8.2 OBSERVATIONS ABOUT COOL-ISLAND PHENOMENA IN URBAN PARK

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1. INTRODUCTION

Green space in urban area have been expected to mitigate the urban heat island as well as water surface. In Japan, its cooling effect in hot and humid summer is especially important and it is considered as a natural resource to be available for city planning. In this paper, we show the results of micro-climatological observations performed in and around large park "Shinjyuku Gyoen" during summer. Its area is 58.3*ha*, and located in one of the main CBD with Tokyo Metropolitan Government Office. It consists of dense forest area, lawn area, and some kinds of garden with pond. Topography is almost flat but few meter low area around ponds. There is no irrigation system here, water supply is only natural rain.

2. MEASUREMENT METHOD

Air temperature was measured at 1-minute intervals at totally 88 points including three measuring lines crossing the park (see Figure 3). In order to catch seeping-out phenomena of cool air in calm condition, four 3-dimensional ultrasonic anemometer-thermometers were set along the boundary as well as at center lawn area. Measuring height is about 1.5m above ground, and sampling frequency is 10Hz.

3. COOL-ISLAND INTENSITY

Green area is always cooler than surrounding residential and commercial area. There is temperature difference between forest area and lawn area, cool-island intensity is larger in forest during daytime, but larger in lawn surface during nighttime (Figure 1). In daytime windy condition, cold air mass from green space chilled the leeward built-up area to the extent about 250m from boundary. On the contrary, warm air advection from windward built-up area into the green space was also existed. Considering to these results, in Figure 1, urban temperature and forest temperature mean the average of points in built-up area or in forest area which don't affected by park or surrounding area, respectively (marked by square frame in Figure 3).

4. SEEPING-OUT PHENOMENA IN CALM NIGHT

In clear calm night, flow-out wind direction from green space to surrounding area were discerned at all measuring points along boundary (Figure 3). In this case, obvious shift of wind direction were appeared about 22:00 with sharp temperature fall of 1℃. After that, decline of air temperature was not constant, periodical oscillation can be seen at some points. These imply the accumulation of cold air mass in the park and its gravitational flow-out into surrounding area. During this condition, significant air temperature drop in adjacent built-up area were observed within the range of 80-90m from the boundary (Figure 5). This limit is almost fixed through the night regardless of cool-island intensity.

Air temperature above lawn surface was lower than that of under tree crown during night. This temperature difference was diminished by intermittent wind and cloud cover (Figure 2). It means that lawn surface was getting cold by radiative cooling, and cold air deposition was sometimes destroyed by forced convection.

5. HEAT BUDGET AT LAWN SURFACE

According to the eddy correlation measurement, sensible heat flux at lawn surface was about 100W/m^2 in mid-day, which amounts to 15% of net radiation. It was changed to negative immediately after sunset, then lawn surface was acted as a heat sink all the night through.

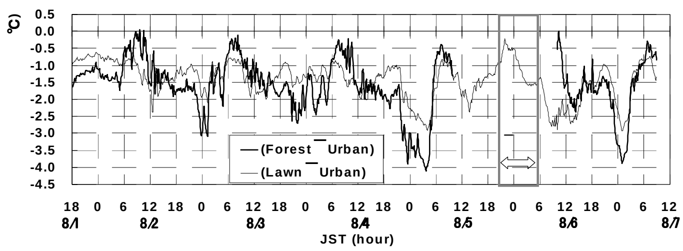

Figure 1. Time variation of cool-island intensity.

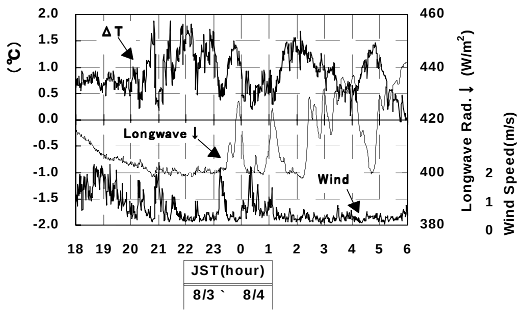

Figure 2. Air temperature difference between under tree crown and above lawn surface , and its relations to wind speed and downward longwave radiation.

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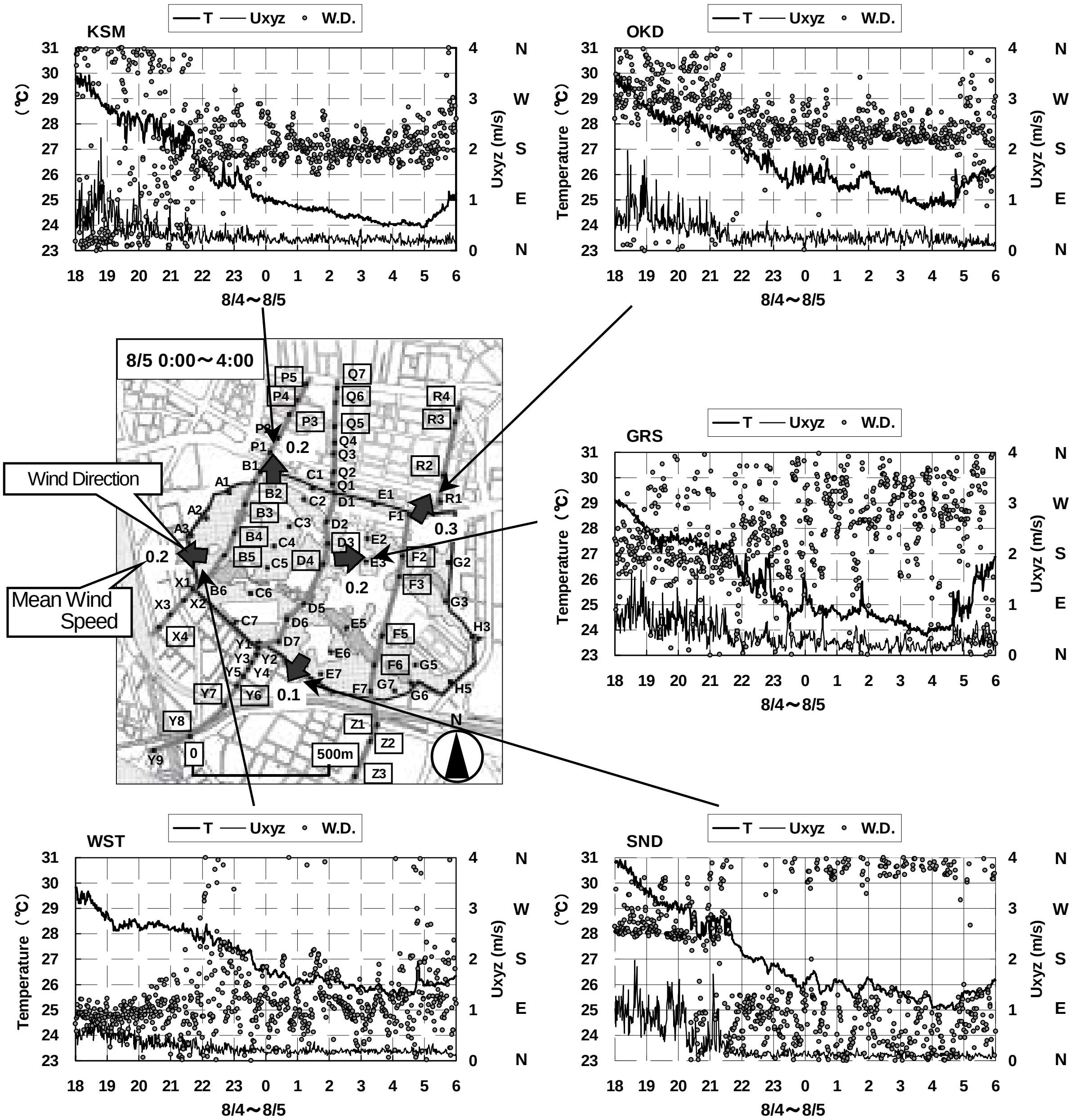

Figure 3. Seeping-out phenomena of cool air in calm night―1-minute average time variations of temperature, wind speed and direction at boundary points― wind direction of all point change to outgoing direction from the park about 22:00.

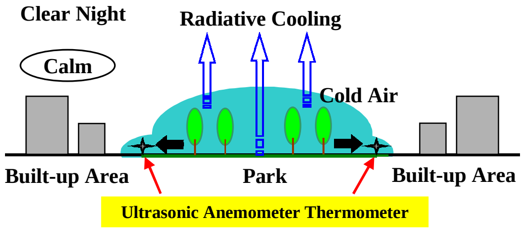

Figure 4. Schematic image of seeping-out phenomena.

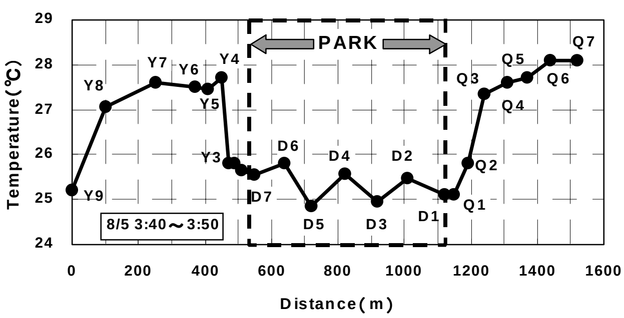

Figure 5. Temperature distribution along cross section line when seeping-out phenomena appeared.