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Optimizing retro-reflective surfaces to untrap radiation and cool cities

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Supplementary Table

Table S1 Environmental parameters and material properties (α_W: wall albedo; η_W: wall retro-reflectivity; α_G: ground albedo; η_G: ground retro-reflectivity) for each scenario in numerical experiments

Research focus	Environmental parameters					Material properties					
	Latitude	Dates	Aspect ratio	Street orientation	Wall energy budget(s)	Material type	Applied surface	α_W	η_W	α_G	η_G
Baseline	40° N	July 7th	1	NE-SW	1	Normal	/	0.25	0	0.15	0
Urban heat island reduction	40° N	July 7th	1	NE-SW	1	/	walls	0.3-0.9[a]	0-0.5[b]	0.15	0
						/	ground	0.25	0	0.3-0.9[a]	0-0.5[b]
						RR-glass bead	walls	0.39	0.19	0.15	0
						RR-capsule	walls	0.69	0.19	0.15	0
						RR-prism	walls	0.83	0.44	0.15	0
						HR	walls	0.83	0	0.15	0
						RR-glass bead	ground	0.25	0	0.39	0.19
						RR-capsule	ground	0.25	0	0.69	0.19
						RR-prism	ground	0.25	0	0.83	0.44
						HR	ground	0.25	0	0.83	0
Human thermal comfort improvement	40° N	July 7th	1	NE-SW	1	RR-prism	walls	0.83	0.44	0.15	0
						HR	walls	0.83	0	0.15	0
						RR-prism	ground	0.25	0	0.83	0.44
						HR	ground	0.25	0	0.83	0
						RR-prism	walls + ground	0.83	0.44	0.83	0.44
						HR	walls + ground	0.83	0	0.83	0
Urban geometry	40° N	July 7th	0.5-5[c]	NE-SW	1	RR-prism	walls	0.83	0.44	0.15	0
						HR	walls	0.83	0	0.15	0
						RR-prism	ground	0.25	0	0.83	0.44
						HR	ground	0.25	0	0.83	0
						RR-prism	walls + ground	0.83	0.44	0.83	0.44

						HR	walls + ground	0.83	0	0.83	0
Solar radiation distribution	75° N-75° S[d]	Jan.-Dec. 21st[e]	1	[N-S, NE-SW, E-W, NW-SE]	2	RR-prism	wall1	0.83	0.44	0.15	0
						RR-prism	wall2	0.83	0.44	0.15	0
						RR-prism	ground	0.25	0	0.83	0.44
						Normal	/	0.25	0	0.15	0
Generalized design guidelines	75° N-75° S[d]	summer[f]	[0.5, 1, 2, 5]	[N-S, NE-SW, E-W, NW-SE]	2	RR-prism	wall1	0.83	0.44	0.15	0
						RR-prism	wall2	0.83	0.44	0.15	0
						RR-prism	ground	0.25	0	0.83	0.44
						Normal	/	0.25	0	0.15	0

[a] 0.3-0.9, with intervals of 0.15, specifically [0.3, 0.45, 0.6, 0.75, 0.9]

[b] 0-0.5, with intervals of 0.1, specifically [0, 0.1, 0.2, 0.3, 0.4, 0.5]

[c] 0.5-5, with intervals of 0.5, specifically [0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0]

[d] 75° N-75° S, with intervals of 15°, specifically [75° N, 60° N, 45° N, 30° N, 15° N, 0, 15° S, 30° S, 45° S, 60° S, 75 ° S]

[e] Jan.-Dec. 21st, i.e., 21st day in each month

[f] Jun., Jul., and Aug. 21st for the North hemisphere and Dec., Jan., and Feb. 21st for the South hemisphere

Supplementary Figures

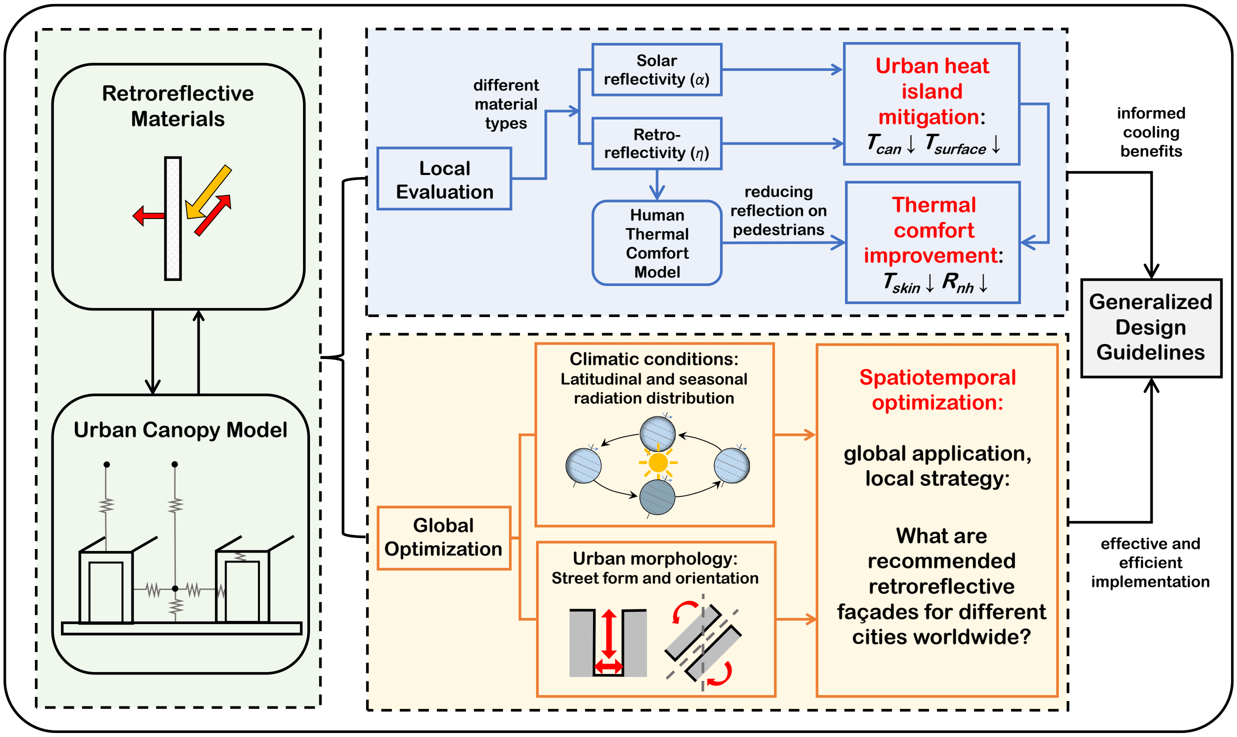

Fig. S1 Roadmap of the retroreflective surface study. T_{can}: street canyon air temperature, $T_{surface}$: urban surface temperatures, T_{skin}: human skin temperature, R_{nh}: net radiation of human body.

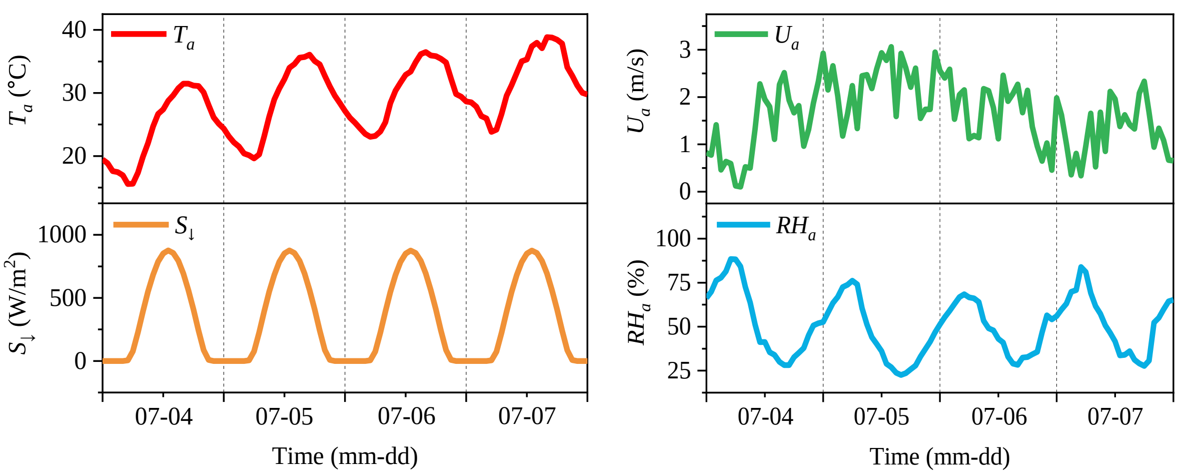

Fig. S2 Meteorological conditions during the tested period: July 4th-7th, with the first three days as spin-up period and the last day as test day. T_a: atmospheric temperature (°C), $S_\downarrow$: downwelling shortwave radiation (W/m^2), U_a: wind speed (m/s), RH_a: atmospheric relative humidity (%).

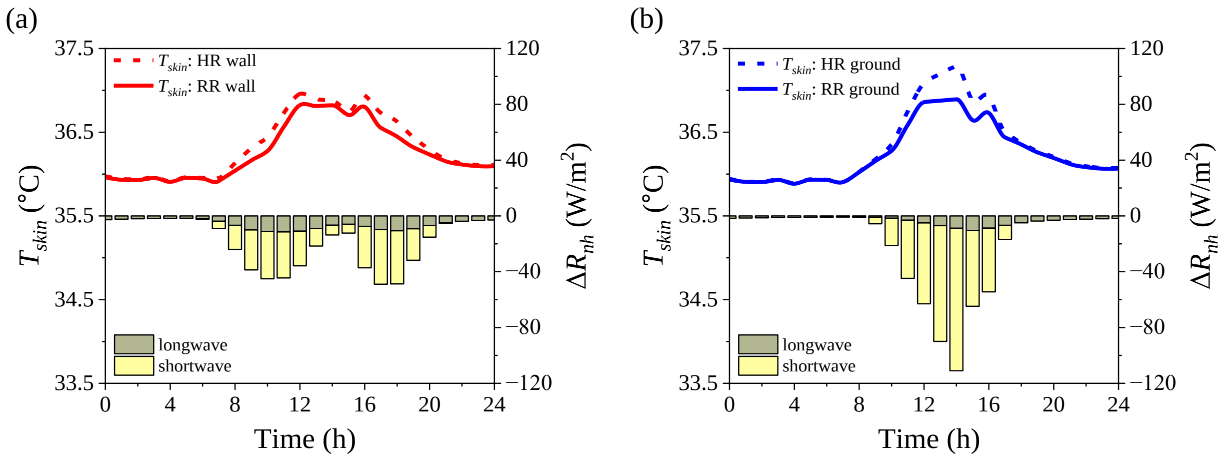

Fig. S3 Comparison of human skin temperatures and net human radiation with high-reflective and retro-reflective (a) walls and (b) ground. Lines show human skin temperatures (dash: high-reflective; solid: retro-reflective), and bars show the longwave (grey) and shortwave (yellow) reduction in net human radiation by retro-reflective surfaces.