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英 文 要 旨

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論文題目	An observational study on the three-dimensional structure of heat islands in small and medium-sized cities and its adaptation

This study aims to contribute to the elucidation of the formation mechanism of heat island and the improvement of heat stress of urban residents by understanding the daily variation and three-dimensional structure of heat island and its mitigation measures in small and medium-sized cities through observation and experiments.

We investigated the horizontal distribution of surface air temperature in Kumagaya City, Saitama Prefecture, a small-to-medium-sized city, based on long-term observations at multiple fixed points, and clarified the horizontal structure and seasonal variation of the heat island. The horizontal distributions of surface air temperature in Kumagaya City indicate that the heat island is more pronounced at night than in the daytime, regardless of the season. The daytime heat island is more pronounced in summer, while the nighttime heat island is more pronounced in winter. The daytime heat island intensity in Kumagaya City is maximum in summer and minimum in winter. These characteristics are suggested to be due, first, to the lower building height in Kumagaya City, a small-to-medium-sized city, and the smaller cooling effect of shading by buildings compared to larger cities, and second, to the larger difference in the surface heat balance between urban areas and suburban areas with many rice paddies in summer. In contrast to other cities, the nighttime heat island of Kumagaya City reaches its maximum in April and May. This characteristic is thought to be due to the strong northwesterly airflow over the mountains in winter, and the influence of a migratory anticyclone in April and May, which causes many calm and sunny days.

The spatial distribution of urban boundary layer height and three-dimensional wind velocity was investigated by moving Doppler lidar observations in order to understand the actual condition of heat islands in a medium-sized city. The results confirm that the boundary layer height within the city is higher than that of the surrounding area. Furthermore, it was found that the position of the peak of the urban boundary layer height varied depending on the prevailing wind. Specifically, the position of the peak of the urban boundary layer height changes to 600 m downwind with each 1 ms-1 increase in wind speed. This indicates that the structure of the urban boundary layer depends on wind speed.

The effectiveness of heat stress mitigation measures such as parasols and roadside trees, which are heat adaptation measures for urban residents, was evaluated by conducting a verification experiment using UTCI and subject experiments. Specifically, UTCI of -4.1° C was observed, which was equivalent to about 65% of that of street trees. The reason for the large difference in UTCI was due to the fact that most of the downward shortwave radiation was shielded by the parasol, which in the case of the parasol used in this study shielded 98.9% of the radiation. On the other hand, the results of the subject experiment showed that the parasol mitigated the subject's sensation of warmth and coolness, but the effect was limited to about 30% of that of the street trees. This may be due to the fact that the area of solar radiation that the parasol could shield was small, and the subjects could not sufficiently shield the amount of radiation that they were exposed to all over their bodies.

Finally, from the viewpoint of heat stress, in order to improve the summer UHI in a medium-sized city, it is necessary to focus on the low building altitude and the small cooling effect of building shading, and a parasol that can shield most of the solar radiation is considered to be a very effective adaptation measure.