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Numerical simulations of outdoor heat stress maps in the 23 wards of Tokyo, Japan

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In Japan, patients of heat disorder carried by ambulance increase annually due to regional air temperatures increase. This study tried to evaluate the heat stress and heat disorder risk for the urban scale, using urban numerical models. The models include a mesoscale meteorological model, an urban canopy meteorological model, and building energy model.

Outdoor heat stress maps including the 23 wards of Tokyo, Japan, were produced with a 1-km horizontal resolution for the period of July–September, 2010. Numerical simulations of the daily maximum wet-bulb globe temperature (WBGTmax), which was adopted as a heat stress index, were executed in this study. Heat stress hazard was greater in the inland western region of Tokyo, particularly for sunny conditions in July and August. In both July and August, the spatial maximum difference of simulated monthly mean WBGTmax was 2.5°C and 2°C for sunny and shaded conditions, respectively. This likely occurred owing to greater spatial heterogeneity in the globe temperature than in the air temperature among model grid cells, with differences in the radiation environment induced by differences in urban geometric parameters.

Based on the spatial distribution of WBGT index, this study made risk maps of the summertime heat disorder in Tokyo. This is a reason why the public people are easy to intuitively understand the regional heat disorder as the incident risk. Hence, the risk functions of heat disorder, using the actual data of heat disorder patients in Tokyo, were developed, and were used for creating the heat disorder risk map. The simulations of risk map were achieved by combining the exponential relationships between the actual WBGTmax and the number of heat disorder patients with the daytime grid population. Eventually, the resulting numerical maps incorporated the effects of the spatial heterogeneities of both the outdoor heat stress hazard and the daytime grid population.