Recent Modifications of Tropical Cyclone Bogus Data in the JMA Global Data Assimilation System

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Introduction

In the JMA global data assimilation system, bogus data are generated and assimilated for tropical cyclones (referred to here as TCs) over the western North Pacific. Generally in areas mainly over the ocean, the number of observational data from around TCs is insufficient to allow the generation of an appropriate TC structure in an initial field. Bogus data are intended to represent accurate TC structure in initial fields and improve TC forecasting.

How bogus data are generated

Bogus data consist of surface pressure and winds around a TC. A typical TC structure is created using the central position, the central sea level pressure and a 15 m/s wind speed radius, which are analyzed by forecasters.

The TC structure is created as follows: First, the axisymmetric surface pressure is calculated using Fujita's formula (Fujita, 1952). Then, upper wind data are also produced using an empirical formula based on Frank's statistical analysis (Frank, 1977). Finally, the asymmetric component is derived from the first guess field and added to the axisymmetric structure.

The bogus data are produced from observation of this structure, and are simultaneously assimilated with other observational data. Until March 2009, bogus data in operational global analysis were distributed as shown in Figure 1.

Modification of horizontal distribution

Bogus data located in the vicinity of a TC's center seem to have a relatively higher level of quality than those far from it because they are based on analysis by forecasters, while those farther away are estimated using an empirical formula.

Figure 2 shows the modified distribution of bogus data; it can be seen that more are near the TC center, with fewer farther away. An experiment was performed using the JMA operational global data assimilation system to examine the impact of this change. The experimental period was from September 1 to 30 2008; forecasts were produced from each 12 UTC initial for the test run, while the control run employed original distribution (Figure 1). Figure 3 shows the forecast for Typhoon Sinlaku (T0813) from the initial time of 12 UTC on 9 September, 2008, as a case in which the test run improves on the TC forecast. From the initial field study, it is considered that this improvement was brought about by the reduced number of bogus data far from the center. Figure 4 shows statistical verification of the TC central position error. The test run reduces this error especially for longer-range forecasting as a result of the change. This modification was implemented in operational JMA global analysis in March 2009.

Re-modification

In 2009, it was found by assimilating bogus data for modified distribution that those located 50 km from the TC center tended to cause serious errors in analysis fields for some typhoons. When a TC significantly develops, the horizontal gradient of the physical fields (e,g,, sea level pressure, vorticity) may become steep in the vicinity of the TC center. In such cases, the difference between bogus data and the first guess near the center often has a much steeper gradient than the characteristic scale of increment in data assimilation, and this results in unrealistic deformation of the initial fields. In October 2009, the distribution of bogus data was re-modified as shown in Figure 5 to avoid unrealistic deformation near the TC center.

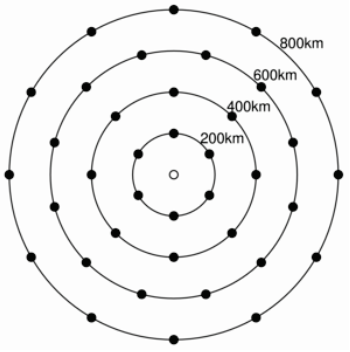

Figure 1. Horizontal distribution of TC bogus data. The white circle is the TC center, which has only surface pressure bogus data. The black dots have surface pressure data for the surface and wind data for upper levels (up to 300 hPa).

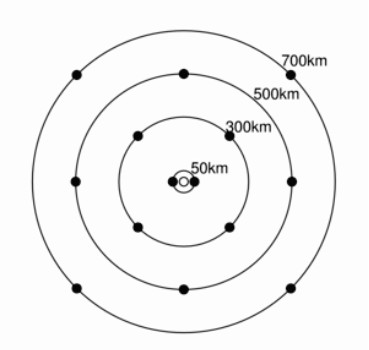

Figure 2. As per Figure 1, but with more data near the TC center and fewer farther away.

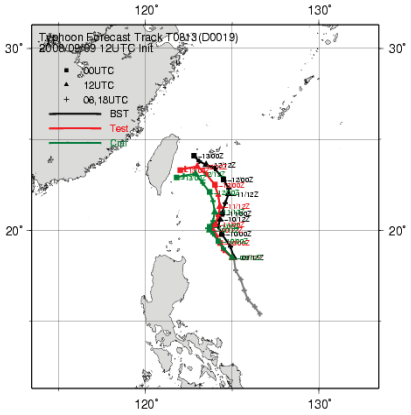

Figure 3. TC track forecast improvement resulting from changed bogus data distribution. The green line is the control, the red line is the test, and the black line is the best track.

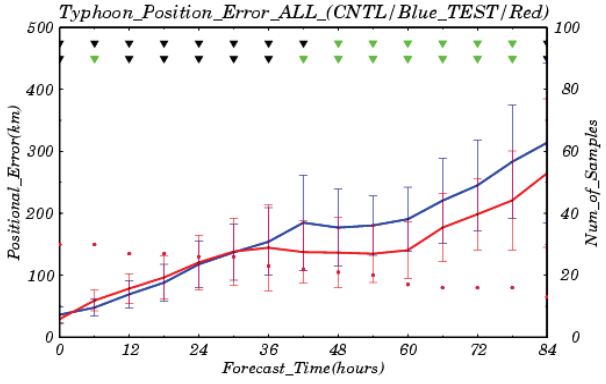

Figure 4. Statistics of TC central position error against forecast time. The blue line is the control, and the red one is the test.

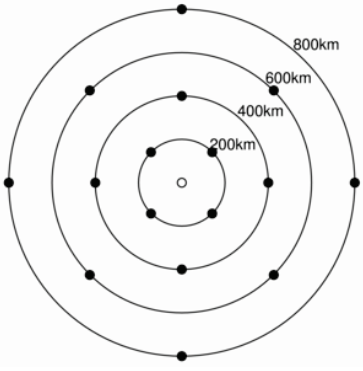

Figure 5. Distribution of TC bogus data as used in operational global analysis since October 2009

References

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