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Behavior of GEONET Retrieved Precipitable Water Vapor

Tetsuya Iwabuchi[1], Manabu Kanda[2]

[1] JSPS (MRI), [2] Civil Eng.,TIT

To use the GEONET PWV for meteorology, evaluations of the consistency in spatial distribution of GEONET PWV are firstly required. We thus visualize nationwide distribution of 3-hourly PWV in the case of a front passage and compare those with PWV in Japan area objective analysis data for numerical weather prediction of JMA. Also, to use the GEONET PWV for practical monitoring of the localized heavy rain and its prediction, investigation of correspondence of variations between GEONET PWV and rainfall are needed. We thus also investigate correlation between spatio-temporal variations in GEONET PWV estimated with interval of 30 minutes and those in localized convectional heavy rain.

During a front passage in summer, we illustrate behavior of GPS retrieved water vapor around the front with heavy rains, where errors due to GPS analysis is estimated as about 1 mm. Such information about PWV could not retrieve radiosonde observation. These show potential of the GEONET for water vapor sensor over the Japanese Islands at all weather conditions. However, comparison between GPS retrieved PWV and those based on numerical weather prediction (NWP) in JMA shows small underestimation of GPS PWV of about 3 mm. Lately most of the biases were explained by phase center variation (PCV) of antenna and radome (monument) in GEONET (Hatanaka et al., 2000), and we can now estimate precise PWV with the PCV model for GEONET made by Hatanaka et al. (Nishimira et al., 2002).

The results suggest that GEONET can offer spatially consistent PWV data even in the heavy rain.

The prediction of localized convective heavy rainfall is crucial for water-disaster prevention especially in urban regions. Although the detailed structure of mature clouds has been analyzed well using Doppler radar systems, the initiation process is still unknown and the monitoring of water vapor prior to cloud formation is necessary. We thus investigate the correlation between spatio-temporal variations in GEONET PWV estimated from 30 minutes time interval and those in Radar-AMEDAS rainfall, for six events of localized convective heavy rainfalls in 1998 at Kanto area.

The results show that (1) the peaks of GEONET PWV are one to two hours prior to those of rain, (2) the hourly increments of rain are correlated with those of GEONET PWV with one to two hours lag, and (3) GEONET PWV are already decreasing at the peaks of rainfall. The mechanism of GEONET PWV prior to heavy rainfall could be related to the life cycle of each cumulus cloud. This hypothesis is supported by the fact that the increases of GEONET PWV correspond to convergences of surface winds. Simply using the hourly increments of GEONET PWV as a signal to predict one-hour late increases of rainfall gives only 60 % accuracy. To improve this, the hourly increments of GEONET PWV are recalculated with the consideration of PWV advection effect. Advection vectors of PWV are estimated only from spatio-temporal changes of PWV. As a results, the accuracy of GEONET PWV as a prior signal to heavy rainfall is improved to 70 %. Although this accuracy is still not satisfactory as a stand-alone index to predict severe rainfall, GEONET PWV is proved to be very useful information to support the short-term prediction and monitoring of heavy rainfall.

All the above results shown here suggest that GEONET has much potential to improve forecast of the heavy rain when its PWV are suitably assimilated into numerical weather prediction model as long as we can get GEONET data with near realtime.