Tool for describing urban climate processes: **land surface models (LSMs)**

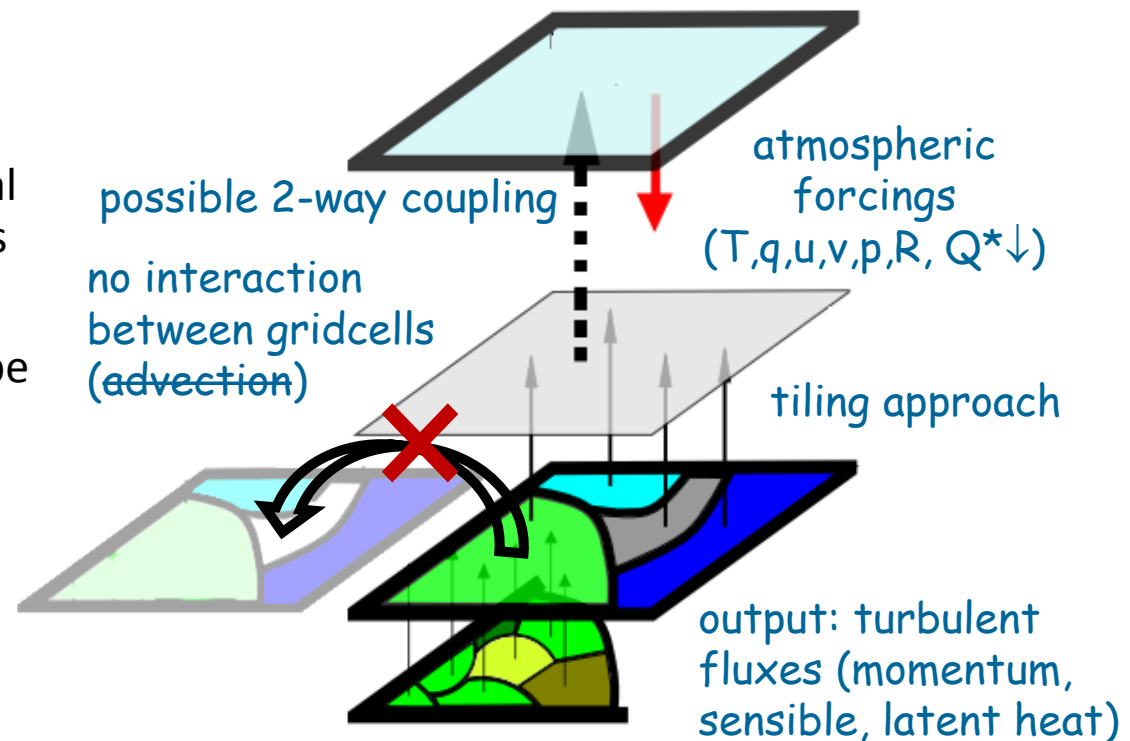
SURFEX land surface model

Why LSMs for urban climate modelling?

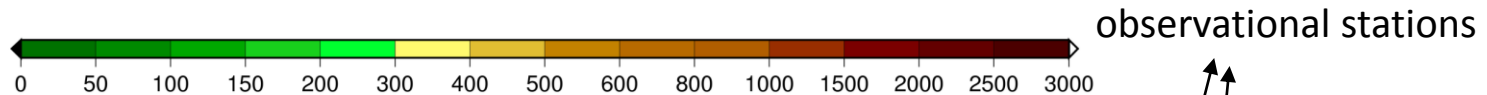
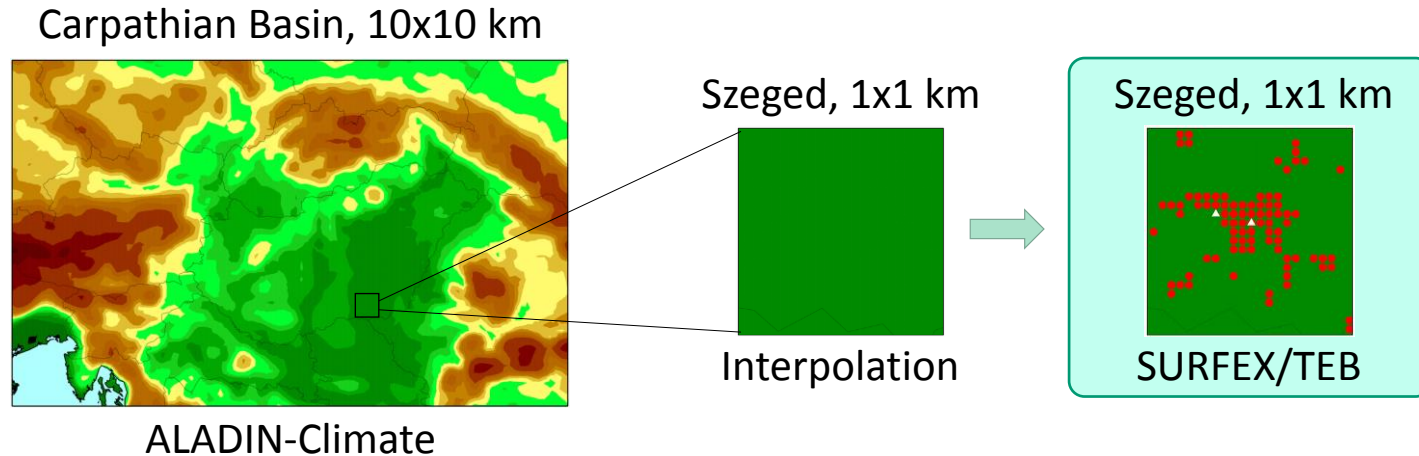
- ✓ RCM output fields as atmospheric forcings + physical description of urban processes (→↔ statistical methods)
- ✓ meso-scale modelling → can be applied on decadal time-scale over the entire city (cost efficiently) (→↔ microscale models)

TEB (Town Energy Balance Model)

- Canyon scheme
- Prognostic equations for surface energy and water budget of roof, wall and road



Urban climate modelling at OMSZ

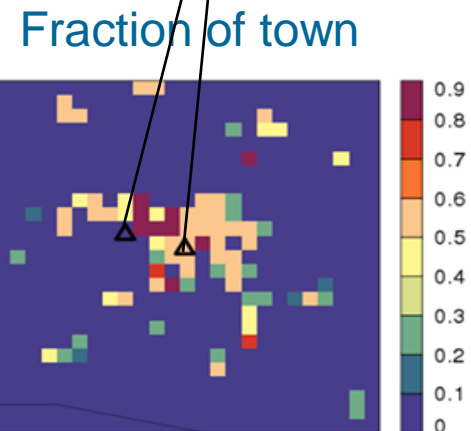


1. step: validation

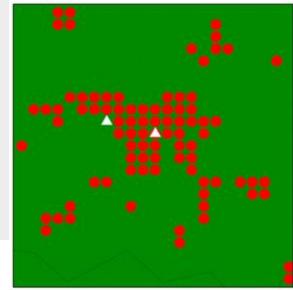
- Forcings: re-analysis driven ALADIN-Climate
- Simulation period: 1991–2000

Evaluation methods:

- Mostly visually, because only a few station data is available

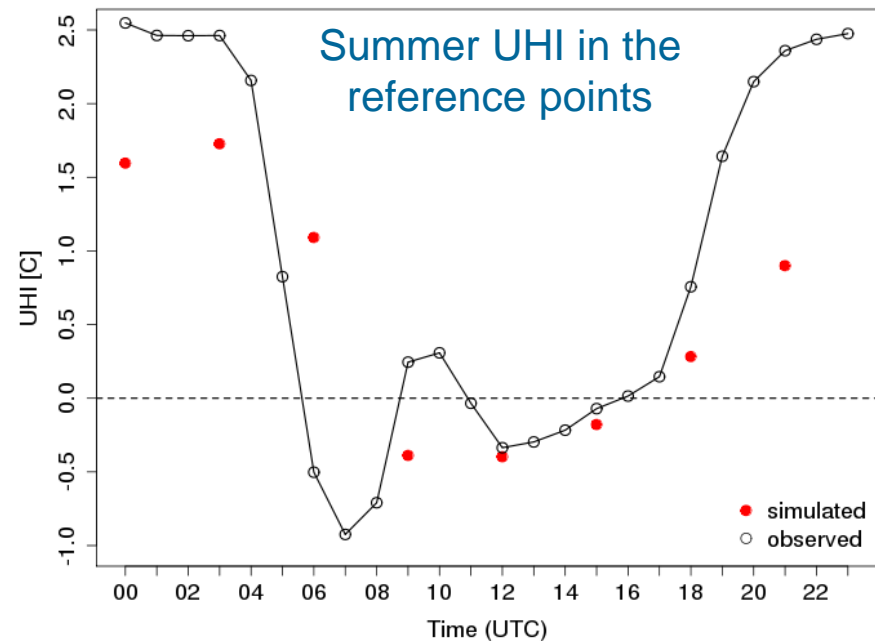
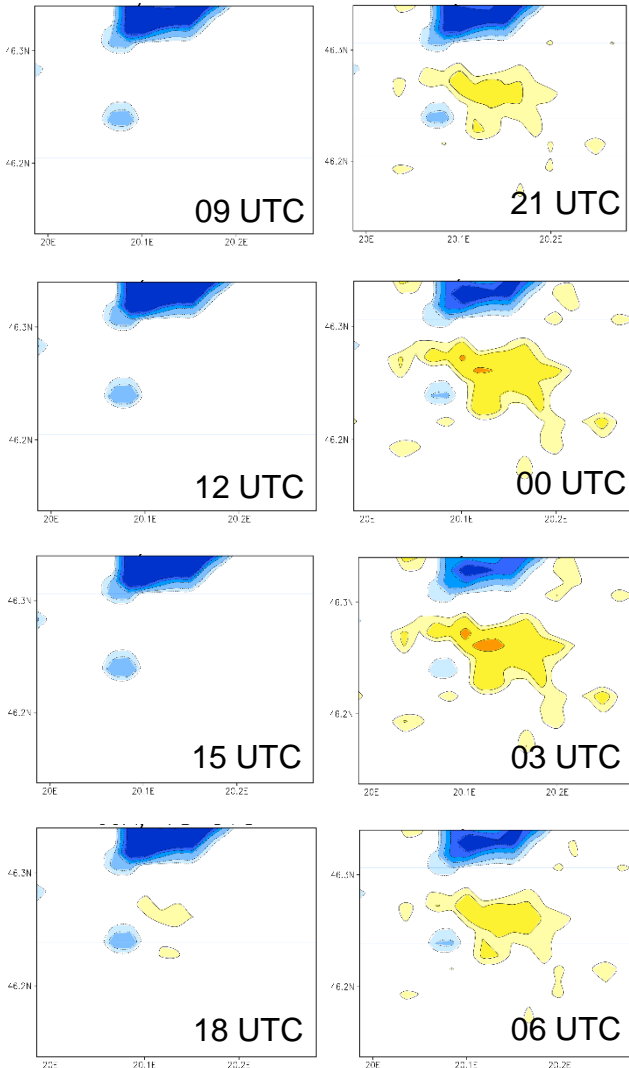


Results in 1991–2000



Daily cycle of summer UHI

← Seems realistic, but accurate in space and time?



Quite good agreement, however

- delay in diurnal changes
- daily amplitude is smaller

attempt to improve

Sensitivity test

Goals:

- Improving the results: find the most sensitive settings
- Understand model behaviour

Execution: focus on coupling strategy of atmospheric forcings in offline mode

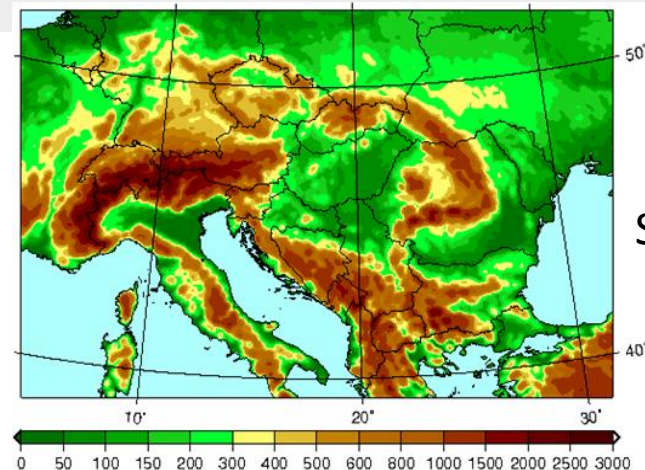
- *Frequency of forcings update*
(convention: RCM outputs saved 3 hourly → enough?)
- *Height of forcings*
(values near the lowest model level are used)

Model set-up

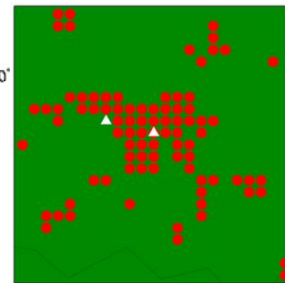
Atmospheric forcings: **ALADIN-Climate**

Version	5.2
LBC	ERA-Interim
Domain	Central-Europe
Resolution	10 km
Period	1 year (2001)

ALADIN domain



SURFEX domain



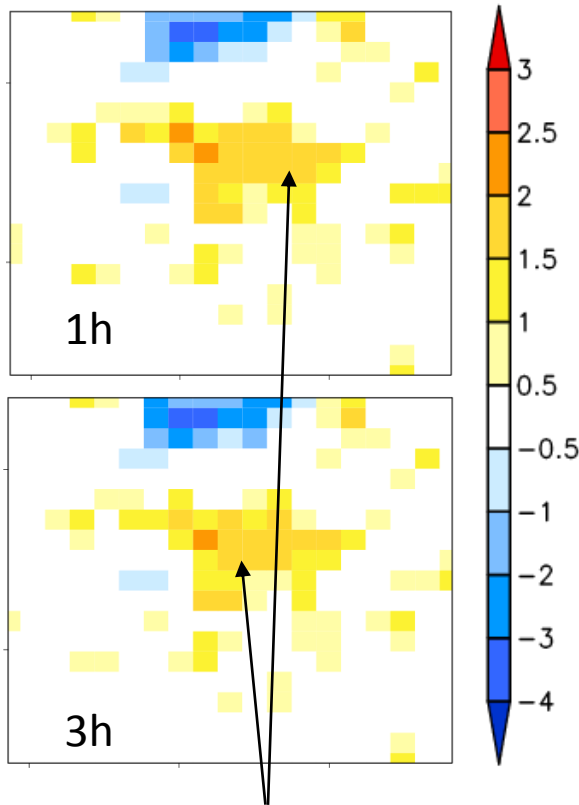
SURFEX

Version	7.3 (upgrade)	
Domain	Szeged	
Resolution	1 km	
Frequency of forcing update	1 h / 3 h	EXP_[.]h
Height of forcings	20, 30, 40, 50 m	EXP_[.]m

name

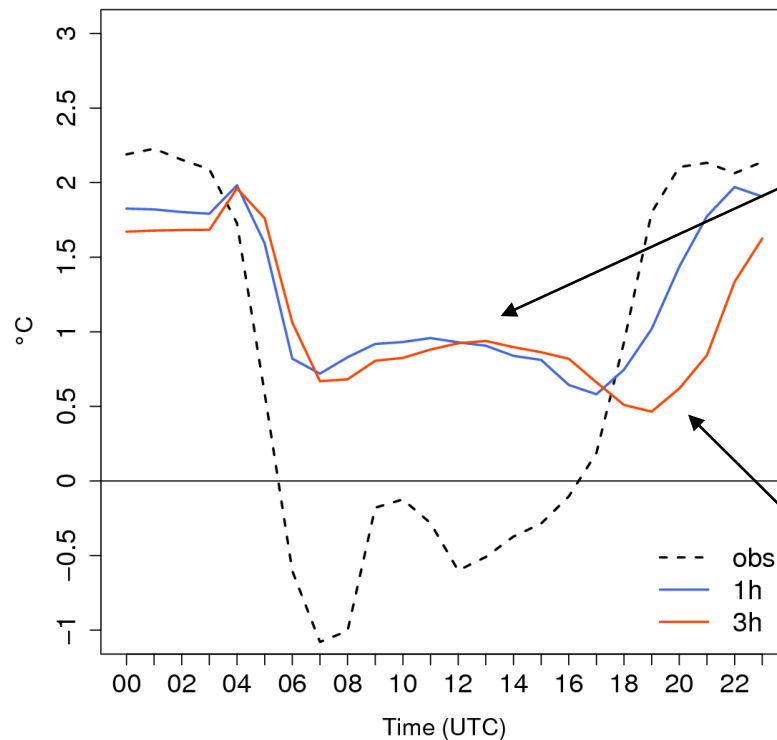
Results – forcing update

UHI
JJA, 03UTC



EXP_1h: larger UHI extended

Summer daily cycle of UHI in
the reference points



- Daily cycle is poorly simulated

Day

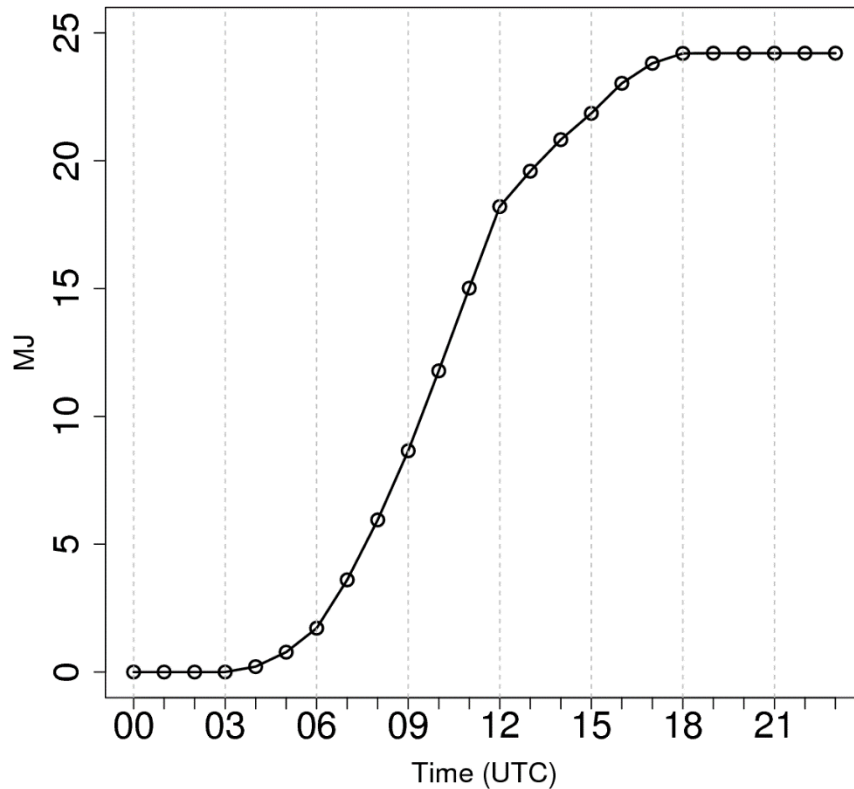
- urban gridpoint is too warm

Night

- Larger UHI in *EXP_1h*
- Evolution of nocturnal UHI delayed

Behind of this...

Surface incident direct SW radiation
during a day in July 2001

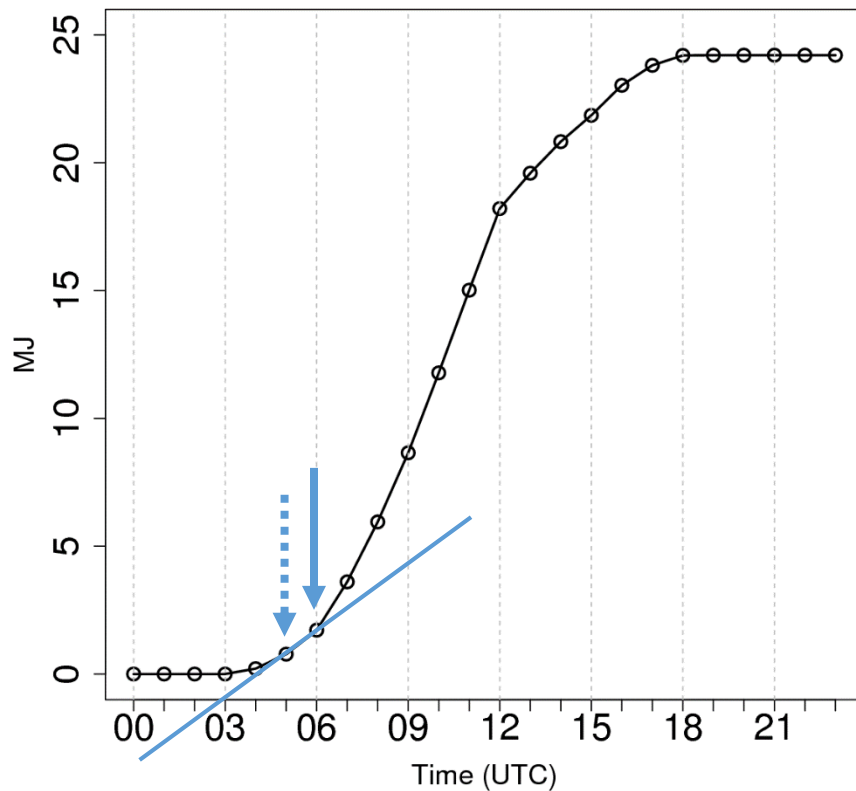


- radiation is a cumulative variable in ALADIN
- Forcings for SURFEX: instant values in each forcing timestep → calculation is needed in case of radiation

$$\frac{X_t - X_{t-1}}{3600h} \quad h=1,3$$

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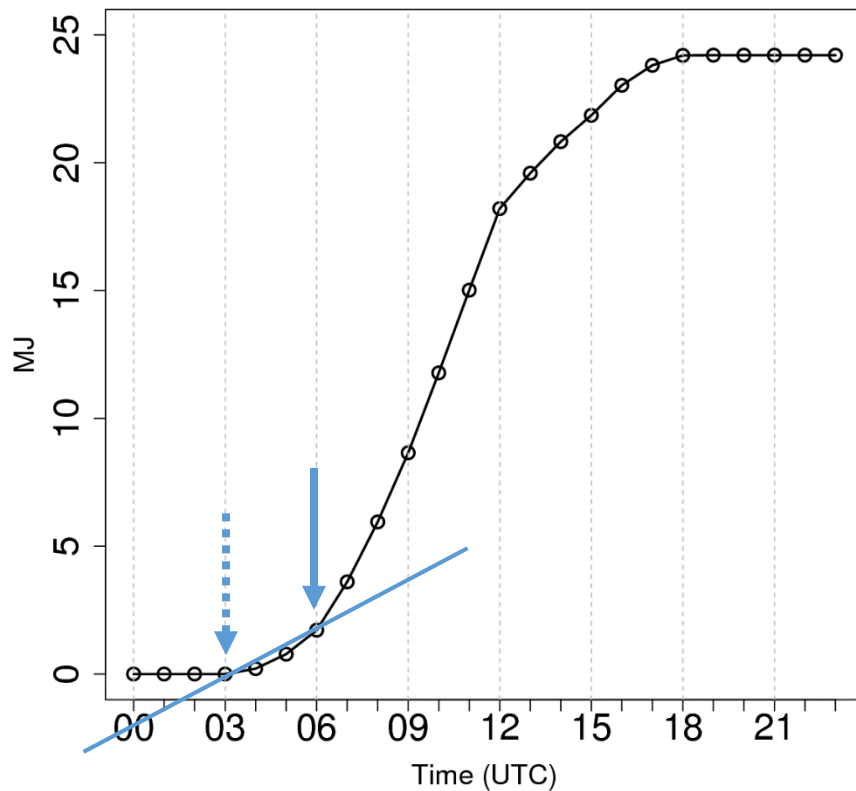


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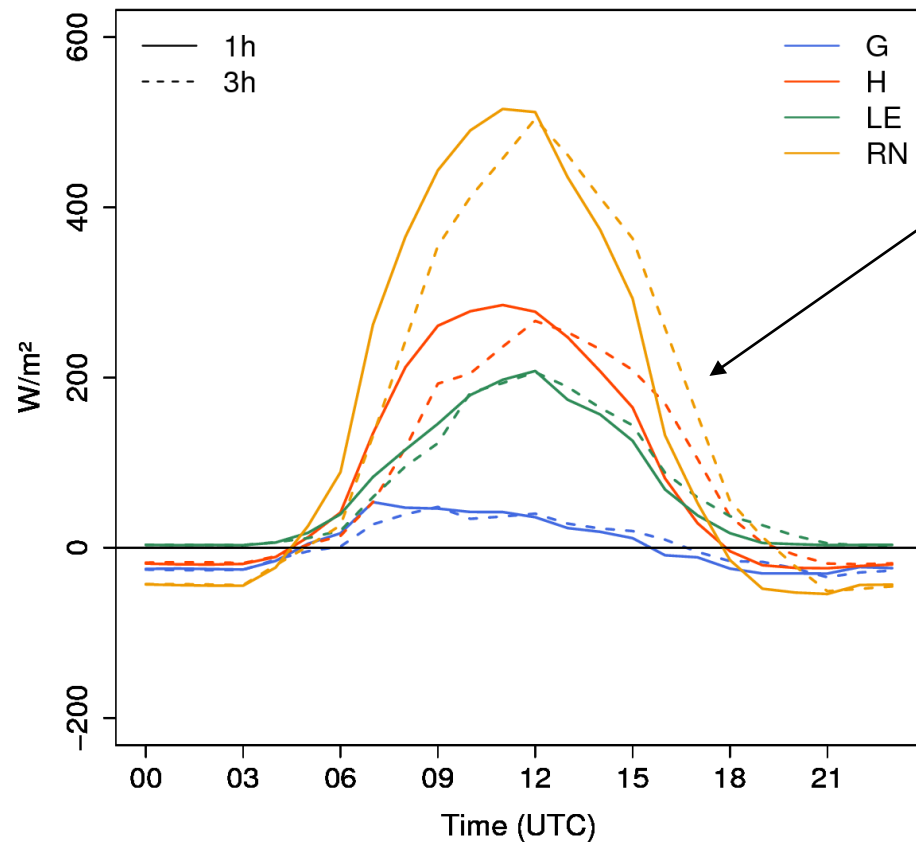


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Behind of this...

Surface energy balance components in the urban gridpoint in summer

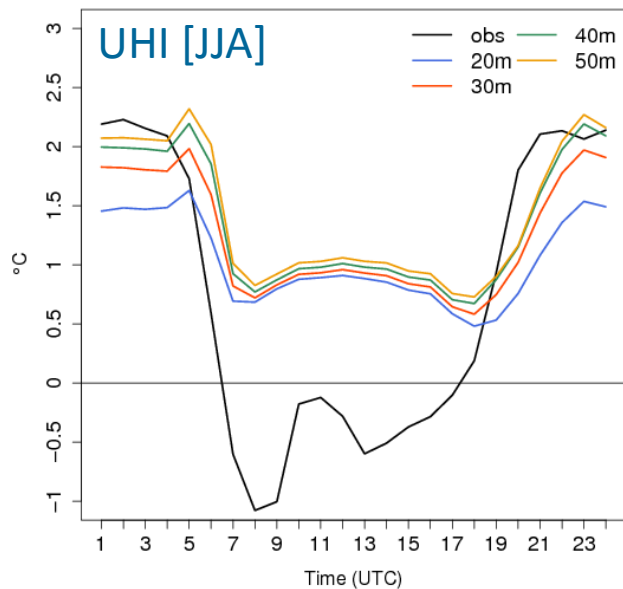
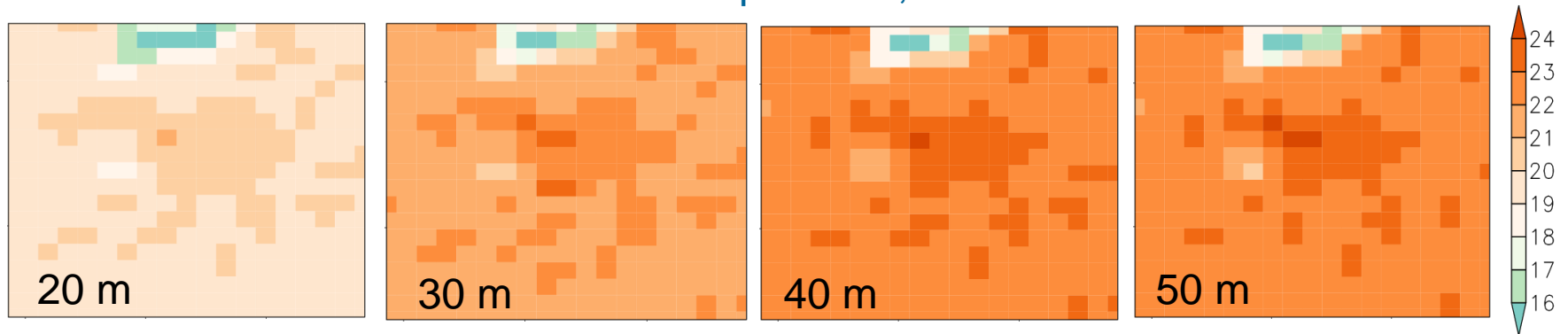


EXP_3h: shift in RN → influence on all turbulent fluxes

Saving ALADIN results 3 hourly is too sparse

Results – height of forcings

2-m temperature, summer



Higher forcing level →

- warmer 2-m temperature
- larger UHI. But only a positive shift, no physical improvement

Conclusions and future plans

Outcome of the first part of our sensitivity test:

- 3-hour forcing timestep cannot describe sufficiently the fast diurnal changes (e.g. solar radiation changes)
 - Note: aim is to apply SURFEX for long term urban climate modelling. Large storage capacity is needed mostly for RCM outputs
- Forcings from higher levels induce larger 2-m temperature and UHI, but does not improve daily variability

Upcoming tasks:

- Extend sensitivity test with more set-up possibilities (e.g. computation of 2-m temperature, TEB in the RCM) and changes of land surface parameters (e.g. proportion of urban and nature tiles in a grid cell)

Thank you very much for your
attention!

e-mail: zsebehazi.g@met.hu