

Article

Supplementary Information on ‘Impact of urban canopy parameters on a megacity’s modelled thermal environment’

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Table S1. The most important namelist settings of the COSMO model configuration used in the study. For the details, please, refer to COSMO User Guide.

Namelist	Parameter	Value	Meaning	Comment
RUNCTL	dt	10	Time step [seconds]	
PHYCTL	loldtur	false	Switch for new ICON-based physical package (false means than is activated)	Suggested based on preliminary test simulations
	itype_vdif	1	Parameter to choose the type of vertical diffusion calculation (-1 means that turbulent diffusion is computed at the end of the physics as in ICON)	
	itype_conv	3	Type of convection parameterization (3 means shallow convection scheme)	Typical for convective-permitting simulations
	lemiss	true	Switch to use an external surface emissivity map	Recommended value for ICON-based physics
	lstomata	true	Switch to use a minimum stomata resistance map for plants	
	itype_albedo	3	Switch to choose the type of solar surface albedo (3 means to use the MODIS-derived external fields, which give average values for every month)	Recommended by Jan-Peter Schults (DWD) in personal communication
	itype_aerosol	2	Switch to choose the type of aerosol map (2 means to use Tegen aerosol climatology)	Recommended value for ICON-based physics
	itype_root	2	Parameter to select the type of root distribution (2 means exponential profile)	
	itype_heatcond	3	Parameter to select the type of soil heat conductivity	
	itype_evsl	4	Parameter to select the type of parameterization for evaporation of bare soil (4 means a new resistance approach (Schults and Vogel, 2020)).	
	itype_canopy	2	Switch to activate the skin-layer temperature formulation (Schults and Vogel, 2020)	Selected based on preliminary test simulations
TUNING	rat_sea	7	Ratio of laminar scaling factors for heat over sea and land	Recommended value for ICON-based physics
	a_hshr	2	Length scale factor for separate horizontal shear production of TKE	
	tkhmin & tkhmin	0.75	Minimal diffusion coefficients for momentum / heat active in stable conditions	Hardcoded default for 5.05 is used instead of recommended value for for ICON-based physics
	pat_len	100	Length scale [m] of sub-scale surface patterns over land	
	c_soil	1	Surface area density of the (evaporative) soil surface	
	crootdp2	2.5	Scaling factor for rooting depth (similar to fac_rootdp2 in 5.0_clm version)	Introduced in COSMO 5.05urb according to previous modelling experience

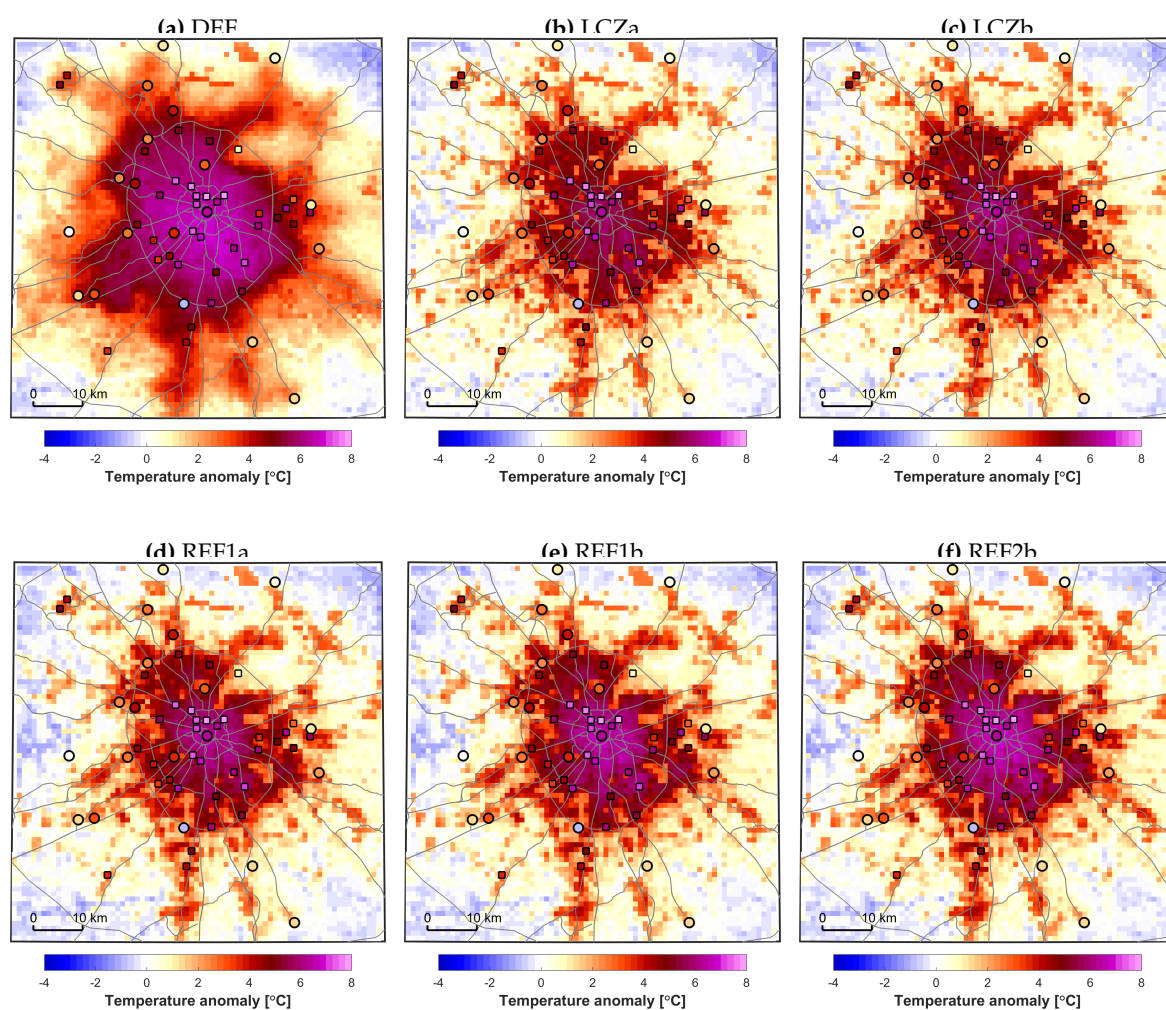


Figure S1. Spatial distribution of the nocturnal (21, 00 UTC) UHI intensity (temperature anomaly with respect to mean rural value), averaged over selected period in June 2019 according to observations at WSs (circle markers), AAQS (square markers) and modelling results (colored background) for DEF (a), LCZa (b), LCZb (c), REF1a (d), REF1b (e), REF2b (f) model runs.

Table S2. Daily-mean, nighttime (21, 00 UTC) and daytime (9, 12 UTC) modelled temperatures, averaged over selected sub-periods in August 2017 and June 2019 for urban grid cells within the major part of the city (within Moscow administrative borders for the year of 2011, that approximately corresponds to Moscow Ring Road) and within the central part of the city (within a distance of 5 km from Kremlin, that approximately corresponds to Third Ring Road), and the pairwise temperature differences between the model runs.

Model run	Summer 2019						Summer 2017					
	Daily-mean temperature		Daytime temperature		Nighttime temperature		Daily-mean temperature		Daytime temperature		Nighttime temperature	
	City	Center	City	Center	City	Center	City	Center	City	Center	City	Center
LCZa	22.5	23.2	26.5	26.9	19.0	20.1	21.3	21.9	24.9	25.3	18.6	19.4
LCZ1b	22.5	23.2	26.2	26.5	19.4	20.5	21.3	21.9	24.5	24.8	18.9	19.8
REF1a	22.8	23.8	26.6	27.2	19.4	21.0	21.6	22.5	25.1	25.7	19.0	20.2
REF1b	22.7	23.7	26.3	26.8	19.7	21.3	21.6	22.5	24.8	25.3	19.3	20.5
REF2a	23.0	23.9	26.7	27.3	19.7	21.2	21.8	22.7	25.2	25.8	19.3	20.4
REF2b	22.9	23.8	26.4	26.9	20.0	21.5	21.8	22.6	24.9	25.3	19.5	20.6
Pairwise differences between the model runs												
REF1a-LCZa	0.26	0.55	0.13	0.30	0.39	0.86	0.35	0.60	0.21	0.38	0.44	0.77
REF1b-LCZb	0.25	0.52	0.16	0.33	0.33	0.75	0.34	0.58	0.25	0.42	0.39	0.69
LCZ1b-LCZ1a	0.00	-0.02	-0.31	-0.41	0.33	0.39	-0.01	-0.03	-0.36	-0.46	0.28	0.31
REF1b-REF1a	-0.01	-0.05	-0.27	-0.39	0.27	0.28	-0.02	-0.06	-0.31	-0.43	0.23	0.23
REF2b-REF2a	-0.03	-0.07	-0.29	-0.40	0.27	0.28	-0.03	-0.06	-0.35	-0.45	0.23	0.23
REF2a-REF1a	0.20	0.14	0.11	0.08	0.30	0.19	0.17	0.12	0.13	0.10	0.21	0.15
REF2b-REF1b	0.18	0.12	0.09	0.06	0.31	0.19	0.16	0.11	0.10	0.08	0.21	0.15

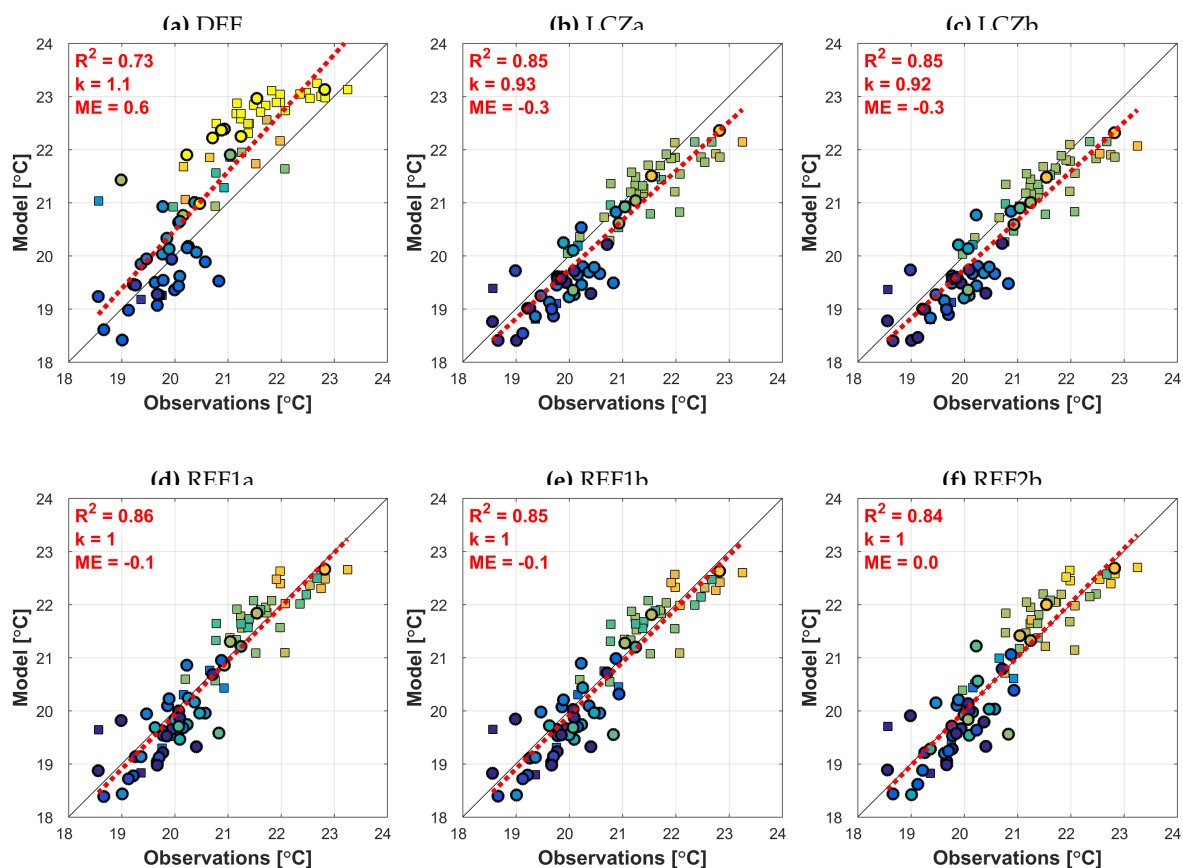


Figure S2. Comparison between observed and modelled daily-mean temperatures, averaged over the selected period in August 2017 for DEF (a), LCZa (b), LCZb (c), REF1a (d), REF1b (e), REF2b (f) model runs. Circle and square markers represent the WSs and AAQs respectively, the color of the marker represent the ISA for the corresponding grid cells (blue-to-yellow colormap indicate ISA values from 0 to 100%). Red dotted lines indicate the linear trends, and digits at the top left corners indicate trend determination coefficient R^2 , slope coefficient k and model mean error ME.

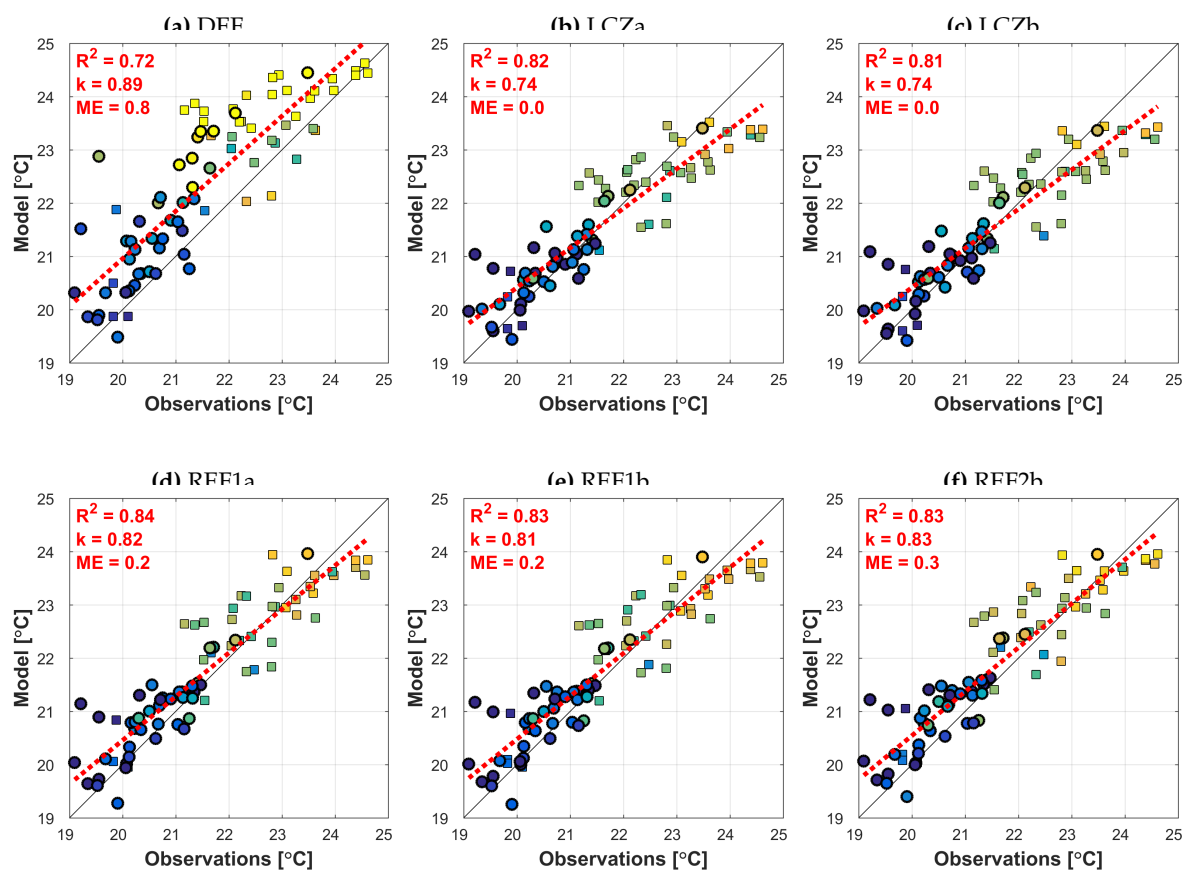


Figure S3. Same as Figure S2, but for daily-mean temperatures for selected sub-periods in June 2019.

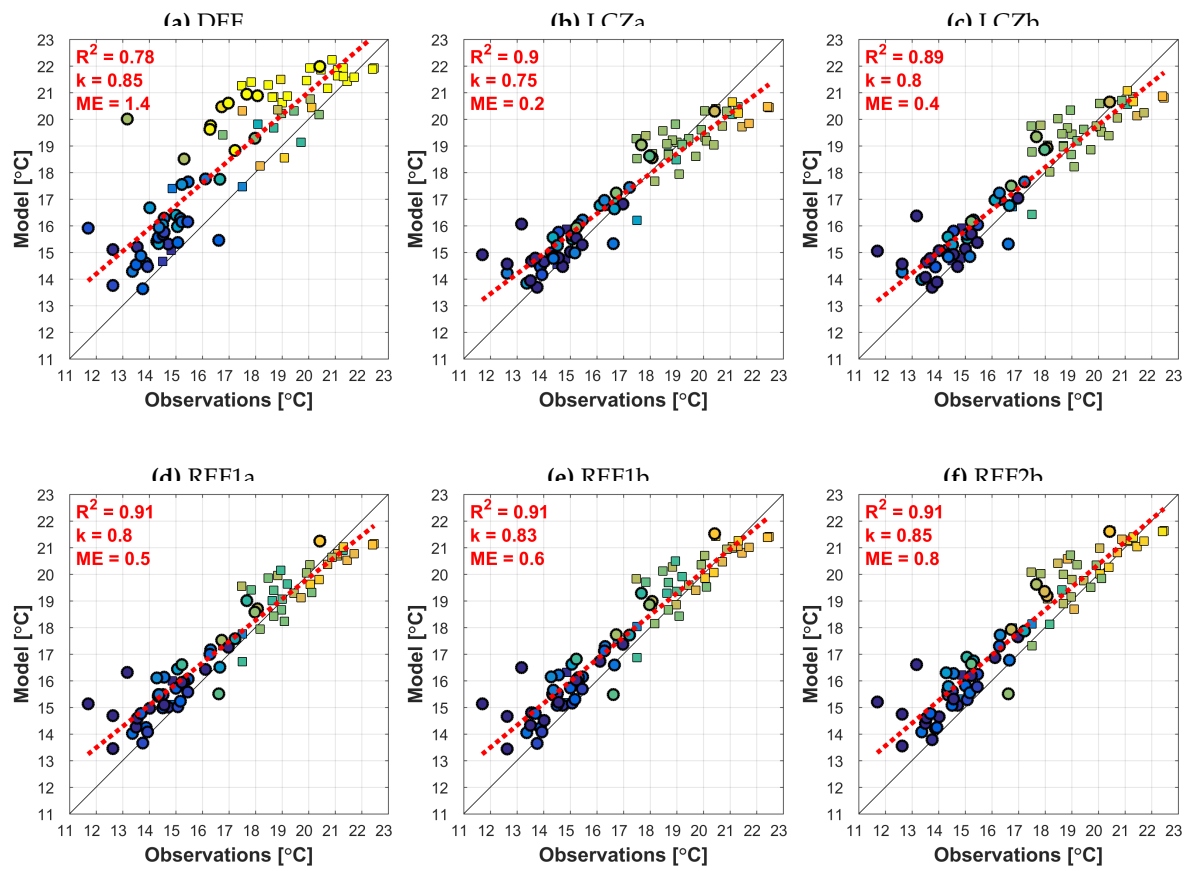


Figure S4. Same as Figure S2, but for mean nocturnal (21, 00 UTC) temperatures for selected sub-periods in June 2019.

Table S3. Model verification scores for air temperature.

Period and time of the day	Model run	Temperature RMSE									Temperature ME								
		All sites	Rural sites	Urban sites (within 25 km from the center)			Central city sites (within 5 km from the center)			All sites	Rural sites	Urban sites (within 25 km from the center)			Central city sites (within 5 km from the center)				
				WS	AAQS	All	WS	AAQS	All			WS	AAQS	All	WS	AAQS	All		
August 2017, all times	DEF	1.60	1.49	2.19	1.54	1.70	1.17	1.20	1.20	0.56	0.01	1.21	0.91	0.98	0.30	0.62	0.58		
	LCZa	1.30	1.41	1.39	1.19	1.24	1.16	1.12	1.12	-0.31	-0.50	-0.09	-0.21	-0.18	-0.47	-0.40	-0.40		
	LCZb	1.31	1.42	1.46	1.18	1.25	1.21	1.05	1.07	-0.31	-0.50	-0.08	-0.21	-0.18	-0.51	-0.43	-0.44		
	REF1a	1.30	1.40	1.42	1.18	1.24	1.05	1.06	1.06	-0.07	-0.33	0.14	0.13	0.13	-0.16	0.01	-0.01		
	REF1b	1.32	1.42	1.50	1.18	1.26	1.11	1.01	1.02	-0.09	-0.34	0.09	0.10	0.10	-0.20	-0.04	-0.06		
	REF2a	1.32	1.40	1.47	1.21	1.28	1.05	1.06	1.06	0.02	-0.29	0.21	0.24	0.24	-0.09	0.11	0.09		
	REF2b	1.33	1.42	1.54	1.20	1.29	1.12	1.01	1.02	0.00	-0.30	0.21	0.21	0.21	-0.14	0.07	0.04		
August 2017, nighttime (21, 24 UTC)	DEF	1.82	1.65	2.82	1.68	1.96	1.16	1.14	1.15	1.01	0.70	2.27	0.98	1.30	0.59	0.37	0.40		
	LCZa	1.34	1.33	1.36	1.33	1.34	0.94	1.31	1.27	-0.21	-0.13	0.34	-0.45	-0.26	-0.49	-0.91	-0.85		
	LCZb	1.32	1.34	1.41	1.26	1.30	0.79	1.12	1.08	-0.03	-0.08	0.57	-0.16	0.02	-0.13	-0.59	-0.53		
	REF1a	1.36	1.40	1.51	1.27	1.33	0.84	1.12	1.09	0.11	0.14	0.64	-0.05	0.12	-0.03	-0.38	-0.34		
	REF1b	1.37	1.42	1.58	1.27	1.34	0.85	1.06	1.03	0.24	0.19	0.74	0.17	0.31	0.21	-0.15	-0.11		
	REF2a	1.38	1.42	1.58	1.30	1.37	0.87	1.10	1.08	0.22	0.20	0.71	0.10	0.25	0.07	-0.24	-0.20		
	REF2b	1.41	1.42	1.67	1.32	1.40	0.90	1.06	1.04	0.37	0.24	0.91	0.33	0.47	0.31	0.01	0.05		
August 2017, daytime (9, 12 UTC)	DEF	1.26	1.19	1.10	1.40	1.33	1.10	1.44	1.40	0.28	-0.38	0.07	0.93	0.72	0.15	0.98	0.87		
	LCZa	1.12	1.24	1.20	1.02	1.06	1.09	1.07	1.07	-0.20	-0.54	-0.50	0.15	-0.01	-0.28	0.26	0.19		
	LCZb	1.15	1.27	1.31	1.02	1.09	1.34	1.07	1.10	-0.42	-0.60	-0.72	-0.21	-0.33	-0.85	-0.20	-0.28		
	REF1a	1.13	1.21	1.12	1.09	1.10	1.08	1.17	1.16	-0.05	-0.48	-0.36	0.39	0.21	-0.14	0.48	0.40		
	REF1b	1.13	1.24	1.22	1.03	1.07	1.21	1.08	1.10	-0.26	-0.54	-0.57	0.06	-0.10	-0.56	0.08	0.00		
	REF2a	1.15	1.21	1.11	1.13	1.12	1.09	1.19	1.17	0.01	-0.45	-0.28	0.47	0.29	-0.10	0.56	0.47		
	REF2b	1.12	1.23	1.19	1.03	1.07	1.21	1.07	1.08	-0.21	-0.52	-0.49	0.11	-0.04	-0.54	0.12	0.03		
June 2019, all times	DEF	2.05	2.00	2.59	1.98	2.14	1.87	1.64	1.67	0.79	0.59	1.58	0.89	1.07	0.97	0.55	0.61		
	LCZa	1.80	1.89	1.73	1.73	1.73	1.64	1.70	1.69	0.02	0.18	0.23	-0.13	-0.04	-0.08	-0.37	-0.33		
	LCZb	1.79	1.88	1.76	1.70	1.72	1.63	1.58	1.59	0.01	0.17	0.24	-0.15	-0.05	-0.11	-0.41	-0.37		
	REF1a	1.80	1.91	1.77	1.70	1.72	1.66	1.57	1.58	0.18	0.24	0.38	0.13	0.20	0.48	-0.01	0.06		
	REF1b	1.79	1.91	1.80	1.68	1.71	1.68	1.50	1.53	0.18	0.25	0.39	0.11	0.18	0.42	-0.06	0.01		
	REF2a	1.81	1.92	1.81	1.71	1.73	1.70	1.56	1.58	0.29	0.30	0.52	0.28	0.34	0.56	0.11	0.18		
	REF2b	1.81	1.91	1.86	1.70	1.74	1.68	1.49	1.52	0.28	0.32	0.50	0.25	0.31	0.47	0.04	0.10		
June 2019, nighttime (21, 24 UTC)	DEF	2.47	2.38	3.68	2.29	2.65	2.17	1.61	1.69	1.44	1.34	3.10	1.25	1.72	1.55	0.30	0.47		
	LCZa	1.95	1.98	2.00	1.91	1.94	1.34	1.86	1.79	0.18	0.59	0.70	-0.28	-0.03	-0.12	-1.07	-0.93		
	LCZb	1.95	2.01	2.10	1.87	1.93	1.31	1.69	1.63	0.38	0.64	0.96	0.03	0.27	0.23	-0.69	-0.56		
	REF1a	1.99	2.07	2.14	1.87	1.94	1.70	1.64	1.65	0.45	0.76	0.92	0.07	0.29	0.82	-0.48	-0.29		
	REF1b	1.99	2.07	2.20	1.86	1.95	1.82	1.55	1.59	0.62	0.80	1.13	0.33	0.54	1.10	-0.25	-0.06		
	REF2a	2.02	2.11	2.23	1.89	1.98	1.74	1.58	1.60	0.62	0.82	1.18	0.31	0.53	0.94	-0.31	-0.13		
	REF2b	2.04	2.12	2.34	1.91	2.02	1.85	1.51	1.56	0.80	0.91	1.37	0.57	0.78	1.19	-0.03	0.15		
June 2019, daytime (9, 12 UTC)	DEF	1.74	1.82	1.65	1.77	1.74	1.73	1.70	1.70	0.95	0.95	0.90	1.05	1.01	1.24	1.25	1.25		
	LCZa	1.57	1.79	1.44	1.44	1.44	1.46	1.38	1.39	0.66	0.89	0.53	0.55	0.55	0.76	0.72	0.73		
	LCZb	1.53	1.76	1.43	1.38	1.39	1.37	1.27	1.28	0.45	0.82	0.32	0.21	0.24	0.29	0.27	0.27		
	REF1a	1.60	1.80	1.47	1.49	1.48	1.58	1.41	1.44	0.72	0.84	0.63	0.72	0.69	1.04	0.90	0.92		
	REF1b	1.55	1.78	1.43	1.41	1.41	1.44	1.30	1.32	0.57	0.83	0.47	0.42	0.44	0.60	0.54	0.55		
	REF2a	1.60	1.80	1.50	1.49	1.49	1.65	1.49	1.51	0.77	0.87	0.65	0.79	0.75	1.06	0.94	0.96		
	REF2b	1.54	1.77	1.48	1.39	1.41	1.44	1.29	1.31	0.60	0.85	0.49	0.48	0.48	0.62	0.54	0.55		
Janyary 2017, all times	DEF	1.75	1.94	1.52	1.55	1.55	1.35	1.52	1.50	-0.67	-0.53	-0.32	-0.76	-0.67	-0.74	-0.87	-0.86		
	LCZa	2.22	2.04	1.85	2.44	2.33	2.31	2.63	2.59	-1.34	-0.75	-1.05	-1.92	-1.76	-1.78	-2.16	-2.11		
	LCZb	2.24	2.04	1.87	2.47	2.36	2.35	2.67	2.63	-1.36	-0.76	-1.08	-1.94	-1.78	-1.80	-2.18	-2.14		
	REF1a	1.71	1.89	1.44	1.56	1.54	1.25	1.45	1.43	-0.57	-0.45	-0.32	-0.74	-0.67	-0.40	-0.78	-0.74		
	REF1b	1.72	1.89	1.44	1.57	1.55	1.26	1.47	1.45	-0.59	-0.46	-0.34	-0.77	-0.69	-0.42	-0.80	-0.76		
	REF2a	1.70	1.89	1.43	1.53	1.51	1.23	1.43	1.41	-0.54	-0.43	-0.29	-0.70	-0.63	-0.37	-0.74	-0.70		
	REF2b	1.71	1.89	1.44	1.55	1.53	1.25	1.45	1.43	-0.56	-0.44	-0.31	-0.73	-0.65	-0.40	-0.77	-0.72		

Table S4. Model verification scores for UHI intensity, defined as a temperature anomaly with respect to the mean rural temperature.

Period and time of the day	Model run	UHII RMSE									UHII ME								
		All sites	Rural sites	Urban sites (within 25 km from the center)			Central city sites (within 5 km from the center)			All sites	Rural sites	Urban sites (within 25 km from the center)			Central city sites (within 5 km from the center)				
				WS	AAQS	All	WS	AAQS	All			WS	AAQS	All	WS	AAQS	All		
August 2017, all times	DEF	1.51	1.21	2.02	1.64	1.73	1.24	1.44	1.42	0.69	0.13	-0.16	1.03	1.10	0.43	0.74	0.70		
	LCZa	1.18	1.08	1.31	1.24	1.26	1.18	1.23	1.22	0.20	0.01	-0.10	0.30	0.33	0.04	0.11	0.10		
	LCZb	1.15	1.08	1.34	1.17	1.21	1.13	1.08	1.09	0.19	0.00	-0.10	0.29	0.32	-0.01	0.08	0.07		
	REF1a	1.21	1.10	1.31	1.29	1.29	1.14	1.27	1.26	0.23	-0.03	-0.20	0.43	0.43	0.14	0.31	0.29		
	REF1b	1.18	1.10	1.32	1.21	1.24	1.11	1.15	1.14	0.20	-0.05	-0.22	0.39	0.39	0.09	0.25	0.23		
	REF2a	1.24	1.11	1.37	1.33	1.34	1.15	1.29	1.28	0.33	0.01	-0.13	0.55	0.54	0.22	0.42	0.39		
	REF2b	1.20	1.11	1.37	1.25	1.28	1.10	1.17	1.16	0.30	-0.01	-0.14	0.51	0.51	0.15	0.36	0.34		
August 2017, nighttime (21, 24 UTC)	DEF	1.52	1.40	2.32	1.38	1.61	0.92	1.03	1.01	0.50	0.18	-0.18	0.47	0.78	0.08	-0.14	-0.11		
	LCZa	1.21	1.20	1.28	1.21	1.23	0.86	1.22	1.18	-0.07	0.01	-0.02	-0.31	-0.11	-0.35	-0.76	-0.71		
	LCZb	1.21	1.20	1.35	1.17	1.22	0.76	1.08	1.04	0.06	0.01	-0.03	-0.07	0.11	-0.04	-0.50	-0.44		
	REF1a	1.23	1.23	1.32	1.20	1.23	0.87	1.17	1.13	-0.09	-0.06	-0.22	-0.25	-0.08	-0.23	-0.58	-0.54		
	REF1b	1.23	1.25	1.37	1.18	1.22	0.82	1.10	1.07	-0.03	-0.08	-0.31	-0.10	0.04	-0.06	-0.42	-0.38		
	REF2a	1.24	1.25	1.38	1.21	1.25	0.85	1.13	1.09	0.02	0.00	-0.18	-0.10	0.05	-0.13	-0.44	-0.40		
	REF2b	1.24	1.25	1.43	1.20	1.25	0.82	1.07	1.04	0.09	-0.04	-0.21	0.05	0.19	0.03	-0.27	-0.23		
August 2017, daytime (9, 12 UTC)	DEF	1.26	0.99	1.07	1.57	1.45	1.00	1.60	1.53	0.69	0.03	-0.04	1.33	1.12	0.55	1.38	1.28		
	LCZa	0.98	0.97	0.91	1.02	1.00	0.79	1.09	1.05	0.29	-0.04	-0.13	0.65	0.49	0.21	0.75	0.68		
	LCZb	0.91	0.97	0.92	0.87	0.89	0.82	0.89	0.88	0.12	-0.05	-0.10	0.34	0.21	-0.30	0.35	0.27		
	REF1a	1.03	0.96	0.91	1.15	1.09	0.87	1.21	1.17	0.39	-0.04	-0.10	0.83	0.64	0.30	0.92	0.84		
	REF1b	0.95	0.96	0.90	0.96	0.95	0.80	0.97	0.95	0.23	-0.05	-0.06	0.54	0.39	-0.08	0.56	0.48		
	REF2a	1.07	0.97	0.93	1.22	1.15	0.92	1.28	1.24	0.46	-0.01	-0.02	0.92	0.73	0.35	1.00	0.92		
	REF2b	0.96	0.95	0.89	1.00	0.97	0.81	1.00	0.97	0.30	-0.02	-0.01	0.62	0.47	-0.04	0.62	0.54		
June 2019, all times	DEF	1.70	1.55	2.21	1.73	1.85	1.61	1.55	1.56	0.31	0.10	-0.23	0.40	0.58	0.48	0.06	0.12		
	LCZa	1.53	1.46	1.52	1.60	1.58	1.64	1.70	1.69	-0.21	-0.05	-0.38	-0.36	-0.27	-0.31	-0.60	-0.56		
	LCZb	1.53	1.45	1.55	1.61	1.59	1.66	1.64	1.64	-0.21	-0.05	-0.37	-0.37	-0.27	-0.34	-0.64	-0.59		
	REF1a	1.51	1.49	1.51	1.54	1.54	1.57	1.56	1.56	-0.12	-0.06	-0.31	-0.17	-0.11	0.17	-0.31	-0.24		
	REF1b	1.52	1.48	1.54	1.55	1.55	1.61	1.54	1.55	-0.14	-0.07	-0.32	-0.21	-0.14	0.10	-0.38	-0.31		
	REF2a	1.51	1.50	1.54	1.54	1.54	1.57	1.55	1.55	-0.08	-0.07	-0.16	-0.09	-0.03	0.19	-0.26	-0.19		
	REF2b	1.52	1.49	1.58	1.55	1.56	1.58	1.52	1.53	-0.10	-0.06	-0.27	-0.13	-0.06	0.09	-0.33	-0.27		
June 2019, nighttime (21, 24 UTC)	DEF	1.92	1.73	2.70	1.89	2.10	1.47	1.73	1.69	0.33	0.22	-1.00	0.13	0.61	0.44	-0.82	-0.64		
	LCZa	1.71	1.55	1.59	1.89	1.81	1.47	2.21	2.11	-0.47	-0.06	-1.10	-0.94	-0.69	-0.77	-1.72	-1.58		
	LCZb	1.68	1.58	1.61	1.80	1.75	1.31	2.00	1.90	-0.32	-0.07	-1.03	-0.68	-0.44	-0.48	-1.40	-1.27		
	REF1a	1.70	1.61	1.65	1.80	1.77	1.31	1.95	1.86	-0.37	-0.06	-0.72	-0.75	-0.53	0.00	-1.30	-1.11		
	REF1b	1.67	1.59	1.65	1.76	1.73	1.34	1.86	1.79	-0.27	-0.08	-0.68	-0.56	-0.35	0.21	-1.14	-0.95		
	REF2a	1.68	1.62	1.63	1.76	1.73	1.30	1.87	1.79	-0.27	-0.06	-0.59	-0.58	-0.35	0.05	-1.19	-1.01		
	REF2b	1.66	1.60	1.69	1.72	1.72	1.33	1.77	1.71	-0.16	-0.05	-0.52	-0.39	-0.19	0.23	-0.99	-0.82		
June 2019, daytime (9, 12 UTC)	DEF	1.28	1.37	1.11	1.30	1.25	0.97	1.19	1.16	-0.11	-0.11	-0.12	0.00	-0.04	0.19	0.19	0.19		
	LCZa	1.28	1.39	1.18	1.22	1.21	1.08	1.15	1.14	-0.37	-0.14	-0.31	-0.48	-0.48	-0.26	-0.31	-0.30		
	LCZb	1.36	1.39	1.30	1.36	1.34	1.30	1.32	1.32	-0.52	-0.15	-0.35	-0.76	-0.73	-0.68	-0.70	-0.70		
	REF1a	1.25	1.40	1.14	1.17	1.16	1.07	1.10	1.09	-0.26	-0.15	-0.28	-0.27	-0.30	0.05	-0.09	-0.07		
	REF1b	1.31	1.40	1.20	1.26	1.24	1.17	1.18	1.18	-0.43	-0.17	-0.38	-0.58	-0.57	-0.40	-0.46	-0.46		
	REF2a	1.24	1.39	1.16	1.14	1.15	1.12	1.13	1.13	-0.30	-0.20	-0.24	-0.28	-0.32	0.00	-0.13	-0.11		
	REF2b	1.29	1.38	1.25	1.22	1.23	1.18	1.20	1.19	-0.43	-0.18	-0.36	-0.55	-0.55	-0.41	-0.49	-0.48		
Janyary 2017, all times	DEF	1.38	1.42	1.15	1.35	1.32	1.10	1.34	1.31	-0.25	-0.11	0.10	-0.34	-0.26	-0.32	-0.46	-0.44		
	LCZa	1.70	1.47	1.32	1.99	1.87	1.81	2.21	2.17	-0.86	-0.28	-0.57	-1.44	-1.28	-1.30	-1.68	-1.64		
	LCZb	1.71	1.48	1.33	2.01	1.88	1.84	2.24	2.19	-0.87	-0.27	-0.59	-1.45	-1.29	-1.32	-1.70	-1.66		
	REF1a	1.36	1.44	1.09	1.35	1.30	0.95	1.28	1.24	-0.39	-0.27	-0.14	-0.57	-0.49	-0.22	-0.60	-0.56		
	REF1b	1.37	1.44	1.10	1.36	1.31	0.95	1.29	1.25	-0.40	-0.27	-0.15	-0.58	-0.50	-0.23	-0.61	-0.57		
	REF2a	1.36	1.44	1.09	1.33	1.29	0.94	1.27	1.24	-0.38	-0.27	-0.13	-0.54	-0.47	-0.21	-0.58	-0.54		
	REF2b	1.36	1.45	1.09	1.35	1.30	0.95	1.28	1.25	-0.39	-0.27	-0.14	-0.56	-0.48	-0.22	-0.59	-0.55		