Impacts of GPS derived PWV Data Assimilation on Mesoscale Numerical Weather Prediction

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The Global Positioning System (GPS) has been drawing attention from the field of meteorology recently, as the accurate water vapor sensor under all weather. A near real-time (NRT) analysis system that derives precipitable water vapor (PWV) within several tens minutes after the observation of GPS career phase, has developed at the Meteorological Research Institute (Shoji 2009). A continuous data assimilation (DA) experiments of those NRT derived GPS PWV were conducted with the JMA's mesoscale four dimensional variational assimilation system (Meso 4D-Var) from 1 to 12, September 2006. Then, the impacts of PWV on water vapor field analysis and precipitation forecasts were investigated.

We performed following two sets of sequential data assimilations with three-hour assimilation window. Each experiment differs by assimilated observation data as follows:

(1)CNTL

Conventional observations (radio-sonde, synop, ship, buoy, and aircraft). Radar-AMeDAS analyzed rainfall. Wind, precipitation intensity and PWV field over the ocean retrieved from satellite based micro wave scatterometer/radiometer. Wind-profiler, doppler-radar radial wind, and typhoon bogus data.

(2)GPS

Same observation data used in 'CNTL' experiment and GPS PWV. As Japan has steep mountains and MSM employs smoothed orography for the actual terrain surface, there exist large differences between the GPS antenna height and the corresponding MSM surface height. To adjust the difference of PWVs between the first guess and GPS, the first guess PWV was interpolated or extrapolated from the model surface to the actual terrain surface, using a method by Mannoji et al. (1998), and we used GPS PWV when the D-value of PWV is less than 10 mm after the height correction. Observation error of GPS PWV were set to 5mm.

After the DA with three-hour time window twice in a low, numerical weather predictions (NWP) for up to 18 hours ahead were performed in every 6 hours using hydrostatic mesoscale model (MSM).

Statistical comparison using 96 pair of analyses and 48 pair of predictions revealed following impacts of PWV assimilation.

(1)Statistically, as a result of PWV assimilation, larger specific humidity changes can be seen at vertical levels where background error are large (i.e. 2-5km).

(2)Score of precipitation forecast can be improved by the PWV assimilation. Though, PWV assimilation resulted in underestimation of strong precipitation occured in the first three hours.

In this presentation, discussions of these results and impacts of spatial density of GPS stations will be introduced.