Study on Human Impact Assessment for Various Heat Island Countermeasures Using Numerical Simulation

Purpose of research

Based on the viewpoint of human health effects of heat island, using SET * with simulation of convection / radiation coupling simulation and improvement, investigate the influence on the possible exposure time in outdoor space based on human water loss amount and body temperature rise I do.

Analysis object

We analyze 1 km square around Otemachi in Tokyo.

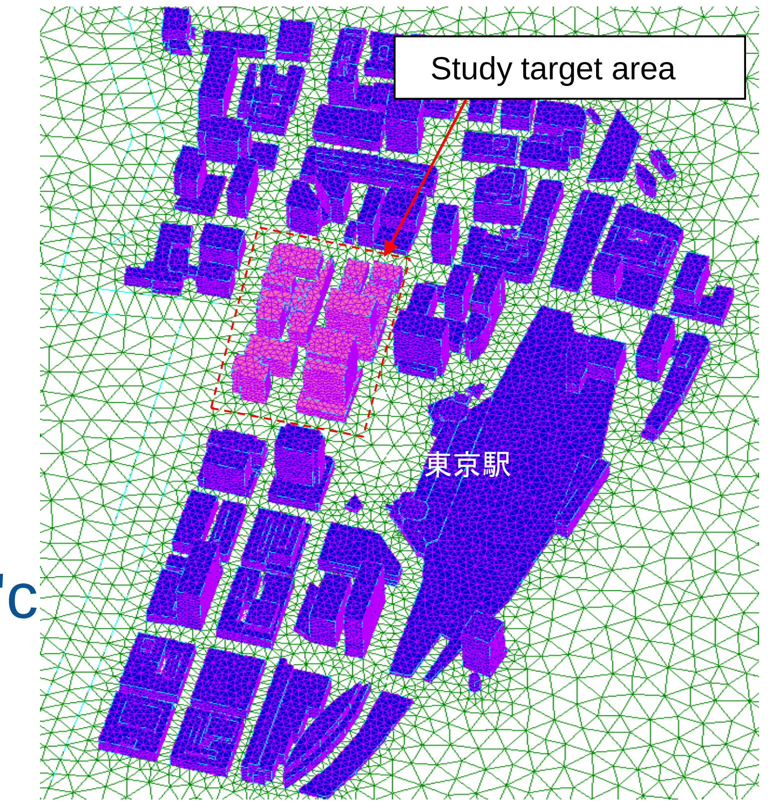


Fig.1 Block model and area to be considered

Analysis date and time

- Radiative conduction analysis: Tokyo's 7 Monday 22th from 0 o'clock to 23 th 24 o'c
- CFD analysis: July 23 at 15 o'clock.

CFD analysis weather conditions

South wind, height 74.5 m, wind speed 3 m / s, air temperature 31.5 ° C., water vapor partial pressure 2.8 kPa.

Conditioning waste heat condition

Sensible heat 30%, latent heat 70%. (Basic case)

Physical properties of buildings and ground used for radiation conduction analysis

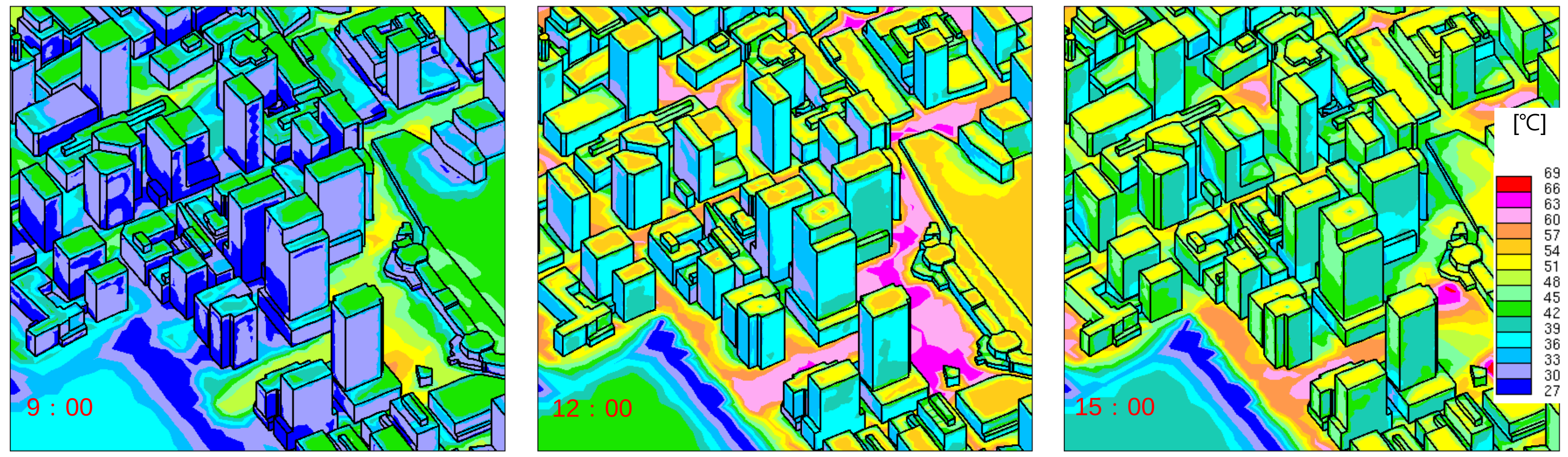
Place	**Material**	**Solar reflectance [-]**	**Long wave emissivity [-]**	**Thermal conductivity [WmK]**	**Volume specific heat [kJ/m^{3}K]**	**Thickness [m]**	**Division number**
Building	Concrete	0.2	0.9	1.64	1900	0.2	10
Surface Underground	Asphalt Grave Sand	0.1	0.95	0.73	2100 1500 3100	0.1 0.1 0.3	4 2 4

Possible exposure time

Exposure allowable time is the time it takes for deep warmth and moisture decrease to reach the tolerance limit (38.0 ° C, 3% of total body weight).

Based on the diversity of people's activities outdoors, we use a modified TNM that incorporates the influence of activities on the sweating model to calculate the exposure time, SET *.

Surface temperature distribution



Air temperature, velocity vector and scalar wind speed distribution

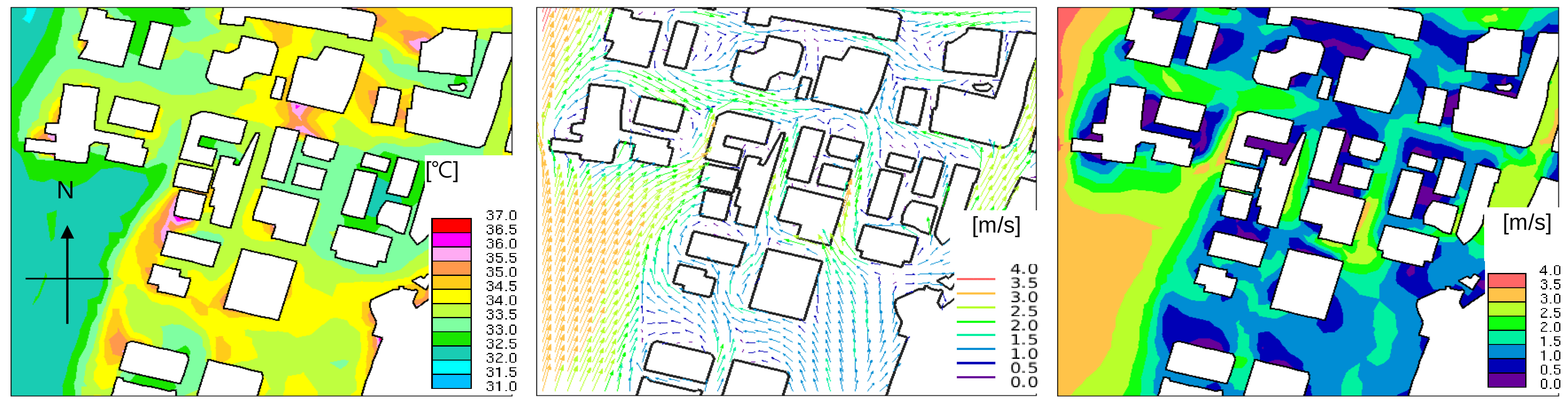


Figure 2 Air temperature distribution diagram 3 Speed vector Figure 4 Scalar wind speed distribution

MRT, SET * and exposure time distribution

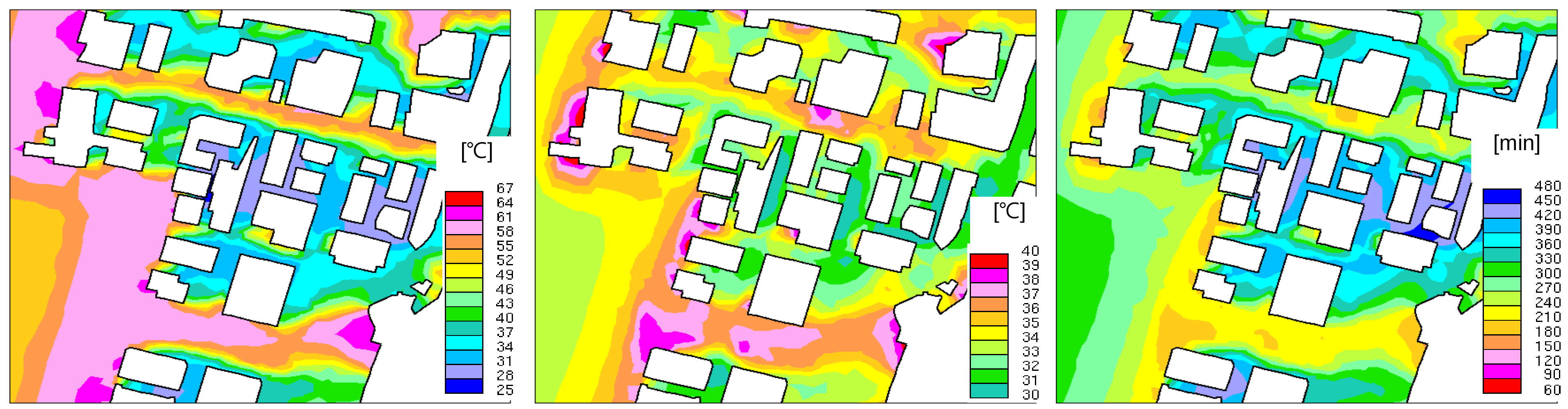


Fig. 5 MRT distribution diagram 6 SET * distribution chart 7 Exposure possible time distribution

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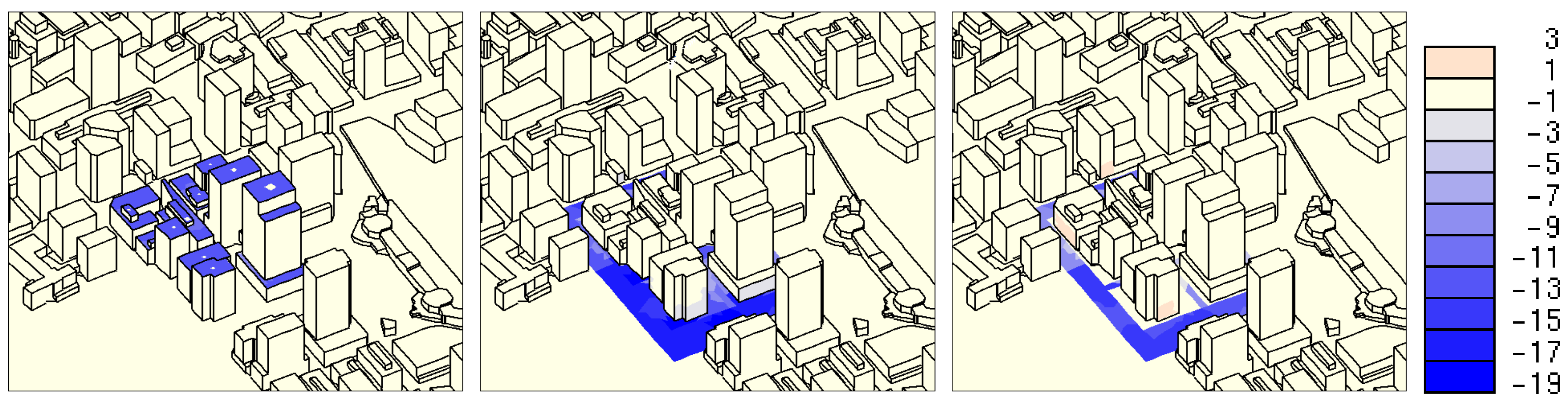
Analysis case

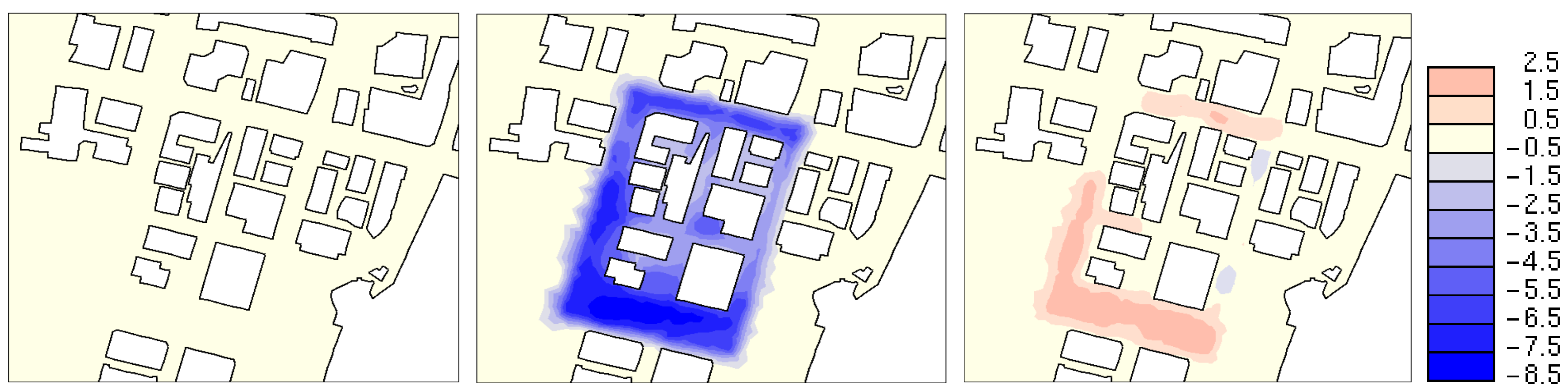
Case		Road: Short wave emissivity	Road: Evaporation emissivity	Site: Short wave emissivity	Site: Evaporation emissivity	Roof top: Short wave emissivity	Roof top: Long wave emissivity	Roof top: Evaporation emissivity	Wast heat: Sensible	Wast heat: Latent
0	No air conditioning and heat exhaust	0.9	0	0.9	0	0.8	0.9	0	0	0
1	Basic Case	0.9	0	0.9	0	0.8	0.9	0	0.3	0.7
2	Air conditioning waste heat All sensible heat	0.9	0	0.9	0	0.8	0.9	0	1	0
3	Rooftop: Greenery	0.9	0	0.9	0	0.8	0.95	0.3	0.3	0.7
4	Rooftop: High reflection	0.9	0	0.9	0	0.5	0.9	0	0.3	0.7
5	Road: water retention, Site: Greening	0.9	0.3	0.8	0.3	0.8	0.9	0	0.3	0.7
6	Road: water retention	0.9	0	0.8	0.3	0.8	0.9	0	0.3	0.7
7	Road: High reflection	0.5	0	0.9	0	0.8	0.9	0	0.3	0.7
8	Road: High reflection, site: greening	0.5	0	0.8	0.3	0.8	0.9	0	0.3	0.7

Surface temperature distribution



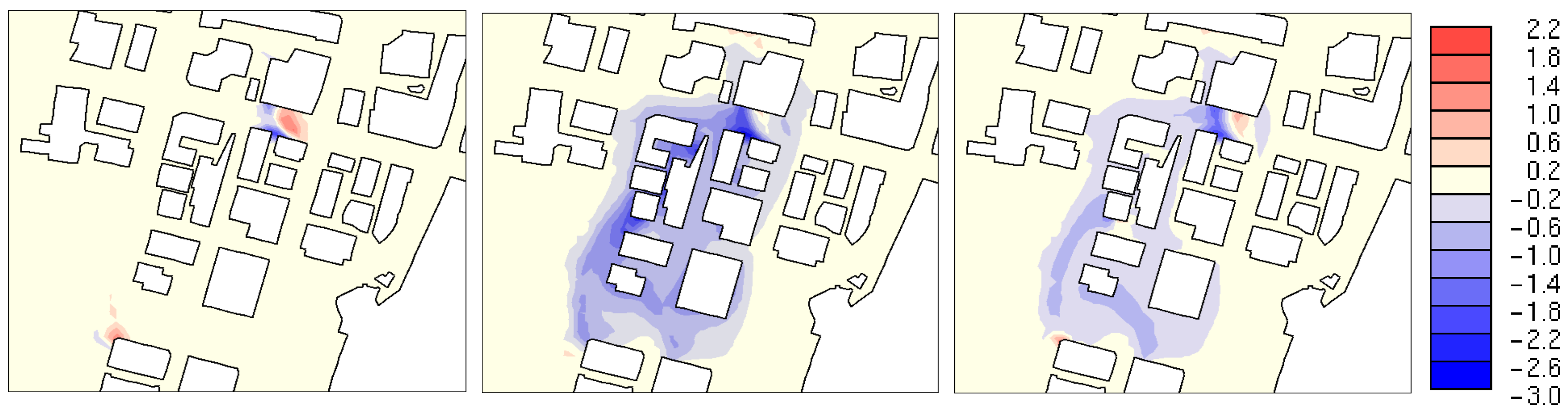
(a) case3(屋上緑化)-case1 (b)case5(道路保水・敷地緑化)-case1 (c)case7(道路高反射)-case1

MRT distribution



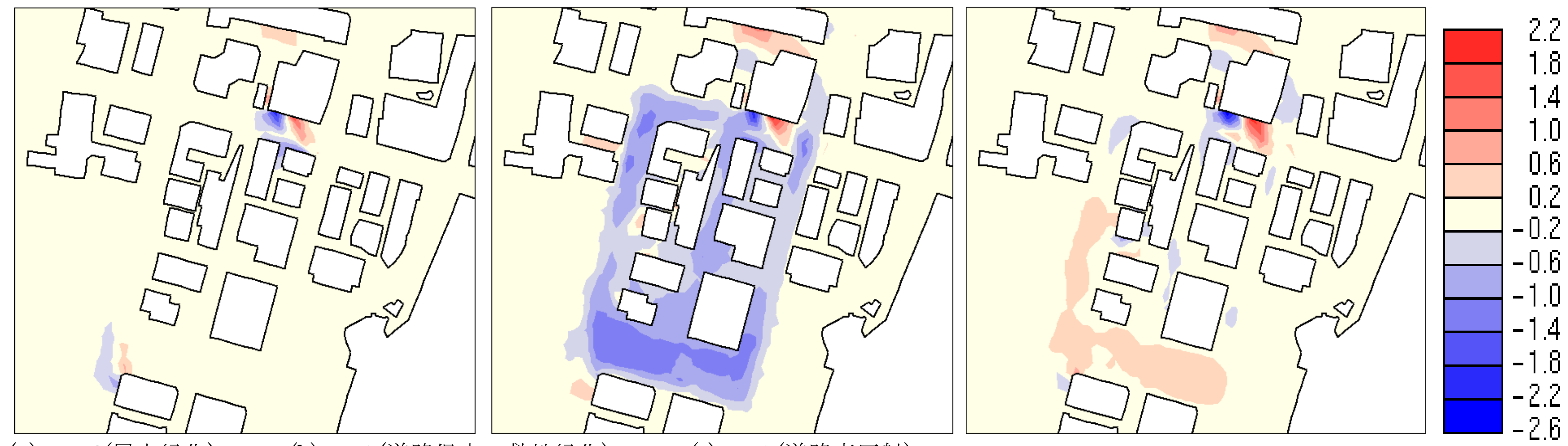
(a) case3(屋上緑化)-case1 (b)case5(道路保水・敷地緑化)-case1 (c)case7(道路高反射)-case1

Temperature distribution



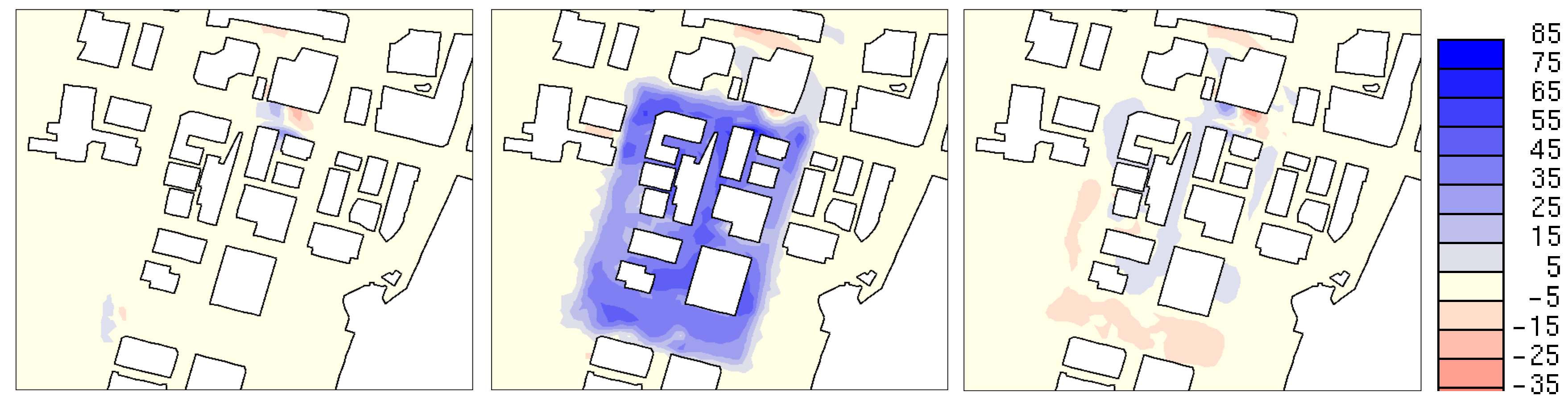
(a) case3(屋上緑化)-case1(b)case5(道路保水・敷地緑化)-case1 (c)case7(道路高反射)-case1

SET * distribution



(a) case3(屋上緑化)-case1 (b)case5(道路保水・敷地緑化)-case1 (c)case7(道路高反射)-case1

Exposible time distribution



(a) case3(屋上緑化)-case1 (b)case5(道路保水・敷地緑化)-case1 (c)case7(道路高反射)-case1

Air conditioning load

		case0 No heat exhaust	case1 Basic	case2 Sensible heat only	case3 Rooftop Greenery	case4 Rooftop high reflection	case5 Road water retention and site greening	case6 Site greening	case7 Road high reflection	case8 Road high reflection and site greening
Wall flow heat load	kW	369	368	363	327	355	362	367	374	373
Air change load	kW	181	181	183	182	182	167	178	170	170
Total	kW	550	549	546	509	537	529	545	544	542
Difference from basic case	kW	0	-	-3	-41	-13	-20	-5	-6	-7
	(%)	(0.0)	-	(-0.6)	(-7.4)	(-2.4)	(-3.7)	(-0.9)	(-1.0)	(-1.3)

Summary

(1)Road water retention and site greening reduces air temperature and MRT and is effective for alleviating the thermal environment. In the case of

(2)High reflection of the road can expect a certain effect on temperature drop, but the radiation environment deteriorates, eventually leading to deterioration of thermal environment. In the case of

(3)Rooftop greening of skyscrapers has little effect on pedestrian-level thermal environment, but it is effective for reducing flow-through heat load on rooftops.

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