Bias Correction of Aircraft Temperature Data in JMA's Mesoscale Data Assimilation System

Yukinari Ota
Numerical Prediction Division, Japan Meteorological Agency
e-mail: y.ohta@met.kishou.go.jp

1. Introduction

Ballish and Kumar (2008) reported that aircraft temperature data exhibit various biases depending on aircraft type, and exhibit statistically higher values than similar data from radiosonde observation.

Against this background, correction for aircraft temperature bias was introduced to the JMA global data assimilation system (GA) in November 2009 (Sako 2010) and to the mesoscale data assimilation system (MA) in March 2019.

2. Bias correction methodology

Estimated temperature biases in the GA system are applied to bias correction for aircraft temperature in the MA system. The bias estimation method for the GA system is based on monthly statistics of first-guess (FG) departures for individual aircraft tail numbers and flight levels over the previous month (Sako 2010).

3. Impacts of bias correction

Observing system experiments on the mesoscale NWP system were performed over a month in summer 2018. Figure 1 compares the resulting FG departure fits to aircraft temperature data between the two experiments without and with bias correction (noBC and BC, respectively). It can be seen that aircraft temperature bias correction significantly reduces biases and standard deviations of FG departure. Figure 2 shows FG departure fits to radiosonde temperature data. It can be inferred that the use of bias-corrected aircraft temperature data leads to bias reduction in radiosonde temperature data from over 300 hPa and standard deviations in many layers, which improves the FG against radiosonde temperature data. In the area of forecast improvement, Figure 3 shows verification of mean errors and root mean square errors against radiosonde temperature data in 12-hour forecasting during the experiment period. A positive impact is generally seen above 300 hPa, with reduced positive temperature bias and root mean square errors.

4. Summary

Aircraft temperature bias correction is generally required in data assimilation systems to reduce positive biases and root mean square errors above 300 hPa. Based on the related impacts, such correction was introduced to JMA's operational mesoscale data assimilation system in March 2019.

References

Ballish, B. A., and K. Kumar, 2008: Systematic differences in aircraft and radiosonde temperatures. Bull. Amer. Meteor. Soc., **89**, 1689–1708.

Sako, H.: 2010: Assimilation of aircraft temperature data in the JMA global 4D-Var data assimilation system, CAS/JSC WGNE Research Activities in Atmospheric and Oceanic Modelling, **40**, 1 – 33.

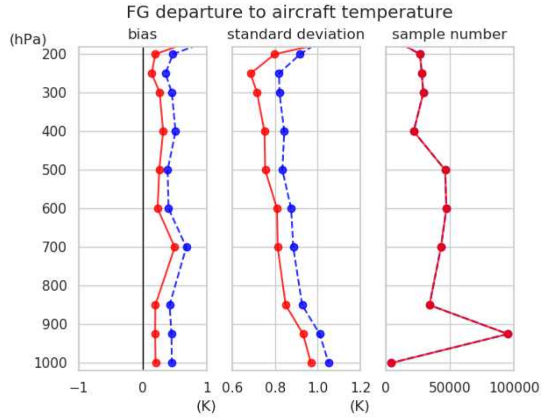

Figure 1. Biases (right), standard deviations (center) and sample numbers (left) of fits of the first-guess departure to aircraft temperature data in the experiment. Blue: noBC; red: BC.

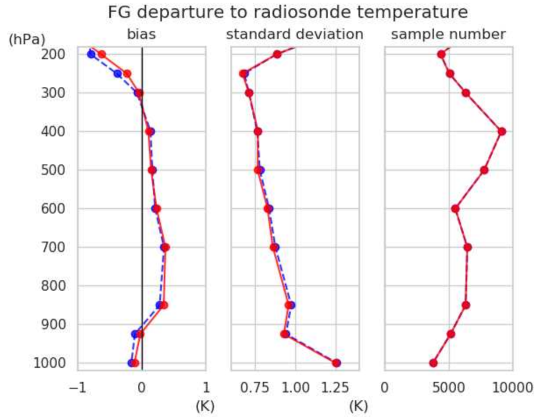

Figure 2. As per Fig. 1, but for radiosonde temperature data.

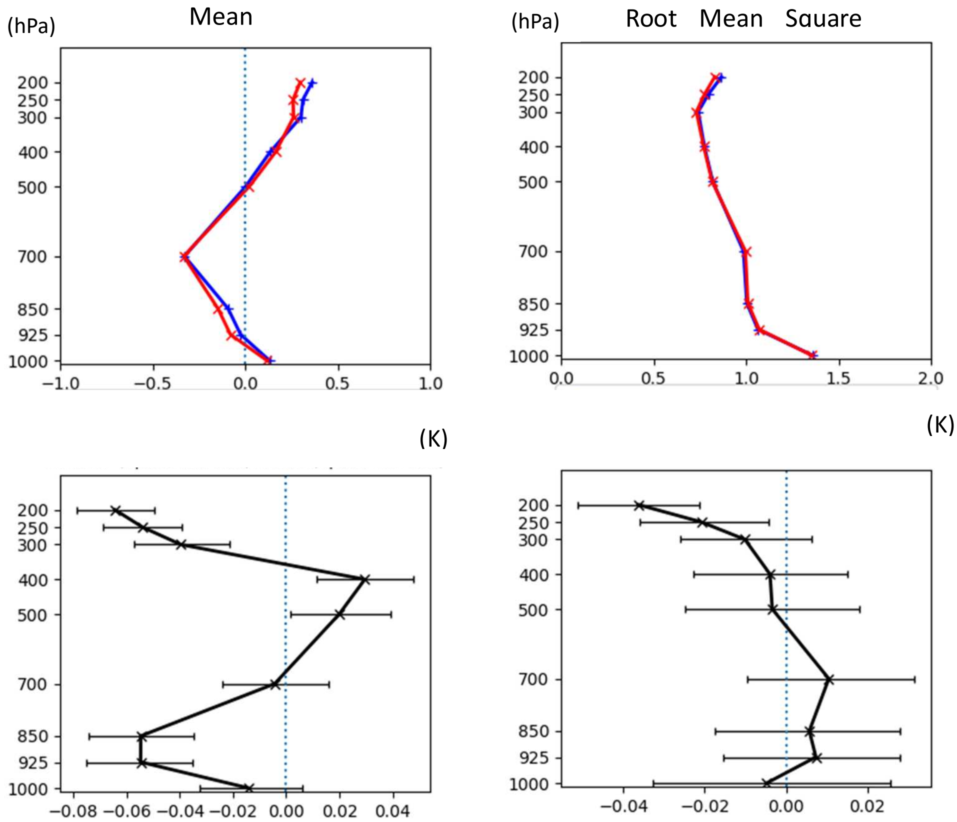

Figure 3. Fits to radiosonde data for 12-hour forecasting of temperature in the experiments. (a) Vertical profile of mean error (ME), (b) BC-noBC of ME, (c) vertical profile of root mean square error (RMSE), (d) ratio of RMSE change ((BC-noBC)/|noBC|). The red and blue lines represent BC and noBC, respectively, and error bars represent 95% confidence intervals.