



Supplement of

A new Earth Observation–based WRF configuration for urban regional climate simulations over Paris

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Table S1: Building height (m), density (%), building width (m), road width (m) and for each LCZ class.

	Building height (m)		Density per 5m classes (%)		Building width (m)		Road width (m)	
LCZ Classes	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data
LCZ 1	40	40	17	17	22.22	22.22	20	20
	45	45	21	21				
	50	50	24	24				
	55	55	21	21				
	60	60	17	17				
LCZ 2		5		0.9	22	35.6	14	9.4
		10		17.3				
	15	15	50	14.8				
	20	20	50	19.2				
		25		30.5				
		30		10.8				
		35		3.7				
		40		1.3				
		45		0.5				
		50		0.3				
		55		0.2				
		60		0.1				
		65		0.4				

Table S1: (Continued)

	Building height (m)		Density per 5m classes (%)		Building width (m)		Road width (m)	
LCZ Classes	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data
LCZ 3	5	5	72	2.8	9.6	52.2	5.2	9.4
	10	10	28	50.2				
		15		22.8				
		20		13				
		25		8				
		30		2.6				
		35		0.5				
		40		0.1				
LCZ 4		5		1.4	42.86	43.5	50	10.9
		10		27.4				
		15		16.7				
		20		9.1				
		25		29.3				
		30		9				
		35		1.7				
	40	40	17	0.5				
	45	45	21	0.3				
	50	50	24	0.9				
	55	55	21	0.3				
	60	60	17	0.7				
		65		0.3				
		95		2				
		105		0.4				

Table S1: (Continued)

	Building height (m)		Density per 5m classes (%)		Building width (m)		Road width (m)	
LCZ Classes	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data
LCZ 5		5		2.6	26.25	31.5	35	11.3
		10		45.3				
	15	15	50	19.5				
	20	20	50	11.1				
		25		9.9				
		30		5.2				
		35		3.2				
		40		1.4				
		45		0.7				
		50		0.4				
		55		0.3				
		60		0.1				
		65		0.3				
LCZ 6	5	5	72	10	13	21	13	9.15
	10	10	28	71.5				
		15		10.9				
		20		4.5				
		25		1.4				
		30		0.7				
		35		0.5				
		40		0.2				
		45		0.1				
		50		0.2				
LCZ 7	5	100	5	100	25	25	3.33	3.33

Table S1: (Continued)

	Building height (m)		Density per 5m classes (%)		Building width (m)		Road width (m)	
LCZ Classes	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data
LCZ 8	5	5	72	2.7	28.9	28.7	32.5	16.1
	10	10	28	51.3				
		15		26.3				
		20		10.2				
		25		4.8				
		30		2.4				
		35		1.2				
		40		0.4				
		45		0.2				
		50		0.1				
		55		0.2				
LCZ 9	5	5	72	4.8	43.33	26.8	43.33	10.1
	10	10	28	43.6				
		15		14.3				
		20		12.1				
		25		13.8				
		30		7.3				
		35		3.1				
		40		0.9				
		50		0.1				
LCZ 10	5	5	16	16	23.8	23.8	28.6	28.6
	10	10	68	68				
	15	15	16	16				
LCZ E	5	5	100	100	5	5	100	100

Table S2: Thermal properties of urban surfaces for each LCZ class.

Properties LCZ Class		Albedo		Emissivity		Heat Capacity (MJ×m ⁻³ ×K ⁻¹)		Thermal Conductivity (J×m ⁻¹ ×sec ⁻¹ ×K ⁻¹)	
		WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data
LCZ 1	Roof	0.3	0.13	0.9	0.91	1.32	1.32	1.54	1.54
	Wall	0.3	0.25	0.9	0.9	1.54	1.54	1.51	1.51
	Road	0.08	0.14	0.95	0.95	1.74	1.74	0.82	0.82
LCZ 2	Roof	0.3	0.134	0.9	0.963	1.32	1.32	1.54	1.54
	Wall	0.3	0.134	0.9	0.963	1.54	1.54	1.51	1.51
	Road	0.08	0.114	0.95	0.962	1.74	1.74	0.82	0.82
LCZ 3	Roof	0.3	0.137	0.9	0.965	1.32	1.32	1.54	1.54
	Wall	0.3	0.137	0.9	0.965	1.54	1.54	1.51	1.51
	Road	0.08	0.12	0.95	0.961	1.74	1.74	0.82	0.82
LCZ 4	Roof	0.3	0.144	0.9	0.966	1.32	1.32	1.54	1.54
	Wall	0.3	0.144	0.9	0.966	1.54	1.54	1.51	1.51
	Road	0.08	0.121	0.95	0.96	1.74	1.74	0.82	0.82
LCZ 5	Roof	0.3	0.146	0.9	0.962	1.32	1.32	1.54	1.54
	Wall	0.3	0.146	0.9	0.962	1.54	1.54	1.51	1.51
	Road	0.08	0.127	0.95	0.96	1.74	1.74	0.82	0.82
LCZ 6	Roof	0.3	0.148	0.9	0.965	1.32	1.32	1.54	1.54
	Wall	0.3	0.148	0.9	0.965	1.54	1.54	1.51	1.51
	Road	0.08	0.135	0.95	0.964	1.74	1.74	0.82	0.82
LCZ 7	Roof	0.3	0.15	0.9	0.9	1.32	1.32	1.54	1.54
	Wall	0.3	0.2	0.9	0.9	1.54	1.54	1.51	1.51
	Road	0.08	0.18	0.95	0.92	1.74	1.74	0.82	0.82

Table S2: (Continued)

Properties LCZ Class		Albedo		Emissivity		Heat Capacity (MJ×m ⁻³ ×K ⁻¹)		Thermal Conductivity (J×m ⁻¹ ×sec ⁻¹ ×K ⁻¹)	
		WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data	WRF v4.6.0 (and later)	EO Paris Data
LCZ 8	Roof	0.3	0.16	0.9	0.955	1.32	1.32	1.54	1.54
	Wall	0.3	0.16	0.9	0.955	1.54	1.54	1.51	1.51
	Road	0.08	0.142	0.95	0.955	1.74	1.74	0.82	0.82
LCZ 9	Roof	0.3	0.162	0.9	0.968	1.32	1.32	1.54	1.54
	Wall	0.3	0.162	0.9	0.968	1.54	1.54	1.51	1.51
	Road	0.08	0.127	0.95	0.966	1.74	1.74	0.82	0.82
LCZ 10	Roof	0.3	0.1	0.9	0.91	1.32	1.32	1.54	1.54
	Wall	0.3	0.2	0.9	0.9	1.54	1.54	1.51	1.51
	Road	0.08	0.14	0.95	0.95	1.74	1.74	0.82	0.82
LCZ E	Roof	0.3	0.13	0.9	0.95	1.32	1.32	1.54	1.54
	Wall	0.3	0.2	0.9	0.95	1.54	1.54	1.51	1.51
	Road	0.08	0.14	0.95	0.95	1.74	1.74	0.82	0.82

Table S3: Coverage (in number of cells and %) of each land use class in Paris region (Île-de-France) for BEP–BEM simulations.

LU_INDEX	Category	No. of Cells	%
1	Evergreen Needleleaf Forest	10	0.8
4	Deciduous Broadleaf Forest	140	11.15
12	Croplands	812	64.65
52	LCZ2 - Compact Midrise	16	1.27
54	LCZ4 - Open High-rise	1	0.08
55	LCZ5 - Open Midrise	39	3.11
56	LCZ6 - Open Low-rise	198	15.76
58	LCZ8 - Large Low-rise	39	3.11
59	LCZ9 - Sparsely built	1	0.08
LCZs Sum		294	23.41
Total		1256	100

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Table S4: Coverage (in number of cells and %) of each land use class in Paris region (Île-de-France) for BULK simulation.

LU_INDEX	Category	No. of Cells	%
1	Evergreen Needleleaf Forest	10	0.8
4	Deciduous Broadleaf Forest	149	11.86
12	Croplands	888	70.7
13	Urban and Built-Up	209	16.64
Total		1256	100

35 **Table S5: Information for all the stations used for the evaluation of the three experiments.**

Site / Network location	Lat (°)	Lon (°)	Alt (m)	Distance from Paris centre (km)	Actual LU Type	WRF BULK Run LU Type	WRF BEP-BEM Runs LU Type
Melun	48.610328 67431640	2.6795001 0299683	91	36.6	Crops	Croplands	Croplands
Wy-Dit-Joli-Village	49.108169 55566410	1.8306699 9912262	126	47.1	Crops	Croplands	Croplands
Fresnoy-La-Riviere	49.284828 18603520	2.9183299 5414734	61	63.4	Crops	Croplands	Croplands
La-Brosse-Montceau	48.351669 31152340	3.0233299 7322083	77	75.0	Crops	Croplands	Croplands
Etampes	48.380828 85742190	2.0818300 2471924	147	56.3	Crops	Croplands	Croplands
Magnanville	48.963668 82324220	1.6741700 1724243	123	50.7	Crops	Croplands	Croplands
Changis	48.964668 27392580	3.0118300 9147644	70	50.2	Crops	Croplands	Croplands
Sours	48.406330 10864260	1.5551700 5920410	147	76.7	Crops	Croplands	Croplands
Maule	48.909168 24340820	1.8474999 6662140	54	37.0	Crops	Croplands	Croplands
Villaines-Sous-Bois	49.075328 82690430	2.3635001 1825562	120	24.5	Crops	Croplands	Croplands
Pontoise	49.090328 21655270	2.0285000 8010864	87	35.0	Crops	Croplands	Croplands
Nangis	48.595329 28466800	3.0076699 2568970	128	56.5	Crops	Croplands	Croplands
Jagny-sous-Bois	49.076499 93896480	2.4448299 4079590	138	25.7	Crops	Croplands	Croplands
Mouroux	48.847171 78344730	3.0569999 2179871	148	52.0	Crops	Croplands	Croplands
Vinantes	49.005500 79345700	2.7398300 1708984	102	33.3	Crops	Croplands	Croplands
Tossus-Le-Noble	48.750671 38671880	2.1135001 1825562	154	20.7	Crops	Croplands	Croplands

Table S5: (Continued)

Site / Network location	Lat (°)	Lon (°)	Alt (m)	Distance from Paris centre (km)	Actual LU Type	WRF BULK Run LU Type	WRF BEP-BEM Runs LU Type
Dourdan	48.526168 82324220	1.9930000 3051758	116	44.9	Forest	Deciduous Broadleaf Forest	Deciduous Broadleaf Forest
Fontainebleau	48.405998 22998050	2.6784999 3705750	84	55.7	Forest	Deciduous Broadleaf Forest	Deciduous Broadleaf Forest
St-Leger	48.706668 85375980	1.7458300 5905151	176	47.1	Forest	Deciduous Broadleaf Forest	Deciduous Broadleaf Forest
Crouy-Sur-Ourcq	49.092830 65795900	3.0703299 0455627	62	59.1	Forest	Deciduous Broadleaf Forest	Deciduous Broadleaf Forest
Paris-Montsouris	48.821670 53222660	2.3378200 5310059	75	3.8	Urban	Urban and Built-Up	LCZ2 - Compact Midrise
Luxembourg	48.844669 34204100	2.3338201 0459900	46	1.5	Urban	Urban and Built-Up	LCZ2 - Compact Midrise
Lariboisiere	48.882831 57348630	2.3519999 9809265	55	3.2	Urban	Urban and Built-Up	LCZ2 - Compact Midrise
St-Maur	48.808670 04394530	2.4923300 7431030	50	11.9	Urban	Urban and Built-Up	LCZ5 - Open Midrise
Longchamp-Bois-De-Boulogne	48.854831 69555660	2.2336699 9626160	27	8.3	Urban	Urban and Built-Up	LCZ5 - Open Midrise
Trappes	48.774330 13916020	2.0098299 9801636	167	26.3	Urban	Urban and Built-Up	LCZ5 - Open Midrise
Beaumont-sur-Oise	49.141670 22705080	2.2691700 4585266	27	31.8	Urban	Urban and Built-Up	LCZ6 - Open Low-rise
Orly	48.717998 50463870	2.3969900 6080627	86	15.7	Urban	Urban and Built-Up	LCZ6 - Open Low-rise
Torcy	48.863498 68774410	2.6510000 2288818	43	22.3	Urban	Urban and Built-Up	LCZ6 - Open Low-rise
Chartres	48.460498 80981450	1.5011700 3917694	155	76.1	Urban	Urban and Built-Up	LCZ6 - Open Low-rise
LeBourget	48.967330 93261720	2.4276700 0198364	49	13.8	Urban	Urban and Built-Up	LCZ6 - Open Low-rise

40 Table S5: (Continued)

Site / Network location	Lat (°)	Lon (°)	Alt (m)	Distance from Paris centre (km)	Actual LU Type	WRF BULK Run LU Type	WRF BEP-BEM Runs LU Type
Villacoublay	48.772499 08447270	2.2039999 9618530	174	13.9	Urban	Urban and Built-Up	LCZ8 - Large Low-rise
Roissy	49.015171 05102540	2.5343298 9120483	108	22.5	Urban	Urban and Built-Up	LCZ8 - Large Low-rise

45 Table S6: Statistical analysis (Bias, RMSE, R) of the two simulations using BEP-BEM UCM, concerning stations located at LCZs, during daytime and nighttime hours (indicated as D and N, respectively), for the summer (JJA) of 2020. Temporal correlation (R) is calculated on the totality of the 24h span.

Simulations	CTRL								PAR							
Group Stations	LCZ2		LCZ5		LCZ6		LCZ8		LCZ2		LCZ5		LCZ6		LCZ8	
Day Period	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Bias (°C)	1.45	2.23	0.96	2.76	0.84	2.37	0.77	1.43	2.71	2.19	1.52	2.36	1.08	2.01	0.67	1.13
RMSE (°C)	3.06	3.18	2.8	3.89	2.58	3.46	2.52	2.48	4.13	3.44	3.34	3.62	2.92	3.23	2.75	2.73
R	0.87		0.85		0.87		0.88		0.86		0.85		0.86		0.88	

50 Table S7: Statistical analysis (Bias, RMSE, R) of the three simulations concerning group stations (Urban, Non–Urban) during daytime and nighttime hours (indicated as D and N, respectively), for the heatwave of August 2020. Temporal correlation (R) is calculated on the totality of the 24h span.

Simulations	BULK				CTRL				PAR			
Group Stations	Urban		Non–Urban		Urban		Non–Urban		Urban		Non–Urban	
Day Period	D	N	D	N	D	N	D	N	D	N	D	N
Bias (°C)	1.45	3.52	0.43	4.02	0.53	4.25	0.04	3.93	1.47	4.64	-0.29	3.95
RMSE (°C)	4.04	4.74	3.95	4.91	2.98	5.13	3.38	4.68	3.68	5.65	3.26	4.62
R	0.76		0.79		0.80		0.85		0.78		0.86	

Simulations	CTRL								PAR							
Group Stations	LCZ2		LCZ5		LCZ6		LCZ8		LCZ2		LCZ5		LCZ6		LCZ8	
Day Period	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
Bias (°C)	0.89	4.05	0.41	5.4	0.53	4.57	0.44	2.13	2.61	4.71	1.15	5.42	1.05	4.74	0.55	2.82
RMSE (°C)	3.2	4.7	3.42	6.1	2.98	5.35	2.73	3.03	4.23	5.62	3.76	6.56	3.26	5.89	3.08	4.13
R	0.79		0.76		0.84		0.83		0.76		0.79		0.86		0.81	

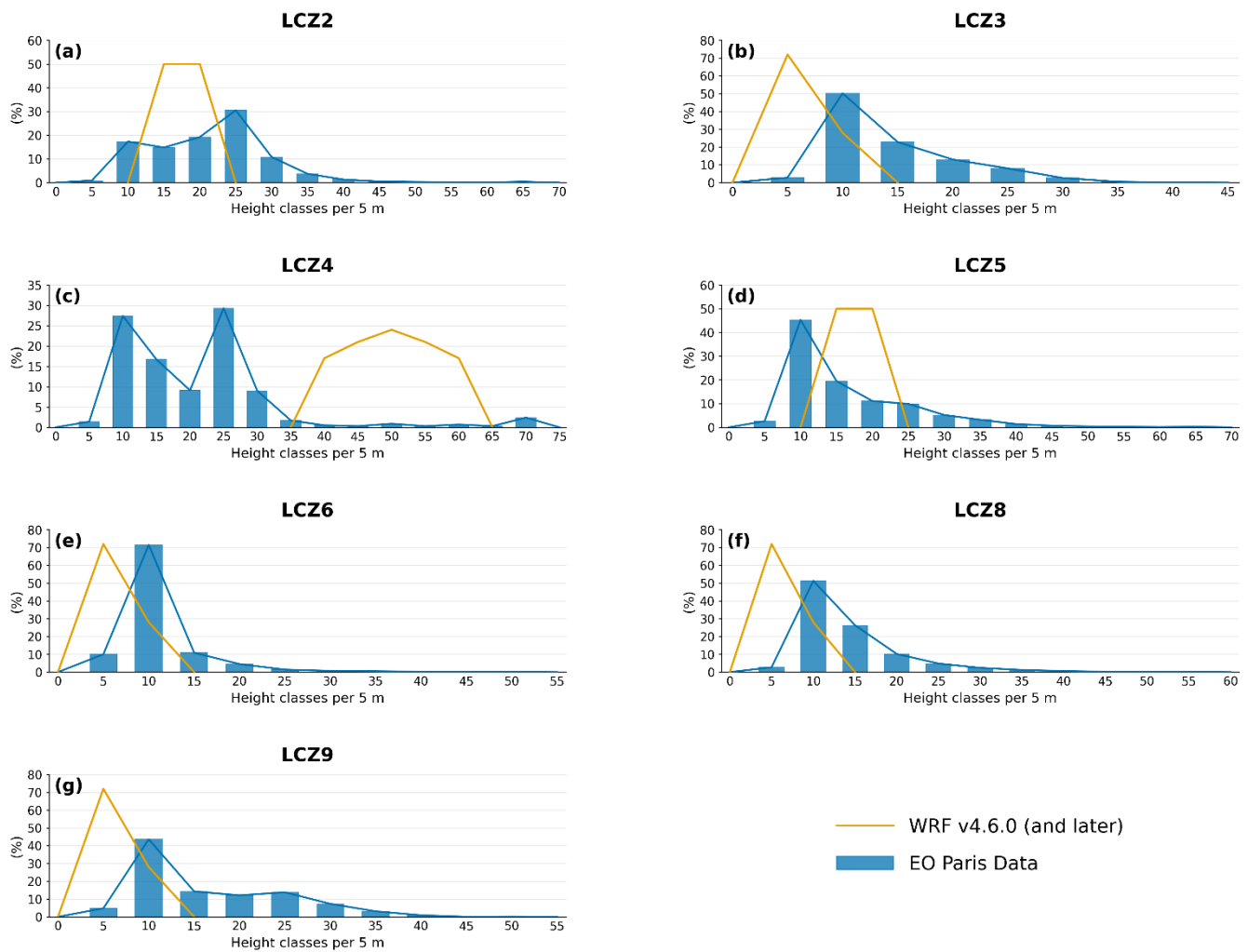


Figure S1: : Building height distribution for: (a) LCZ 2, (b) LCZ 3, (c) LCZ 4, (d) LCZ 5, (e) LCZ 6, (f) LCZ 8, (g) LCZ 9, regarding data in WRF v4.6.0 and later (light orange line) and EO Paris data (blue bars and line), used in CTRL and PAR simulations, respectfully.

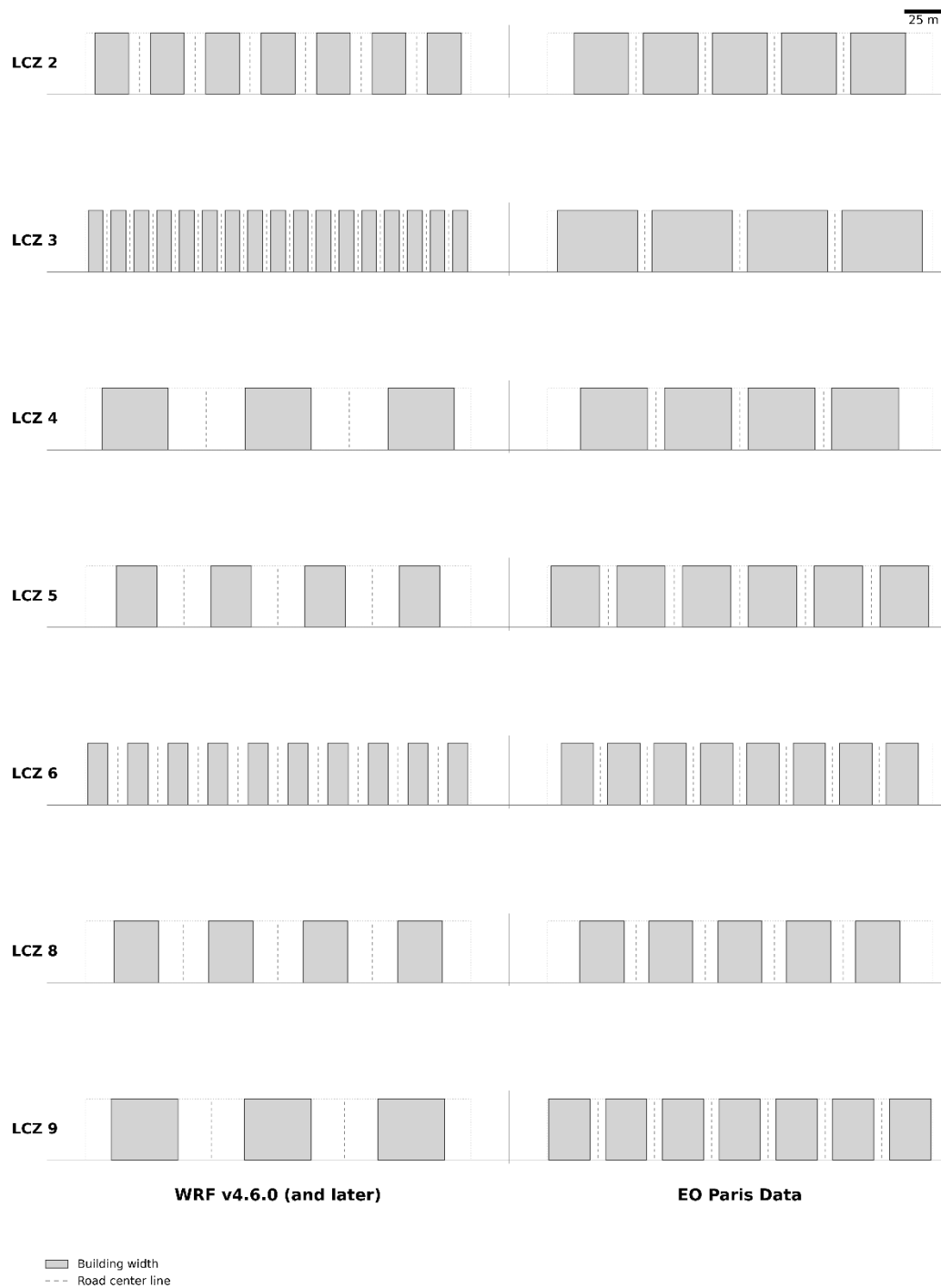


Figure S2: Schematic comparison of building and road widths for each LCZ class, regarding data in WRF v4.6.0 (and later) and EO Paris data, displayed within a common 250 m horizontal extent.

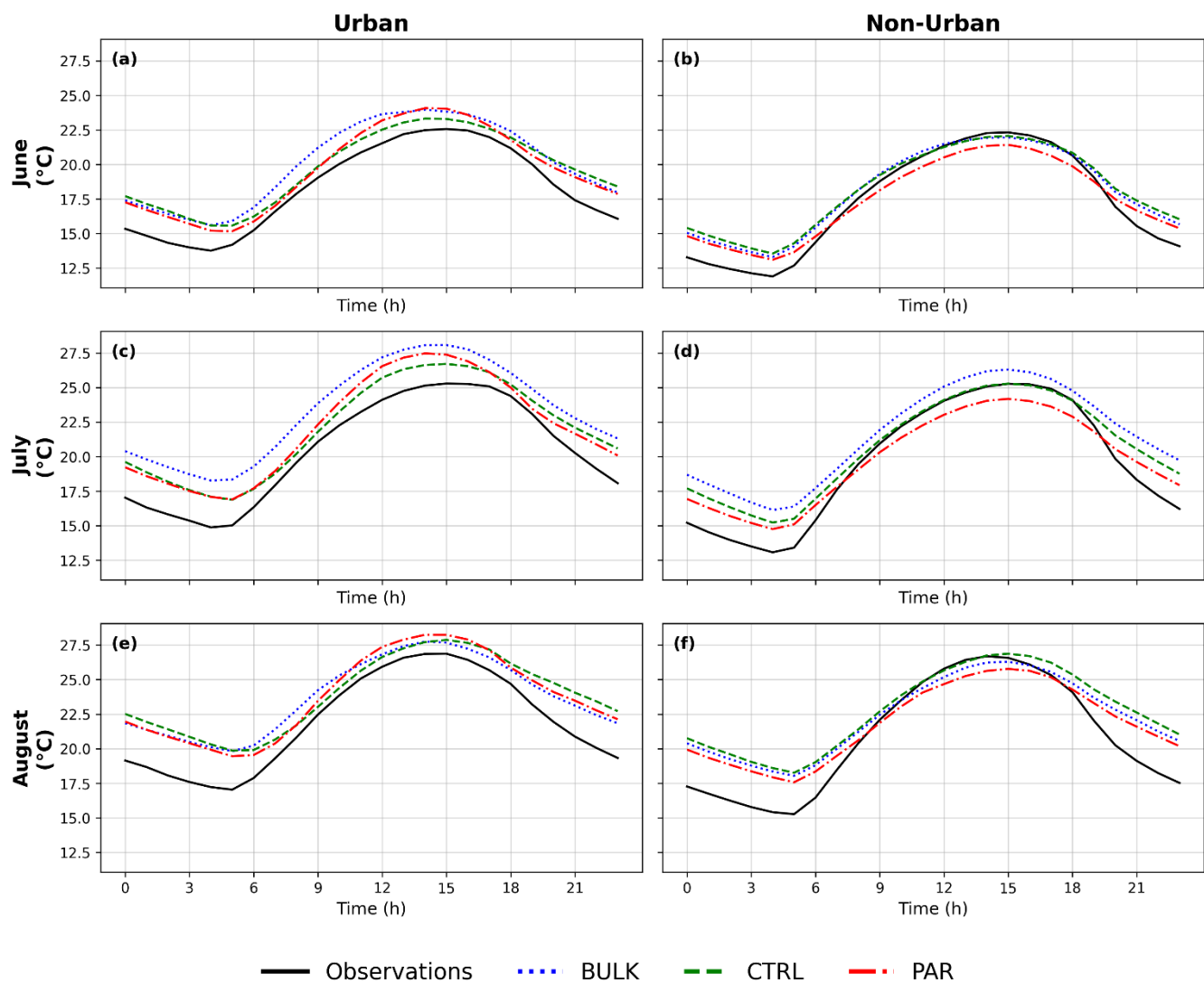


Figure S3: Daily profiles of 2 m air temperature of observations (black solid line), BULK (blue dotted line), CTRL (green dashed line) and PAR (red dash-dot line) for Urban and Non-Urban stations, respectively, in (a,b) June; (c,d) July and (e,f) August.

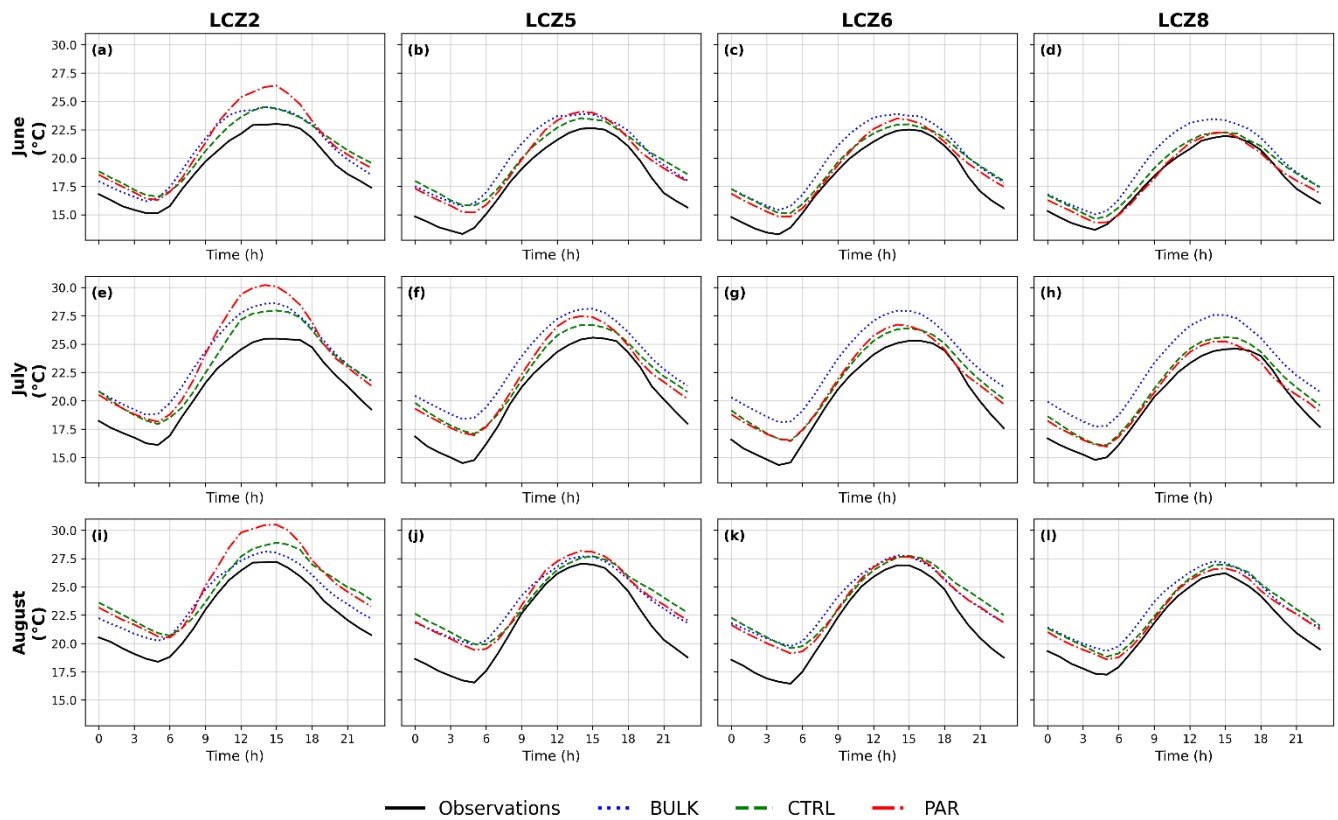


Figure S4: Daily profiles of 2 m air temperature of observations (black solid line), BULK (blue dotted line), CTRL (green dashed line) and PAR (red dash-dot line) for LCZs in (a), (b), (c), (d) June; (e), (f), (g), (h) July and (i), (j), (k), (l) August.

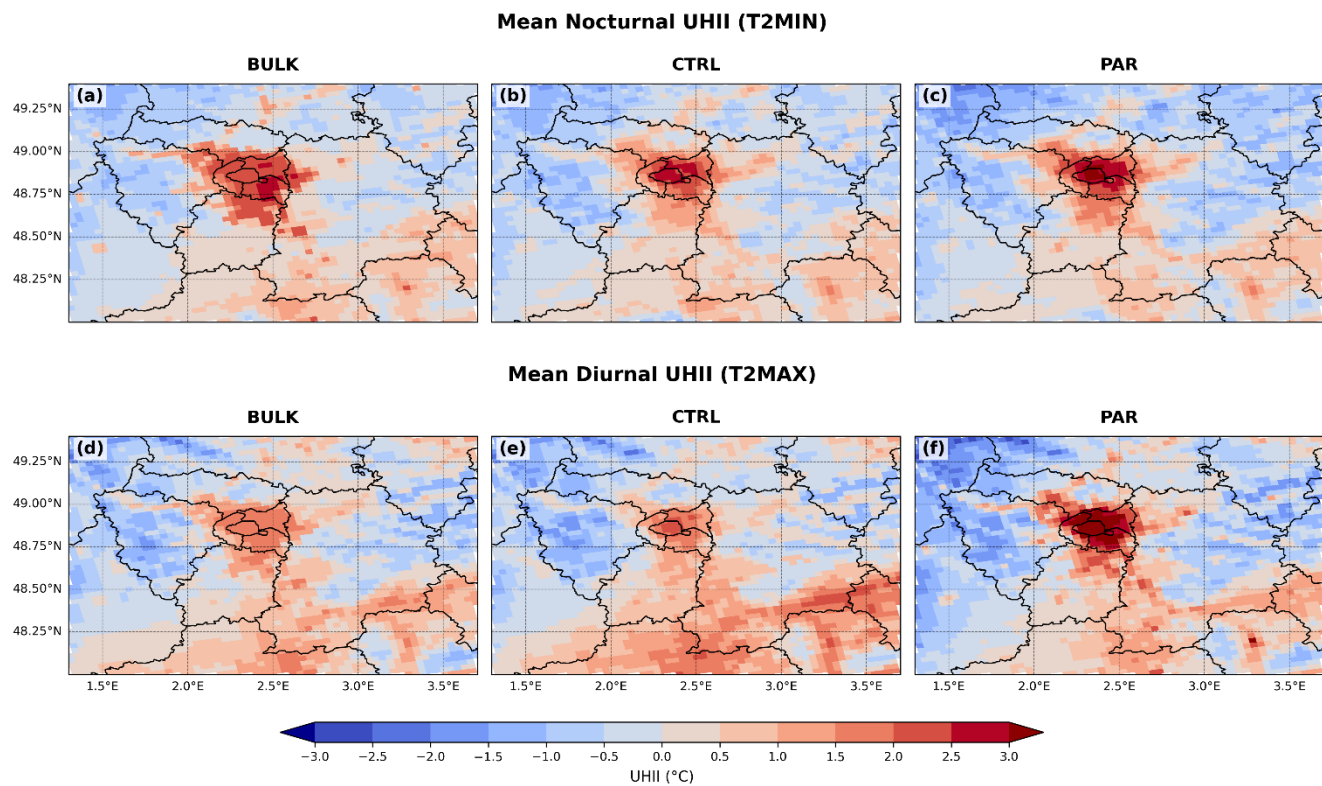


Figure S5: Spatial distribution of the monthly mean nocturnal (upper panel) and diurnal (lower panel) UHI in each simulation, for August 2020.