Utilization of Metop-B data in JMA's Operational Global and Mesoscale NWP Systems

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1. Introduction

Metop is a series of three polar-orbiting meteorological satellites operated by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). Launched in October 2006, Metop-A is the first satellite in the series, and the Japan Meteorological Agency (JMA) has been assimilating the unit's observation data in its numerical weather prediction (NWP) systems since 2007. The current assimilation targets are Advanced Microwave Sounding Unit-A (AMSU-A), Microwave Humidity Sounder (MHS), GNSS Receiver for Atmospheric Sounding (GRAS) and Advanced Scatterometer (ASCAT) data along with one set of retrieval data (atmospheric motion vector (AMV) information) from the Advanced Very High Resolution Radiometer (AVHRR). These are useful measurements for atmospheric analysis to provide initial conditions for NWP.

Metop-B was launched in September 2012 as the second unit in the series, and became the prime operational satellite in April 2013 with Metop-A still active. JMA began assimilating data from Metop-B in addition to those from Metop-A on 28 November 2013, as Metop carries a set of heritage instruments. This report details the impacts of Metop-B data assimilation on both the global and mesoscale NWP systems.

2. Impacts on the global NWP system

To evaluate the quality of data from Metop-B, statistical research was performed in advance based on the mean and standard deviation of differences between the results of observation and global model simulations. The results showed that the quality of Metop-B data was comparable to that of Metop-A data, meaning that the utilization of Metop-B data increases the body of same-quality AMSU-A, MHS, GRAS, AVHRR-AMV and ASCAT data available. Accordingly, the additional use of Metop-B data into NWP systems is expected to improve analysis accuracy.

Observation system experiments were performed using the global NWP system for the one-month period of August 2013 to investigate the impacts of Metop-B data assimilation. The control experiment (CNTL) had the same configuration as the operational global system, and the additional use of Metop-B data was implemented in the test experiment (TEST). The results revealed that the assimilation of Metop-B data improved analysis and forecast fields. Figure 1 shows the outcomes of analysis and the background error of the wind speed field against radio-sonde observations in the tropics and the Southern Hemisphere. The bias at around 500 hPa in the tropics and both the bias and the root mean square error (RMSE) at around 300 hPa in the Southern Hemisphere were reduced. For other elements such as temperature and relative humidity, the bias and RMSE were slightly reduced. The quality of typhoon track predictions was improved as shown in Figure 2.

3. Impacts on the mesoscale NWP system

In the mesoscale NWP system, the usage of Metop data is restricted to AMSU-A and MHS. The quality of AMSU-A and MHS data from Metop-B was investigated with the mesoscale NWP system in the same way as with the global NWP system, and the results showed that data quality was also comparable to that of Metop-A (not shown). A study to determine the impacts of Metop-B data assimilation on the mesoscale NWP system was also conducted, and some forecast scores relating to precipitation and elements such as temperature and wind vectors were found to be almost neutral (not shown).

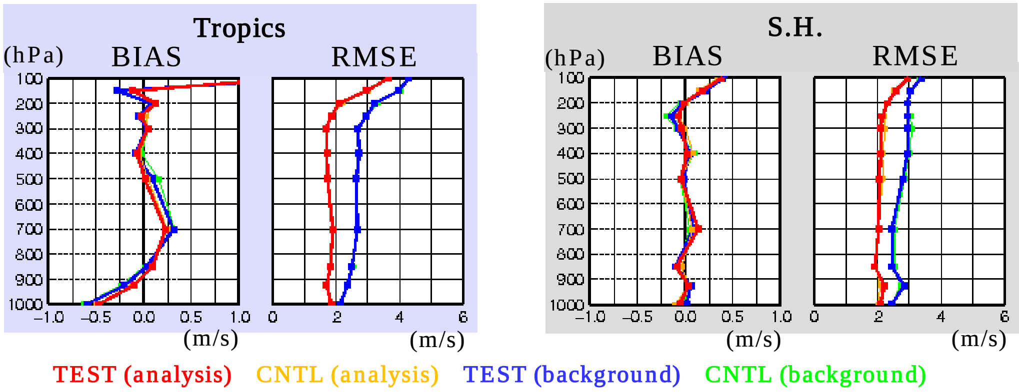

Figure 1: Wind speed error profiles of analysis and background against radio-sonde observation in the tropics (left panel) and the Southern Hemisphere (right panel). BIAS (right) and RMSE (left) are shown in each panel. The red, orange, blue and green lines represent analysis for TEST, analysis for CNTL, background for TEST and background for CNTL, respectively.

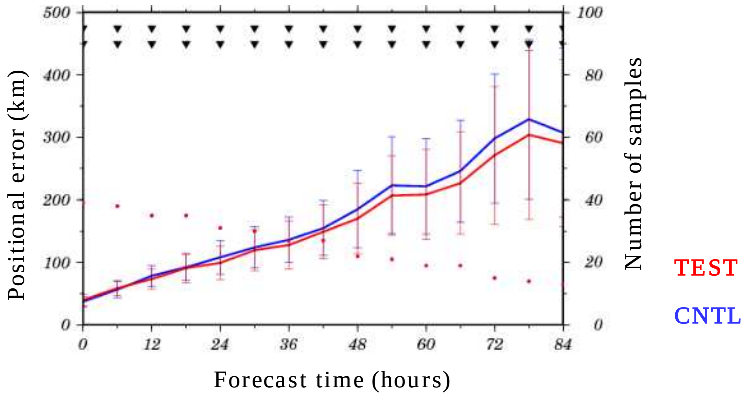

Figure 2: Average typhoon track forecast errors for August 2013. The red and blue lines represent the positional errors of TEST and CNTL, respectively. Red dots indicate the number of cases included in the statistics. The error bars represent a 95% confidence interval.