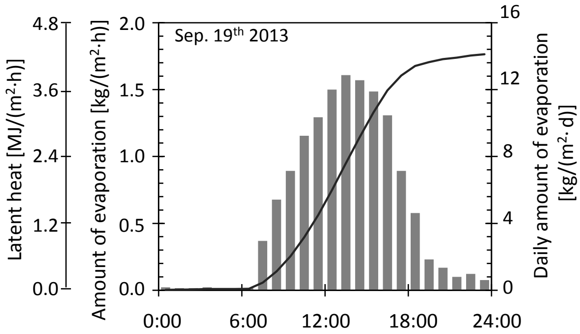

Figure 9 Evaporation rate and daily amount.

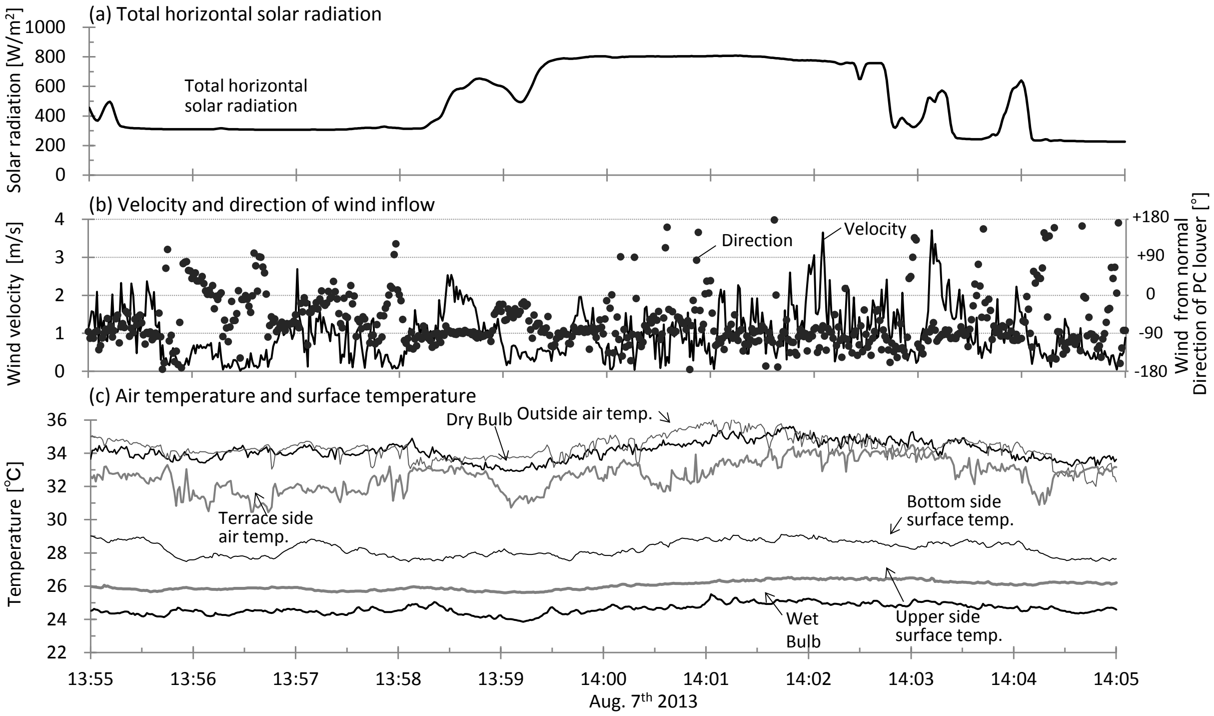

Figure 10 Air temperature at the vicinity of the PC louver. (Data interval: 1sec.)

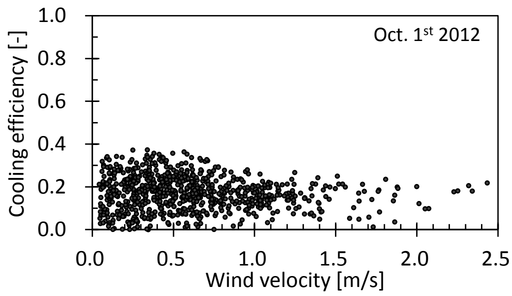

Figure 11 Cooling efficiency of air passing through the PC louver.

Evaporation Rate Evaporation rate per vertical surface plane of a representative sunny day is shown in Figure 9. Water was supplied continuously for 24 hours during this period. From the experimental results, 14 kg/m^2 of water evaporated in a day, which is equivalent to 34 MJ/m^2 of latent heat flux. This is about two to three times larger than that of standard water retentive pavements.

Air temperature in front and behind the PC louver Wind direction in Figure 10 is shown by considering the normal direction from outside to PC louver as 0°. When wind speed was larger than 0.5 m/s, air temperature at the vicinity of the PC louver varied depending on wind's direction. When wind direction is 0° to ±45° at 13:56–13:58, air temperature decreased approximately 2 °C in the terrace side compared to the outside air temperature. When wind direction is ±45° to ±90°at 14:02–14:03, air temperature difference was not significant. Air temperature in terrace side also decreased with a breeze (wind velocity less than 0.5 m/s) at 13:59 and 14:04. Here, the cooling effeciency of wind penetrating the PC louver is evaluated by the following index η, based on the ambient wet bulb temperature:

$$\eta = (T_a - T_l)/(T_a - T_{wb}) \quad (1)$$

Figure 11 shows the calculated data when wind continuously passed through the louver from the normal direction for more than 3 sec. η tended to stabilize at 0.2 when wind velocity is larger than 2 m/s, and distributed between 0–0.4 at breeze. This is a similar feature to the former PCW that the maximum value of η is recognized at breeze, but stabilizes at smaller value as wind velocity increases.

CONCLUSION

This study investigated the potential use of an evaporative cooling system during daytime in urban cities in hot and humid regions. A "Passive Cooling Louver System," coated with hydrophilic resin, porous particles, and a photocatalyst was developed as an exterior material for residences.

From the outdoor experiment the following thermal performances were revealed: 1) The surface temperature of the wet PC louver was approximately the ambient wet bulb temperature. 2) The distribution of the wet PC louver's surface temperature was small enough that it can be modeled as an averaged value of an equivalent vertical plane. 3) Transmittance of direct solar radiance is few. 4) The maximum amount of daily evaporation of the PC louver is approximately 14 kg/m^2 (≈ 34 MJ/m^2 of latent heat) per vertical plane. 5) Air temperature at the vicinity of PC louver decreased by 3 °C at most. From these results, the required cooling performance as a development of the PC louver was confirmed. For the next step, we will construce a thermal transfer model of the PC louver and incorporate it to a microclimate simulation tool, in order to aid spatial design to form cool microclimate.

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NOMENCLATURE

Φ	= Diameter [mm]	ε	= Emissivity [-]
R_L	= Long wave radiation [W/m^2]	σ	= Stefan-Boltzmann constant [-]
T_s	= Surface temperature [°C]	T_{aw}	= Air temperature at windward of PC louver [°C]
T_{wb}	= Wet bulb temperature [°C]	T_{al}	= Air temperature at leeward of PC louver[°C]
T_w	= Water temperature [°C]	η	= Cooling efficiency [-]
k	= mass transfer coefficient [-]	β	= Evaporation efficiency [-]
α_c	= Convection coefficient between air and the surface of PC louver[W/(m^2 K)]		
α_w	= Heat transfer coefficient between water and the surface of PC louver[W/(m^2 K)]		

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