Assimilation of Aircraft Temperature Data
in the JMA Global 4D-Var Data Assimilation System

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JMA had not assimilated commercial aircraft temperature data in the operational global data assimilation system because of temperature biases at cruising altitudes (particularly above 300 hPa). We developed a bias correction method to deal with this problem and studied the impact of aircraft temperature data assimilation in the JMA global analysis and forecast system using the new correction method.

The results showed a positive impact in global analysis and forecasting. Since the method's effectiveness was confirmed in the JMA high-resolution global data assimilation system (TL959L60), use of aircraft temperature data was implemented operationally in November 2009.

Quality control and bias correction for aircraft temperature data

Some NWP centers have pointed out that some aircraft data have temperature biases, most of which are warm ones.

In order to reduce such biases, a bias correction scheme was introduced to quality control for aircraft data (AMDAR and ACARS temperature reports, but not AIREP). This approach is known as a static bias correction scheme; when observed temperatures show noticeable biases in one-month statistics, the aircraft data for the next month are modified to reduce the calculated bias. The statistics are based on the difference between the reported temperature and the background temperature (O-B). JMA also employs a similar bias correction method for radiosonde data.

Additionally, when temperature data from an aircraft show biases larger than 2.5 K in one-month statistics, data from the aircraft are not used the next month. The aircraft reporting data with large temperature biases are blacklisted for exclusion from use due to doubtful data quality.

Experiments

Experiments were performed using the JMA low-resolution global data assimilation system (TL319L60). The two separate periods of 1 – 30 September 2008 and 1 – 31 January 2009 were studied. Nine-day forecasts were run from each 12 UTC analysis, making a total of 30 and 31 forecasts for each period, respectively. In both the control run and the test run, the JMA operational data set was used, including conventional data and satellite data. Aircraft temperature data were used only in the test run.

Results

Figure 1 shows the 500-hPa geopotential height anomaly correlation score for January 2009.

A positive impact was found in both the Northern Hemisphere (from day 1 to day 9) and the Southern Hemisphere (from day 1 to day 7).

Figure 2 shows the rate of improvement in the RMSE of forecast errors for 850-hPa temperature (T850), 500-hPa geopotential height (Z500) and 250-hPa wind velocity (Wspd250). Although the short-range forecast performance of T850 was somewhat worse, the forecast performance of Z500 and Wspd250 improved.

The impact was near neutral in September 2008 experiment, although the medium-range forecast (up to day 5) performance improved slightly (not shown).

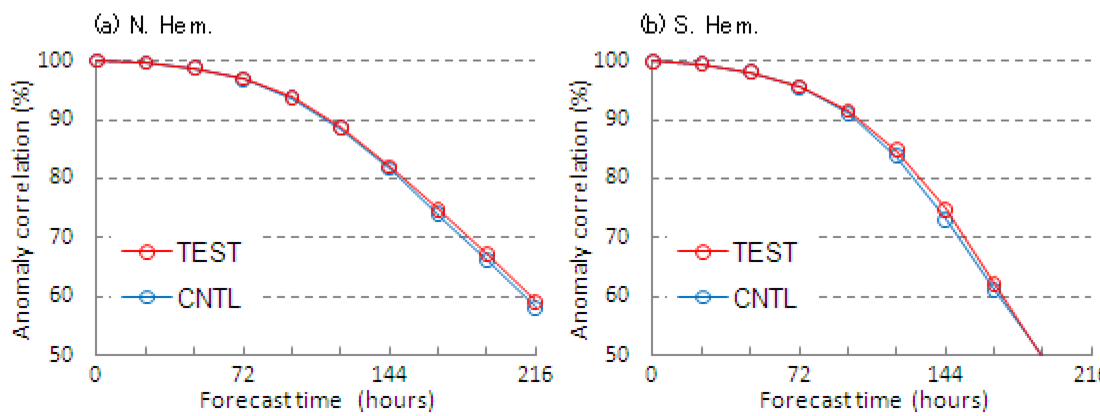

Figure 1. Anomaly correlations of 500-hPa geopotential height for the period 1 – 31 January 2009 (a) in the Northern Hemisphere (20°N – 90°N) and (b) in the Southern Hemisphere (20°S – 90°S). The test run is shown in red and the control run in blue.

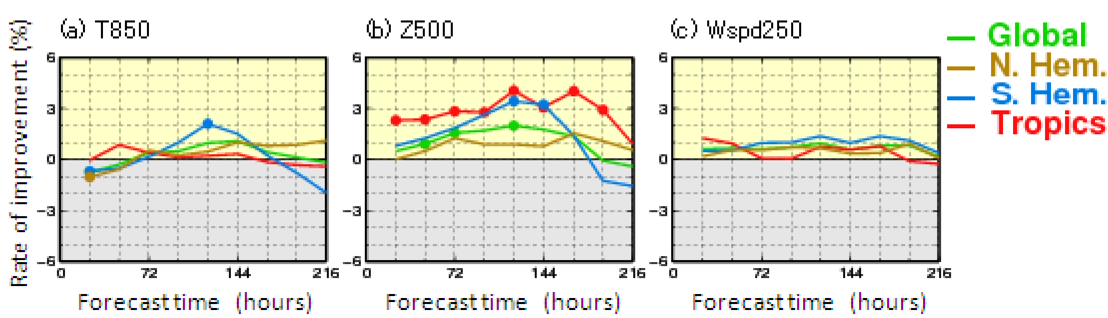

Figure 2. Rate of improvement in the RMSE of forecast errors for the period 1 – 31 January 2009 for (a) 850-hPa temperature, (b) 500-hPa geopotential height and (c) 250-hPa wind velocity. The improvement rate is defined as follows:

Improvement rate = (RMSEcntl - RMSEtest) / RMSEcntl

The dots on the lines indicate statistical significance.

References

C. Cardinali, L. Isaksen and E. Andersson, "Use and Impact of Automated Aircraft Data in a Global 4DVAR Data Assimilation System," *Monthly Weather Review*, Volume 131, Issue 8 (August 2003), pp. 1,865 – 1,877