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# ANNUAL OBSERVATION ON THE TEMPERATURE FIELD IN HIROSHIMA CITY

Ken-ichi Narita

Abstract : In this paper, air temperature data corrected at ten points in and around Hiroshima City during one year are analyzed. The thermal effect of green area is dominant in the daytime in summer, and disappeared during late autumn to early spring because of defoliation. Temperature distribution around river is closely related the distance from river. The nighttime temperature within the narrow street in built-up area is raised by artificial exhaust heat from surrounding buildings.

Key words : Urban climate, Green space, River water, Street orientation, Exhaust heat

## 1. INTRODUCTION

Though a little too late, ecological city planning has begun to arouse considerable attention on the most of public in Japan after the advanced example of Germany. Like a tropical hot summer, the climatic condition of Japan is little different from Germany. So each land cover or street geometry and orientation probably have Japanese original meaning for residential amenity. In order to clarify these climatic characteristics, annual observation of air temperature field was carried out in Hiroshima City.

## 2. OBSERVATION METHOD

Figure 1 shows the locations of observation points. Air temperature was measured at ten stations, one is located suburban area and the other is inner city area. The meaning of each location is as follows:

- GRC** : green space (core of deciduous forest [area:200m×100m]within Central Park )
  - GRP** : green space (peripheral area of same forest, about 20m apart from adjacent road)
  - RIV** : above river water (water level measuring facility by the Ministry of Construction)
  - RS1·RS2·RS3** : river side point (different distance from the river)
  - EWM** : east-west oriented wide main street (road width 40m, at the station of street railway)
  - NSM** : north-south oriented wide main street (same as **EWM**)
  - EWP** : east-west oriented narrow path (road width 6m, amusement area with pub and restaurant)
  - SUB** : suburban area (residential area where farming land lies scattered around)
- \* (**RAD** : radiation, **WSP** : wind speed, **WDR** : wind direction)

Measuring height of air temperature is about 4m above ground except for point (**RIV**). Platinum resistance thermometer was set in the ventilated double rectangular column shelter in Figure 2. Solar Radiation, wind speed and direction were also measured in the Central Park at a height of 8m. Sampling interval of these elements were all one minute. Weather condition of each day was divided into fine day and the other, according to the rate of daily total solar radiation to the value at the top of the atmosphere (Figure 3).

## 3. RESULTS AND DISCUSSIONS

For convenience' sake, mean value of selected three point temperature defined by following equation is used in analysis as a average temperature of inner city area.

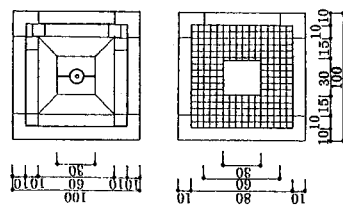
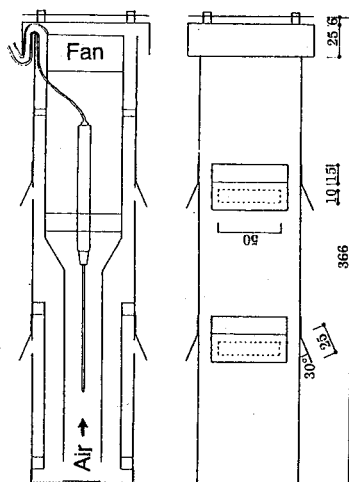


Figure 2 Ventilated shelter

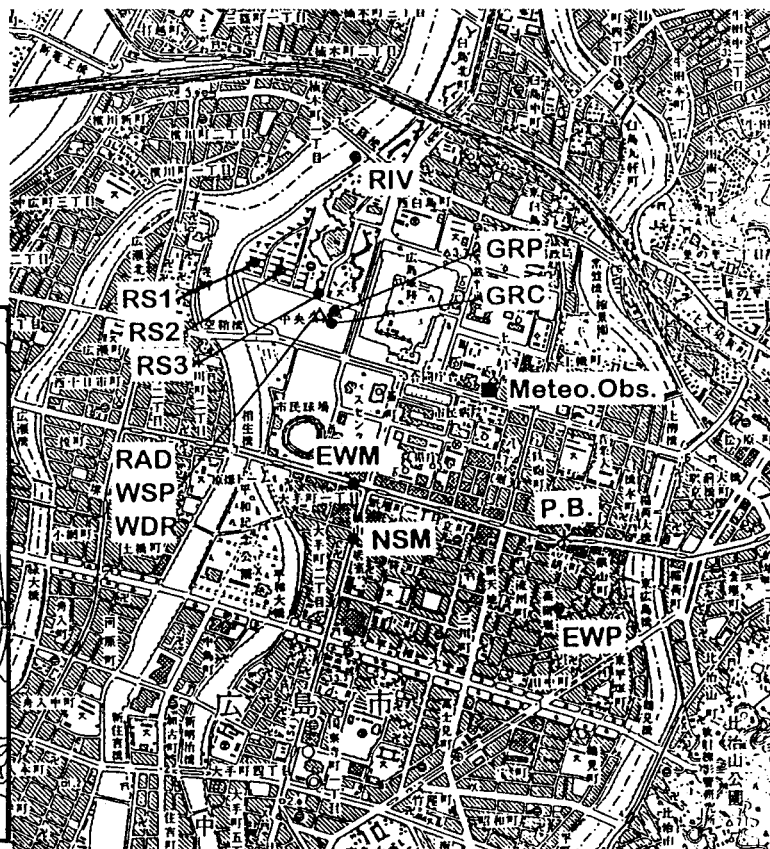
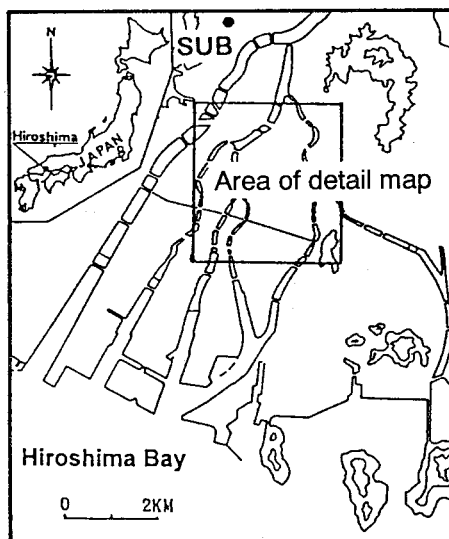


Figure 1 Location of observation points

$$T_{ave} = (EWM + NSM + RS2) / 3 \quad (1)$$

(1) Air temperature difference at amusement area (effect of artificial exhaust heat)

Around point **EWP**, exhaust heat by air-conditioning is released to the lower part of street canyon as a sensible heat, which is different from business district where almost heat by energy consumption are concentrated and released from building rooftop. Figure 4 shows that air temperature at amusement area is higher than surrounding city area 1 or 2 °C during nighttime through the year. Such a temperature difference tends to become smaller on the holiday when most of pub and restaurant are closed (Figure 5).

(2) Air temperature difference due to street orientation

Figure 6 shows example of daily air temperature difference between E-W oriented and N-S oriented street. N-S street is warmer than E-W street about noon, and its relation is reversed at the time after sunrise and before sunset. But these differences are obscure in windy condition (Figure 7).

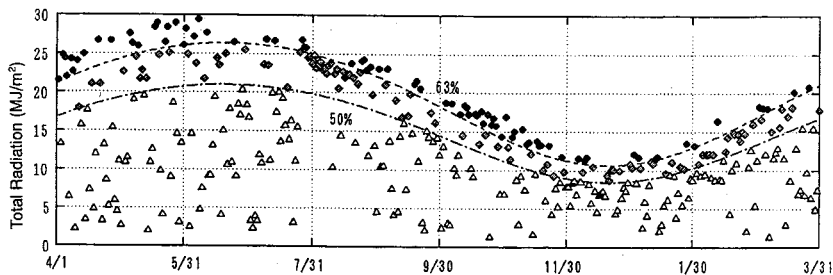


Figure 3 Weather division based on daily total radiation (Fine day ; more than 50% of top of the atmosphere)

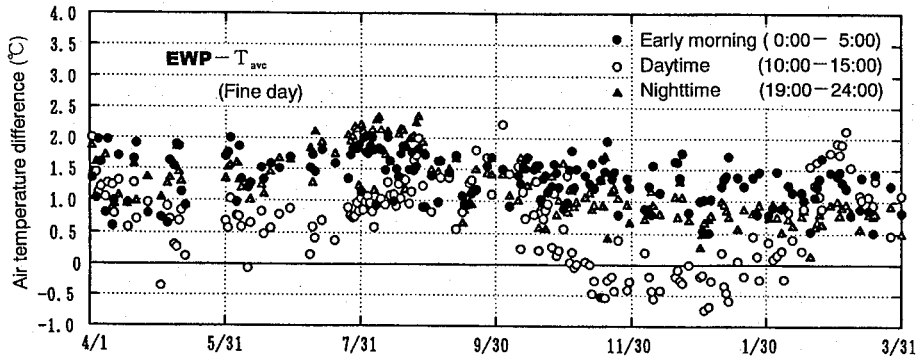


Figure 4 Annual variation of temperature difference between amusement area and inner city average

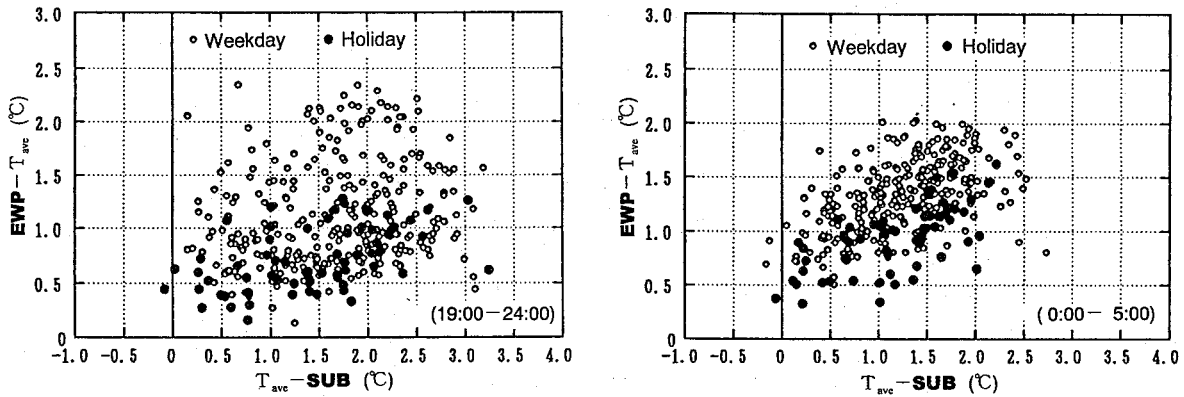


Figure 5 Difference of air temperature in amusement area between weekday and holiday

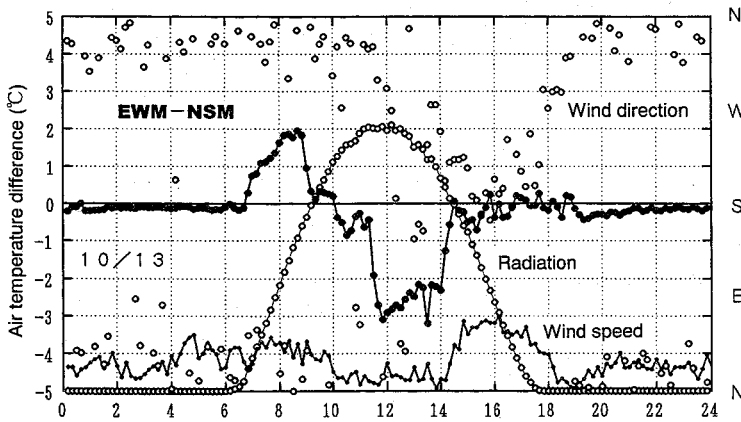


Figure 6 Example of air temperature difference due to street orientation

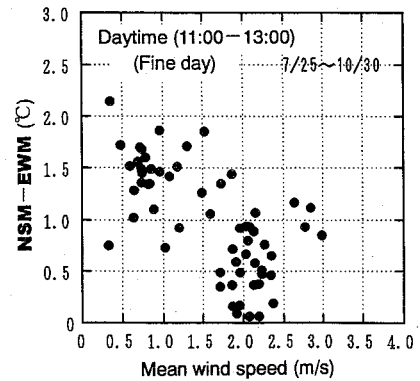


Figure 7 Wind speed dependency of air temperature difference

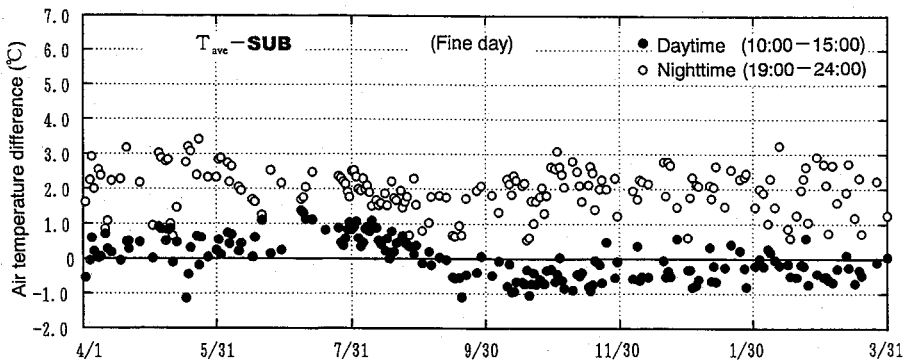


Figure 8 Annual variation of air temperature difference of inner city area from suburban station

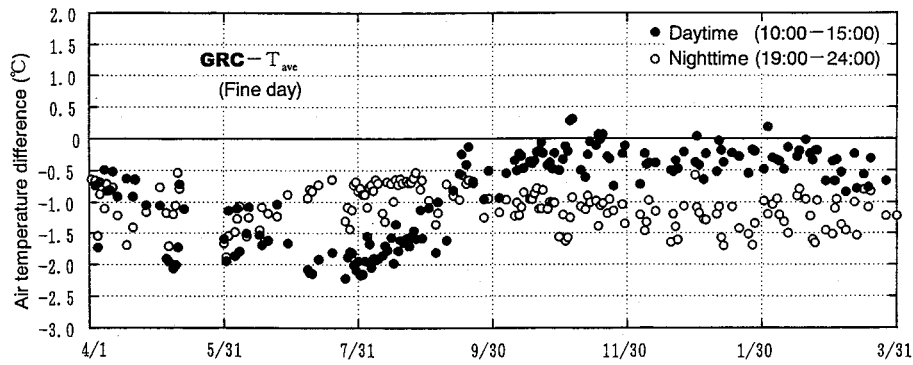


Figure 9 Annual variation of thermal effect of green space

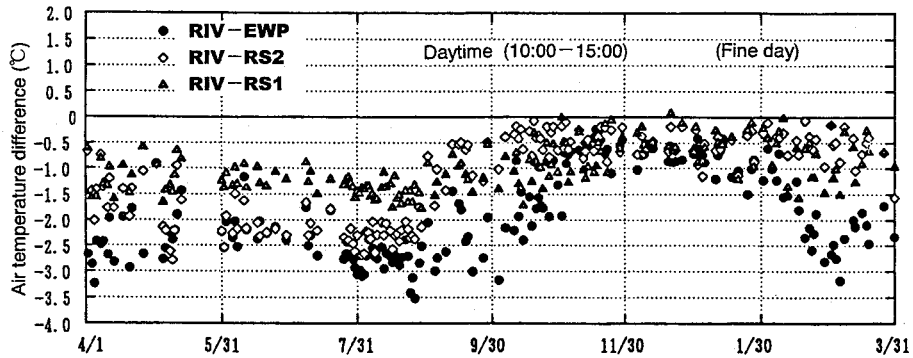


Figure 10 Annual variation of thermal effect of river water

(3) **Annual variation of urban-suburban temperature difference**

The so-called heat island intensity in Hiroshima City is distinguished during nighttime at all seasons (Figure 8). In winter, inner city area is cooler than suburban area in daytime. It is considered as a effect of shadow of high buildings.

(4) **Thermal effect of green space**

In summer, air temperature under the forest is lower than surrounding area about 2°C as a daytime average (Figure 9). But it disappears with leaf fall. On the other hand, temperature difference during nighttime is constant through the year. It means that the daytime temperature difference is due to sunshade effect and transpiration but that of nighttime results from artificial exhaust heat in surrounding area.

(5) **Thermal effect of river water**

Figure 10 shows annual variation of air temperature drop above river water in daytime. It is obvious in summer, and temperature difference is increasing with the distance from river.

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