Case Study of Local Heavy Rainfall, Focusing on GPS Precipitable Water Vapor : Rainfall Event Observed in Tokyo on July 4, 2000

Reprinted from
Geographical Review of Japan Series A 83–5 479–492 2010

Case Study of Local Heavy Rainfall, Focusing on GPS Precipitable Water Vapor: Rainfall Event Observed in Tokyo on July 4, 2000

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The present study examined the essential features of local heavy rainfalls observed in Tokyo on July 4, 2000. The following results were obtained: 1) The atmosphere was unstable while the Japanese islands were covered by the Pacific high. 2) The easterly surface winds converged with southerly winds (E–S-type wind system) in the central part of the urban area several hours before the precipitation occurred. 3) The cold air outflow associated with the precipitation system flowed into the convergence zone formed by the E–S wind system.

Examining the spatial distribution of and temporal change in the precipitable water vapor (PWV) on the Kanto plain shows that the PWV tends to increase before rainfall occurs both over the mountains and on the plain. However, it does not appear that the PWV increased in Tokyo due to the urban heat island circulation. Therefore, the urban heat island did not produce heavy rainfall by inducing a strong upwind and drawing in water vapor in this case.

Key words: local heavy rainfall, urban rainfall, heat island phenomenon, GPS precipitable water vapor

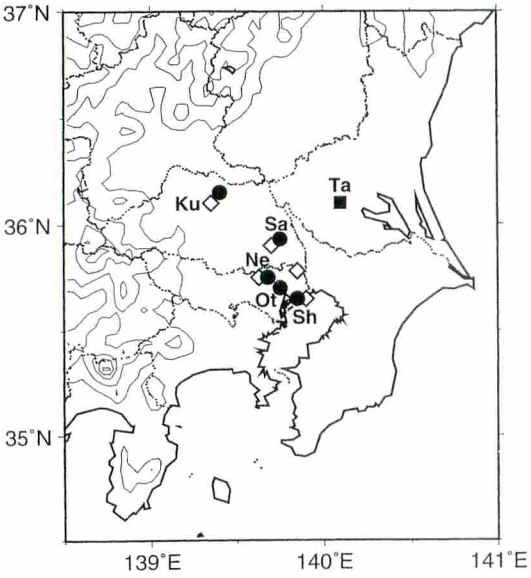

Fig. 1 Terrain and geographical location
●, AMeDAS observation sites; ◇, GPS station sites; ■, radiosonde observation site; Ta, Ku, Sa, Ne, Ot, and Sh, Tateno, Kumagaya, Saitama, Nerima, Otemachi, and Shinkiba, respectively.

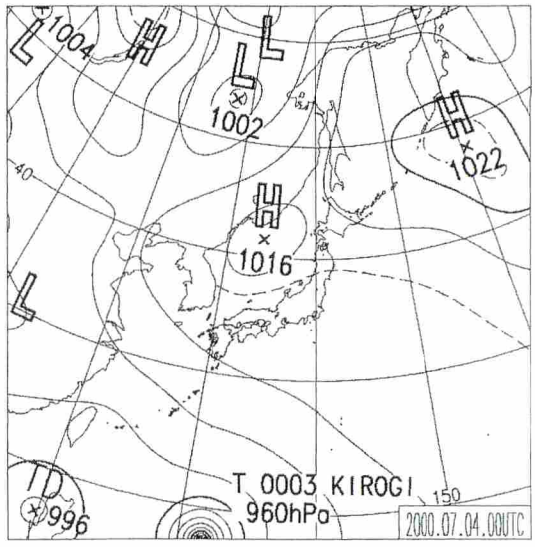

Fig. 2 Surface weather chart at 09:00 Japan Standard Time (JST) on July 4, 2000

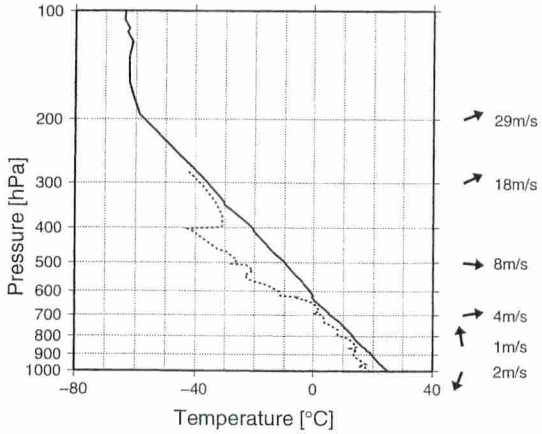

Fig. 3 Vertical profile of air temperature (solid line), dew point temperature (broken line), wind direction (arrow), and wind speed (value) at Tateno station at 09:00 JST on July 4, 2000
Upward pointing arrow indicates south.

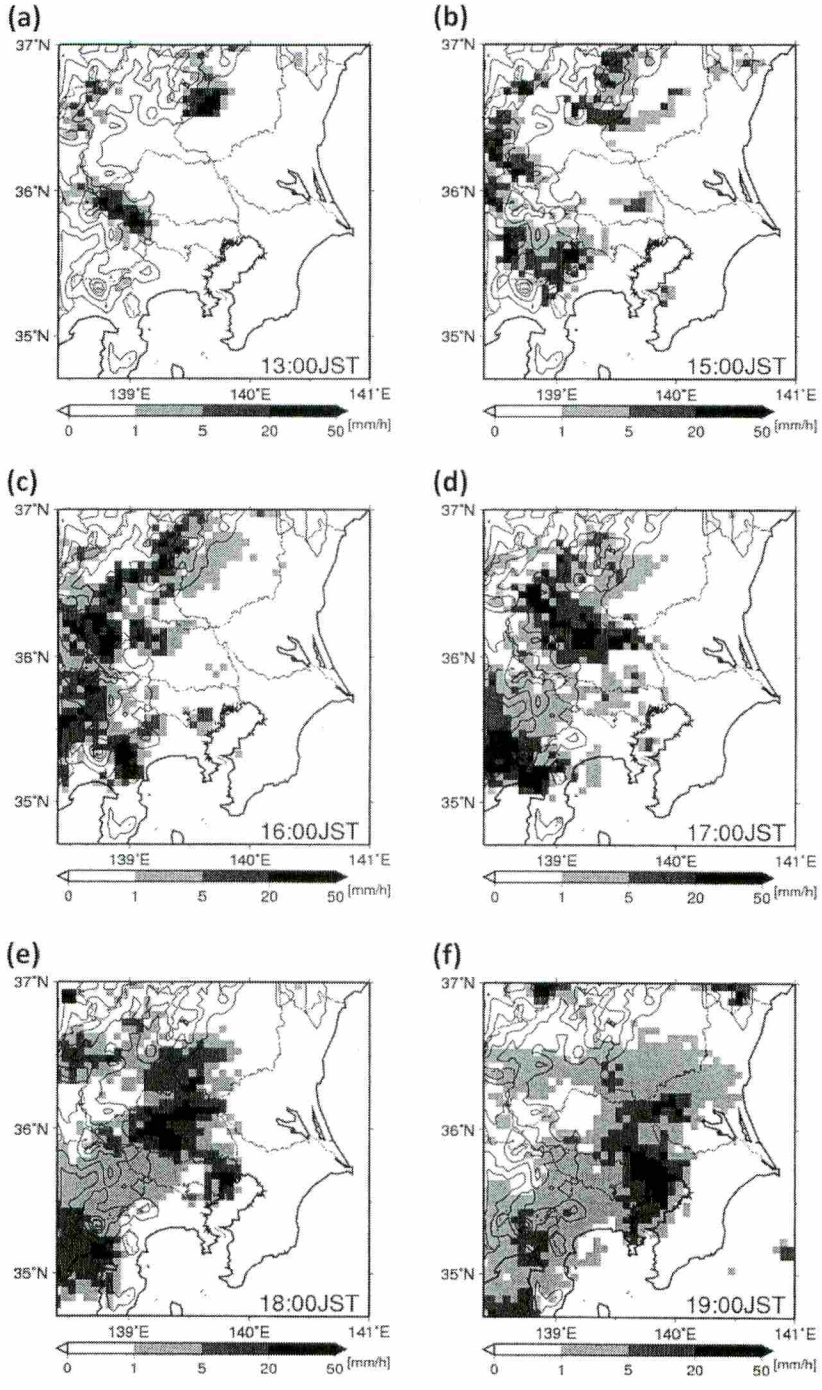

Fig. 4 Distribution of hourly precipitation amount from radar AMeDAS precipitation analysis data

(a), 13:00 JST; (b), 15:00 JST; (c), 16:00 JST; (d), 17:00 JST; (e), 18:00 JST; (f), 19:00 JST.

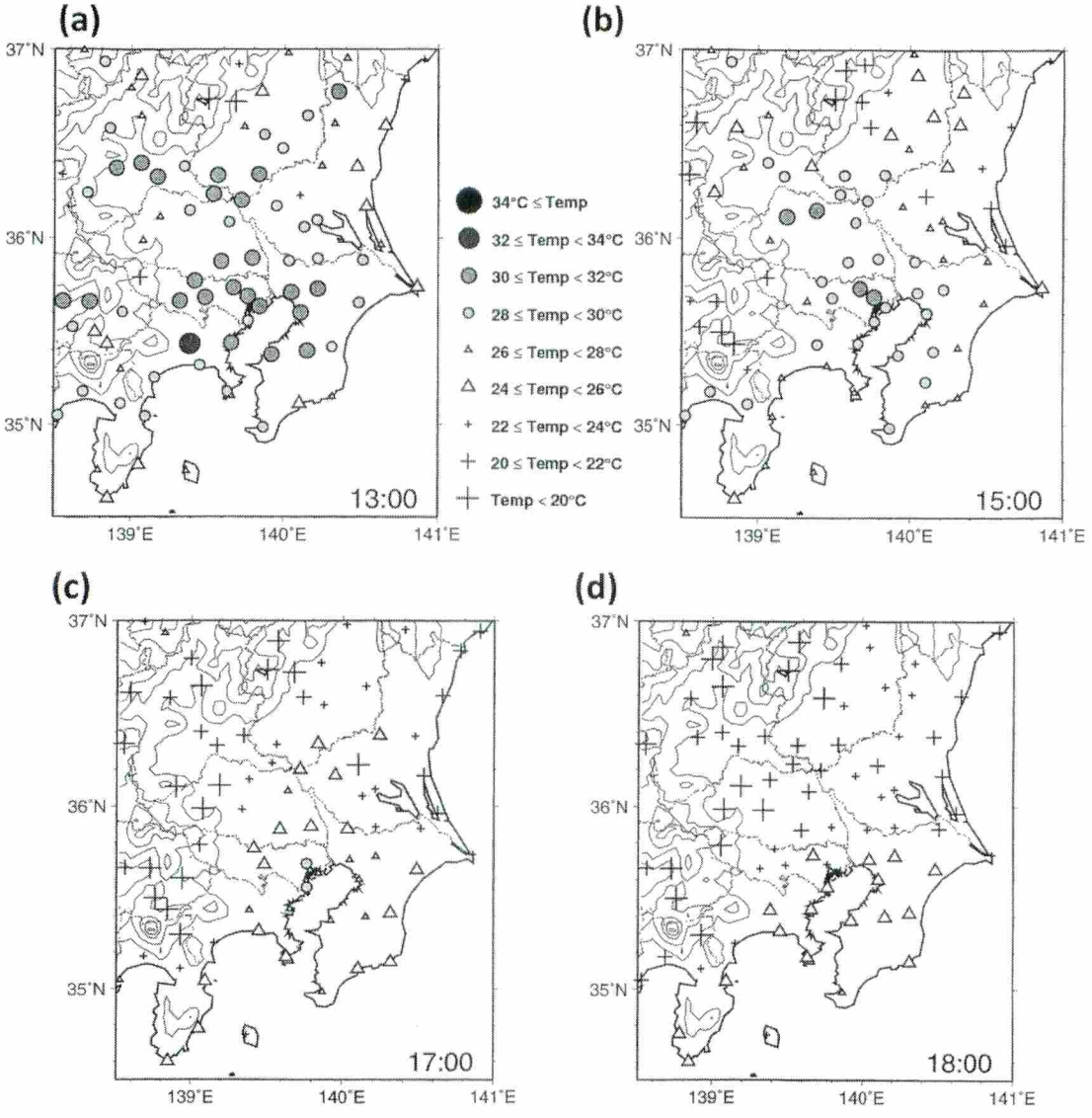

Fig. 5 Surface air temperature distribution from AMeDAS data
(a), 13:00 JST; (b), 15:00 JST; (c), 17:00 JST; (d), 18:00 JST.

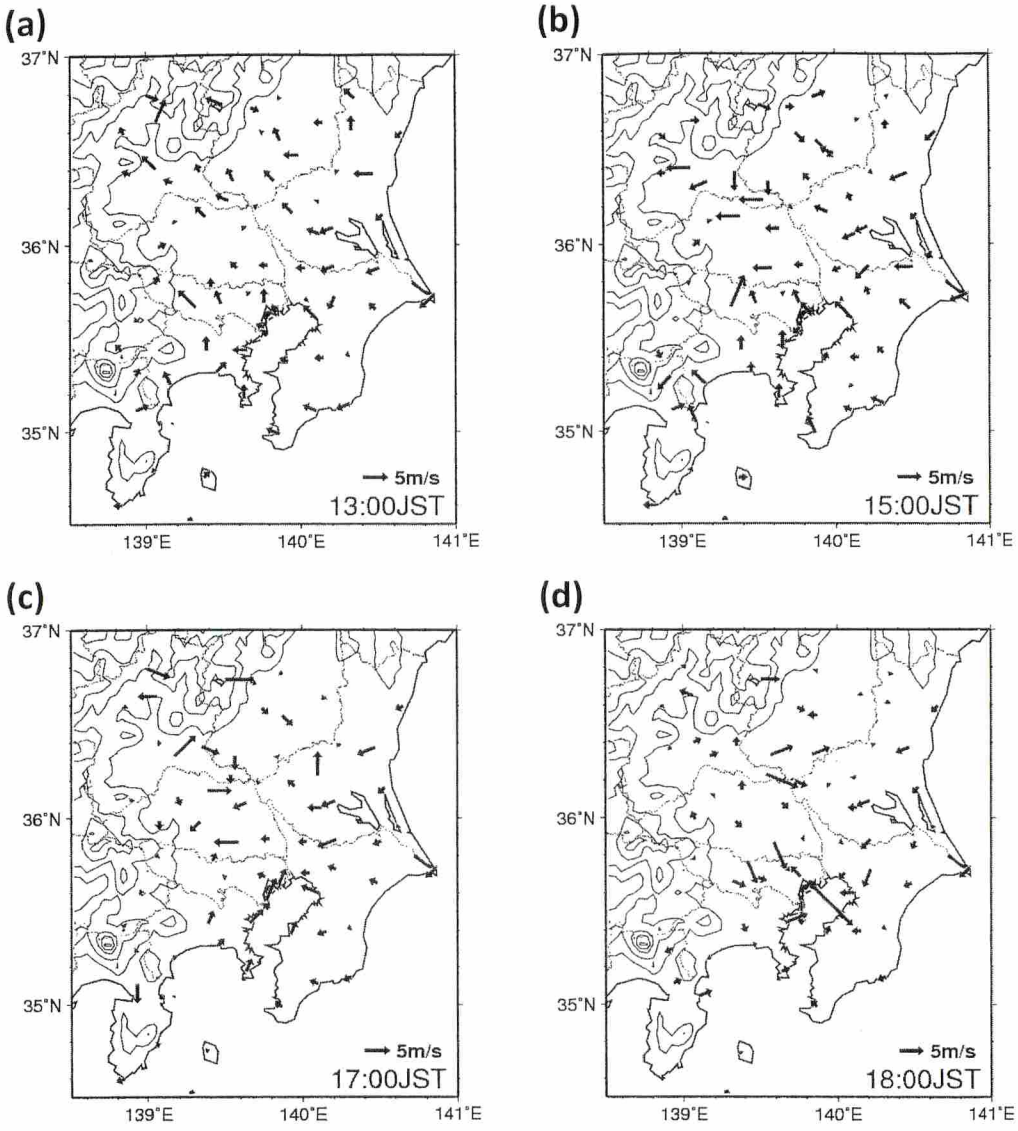

Fig. 6 Surface wind system from AMeDAS data
(a), 13:00 JST; (b), 15:00 JST; (c), 17:00 JST; (d), 18:00 JST.

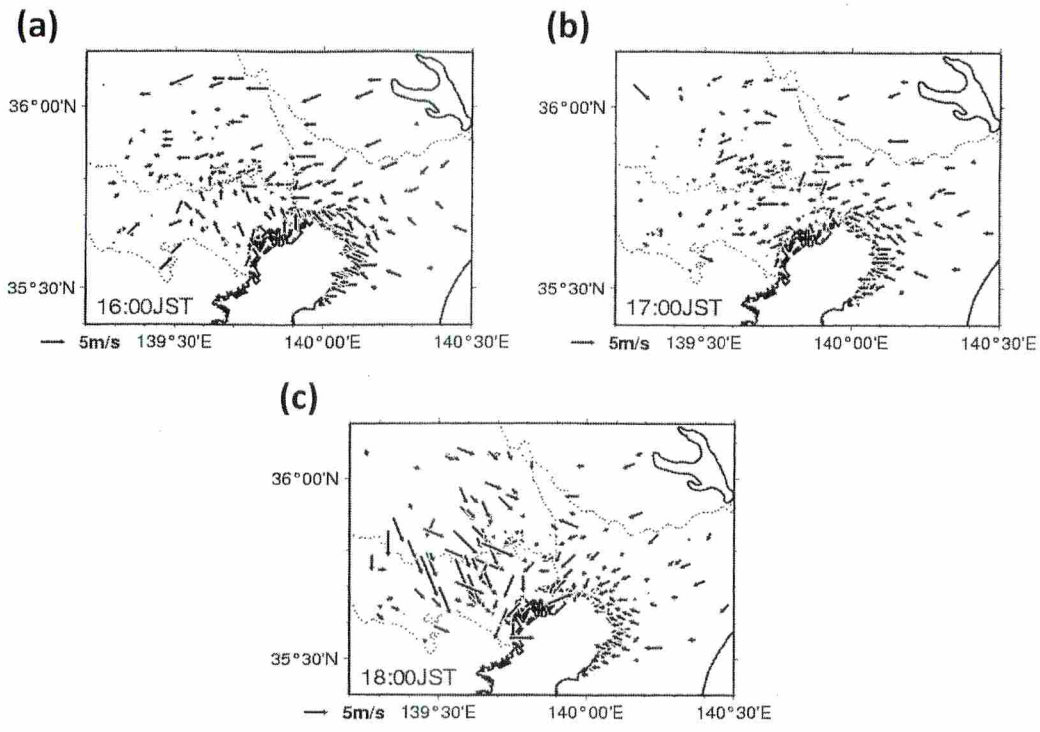

Fig. 7 Surface wind system from ambient air pollution monitoring station data
(a), 16:00 JST; (b), 17:00 JST; (c), 18:00 JST.

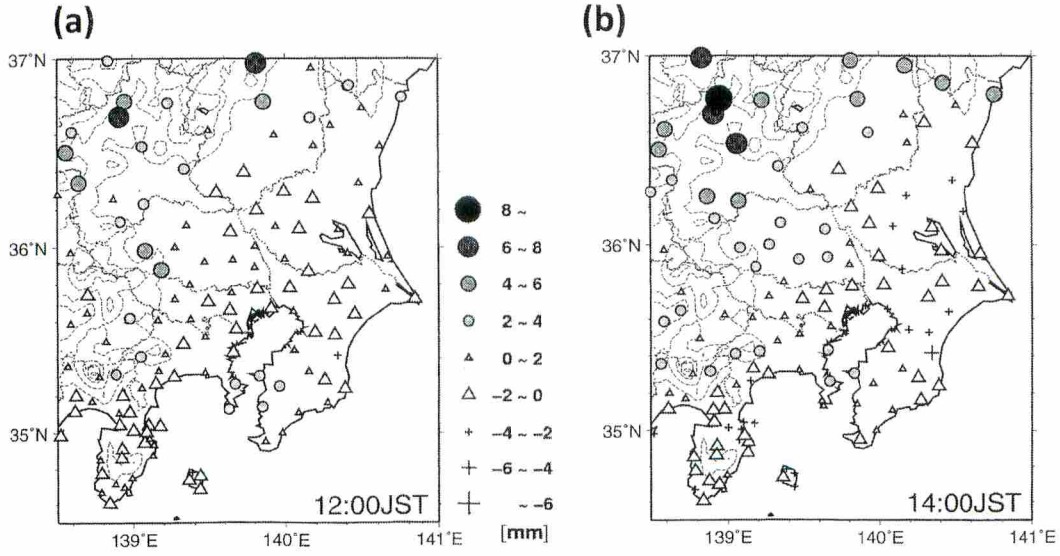

Fig. 8 Distribution of precipitable water vapor derived from GPS (GPS-PWV) (Anomaly from the GPS-PWV at 09:00 JST)
(a), 12:00 JST; (b), 14:00 JST; (c), 15:00 JST; (d), 16:00 JST; (e), 17:00 JST; (f) 18:00 JST.

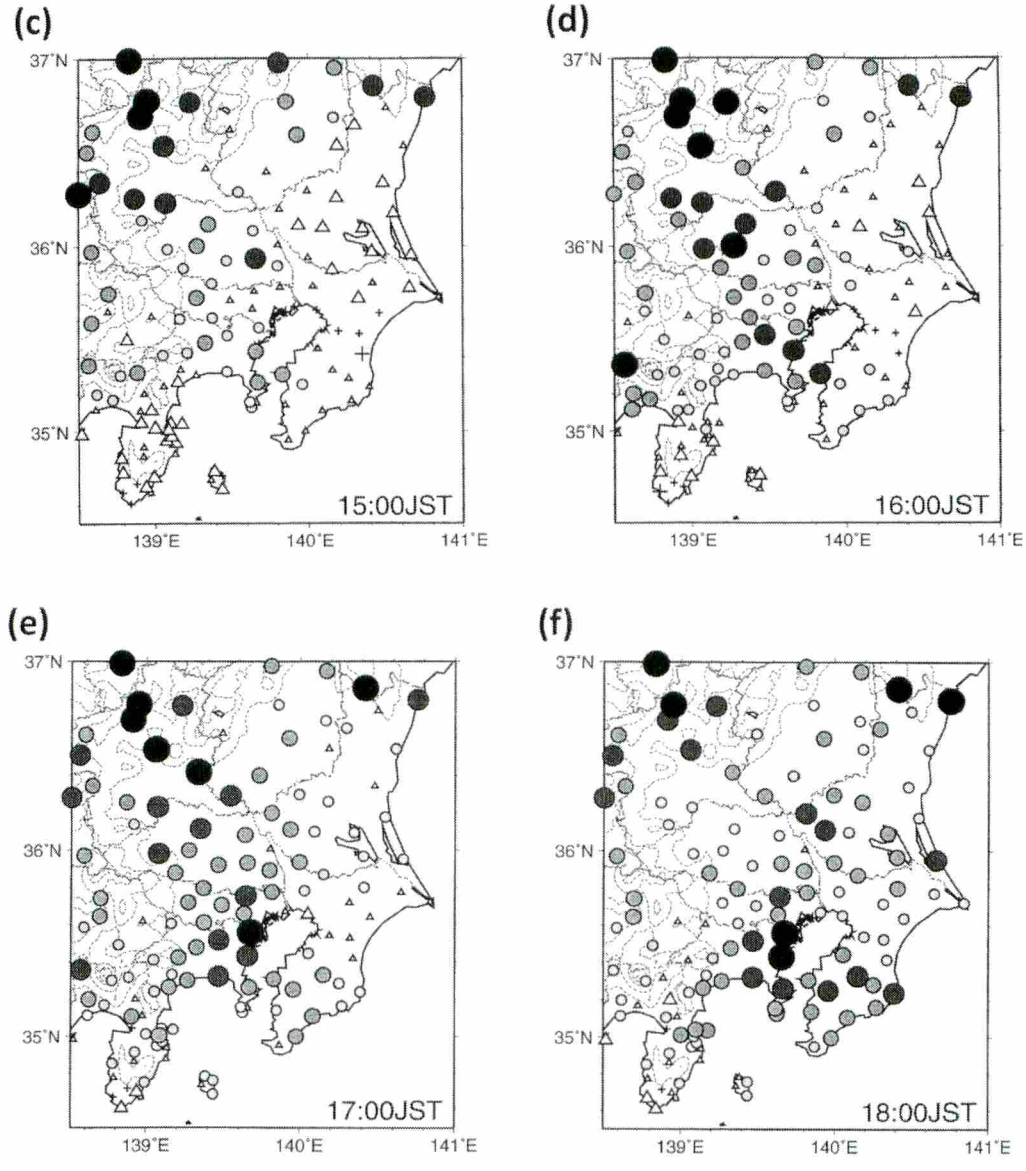

Fig. 8 Distribution of precipitable water vapor derived from GPS (GPS-PWV) (Anomaly from the GPS-PWV at 09:00 JST)
(a), 12:00 JST; (b), 14:00 JST; (c), 15:00 JST; (d), 16:00 JST; (e), 17:00 JST; (f) 18:00 JST.

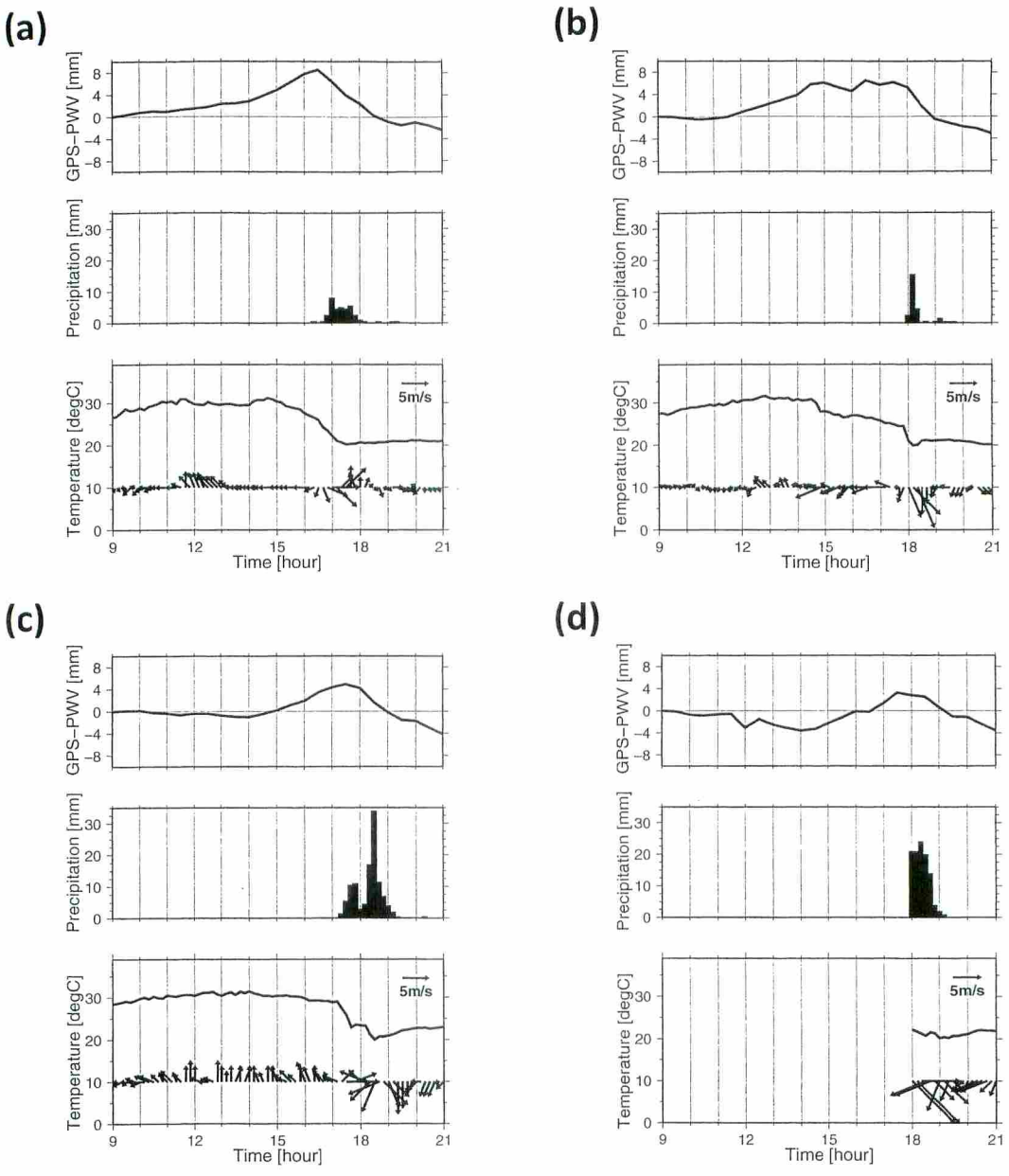

Fig. 9 GPS-PWV, hourly precipitation amount, surface air temperature, and surface wind at the observation sites where the precipitation system was passing
(a), Kumagaya; (b), Saitama; (c), Otemachi; (d), Shinkiba.

Reprinted from *Geographical Review of Japan* Series A, 83-5, 479-492, 2010