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Author(s)	Oigawa, Masanori
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ABSTRACTS (MASTER THESIS)

Study on the Variability Characteristics of Precipitable Water Vapor Associated with Heavy Rainfall Using a Non-hydrostatic Model

**(Graduate School of Science,
Laboratory of Atmospheric Sensing and Diagnosis, RISH, Kyoto University)**

Masanori Oigawa

Introduction

GPS Precipitable Water Vapor (PWV) is useful to monitor water vapor variations associated with heavy rainfall. The Geospatial Information Authority of Japan is operating a nationwide GPS network, called GPS Earth Observation Network System (GEONET) with a mean horizontal spacing of about 20 km. PWV from GEONET has already been used for operational mesoscale analysis of Japan Meteorological Agency (JMA). However, water vapor fluctuations ahead of the initiation of deep convection occur at meso-γ scale (2-20 km) (Shoji, 2013). Higher horizontal resolution (1-2 km) PWV observations have been performed by using a dense GPS network installed near Uji campus of Kyoto University (Sato et al., 2013). For the accurate forecast of local heavy rainfall, it is important to observe PWV at meso-γ scale and assimilate the high resolution PWV data into a cloud resolving model.

Method

In this study, an analysis was performed about meso-γ scale water vapor fluctuations associated with a heavy rainfall to verify the feasibility of high resolution PWV data assimilation, using JMA non-hydrostatic model (JMA-NHM) and PWV data observed by the hyper-dense GPS network in Uji. In order to reproduce small scale water vapor distributions, high resolution numerical simulations were performed using JMA-NHM with grid intervals of 250 m. The torrential rainfall event was reproduced which occurred on 14 August 2012 around the dense GPS network.

Result

In the 250 m forecast, PWV values started to increase 9 minutes before starting to rain within the area of about 10 × 5 km^2. At the same time, humid boundary layer grew thick in this area because of the wind convergence near the surface (Fig.1). Similarly, increasing of PWV value 10 minutes ahead of rainfall was also observed by the GPS receiver at Uji campus. These results suggest that PWV fluctuations cloud be a precursor of heavy rainfall and that the forecast accuracy of local heavy rainfall could be improved by assimilating high resolution PWV data into a cloud resolving model.

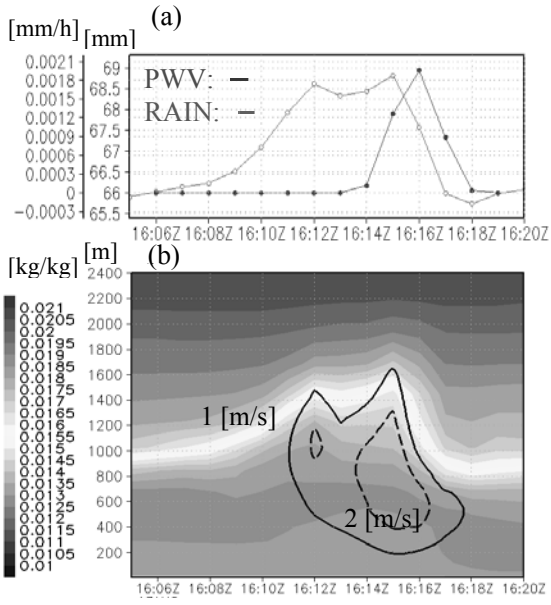

Figure 1. (a) Time variation of PWV and Rain at a certain point in NHM and (b) Time-height cross section of water vapor mixing ratio (shade) and vertical wind velocity (contour) at the same point in NHM.

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