Impact of Data Assimilation of Shipborne GNSS Data on Rainfall Forecast

Hiromu Seko, Ko Koizumi and Yoshinori Shoji

Meteorological Research Institute / Japan Meteorological Agency
e-mail:hseko@mri-jma.go.jp

1. Introduction

Recently, heavy rainfalls occur almost every year in Japan. To reduce the damage caused by heavy rainfall, the accuracy of rainfall forecasts should be improved. Japan is surrounded by the sea and the most of low-level inflows that supply water vapor to heavy rainfalls originate from over the sea. Because water vapor supplied from low-level inflows affects greatly the rainfall amount, accurate water vapor data over the sea is needed to improve the heavy rainfall forecasts. The satellites provide water vapor distributions over the sea. However, the observation frequency is only a few times a day. To overcome this point, we used the GNSS data observed on the vessel (Shipborne GNSS). In this study the impact of GNSS PWV obtained by the JMA's vessel (Ryofu-maru) was investigated by using Meso-NAPEX.

2. Data assimilation method

The Meso-NAPEX (Numerical Analysis and Prediction EXperiment system) is a quasi-operational Data Assimilation system which enables us to make data assimilation cycle experiments(http://jksv-pj.npd.naps.kishou.go.jp/redmine/base/projects/napex-model/wiki/NAPEX%E3%81%A8%E3%81%AF). The grid interval of the Meso-NAPEX is 5 km. The data assimilation window is 6 hours and the observation data are assimilated every hour. As the target event for the data assimilation experiment, the precipitation system associated with the low-pressure system, which passed over Kyushu on 5th June 2017, was adopted. On June 5th, the Ryofu-maru stayed south of Kyushu, on the immediately southern side of precipitation system (windward side of low-level inflow).

We performed two experiments, in which the convectional data of JMA including the satellite was assimilated by using the Meso-NAPEX (CNTL) and the PWV data of shipborne GNSS was added to the conventional data (S-GNSS). The accuracy of shipborne GNSS PWV is 3.4–5.4 mm root mean square differences against radiosonde (Shoji et al 2016). Firstly, the data assimilation period which is needed to improve the rainfall distribution was investigated by changing the start time of data assimilation. After checking the data assimilation period, the differences of water vapor during the assimilation period and the rainfall distributions of extended forecasts are investigated.

3. Impact of Shipborne GNSS data

The start time of data assimilation was changed from 00UTC 4th June to 00UTC 7th June with the increment of 12 hours. The rainfall distribution of the extended forecast, of which the initial

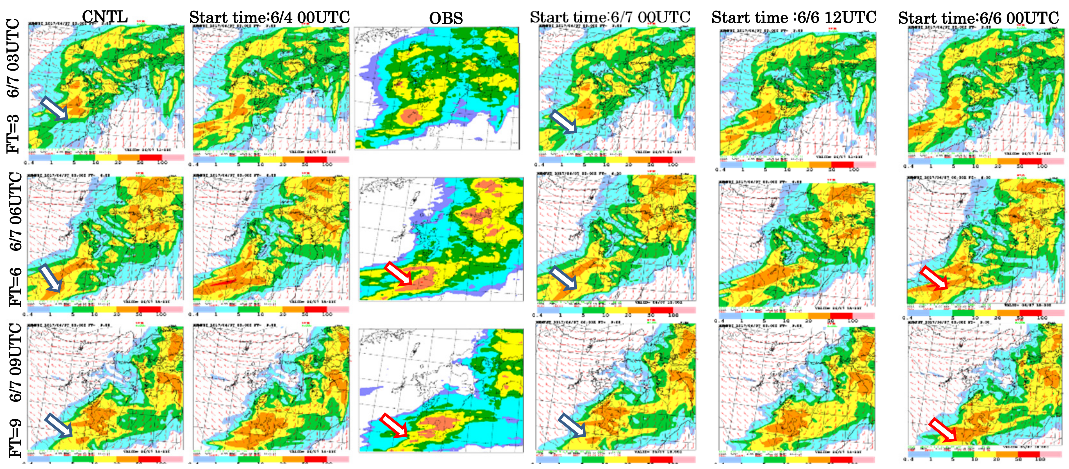

Fig. 1: The rainfall distributions of extended forecasts, of which the start time of data assimilation was changed from 00UTC 4th to 00UTC 7th June 2017. FT stands for the forecast time.

condition was produced from the analysis of 00UTC 7^{th}, was similar to that of CNTL (Fig. 1). When the start time of data assimilation was 00UTC 6^{th}, rainfall distribution became most similar to the observed ones. These results indicate that the impact of one GNSS data is very weak and that one day for the data assimilation was needed to increase the rainfall accuracy in this case. The start time of 00UTC 6^{th} is adopted in the following comparisons.

The difference of T-Td at the height of 850 hPa (S-GNSS - CNTL) during the assimilation period of 00UTC 6^{th} to 00UTC 7^{th} is shown in Fig. 2. The T-Td around the Ryofu-maru was modified and the modified regions expanded south-southeastward with time. The region where water vapor is increased appeared at the southern side of Kyushu at 00UTC 7^{th} (as indicated by the arrow). The comparisons of the rainfall distributions between Observation, CNTL and S-GNSS indicate that the intense rainfall regions south of Kyushu became similar to the observed ones by the assimilation of Shipborne GNSS data (indicated by arrows in Fig. 3). This assimilation result shows that Shipborne GNSS has the potential to improve rainfall forecasts through the data assimilation, even if the number of observations is small.

References

Shoji, Y., K. Sato, M. Yabuki and T. Tsuda, 2016: PWV Retrieval over the Ocean Using Shipborne GNSS Receivers with MADOCA Real-Time Orbits, *SOLA*, **12**, 265-271.

Acknowledgements

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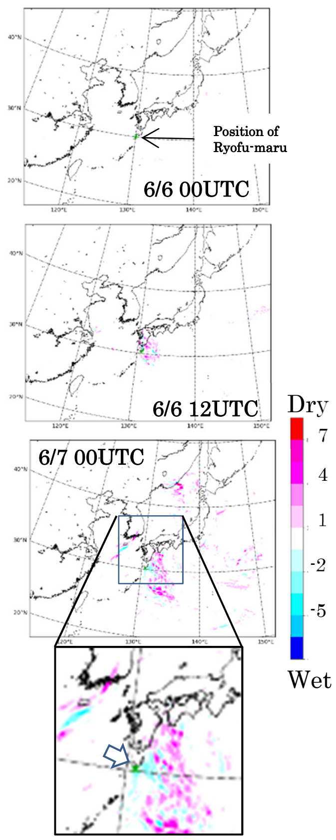

Fig. 2: Difference of analyzed T-Td fields at 850 hPa (S-GNSS -CNTL). The green crosses indicate the positions of Ryofu-maru.

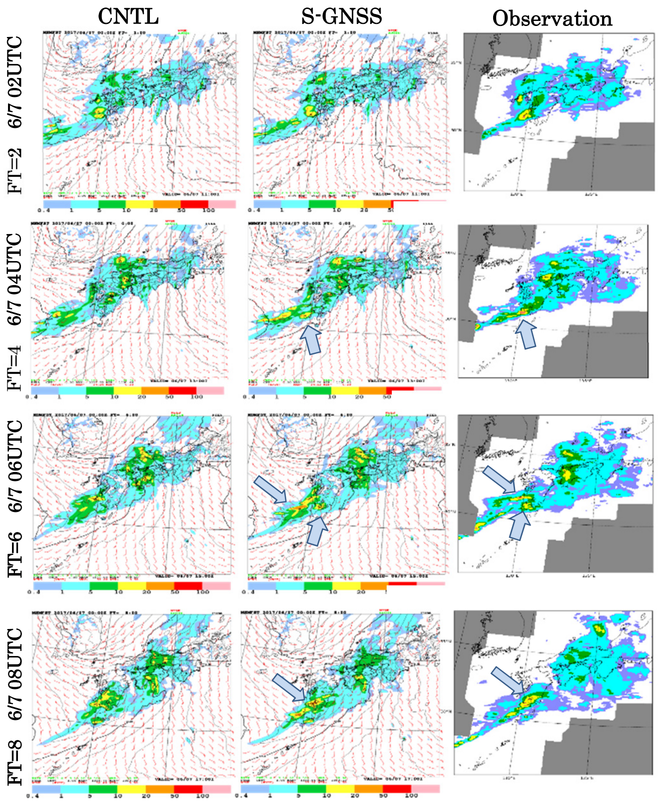

Fig. 3: Rainfall distributions predicted from the analyzed fields of 00UTC of 7^{th} June. (left) CNTL and (center) S-GNSS, (right) Observed rainfall regions obtained by JMA's Radars and rain gauges.