6.4

ANALYSIS OF THE DISTRIBUTION OF AIR TEMPERATURE IN THE BUILT-UP AREA FACING THE MOUTH OF THE VALLEY

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1. INTRODUCTION

In Japan, comparatively many cities face the valley of the mountain. In such cities, in order that cold air may blow from the mountain, it is predicted at summer night that the thermal environment in the built-up area is improved. Field measurements of the temperature distribution in the built-up area facing the mouth of the valley are carried out at summer night. The influence the cold air that flowed out from the valley of the mountain into the built-up area affects the temperature distribution is considered. The process of heat exchange in the built-up area is examined.

2. OBSERVATION

The observation area is in the foot of a mountain, and it is covering 4.0km x 3.5km of the Kita-ku, Kyoto. The Kamo river flows through this area from north-northwest to south-southeast. The valley is in the north-northwest side of this area, and it is considered that cold air flows out from there.

2.1 Observation Method

Observations were carried out at night during 6-9 August 2001. Air temperature and wind direction at the height of 4.0m and 1.5m, and wind velocity at the height of 1.5m, and ground surface temperature and wall surface temperature were measured. We moved between 40 points in this area and measured them for about 1 hour and a half.

2.2 Observation Results

In many cases, Air temperature at the height of 1.5m was higher than that at the height of 4.0m. It is thought that air temperature at the height of 1.5m was influenced by the ground surface and the surrounding buildings (see Figure 1). Air temperature in the riverside area was lower than that in another area (see Figures 2, 3, 4). Wind velocity at the mouth of the valley and in the riverside area was bigger than that in another area. In many cases, wind direction was north-northwest. The wind blew from the valley and was flowing along the river. Ground surface temperature on the asphalt surface of land developed for housing lots was higher than that in another points.

3. CALCULATION

Calculation area is the three dimensional space as same as observation area covering 3.75km of north to south, 2km of west to east, and 150m of the height. Calculation time is 1:00 on 9 August. In this night, comparatively much cold air flowed out from the valley.

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3.1 Calculation Method

In this calculation, it is assumed that the flow is quasi-steady. The k-ε type model is used for the turbulent flow model. The inflow wind profile is created by using the calculation results which carried out for simulating the cold air accumulation process in the valley using the shallow water equations. Ground surface temperature distribution is derived from the observation results. Roughness parameter distribution is created by the digital land use data (see Figure 5).

3.2 Calculation Results

Air temperature in the riverside area is low and that in the southern high-density built-up area is high (see Figure 6). It is generally in agreement with the observation results. The wind distribution of the calculation results is uniform, but that of the observation results varies much. It is thought that one reason is that the wind distribution of the observation results is more strongly influenced by the surrounding building etc.

4. SIMULATION

“Wind path” with a width of 50m from a park from the Kamo river is installed, and the influence which it has on the temperature distribution is considered. Even if it arranges the “Wind path”, its influence hardly attains to the air temperature distribution around the ”Wind path” (see Figure 7). When the “Wind path” has arranged in the transverse direction to the wind direction, air temperature falls slightly in the leeward of the road.

5. CONCLUSIONS

From the observation results, air temperature falls in the riverside area by the cold air drainage which flows from the mouth of the valley. Air temperature distribution of the calculation results is closely to that of the observation results. From the simulation result, even if it installs the “Wind path”, its influence hardly attains to the air temperature distribution around the “Wind path”.

Acknowledgments
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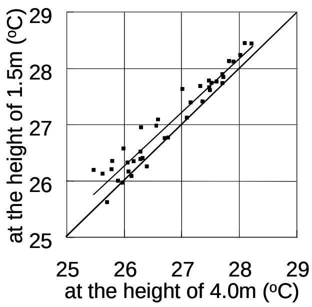

Figure 1 Relationship between the air temperature at the height of 4.0m and 1.5m (22:00, August, 8)

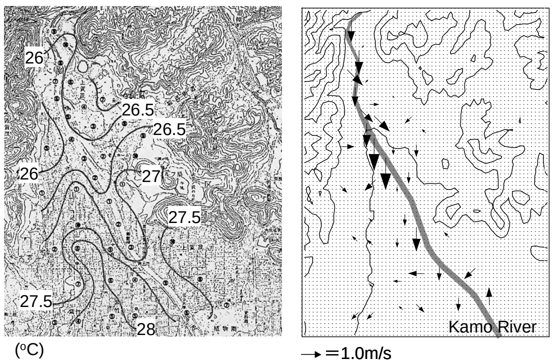

Figure 2 Observation results (22:00, August, 8)
Left: Air temperature distribution at the height of 4.0m
Right: Wind vectors at the height of 1.5m

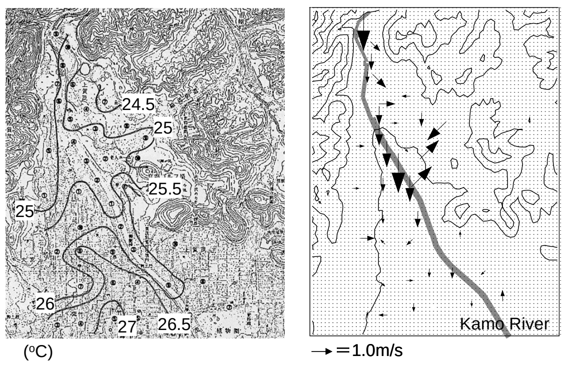

Figure 3 Observation results (1:00, August, 9)
Left and Right: Same as Figure 2

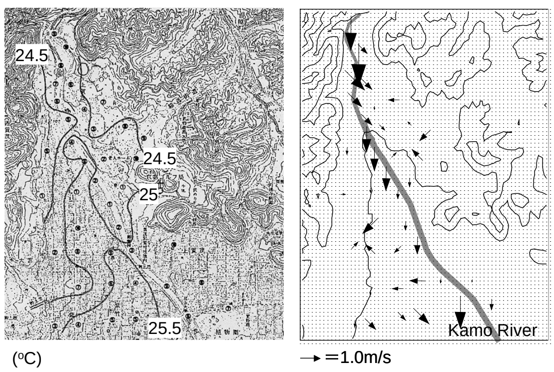

Figure 4 Observation results (4:00, August, 9)
Left and Right: Same as Figure 2

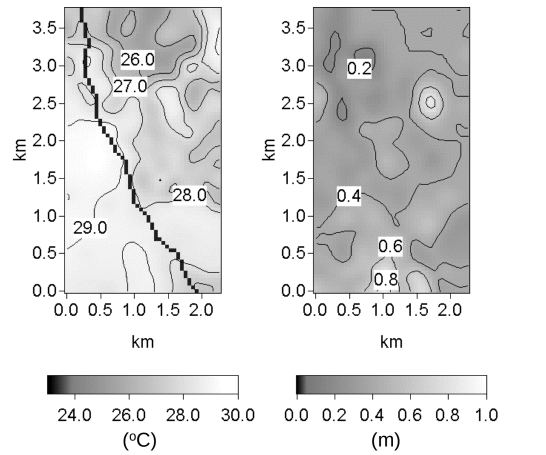

Figure 5 Surface boundary condition
Left: Surface temperature distribution (1:00, August, 9)
Right: Roughness parameter distribution

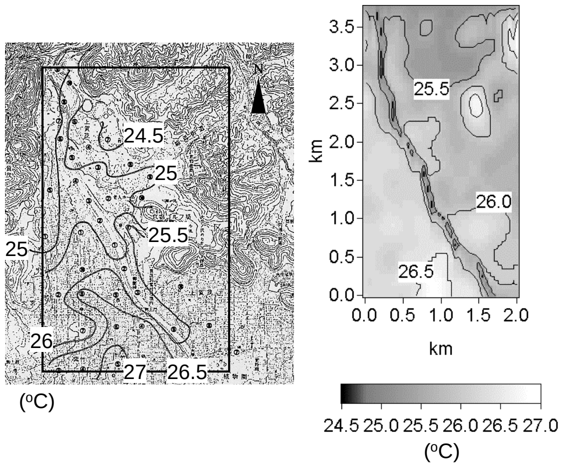

Figure 6 Calculation result (1:00, August, 9)
Left: Air temperature distribution derived from observation data at the height of 4.0m
Right: Calculation result at the height of 4.5m

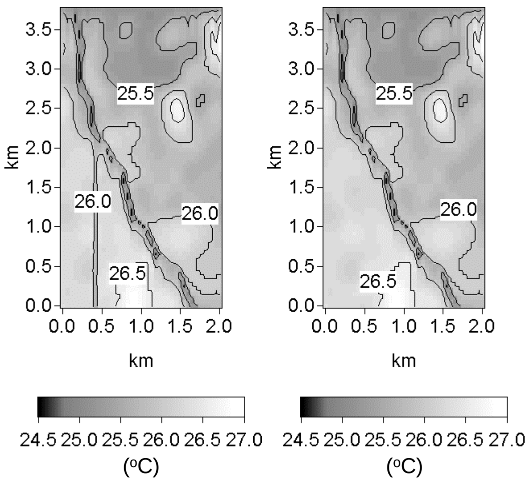

Figure 7 Simulation result (1:00, August, 9)
Left: Simulation result with “Wind path”
Right: Same as Figure 4