Activities and updates from RHM/MSU team: simulations with different urban canopy parameters for Moscow megacity

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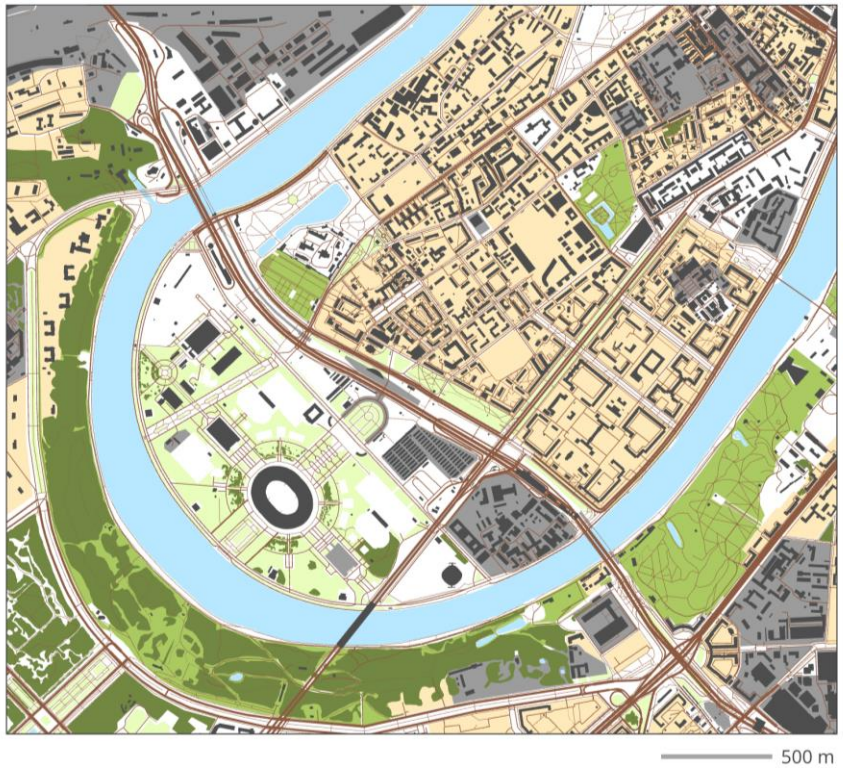
Different data sets on urban canopy parameters

Data set/simulation name	Paved fraction		AHF	UCP-Morphology (BLDH, BLDFR, H2W)	UCP-Radiative (TALB, SALB)	UCP-Thermal (HCAP, HCPN)
DEF	Extpar defaults (Elvidge et al., 2007)		Extpar defaults (Flanner et al., 2009)	Defaults from Wouters et al., 2016	Defaults from Wouters et al., 2016	
LCZa	LCZ-derived		LCZ-derived	LCZ-derived	Defaults from Wouters et al., 2016	
LCZb					LCZ-derived values for individual cells	
REF1a	Expert estimate based on CGLC, Sentinel images and OSM (Samsonov, Varentsov, 2020)	less paved fraction (vegetation that overlaps with buildings and roads moves to vegetated tile)	Expert estimate based on (Stewart, 2017)	Expert estimate based on OSM	Defaults from Wouters et al., 2016	
REF1b					LCZ-derived constants for facets	
REF2a		more paved fraction (vegetation that overlaps with with buildings and roads moves to paved tile)			Defaults from Wouters et al., 2016	
REF2b					LCZ-derived constants for facets	

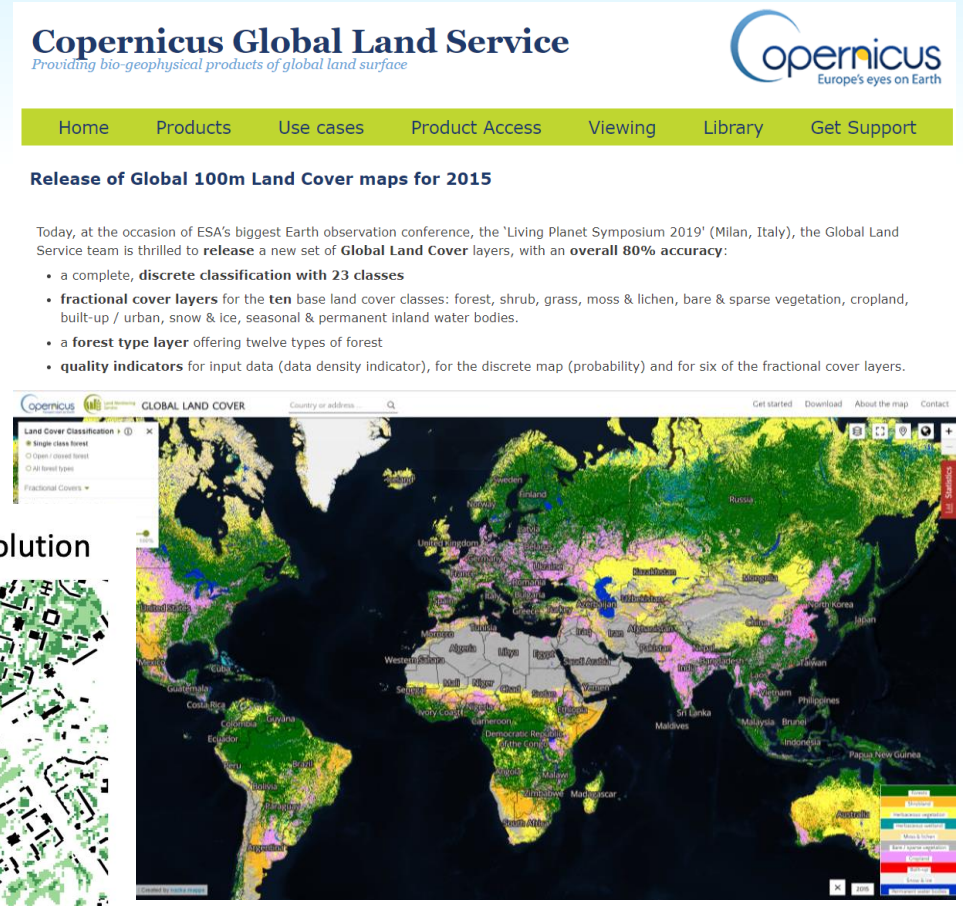
Custom-made urban canopy parameters

Based on combined use of different <u>global</u> data sets

- Built up fraction area from ***Copernicus Global Land Cover*** with 100 m resolution
- Data on buildings and roads from ***OpenStreetMap***
- Data on vegetation derived from ***Sentinel-2 satellite images*** with 10 m resolution



Trees and grass in 10 m resolution

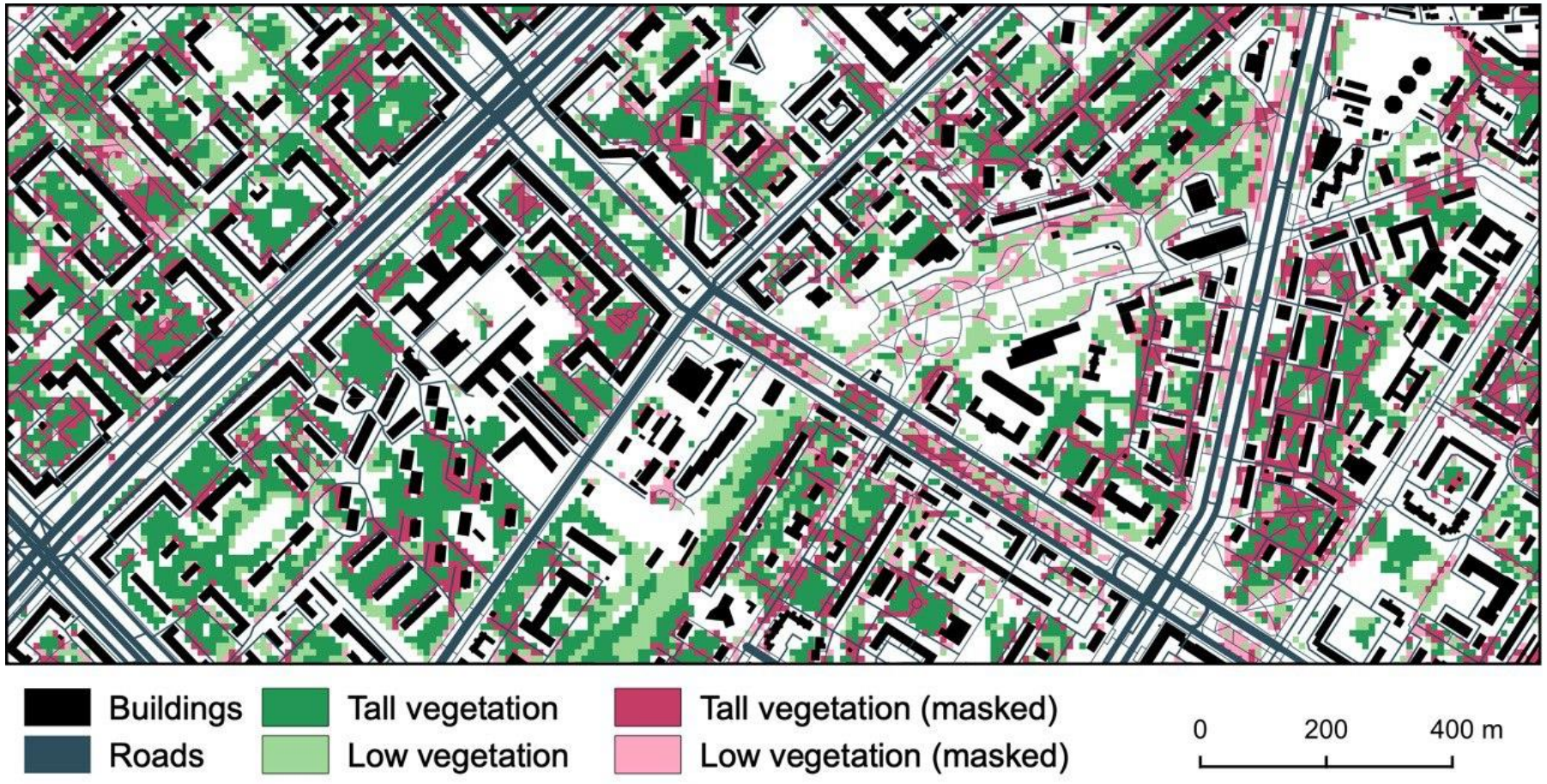


(Samsonov, Varentsov, 2020)

ISA in custom-made data set

$$ISA = \max(\min(URBAN\_FR_{CGLC}, 1 - GREEN\_FR), BLDF\_FR_{OSM} + ROAD\_FR_{OSM})$$

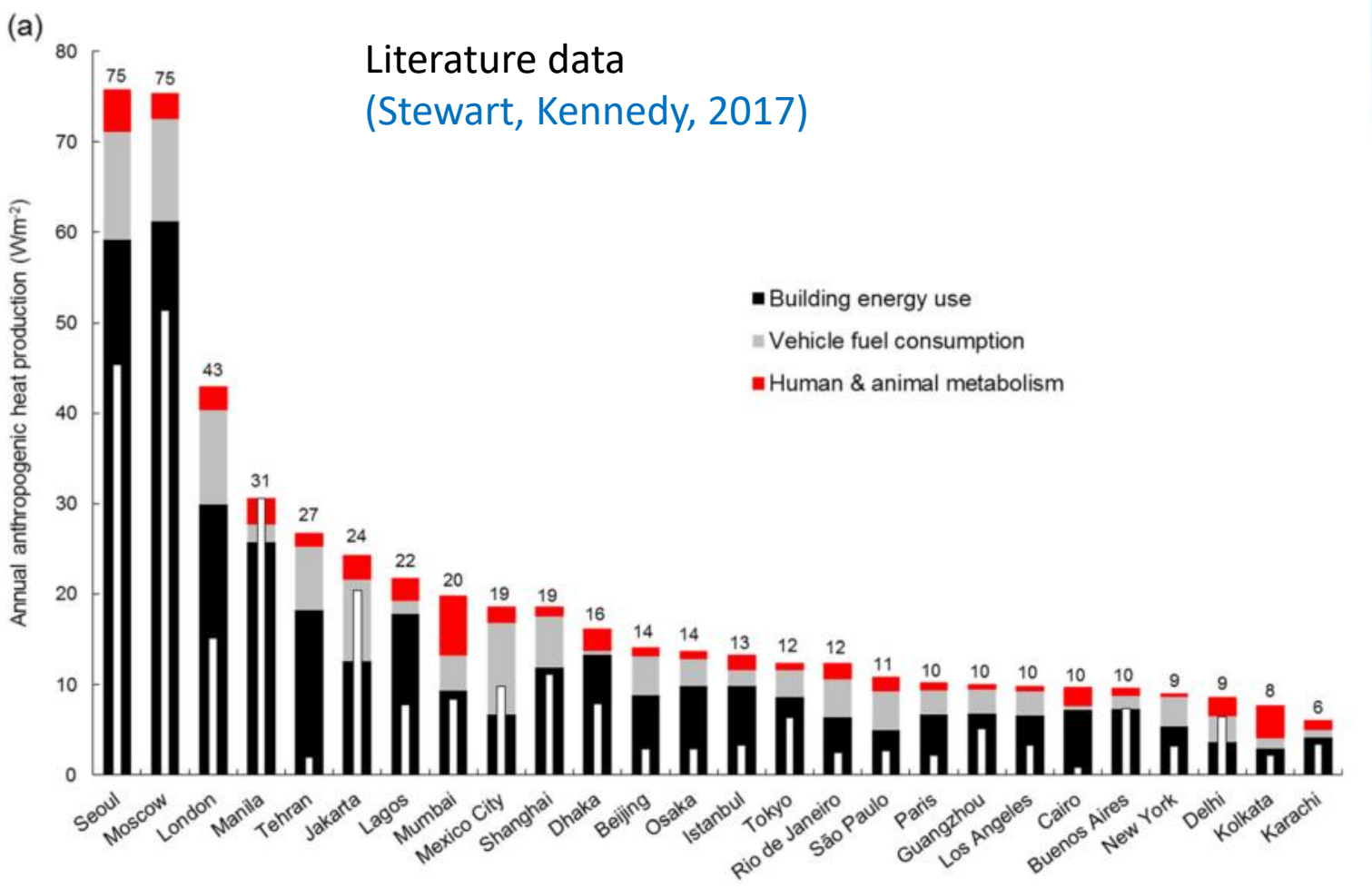
$$GREEN\_FR = \max(GREEN\_FR_{OSM}, GREEN\_FR_{SENTINEL})$$



Uncertainty: what to do with vegetation, that intersects with buildings/roads?

(Samsonov, Varentsov, 2020)

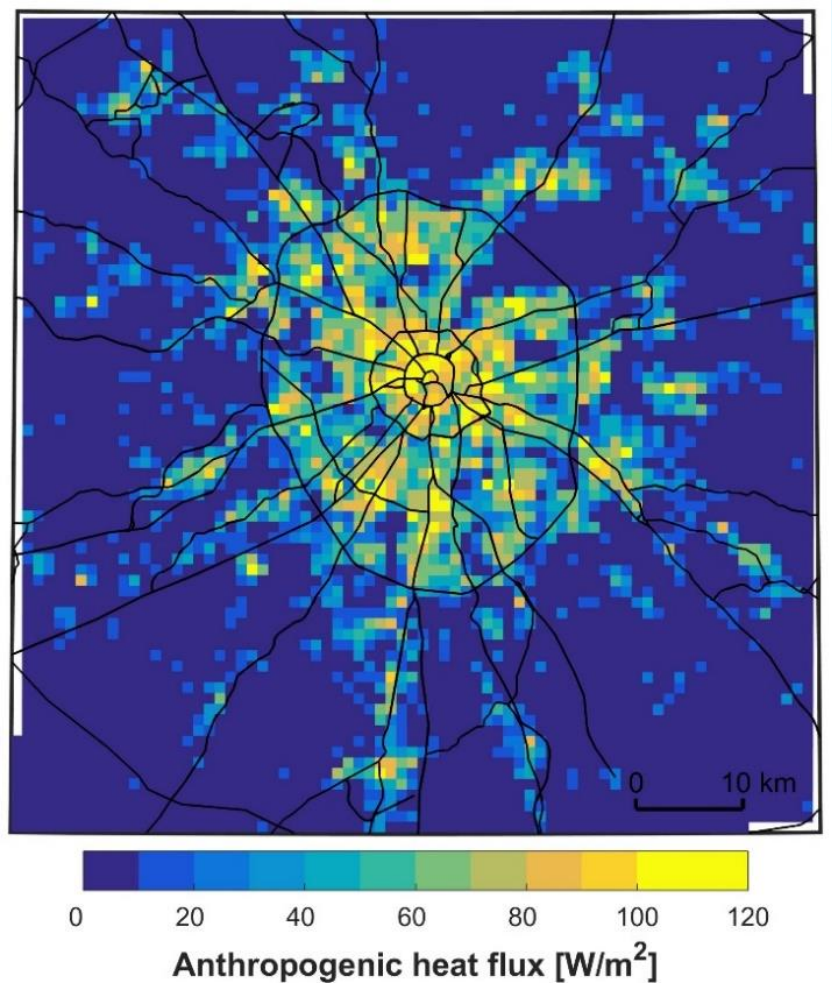
AHF in custom-made data set



Literature data
(Stewart, Kennedy, 2017)

Spatial redistribution:

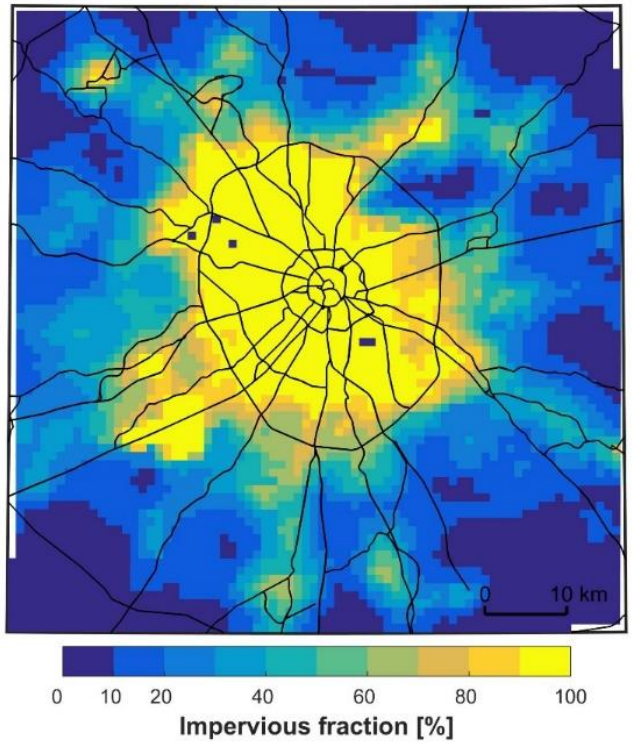
$$AHF = k \cdot BLDH \cdot BLDFR$$



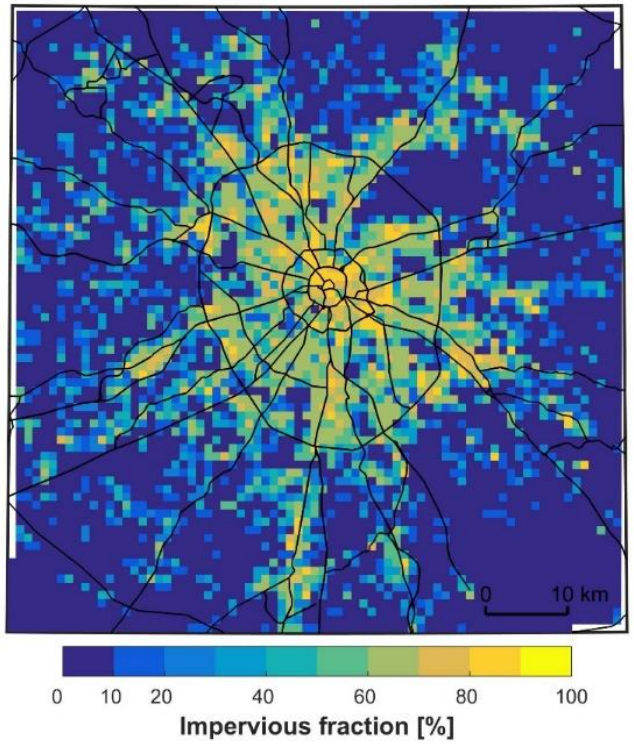
(Samsonov, Varentsov, 2020)

Urban canopy parameters

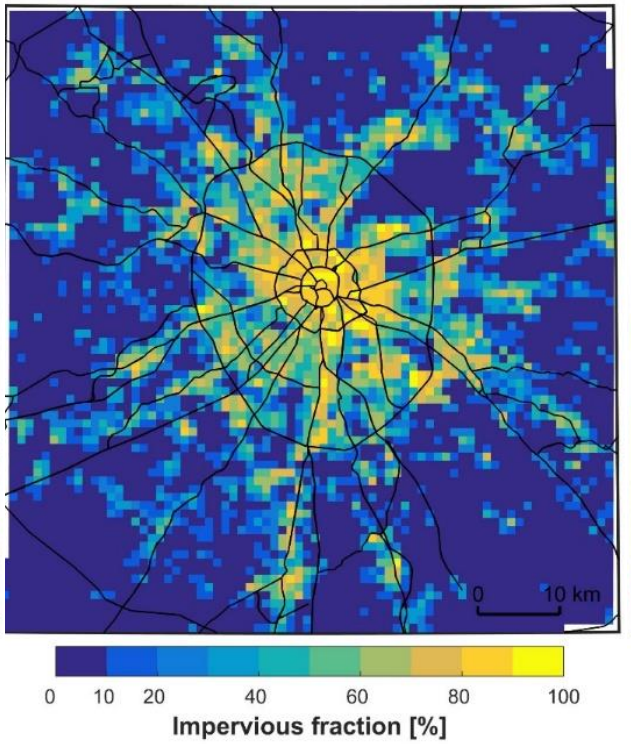
Default values from EXTPAR (DEF)



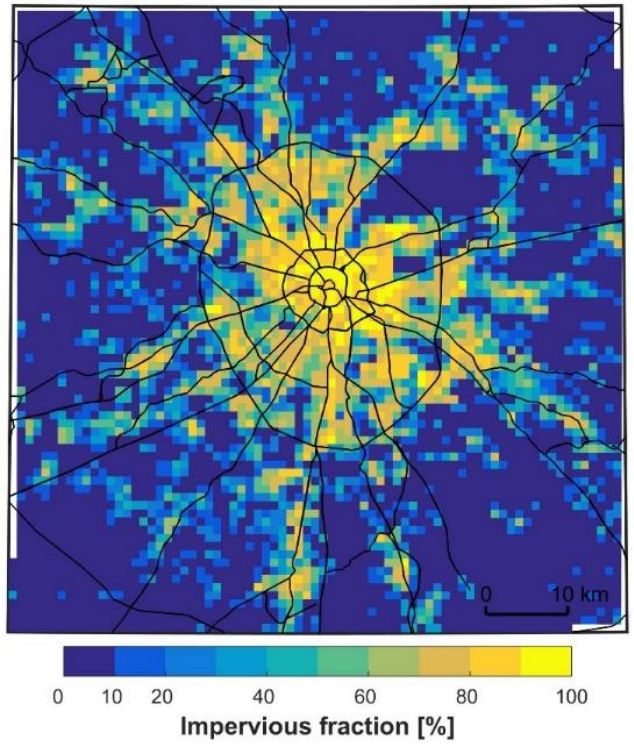
LCZ-derived ISA



REF1



REF2

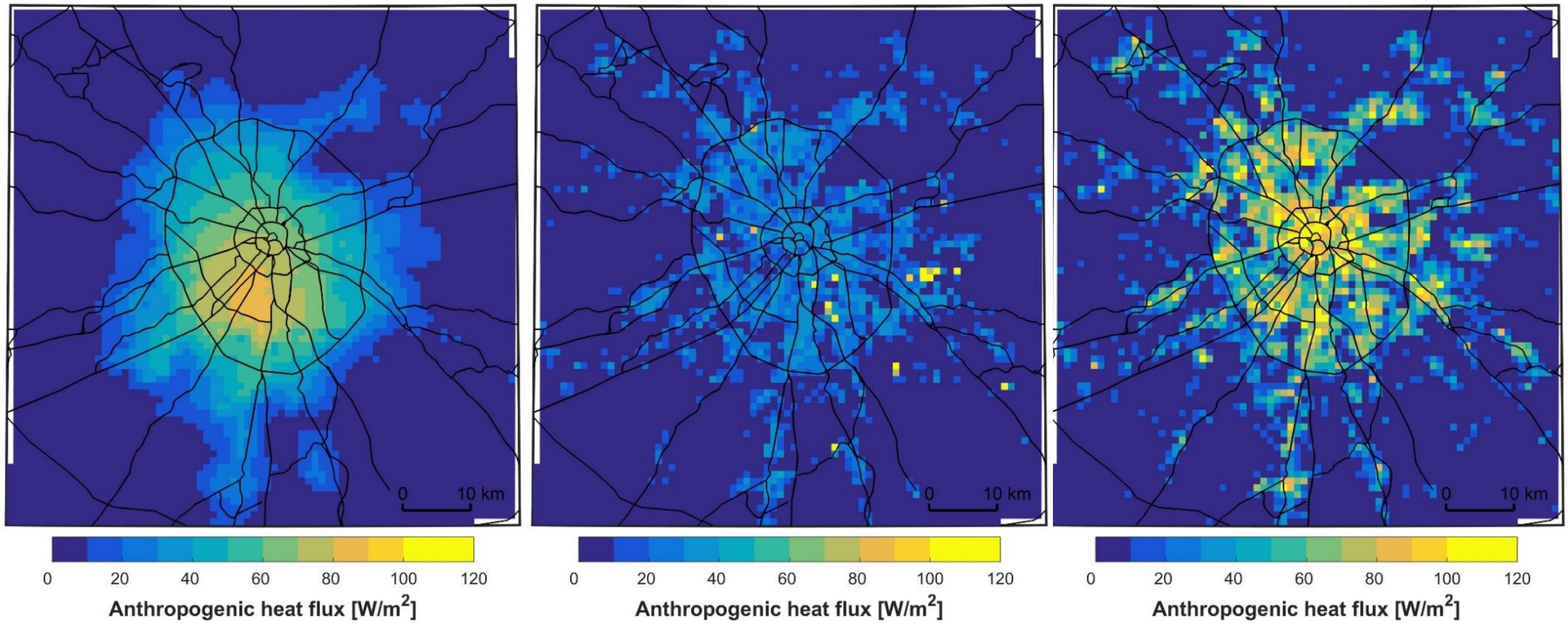


Urban canopy parameters

Default values from EXTPAR (Flanner et al., 2009)

LCZ-based AHF

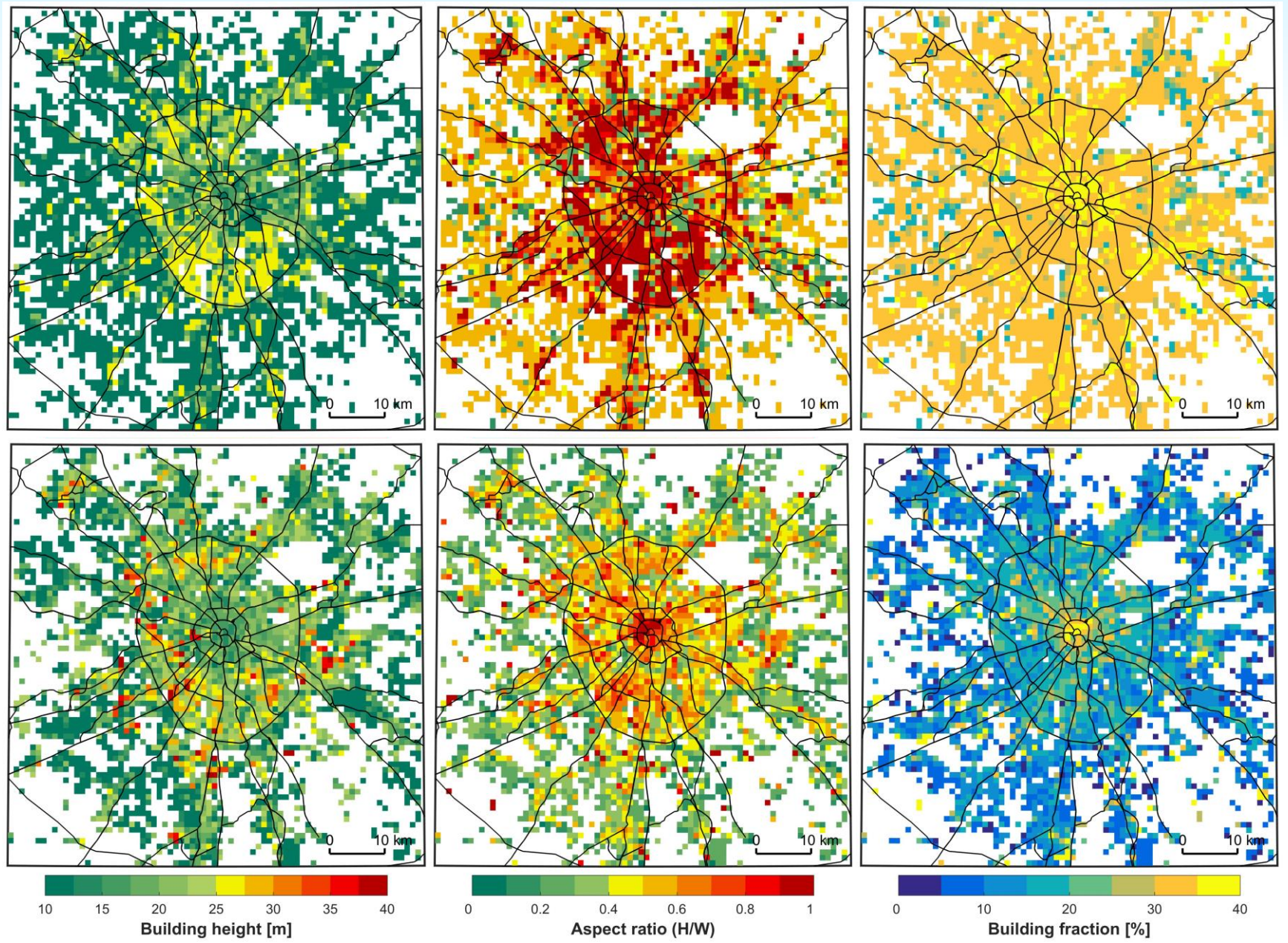
Custom estimate (REF)



Urban canopy parameters

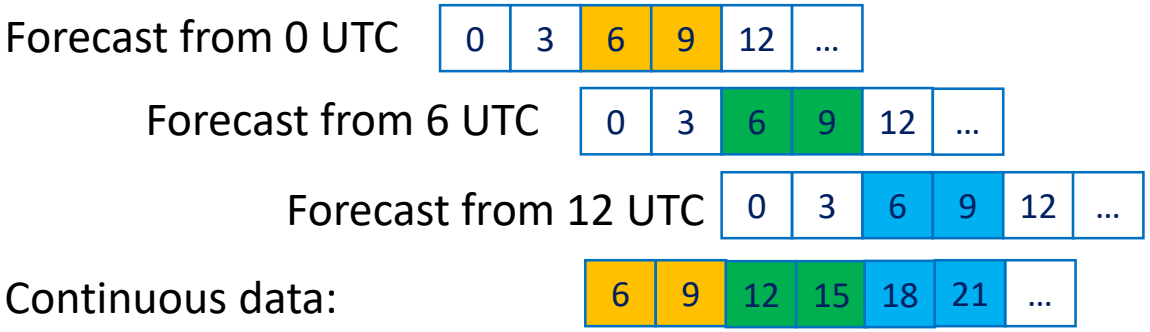
LCZ-based UCP
→

Custom-made UCPs (based on OpenStreetMap data)
→

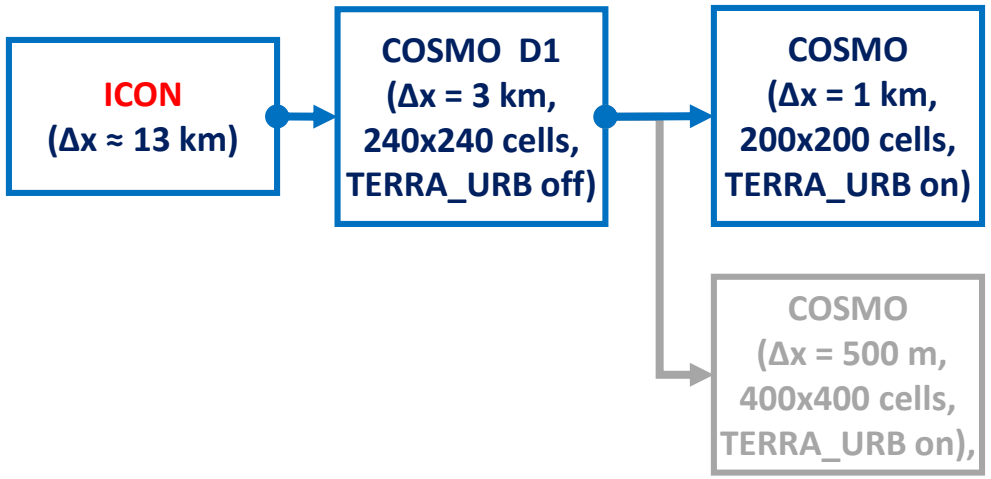


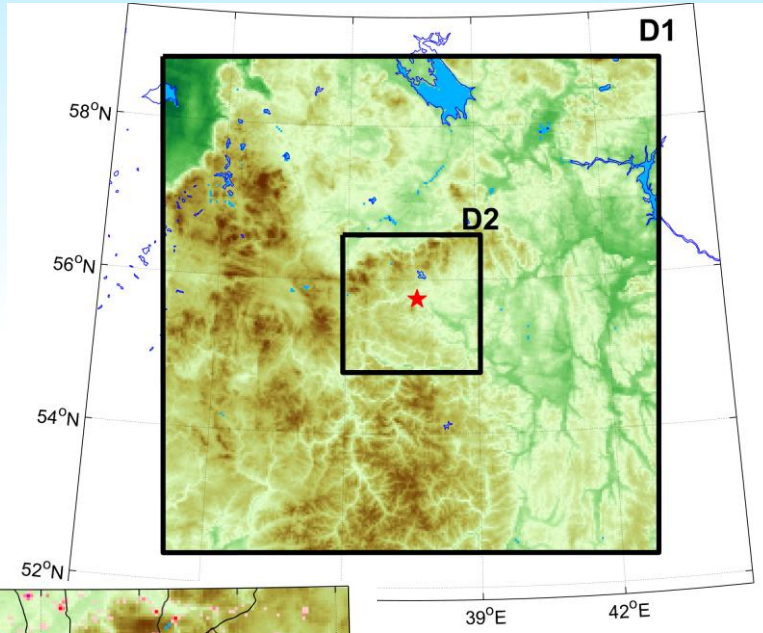
Simulations set up

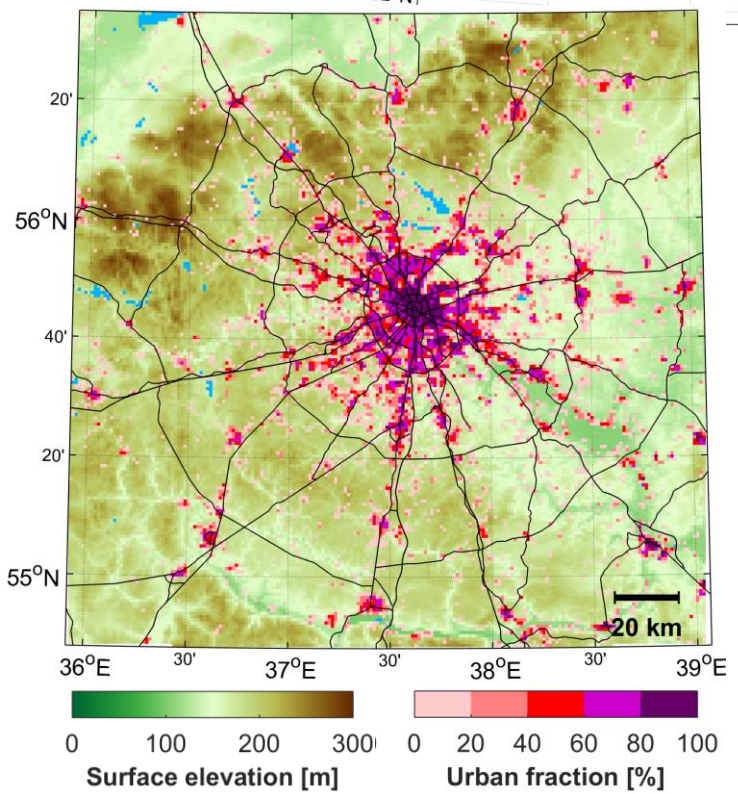
Initial and boundary conditions:
Continuous data set, constructed from ICON forecasts for 3 and 6 hours:



Scheme of dynamical downscaling:







Case studies:
1) 5-20 August 2017
2) 1-15 June 2019

Simulations set up

- ✓ TERRA_URB is always on
- ✓ Namelist settings generally similar to ARPAP's one, with exception for **itype_aerosol** (2 instead 1), **hcorr_*** parameters (model defaults are used), **llake** (TRUE instead FALSE) and some parameters for new turbulence

For common AEVUS paper?

Simulation number	Turbulence	Itype_canopy	Itype_vdif
AEV1	Old	1	-1
AEV2	Old	2	-1
AEV3	New*	1	-1
AEV4	New*	2	-1
AEV5	New*	2	1

→ for comparison between UCP data sets

*Settings for "new turbulence" include **pat_len**=100 (model default, instead of 750 from User Guide), **c_soil** = 1 (model default, instead of 1.75/1.25 from User Guide)

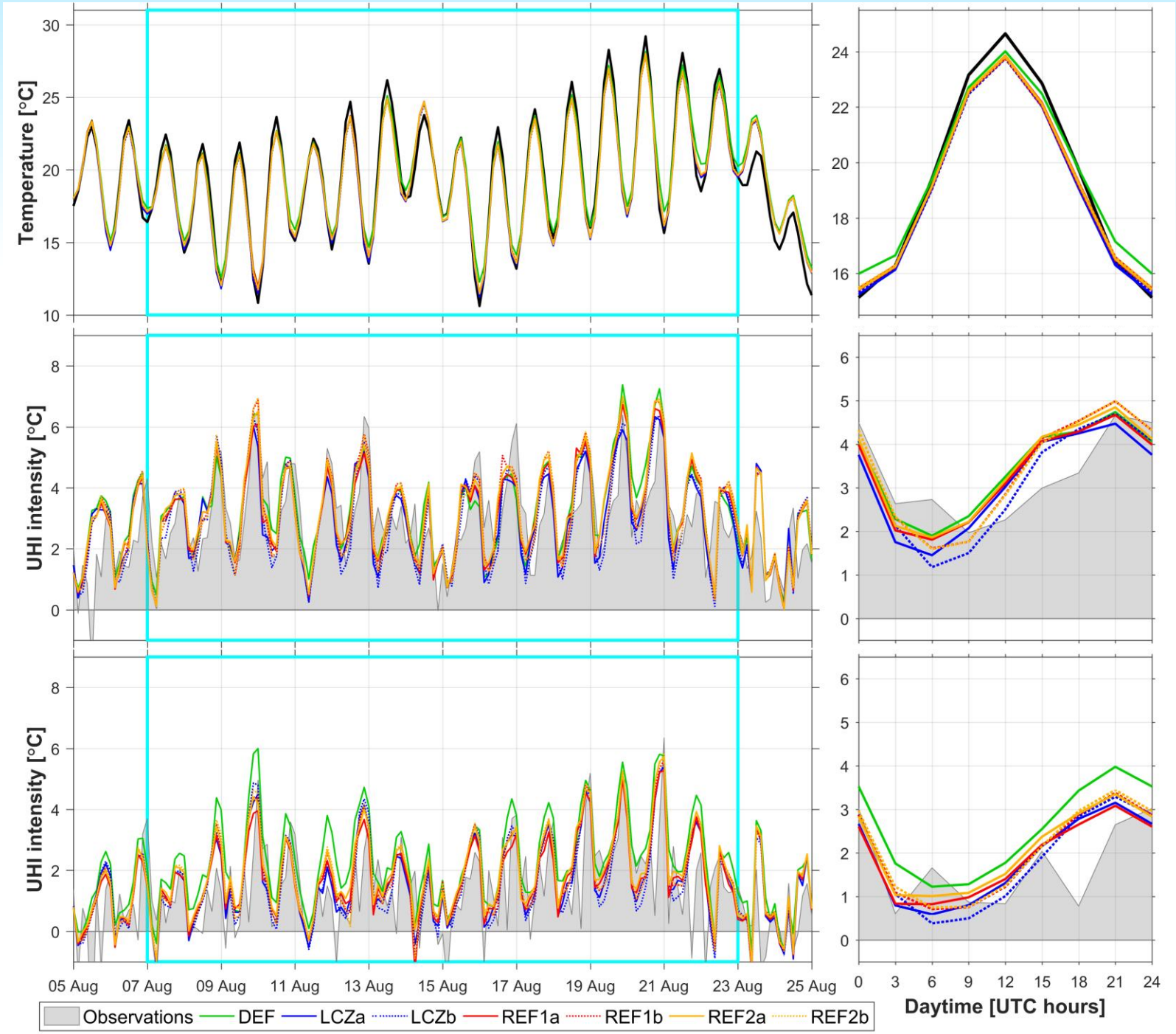
Additional tuning: rooting depth is increased by 2.5 times to decrease warm and dry bias

Summer case, August 2017

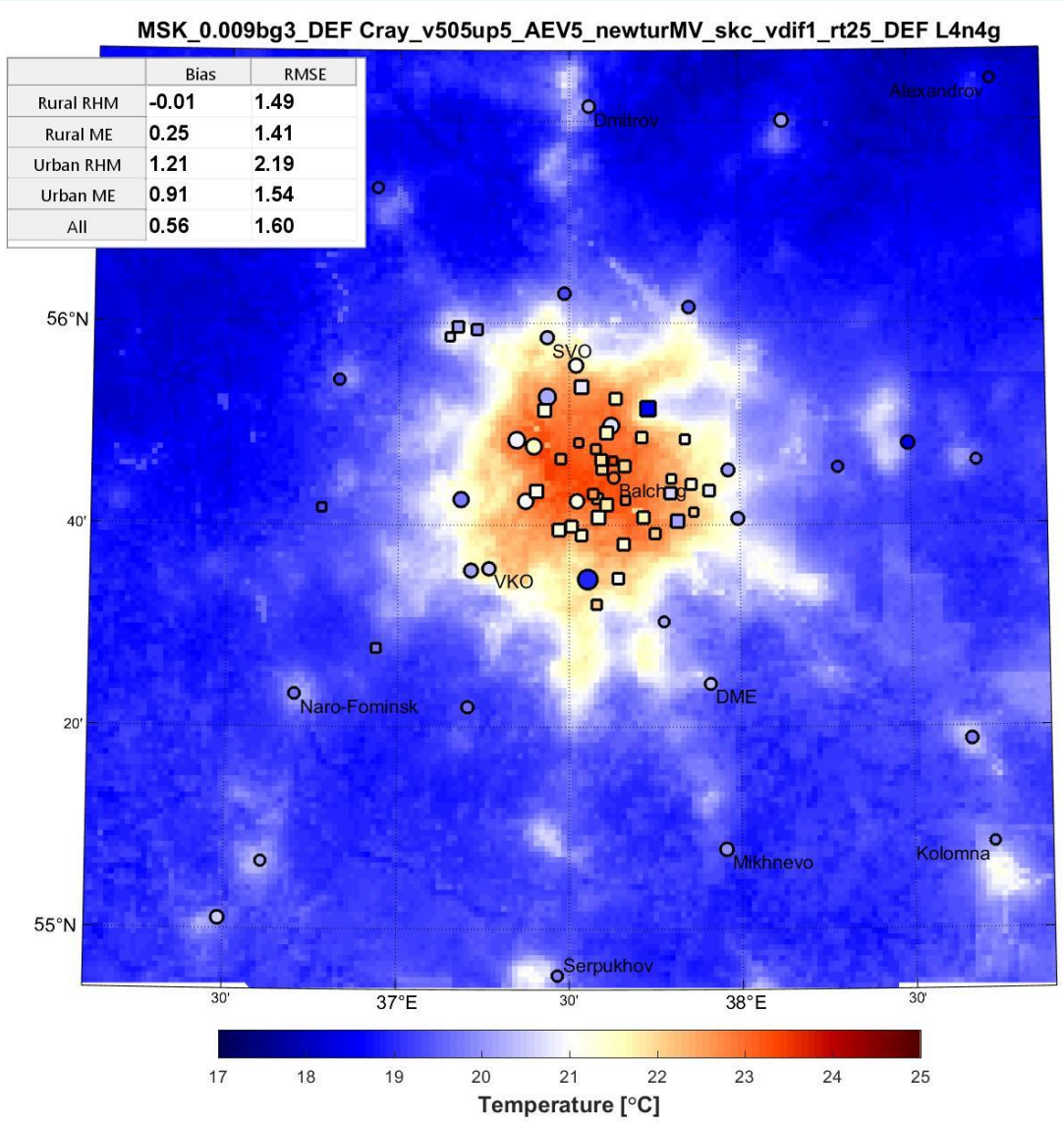
Mean rural temperature →

UHI intensity, city center →

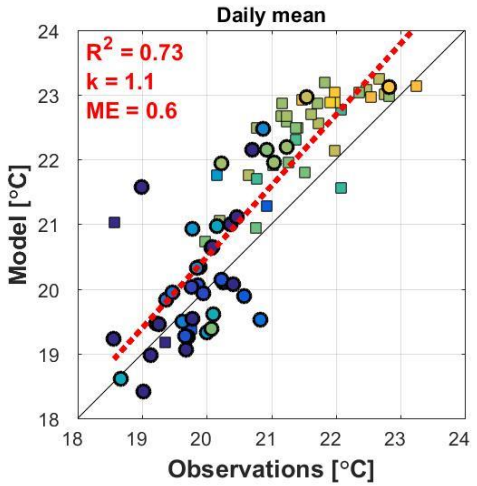
UHI intensity, urban park →

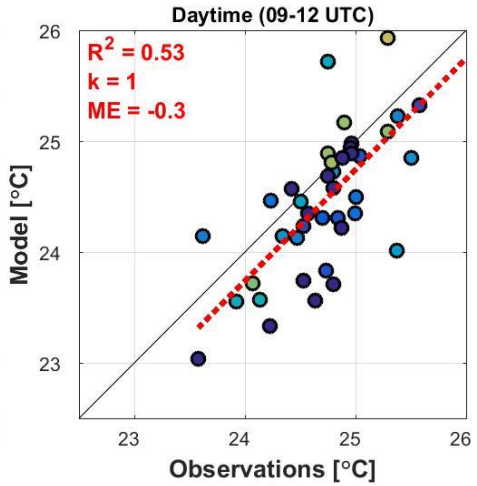


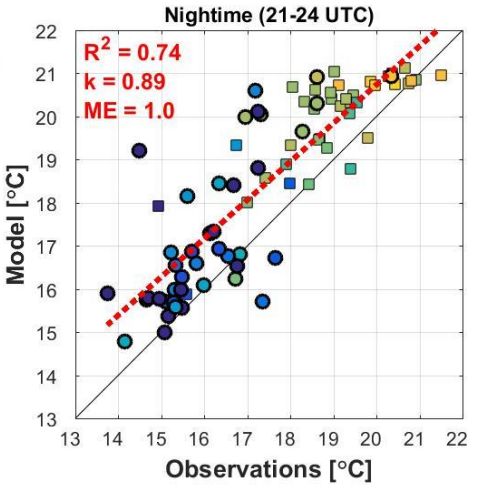
Summer case, August 2017, DEF



	Bias	RMSE
Rural RHM	-0.01	1.49
Rural ME	0.25	1.41
Urban RHM	1.21	2.19
Urban ME	0.91	1.54
All	0.56	1.60

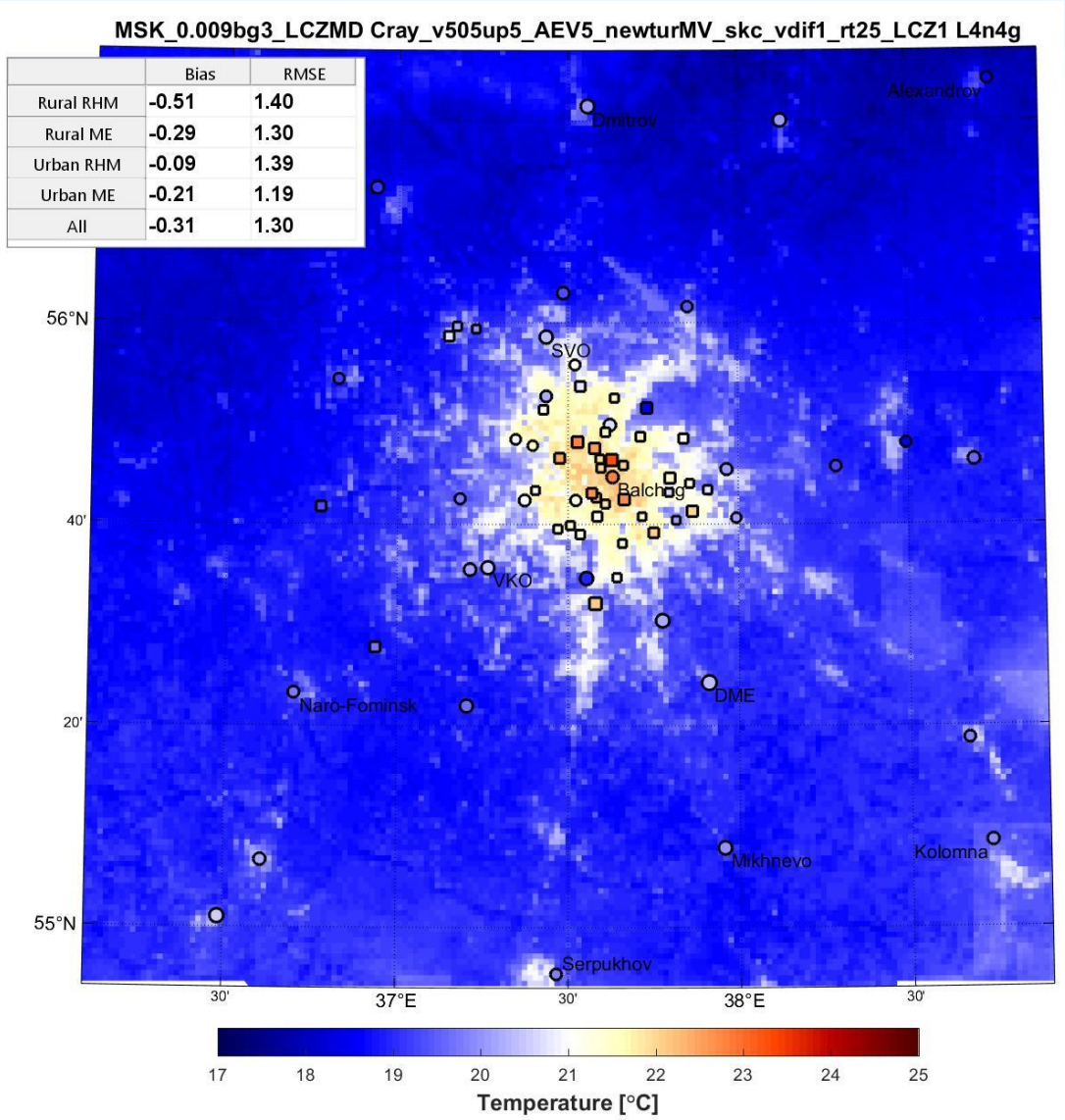


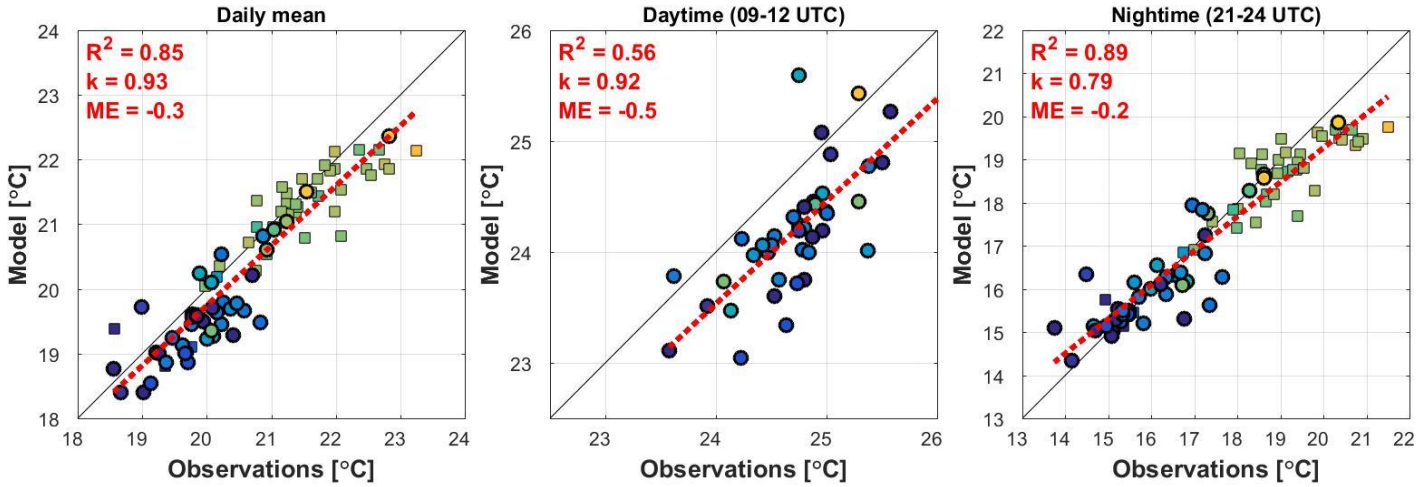




Fields from EXTPAR
default constant UCPs

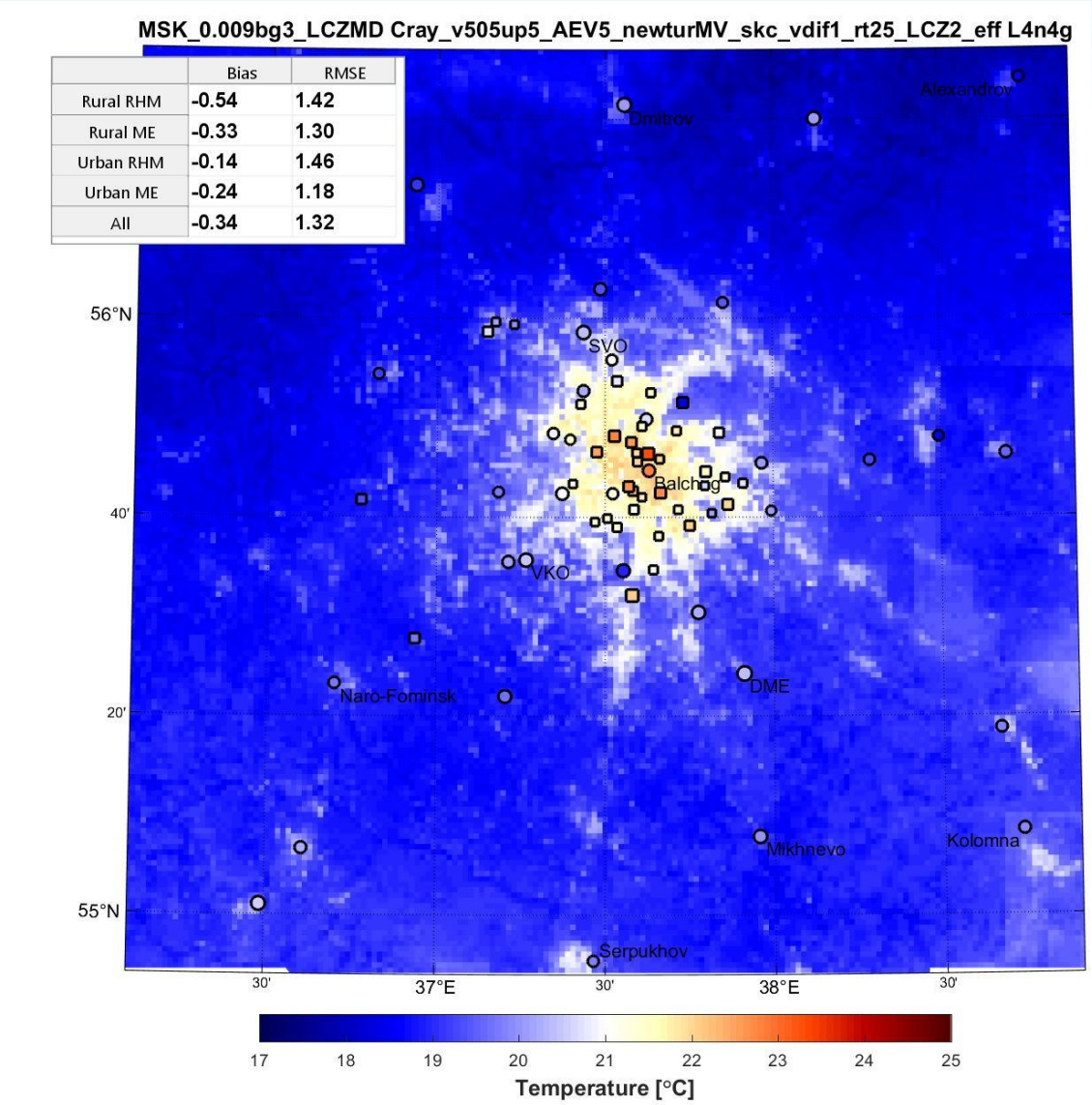
Summer case, August 2017, LCZa

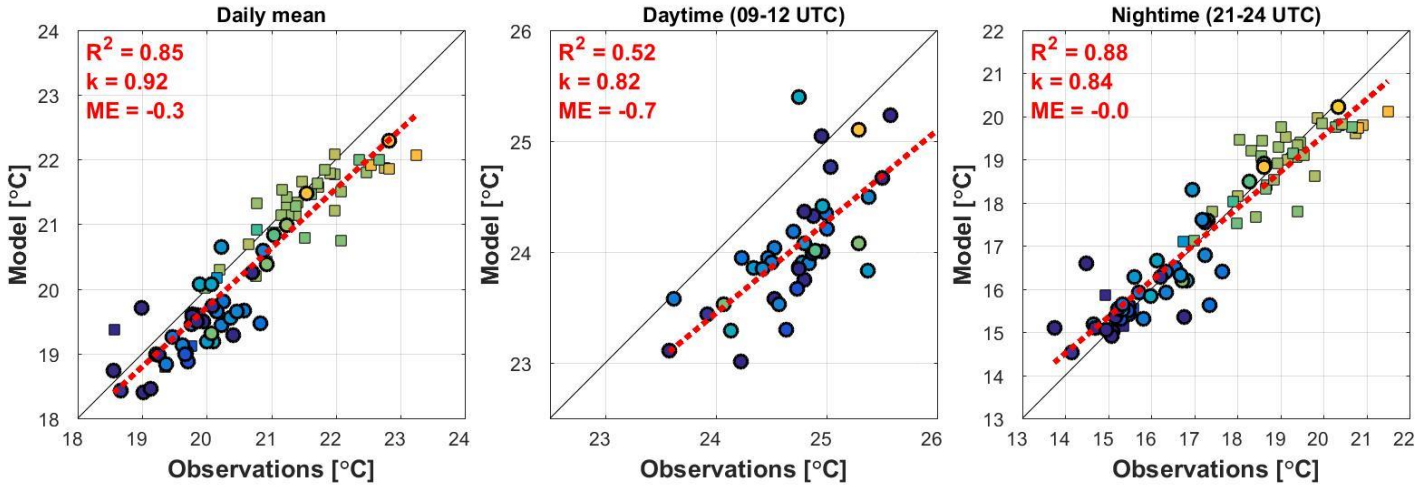




LCZ-based UCPs, default thermal parameters

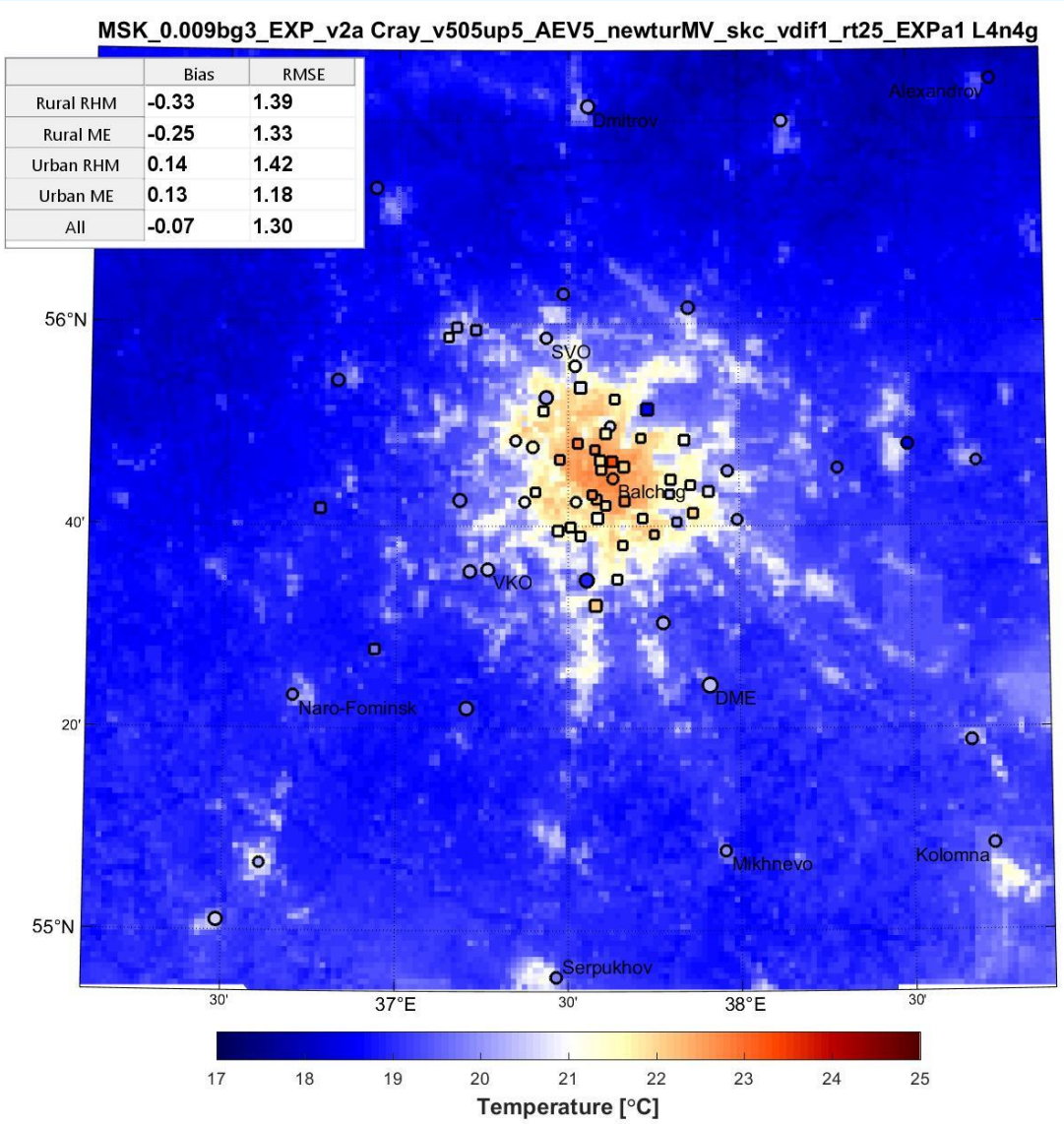
Summer case, August 2017, LCZb



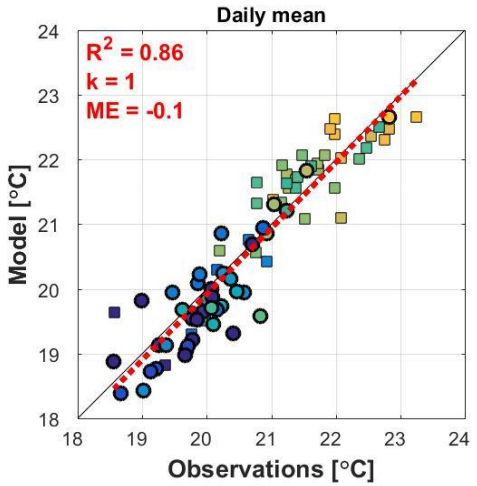


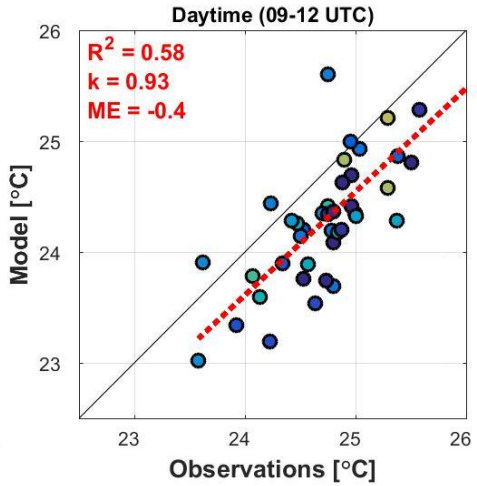
LCZ-based UCPs and thermal parameters

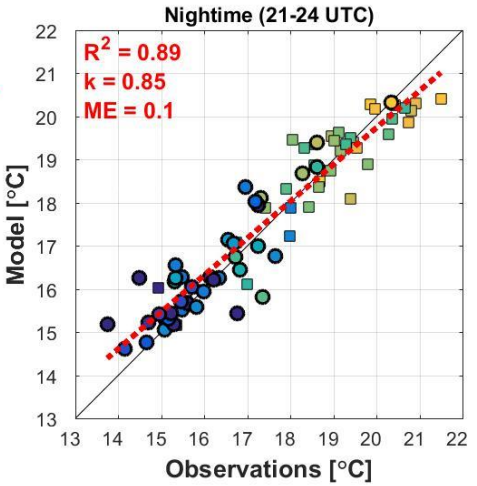
Summer case, August 2017, REF1a



	Bias	RMSE
Rural RHM	-0.33	1.39
Rural ME	-0.25	1.33
Urban RHM	0.14	1.42
Urban ME	0.13	1.18
All	-0.07	1.30

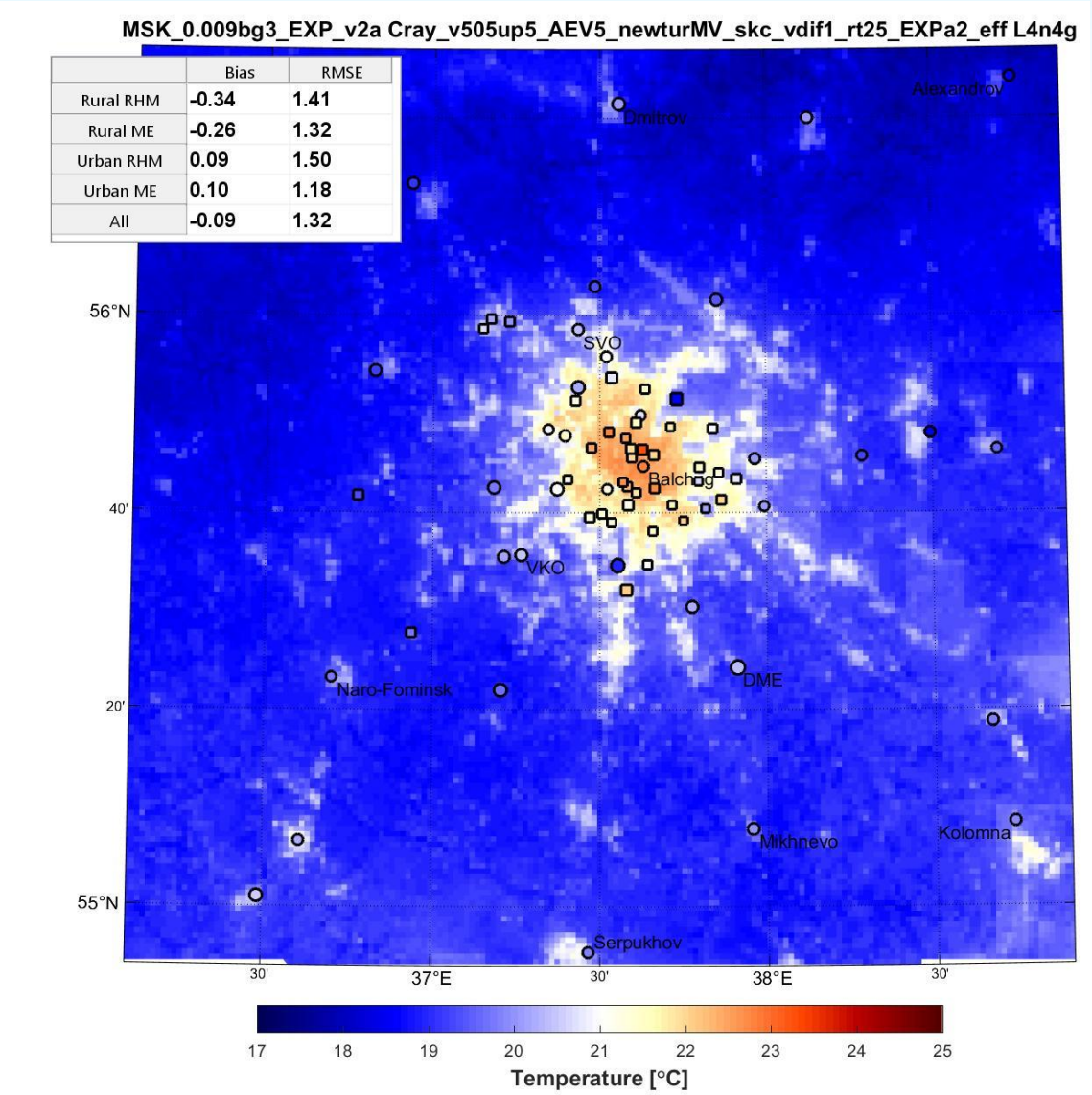


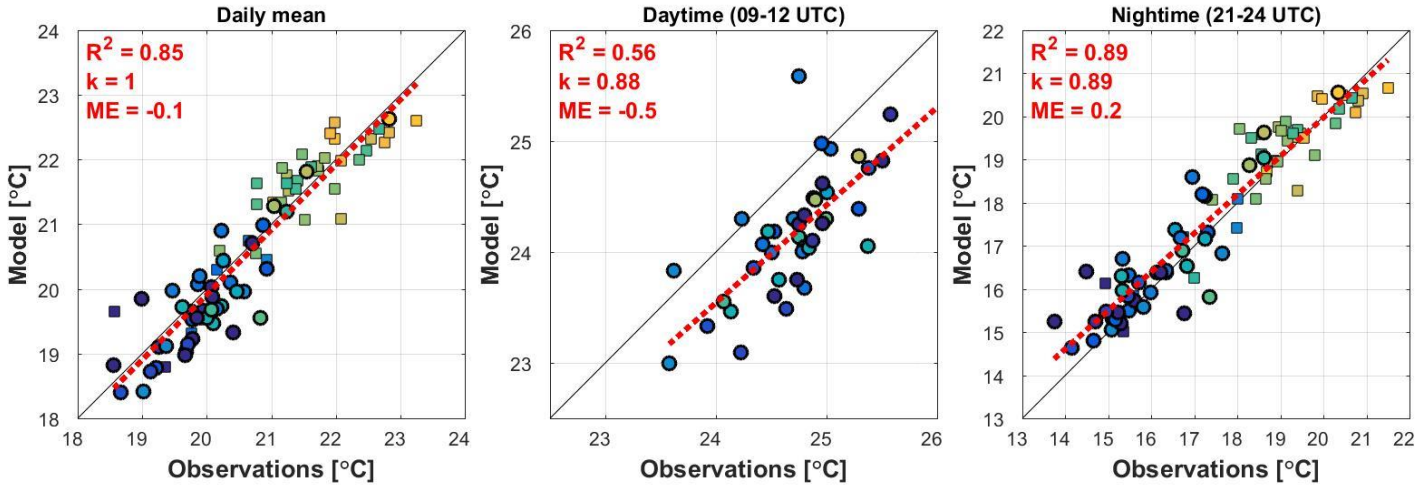




Custom made UCPs (less ISA),
default thermal parameters

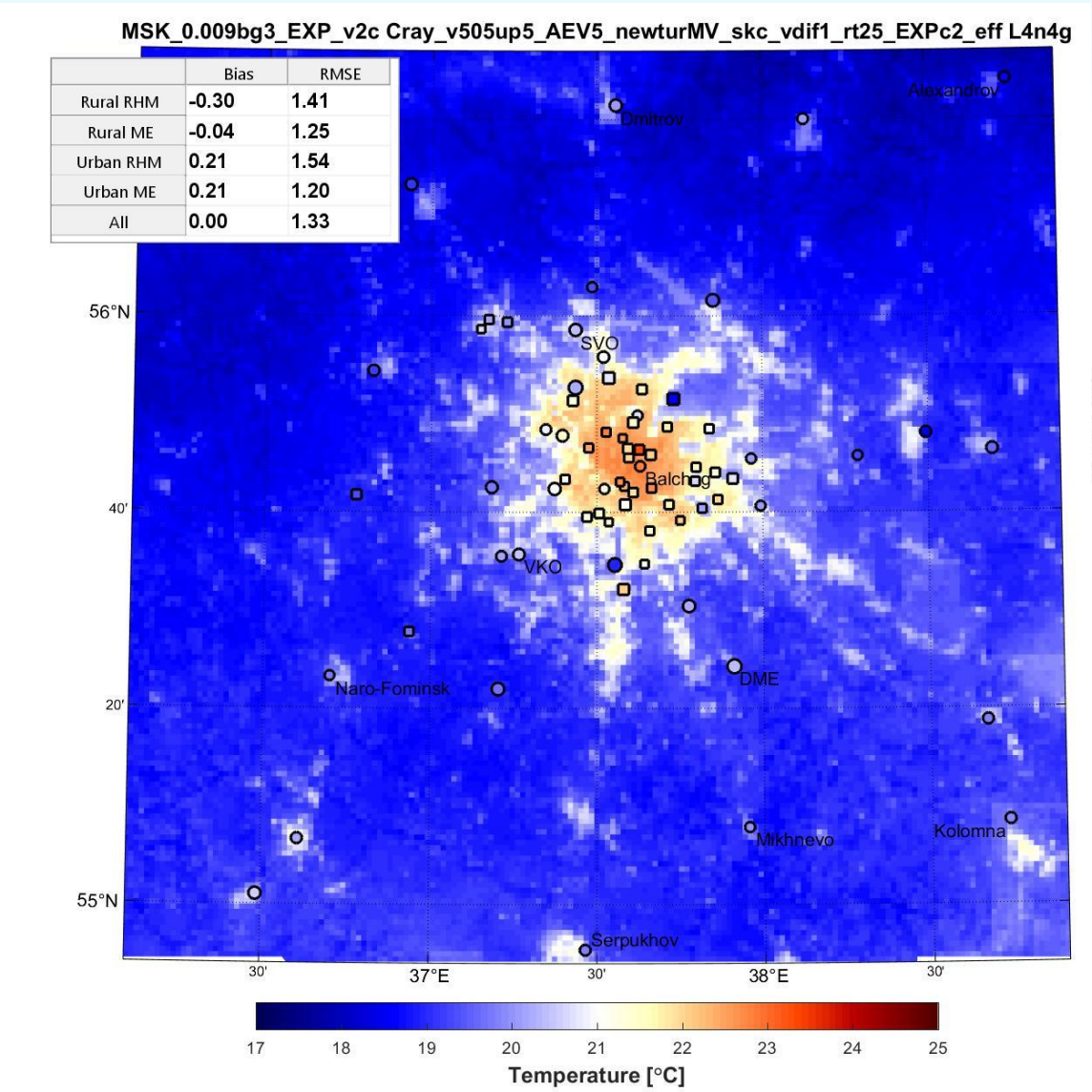
Summer case, August 2017, REF1b

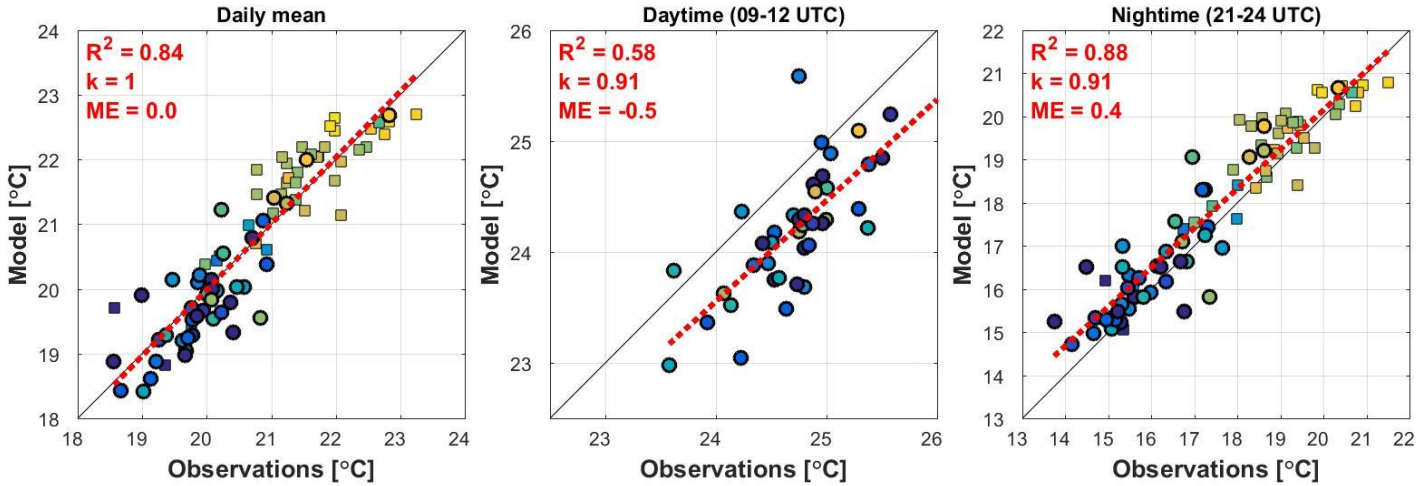




Custom made UCPs (less ISA),
LCZ-based thermal parameters

Summer case, August 2017, REF2b



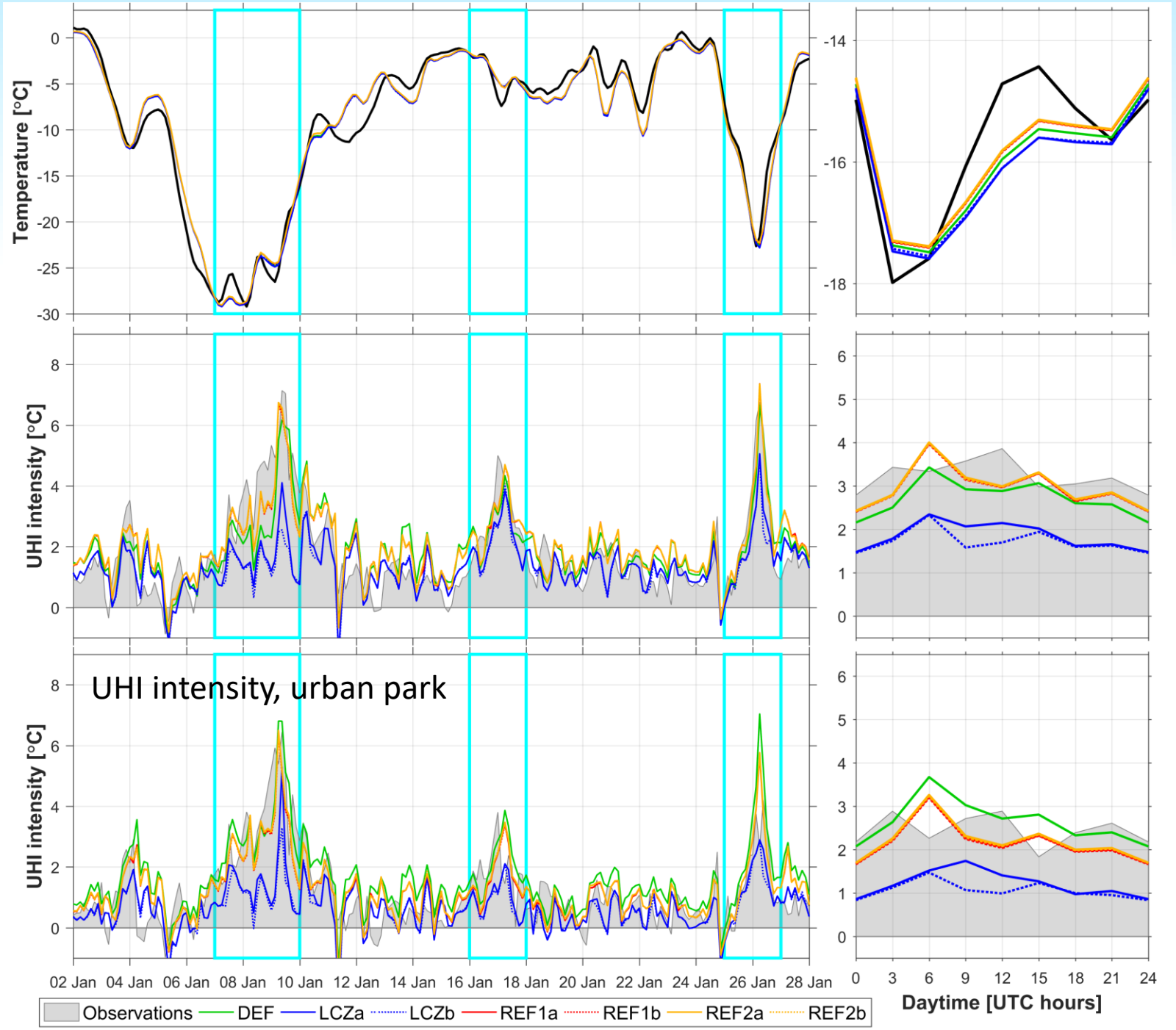


Custom made UCPs (more ISA),
LCZ-based thermal parameters

Winter case, January 2017

Mean rural temperature →

UHI intensity, city center →



Conclusion

- Simulations with LCZ-based urban external parameters provides as good results as simulations with custom-made reference data set for summer season
- For summer, LCZ-base and REF data set provide a noticeable impartments in comparison to default configuration
- For the winter, LCZ-based approach demonstrates worse results due to underestimation of anthropogenic heat flux

Paper under preparation: Varentsov M., Samsonov T., Demuzere M. Impact of urban canopy parameters on a megacity'smodelled thermal environment. Will be submitted to Atmosphere SI (thanks Eduardo for extending the deadline!).