

Table S1: Building height (m), density (%), building width (m), road width (m) and urban fraction (0-1) for each LCZ class.

LCZ Classes	Building height (m)		Density per 5m classes (%)		Building width (m)		Road width (m)		Urban fraction (0-1)	
	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	WRF v4.6.0 (and later)	EO Paris Data
LCZ 1	40	40	17	17	22.22	22.22	20	20	0.95	0.95
	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	0.9	0.84
		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)

LCZ Classes	Building height (m)		Density per 5m classes (%)		Building width (m)		Road width (m)		Urban fraction (0-1)	
	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	WRF v4.6.0 (and later)	EO Paris Data
LCZ 3	5	5	72	2.8	9.6	52.2	5.2	9.4	0.85	0.81
	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	0.65	0.68
		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)

LCZ Classes	Building height (m)		Density per 5m classes (%)		Building width (m)		Road width (m)		Urban fraction (0-1)	
	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	WRF v4.6.0 (and later)	EO Paris Data
LCZ 5		5		2.6	26.25	31.5	35	11.3	0.7	0.73
		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	0.6	0.56
	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	0.85	0.85

Table S1: (Continued)

LCZ Classes	Building height (m)		Density per 5m classes (%)		Building width (m)		Road width (m)		Urban fraction (0-1)	
	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	WRF v4.6.0 (and later)	EO Paris Data
LCZ 8	5	5	72	2.7	28.9	28.7	32.5	16.1	0.85	0.78
	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	0.3	0.3
	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	0.55	0.55
	10	10	68	68						
	15	15	16	16						
LCZ E	5	5	100	100	5	5	100	100	1	1

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

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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: 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							
	LCZ2		LCZ5		LCZ6		LCZ8		LCZ2		LCZ5		LCZ6		LCZ8	
Group Stations	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
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	

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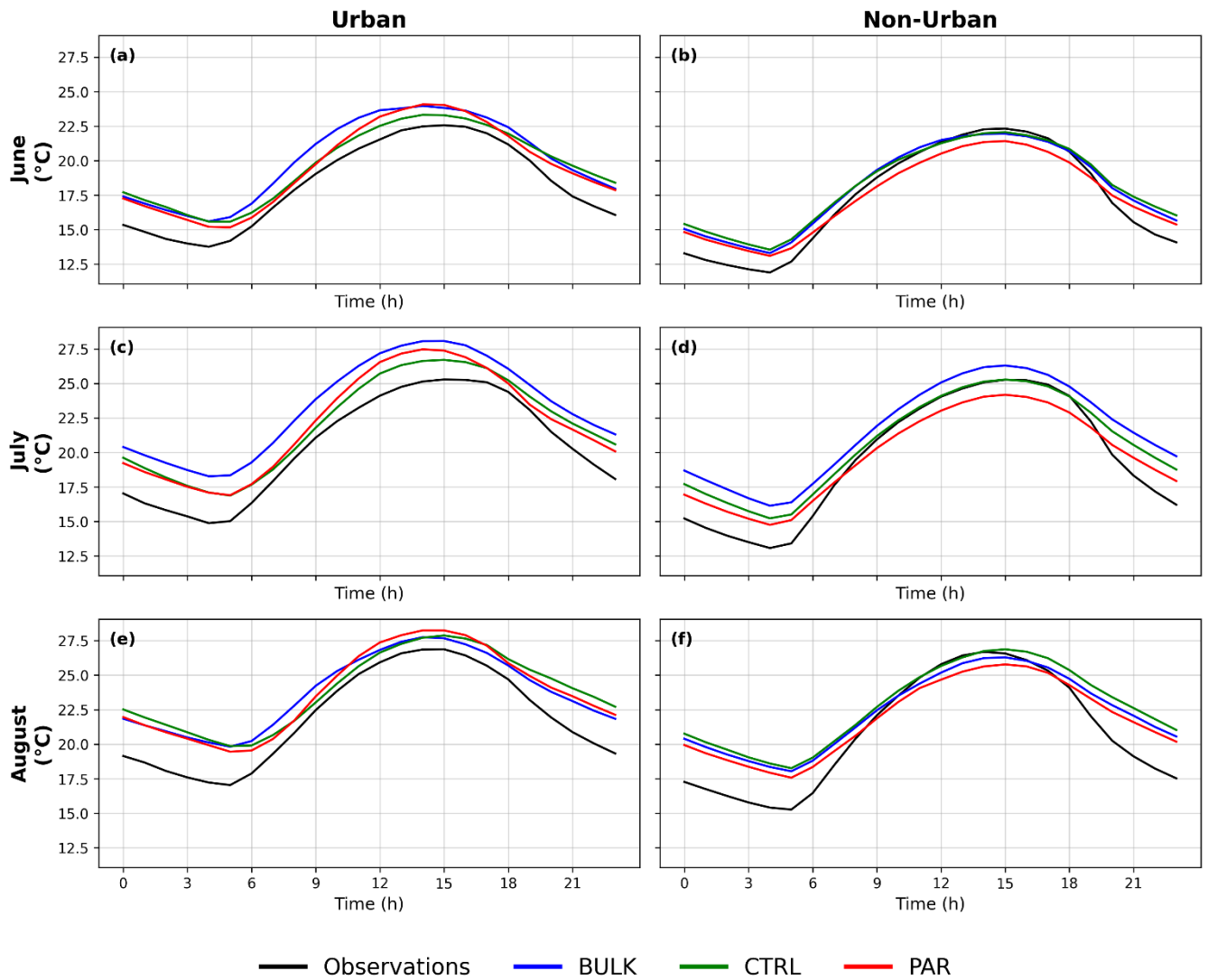
Table S6: Statistical analysis (Bias, RMSE, R) of the three simulations concerning group stations (Urban, Non-Urban) during daytime and nighttime hours (indicated as D and N, respectively), for the heatwave of August 2020. Temporal correlation (R) is calculated on the totality of the 24h span.

Simulations	BULK				CTRL				PAR			
	Urban		Non-Urban		Urban		Non-Urban		Urban		Non-Urban	
Group Stations	D	N	D	N	D	N	D	N	D	N	D	N
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	

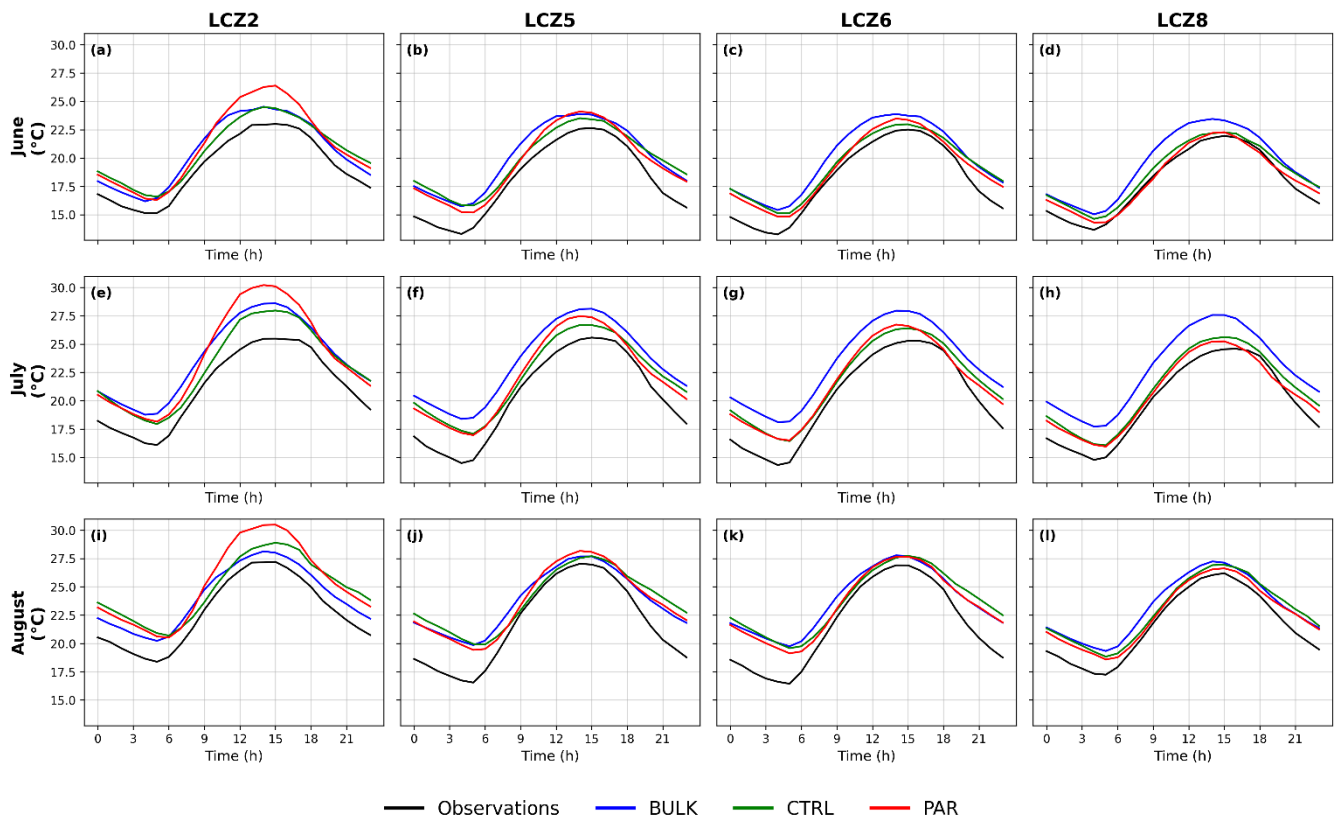
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Table S7: Same as Table S5, but for the heatwave of August 2020.

Simulations	CTRL								PAR							
	LCZ2		LCZ5		LCZ6		LCZ8		LCZ2		LCZ5		LCZ6		LCZ8	
Group Stations	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N
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	



50 **Figure S1: Daily profiles of 2 m air temperature of observations (black), BULK (blue), CTRL (green) and PAR (red) for Urban and Non-Urban stations, respectively, in (a,b) June; (c,d) July and (e,f) August.**



55 **Figure S2: Daily profiles of 2 m air temperature of observations (black), BULK (blue), CTRL (green) and PAR (red) for LCZs in (a), (b), (c), (d) June; (e), (f), (g), (h) July and (i), (j), (k), (l) August.**

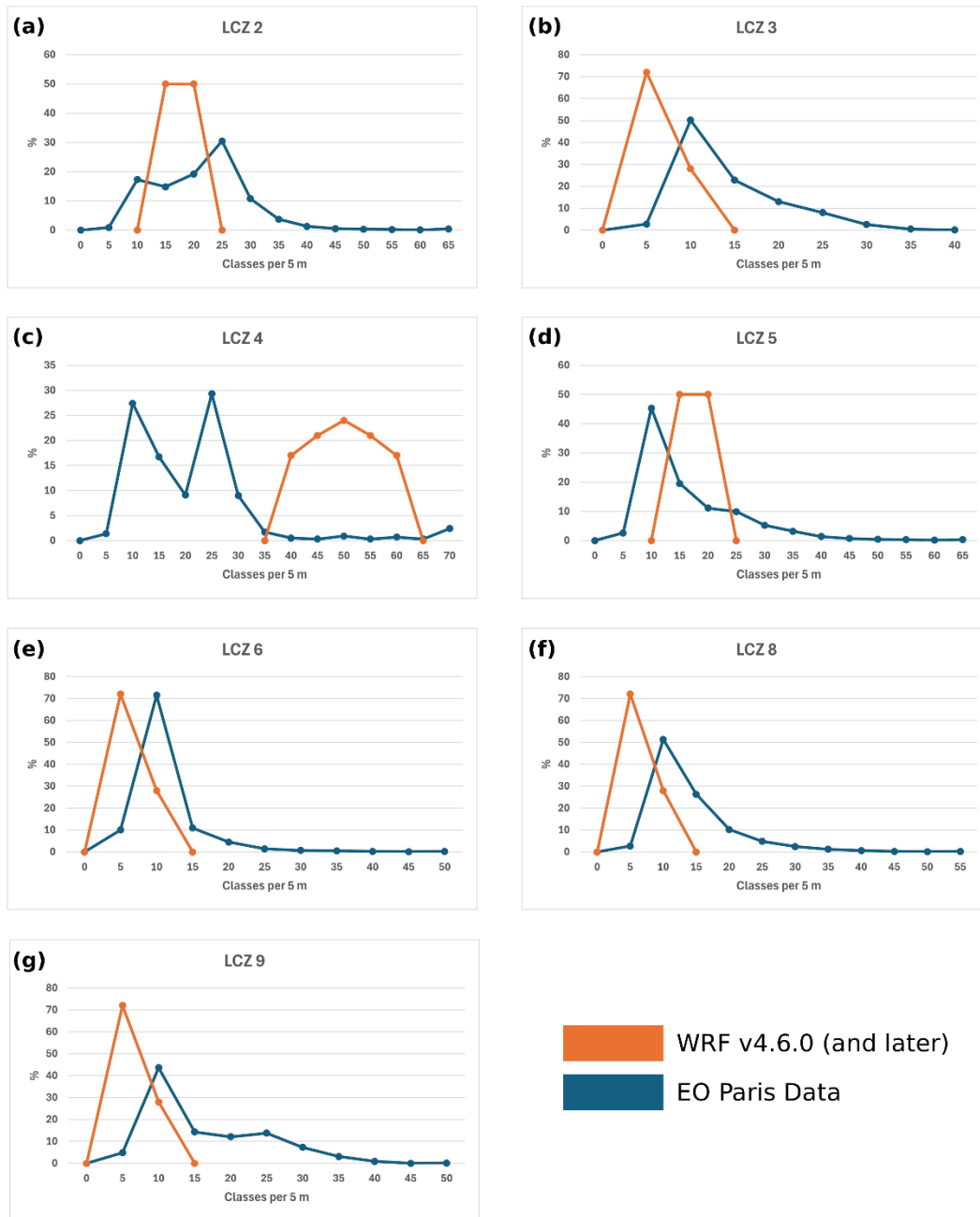


Figure S3: Building height distribution for: (a) LCZ 2, (b) LCZ 3, (c) LCZ 4, (d) LCZ 5, (e) LCZ 6, (f) LCZ 8, (g) LCZ 9, regarding data in WRF v4.6.0 and later (orange) and EO Paris data (blue dotted colored line), used in CTRL and PAR simulations, respectively.