Relationships between Water Vapor Concentration Index derived from GNSS and Surface Wind Convergence during Localized Heavy Rainfall in Tokyo in Summer

*Yoshihito Seto[1], Yoshinori Shoji[2], Nobumitsu Tsunematsu[3], Hideo Takahashi[1]

1. Department of Geography, Graduate School of Urban Environmental Sciences, Tokyo Metropolitan University, 2. Meteorological Research Institute, 3. Tokyo Metropolitan Research Institute for Environmental Protection

In recent years, short-term heavy-rainfall events that have caused severe damages such as flooding have frequently occurred in the Tokyo Metropolitan area in summer. In view of the development process of cumulonimbus clouds, the convergence of surface winds and the spatial concentration of water vapor are supposed to have taken place prior to the occurrence of heavy rainfall. This study aims to clarify the evolutionary process of short-term heavy rainfall as a contribution to short-range forecasting of heavy rainfall that occurs locally.

The relationships between the occurrence of heavy rainfall and the convergence of surface winds and water vapor concentration for heavy-rainfall cases were examined using data from July to September obtained from high-density meteorological observations in Tokyo, Japan. We used the water vapor concentration (WVC) index derived from the global navigation satellite system (GNSS) analysis as indices for the degree of divergence and convergence of water vapor in the lower troposphere (Shoji 2013).

Corresponding to heavy-rainfall areas, the convergence of surface winds tended to increase for several tens of minutes prior to the heavy rainfall. The peak time of wind convergence was observed 10–30 min before the heavy-rainfall occurrence, and the convergence continued to increase for approximately 30 min until the convergence peak time (Seto et al. 2018). Around the heavy-rainfall area, the increase in the WVC index coincided with the increase in convergence. On the other hand, it was considered that the temporal and spatial scales of the WVC index are larger than those of wind convergence. From these results, by monitoring the temporal variations and distributions of these parameters using a high-density observation network, it should be possible to predict the occurrence of heavy rainfall rapidly and accurately.

References
Seto, Y., Yokoyama, H., Nakatani, T., Ando, H., Tsunematsu, N., Shoji, Y., Kusunoki, K., Nakayama, M., Saitoh, Y. and Takahashi, H. 2018. Relationships among rainfall distribution, surface wind, and precipitable water vapor during heavy rainfall in central Tokyo in summer. J. Meteor. Soc. Japan, 96A, 35–49.
Shoji, Y. 2013. Retrieval of water vapor inhomogeneity using the Japanese nationwide GPS array and its potential for prediction of convective precipitation. J. Meteor. Soc. Japan, 91, 43–62.

Keywords: localized heavy rainfall, wind convergence, water vapor, high-density observation