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## The Interaction between Nocturnal Heat Islands and Mountain Breezes in Several Cities located on a Valley Mouth in Japan

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### Abstract

In this paper the author sought to clarify the interaction between the nocturnal heat island phenomenon and the mountain breezes in some cities located on a valley mouth under the meteorological high pressure conditions. As subjects of this study, the author selected three cities as the field of investigation : Hachioji, Ome, and Nikko-Imaichi. All these cities are situated on the valley mouth of a river in the Kanto District in Japan (Figs. 1, 2 & 3). The results of this study are summarized as follows:

1. In these cities the nocturnal heat island phenomenon can be recognized clearly and mountain breezes blow on the warm air over the urban area from the upper part of each river. Under certain meteorological conditions, the mountain breezes blow away the warm air over the city area to a leeward direction.
2. In Hachioji City the heat island intensity is a little weak in comparison with the city's population size. Perhaps because there is a basin around the Hachioji urban district, from a geomorphological viewpoint, a cold-air lake is formed during the night. Specifically, after sunset the air near the ground is cooled gradually by radiation from the earth while the air in the city is pooled from the surrounding area. These factors prevent the heat island phenomenon from developing a clear form.
3. The vertical structure of air over these cities is comprises three different air-layers. The bottommost air-layer is equal to the ground inversion layer, which is a stable layer that also occurs slightly in suburbs. Above this stable layer, a mountain breeze with a comparatively low temperature blows after sunset. Furthermore, above the layer of mountain breeze, wind circulated via land and sea on a wider scale blows as the prevailing wind. From these facts, a figure depicting the vertical structure of air over these cities located on a valley mouth is approximately that shown in Fig. 22.

**Keywords:** ground inversion, valley mouth settlement, heat island phenomenon, mountain breeze

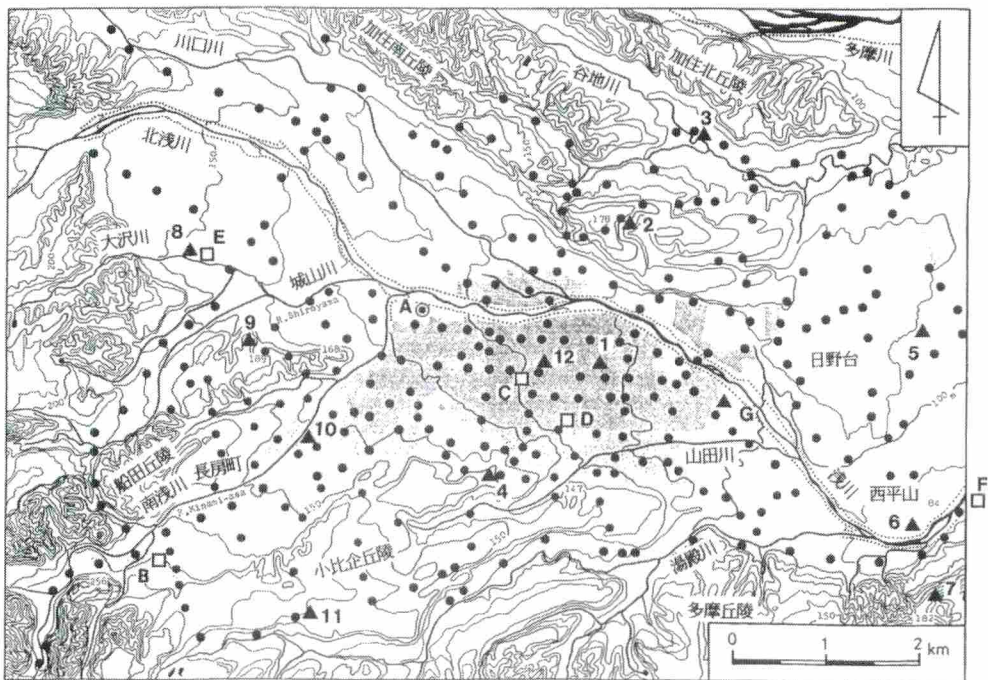


Fig.1 Observation area and distribution of observational points in Hachioji C.,Tokyo.

- black circle : moving observation point by car.
- white square : vertical observation point.
- black triangle : fixed observation point.

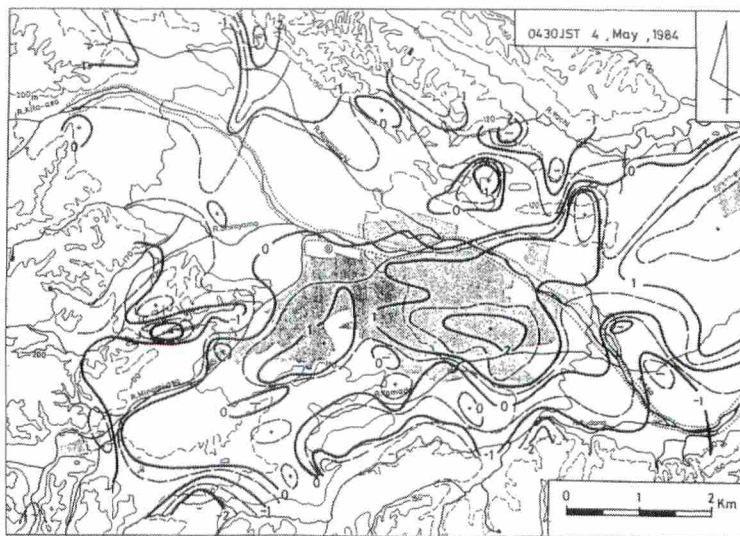


Fig.6 Distribution of air temperature deviations in Hachioji.  
 (2145 JST, on 21th Nov.,1983. cloud amount 0, mean value : +6.5℃,  
 S.D.value : ±1.06).

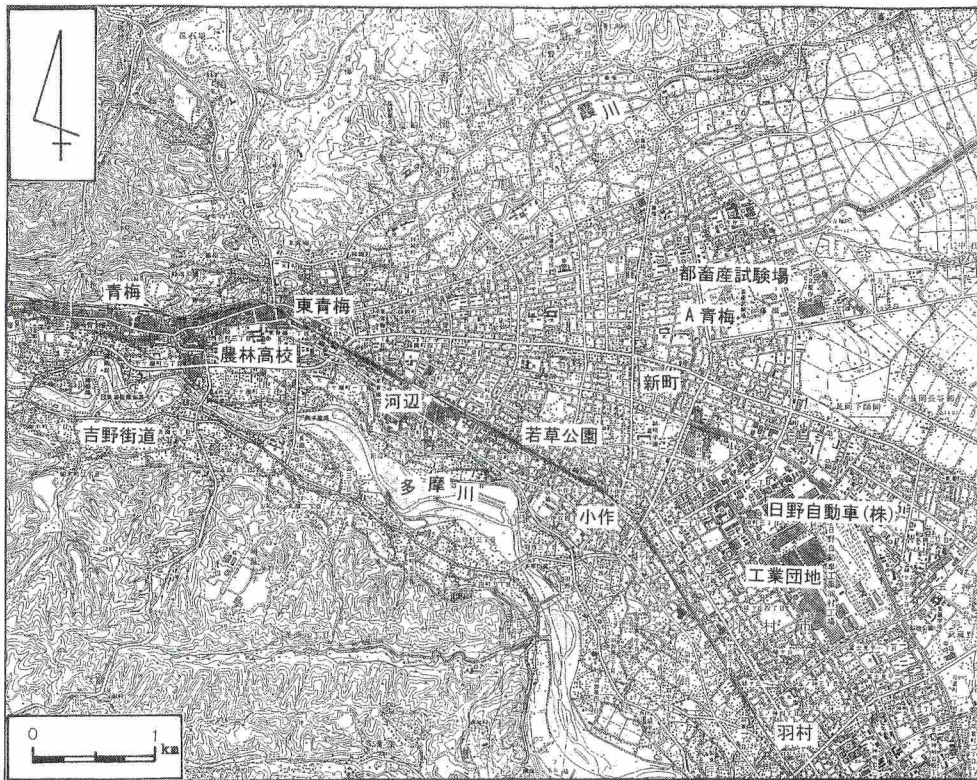


Fig.2 Observation area of Ome C.,Tokyo.

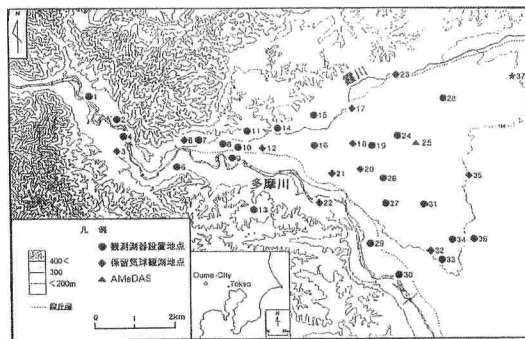


Fig.4 Distribution of fixed obsevation points in Ome C.,Tokyo.

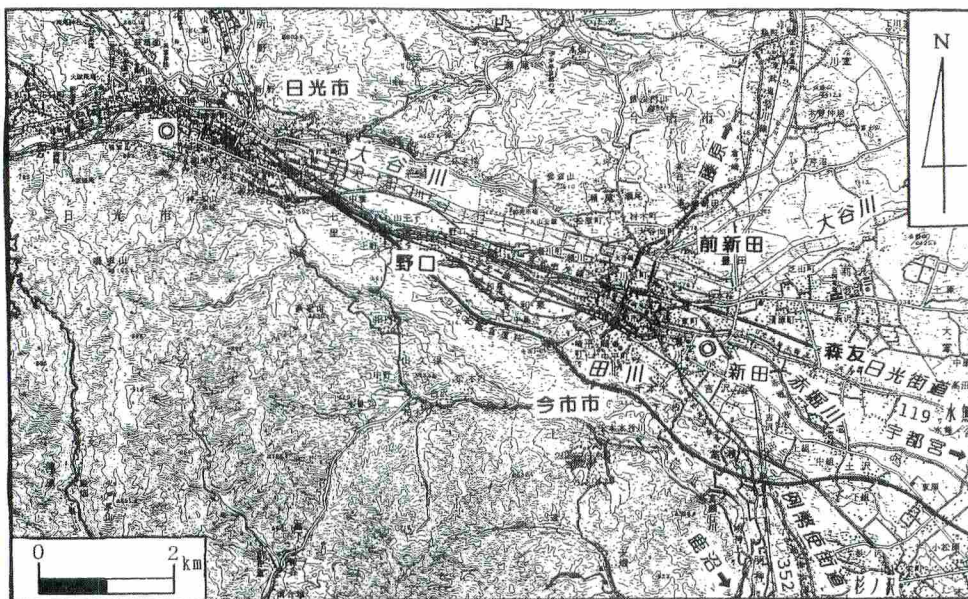


Fig.3 Observation area of Nikko C.,Tochigi Pref.

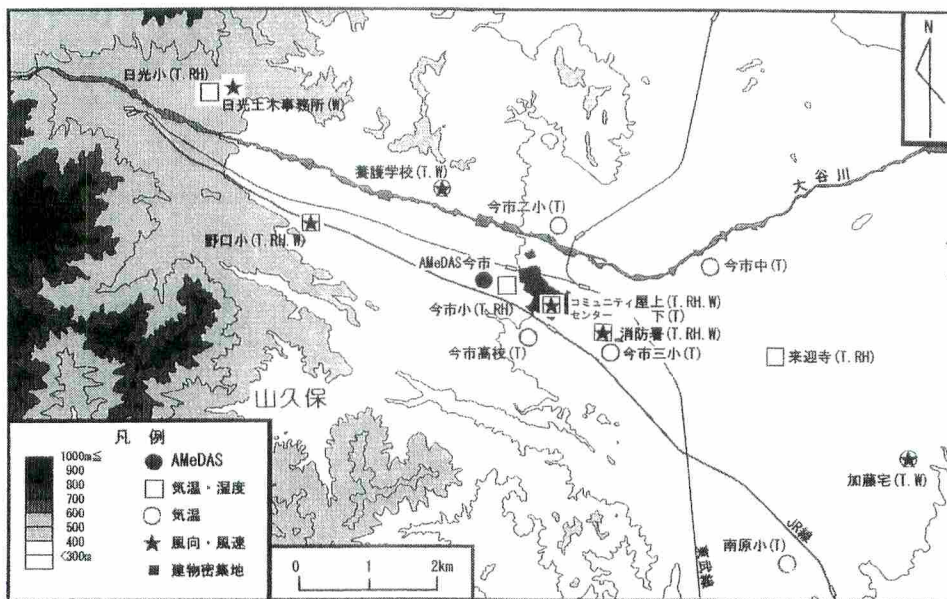


Fig.5 Distribution of fixed observation points in Nikko C.,Tochigi.

White square : observation point of temperature and humidity.

White circle : observation point of temperature.

Black asterisk : observation point of wind.

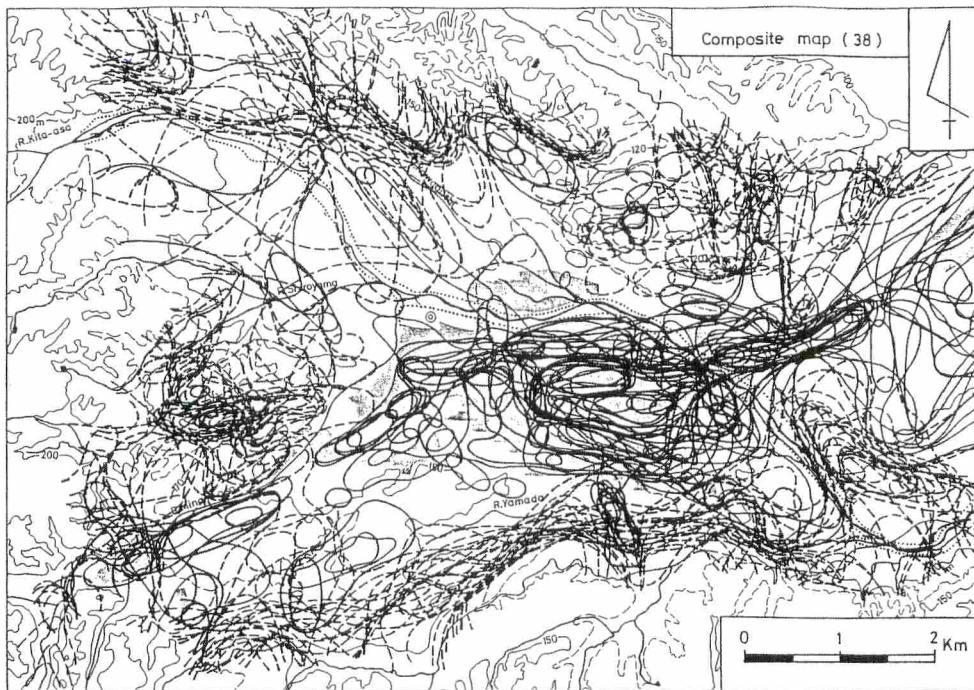


Fig.7 Composite distribution map of air temperature deviations in Hachioji.

solid line : deviation value :  $+1.0^{\circ}\text{C}$ .  
 dotted line : deviation value :  $-1.0^{\circ}\text{C}$ .

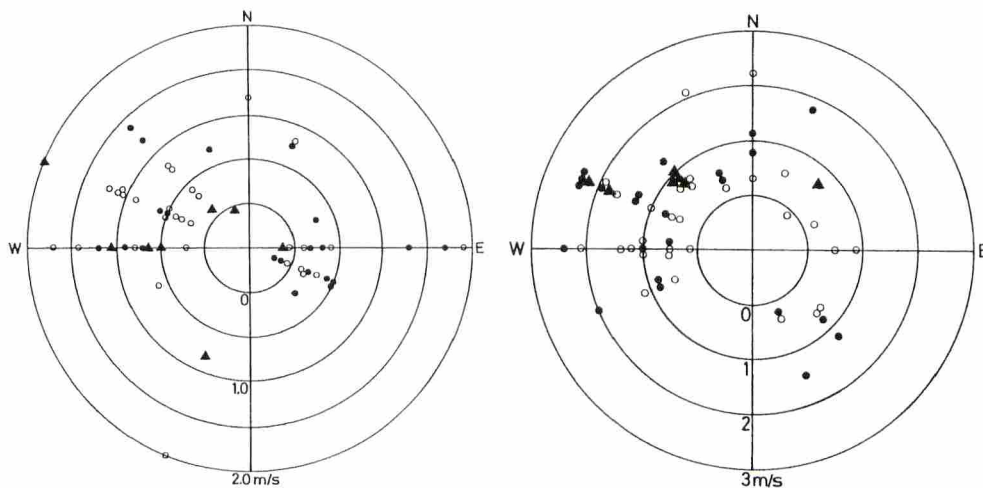


Fig.8 Relationship between change value of air temperature and wind direction & velocity at intervals of 5 minutes.

left : AMEDAS Hachioji(point A in Fig.1. on 3~4th May,1984).  
 right : NTT Hachioji(point G in Fig.1. on 27~28th Nov.,1983).  
 black circle : air temperature rises.  
 white circle : air temperature falls.  
 black triangle : air temperature constant.

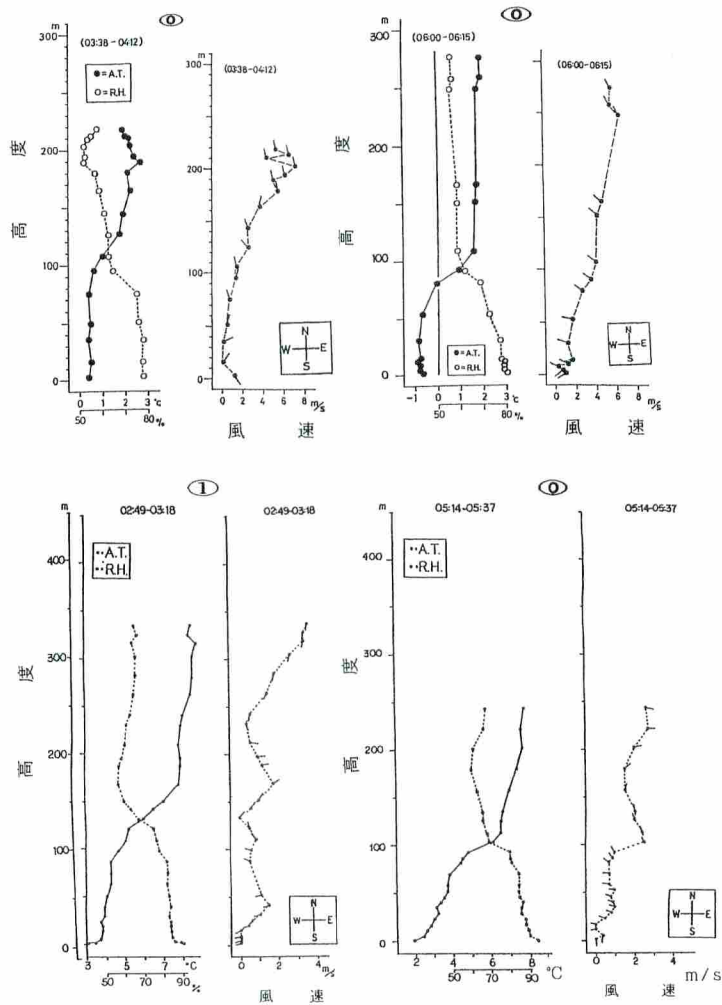


Fig.9 Vertical temperature and humidity profile as well as wind.  
 upper : point D in Fig.1 on 27th Nov.,1983.  
 lower : point F in Fig.1 on 7th Dec.,1986.

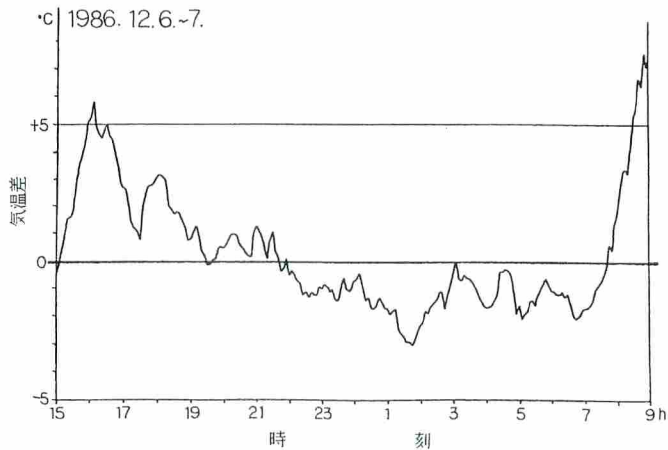


Fig.10 Daily changes of air temperature inversion [p6-p7] between point 6 (85m above sea level) and point 7 (180m above sea level) in Fig.1.

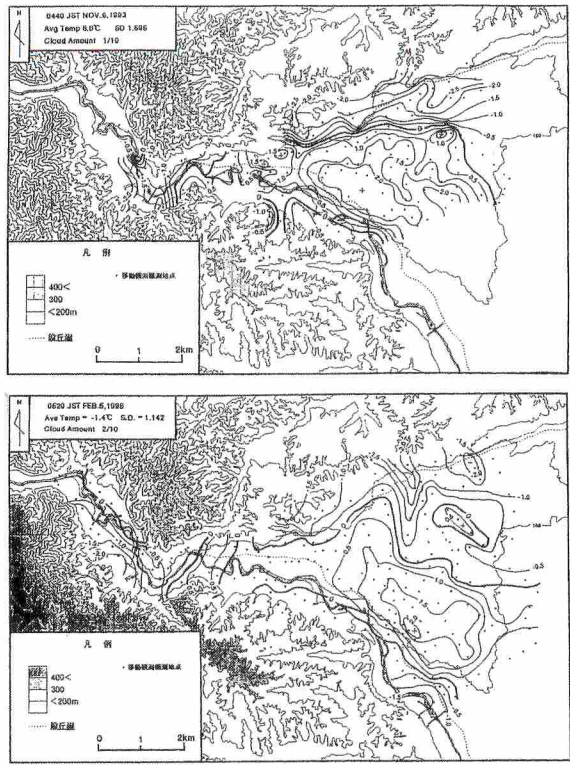


Fig.11 Distribution of air temperature deviations in Ome C.  
 upper : 0440JST, on 6th Nov., 1993. cloud amount 1, mean value :  
 +8.0°C, S.D. value : ±1.69.  
 lower : 0620JST, on 5th Feb., 1996. cloud amount 2, mean value :  
 -1.4°C, S.D. value : ±1.14.

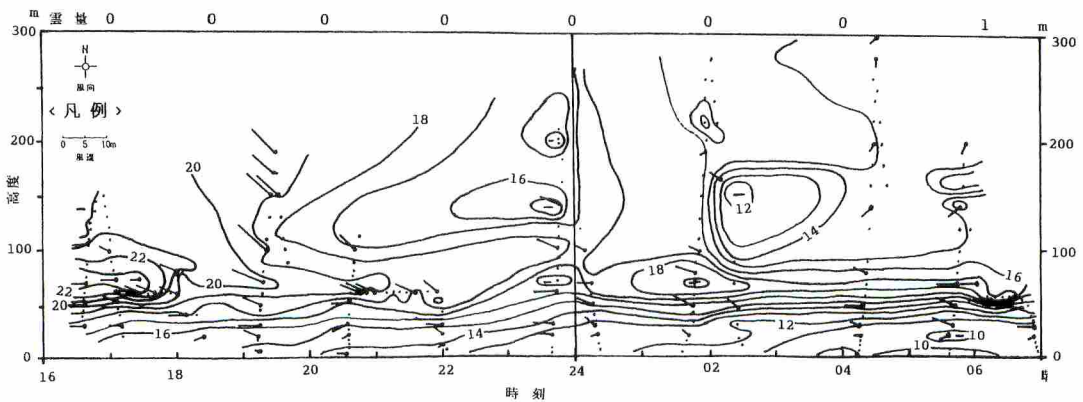


Fig.12 Time-height section of wind direction, wind velocity and air temperature at point 12 in Fig.4.  
 (on 5~6th Nov., 1993).



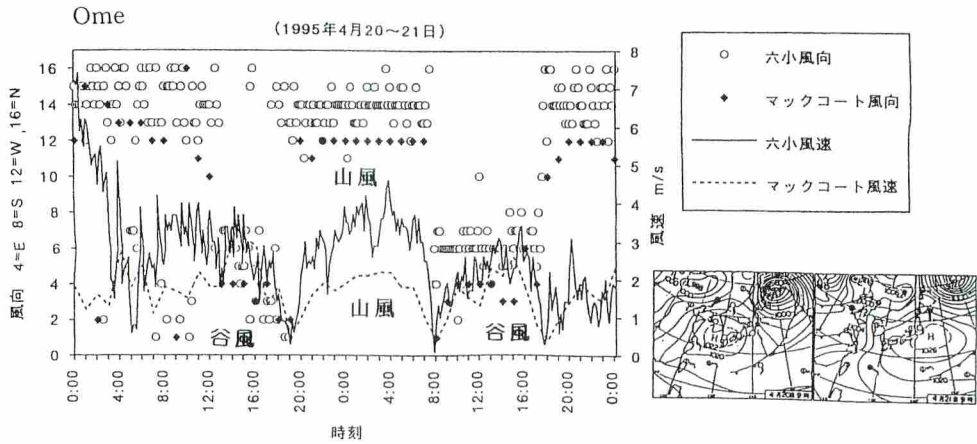


Fig.13 Time changes in wind direction and wind velocity at point 1 (wind direction : white circle and wind velocity : solid line) as well as point 8 (wind direction : black diamond and wind velocity : dotted line) in Fig.4. (on 20~21th April,1995).

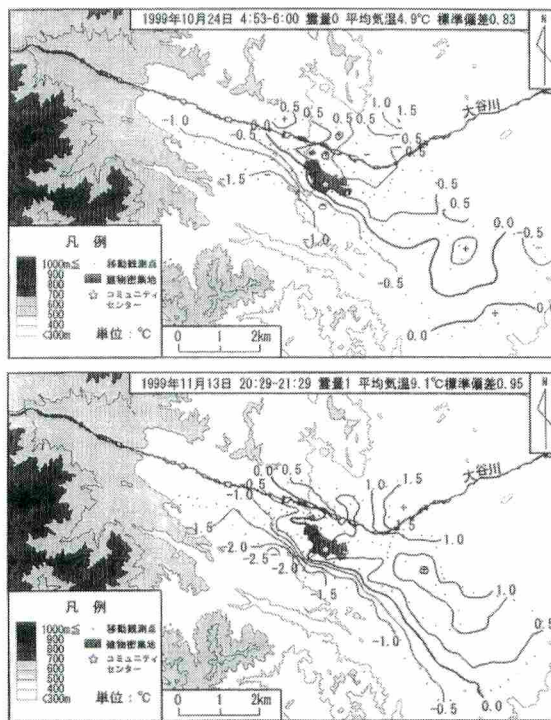


Fig.14 Distribution of air temperature deviations in Nikko C. upper : 0453~0600JST, on 24th Oct.,1999. cloud amount 0, mean value : +4.9℃, S.D.value : ±0.83. lower : 2029~2129JST, on 13th Nov.,1999. cloud amount 1, mean value : +9.1℃, S.D.value : ±0.95.

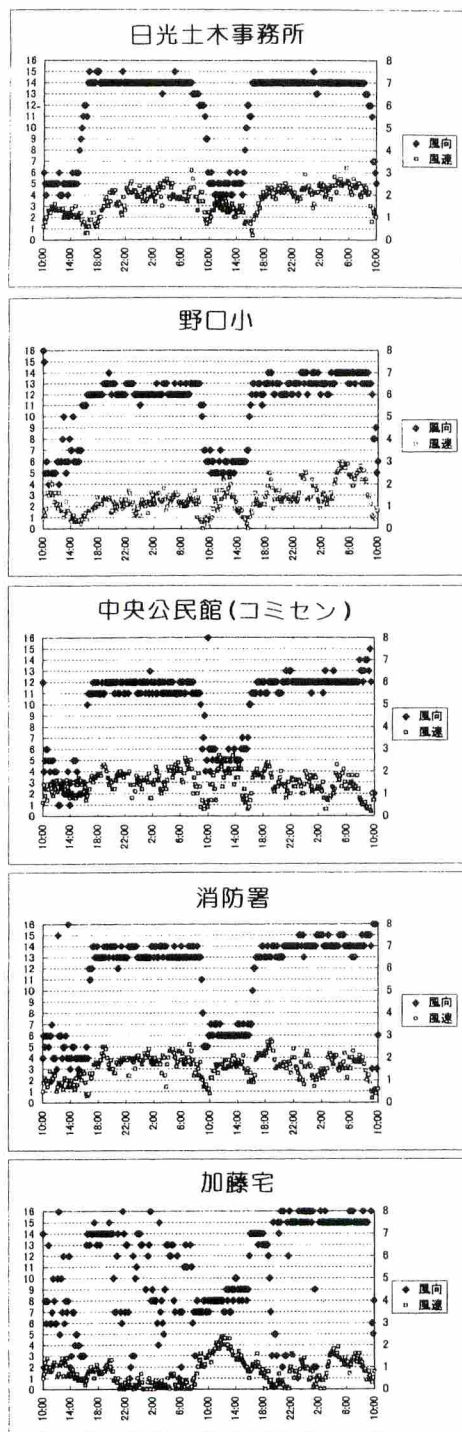


Fig.15 Time changes in wind direction(black diamond) and wind velocity (white square) at some points around Nikko-imaichi under clear weather conditions.

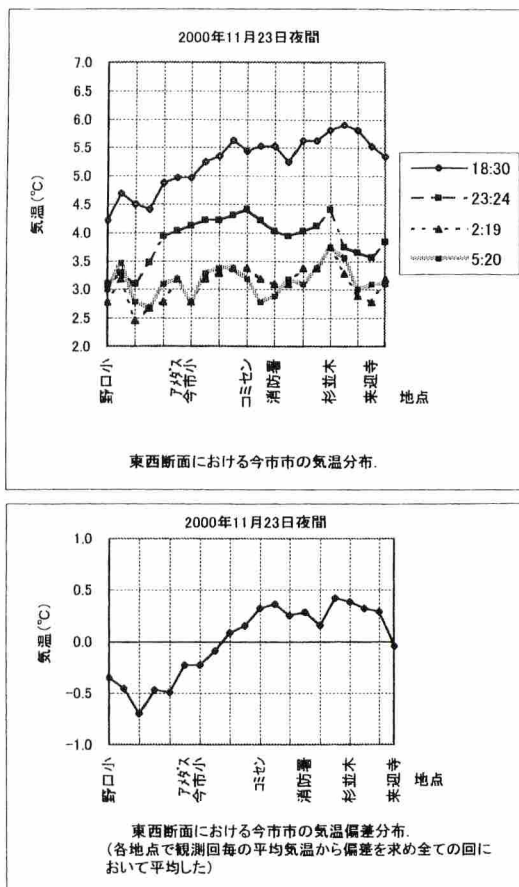


Fig.16 Distribution of air temperature deviations along the Route 119 at Nikko-imaichi on 23~24th Nov.,2000.

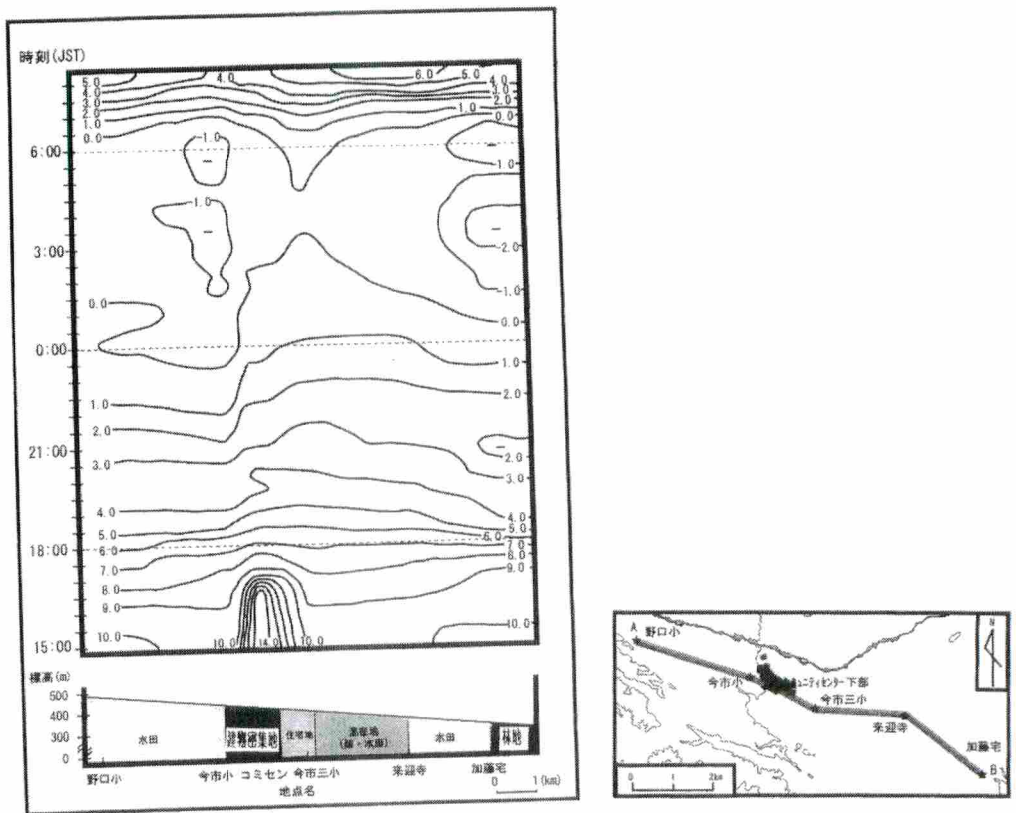


Fig.17 Isopleth of air temperature along the Route 119 at Nikko-Imaichi on 17~18th March,2000.

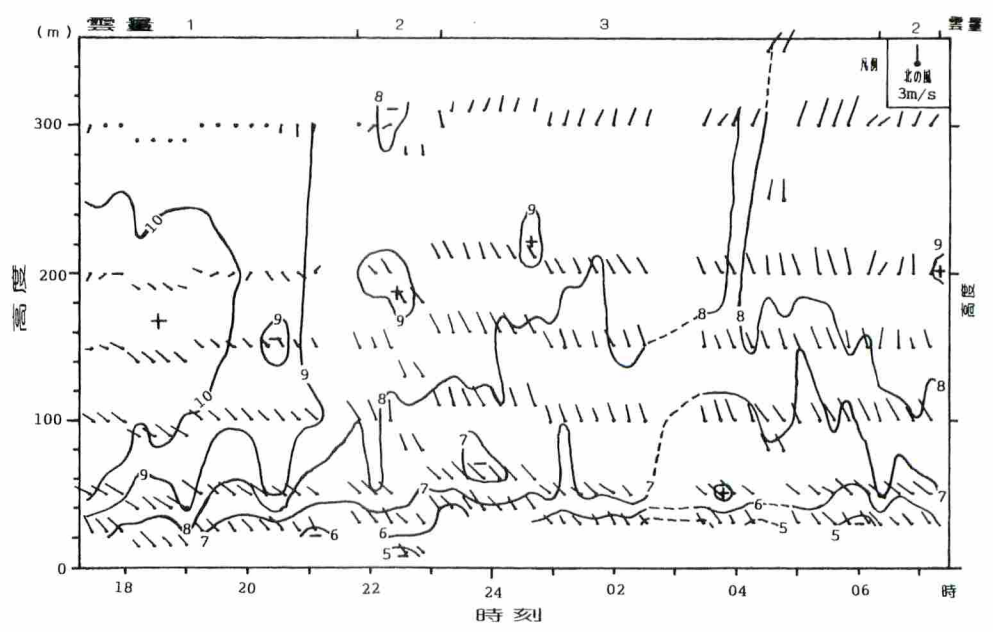


Fig.18 Time-height section of wind direction, wind velocity and air temperature over urban area of Imaichi on 24~25th Nov.,2000.

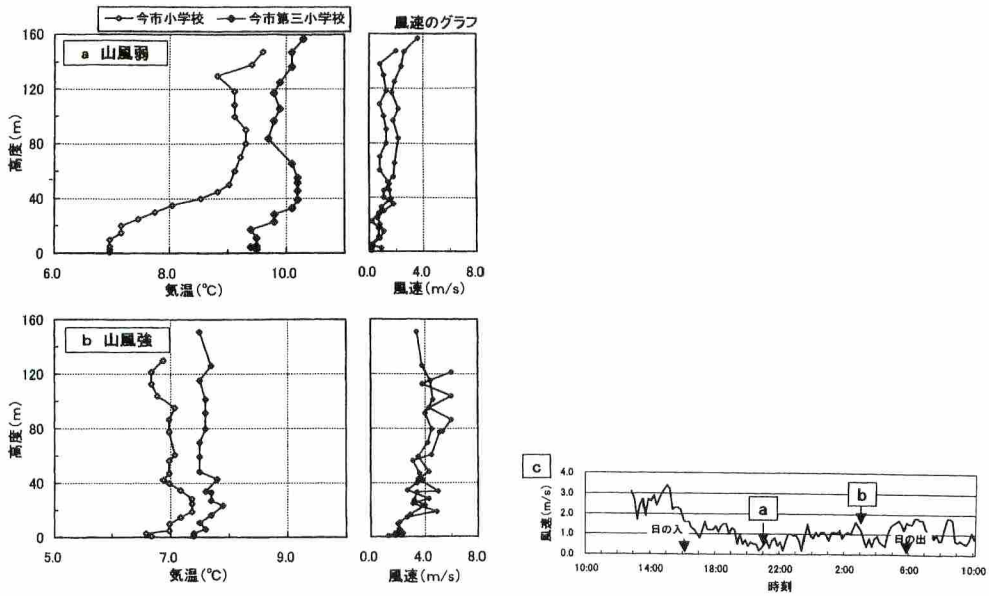


Fig.19 Relationship between vertical temperature(left) and wind velocity profile(right) at Imaichi area on 23~24th Oct.,1999.  
 white diamond : Imaichi Elementary School in suburban area.  
 black diamond : Imaichi Third Elementary School in urban area.  
 upper a : at time of mountain wind weak.  
 lower b : at time of mountain wind strong.  
 bottom c : time changes of mountain wind velocity at urban.

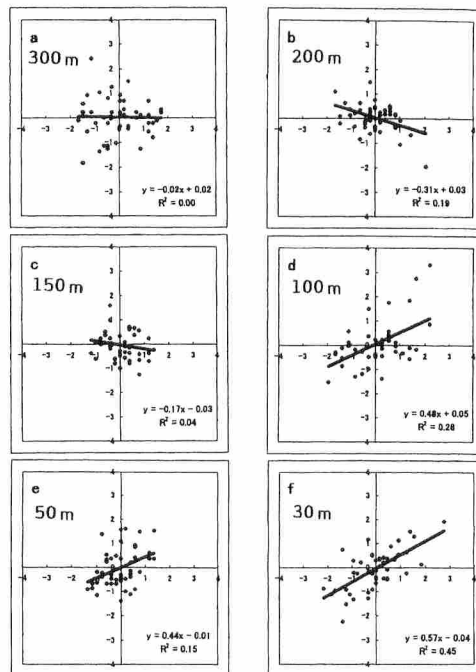


Fig.20 Relationship between variation value of temperature(y) and that of wind velocity(x) at various heights over Imaichi Third Elementary School on 24~25th Nov.,2000.

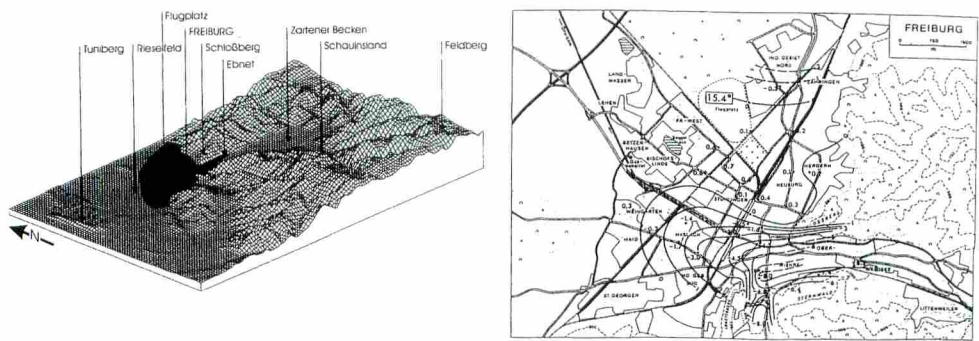


Fig.21 Distribution of air temperature under mountain wind blow at Freiburg, F.R.Germany. (after S.A.Ernst:1995).

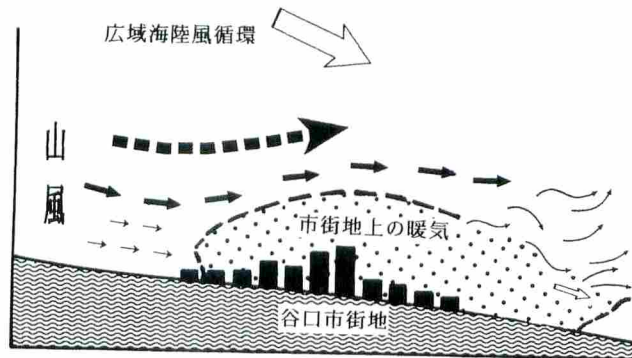


Fig.22 Structure scheme of urban atmosphere at valley mouth settlement of this study.

left side : upper reaches of river as well as mountain wind blowing direction.

right side : lower reaches of river.

center part : urban area of valley mouth settlement.

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