Technical improvement and experimental analysis of the radiosonde of GTS1 type

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ABSTRACT：

The radiosonde of GTS1 type has been used in sounding network of CMA for ten years. Its technology slightly becomes lag. Technical improvements are urgently needed, and it was done on the basis of original technical structure in 2010.

In September 2010, the test of the improved radiosonde of GTS1 type was carried out in Yangjiang upper-air station. In December 2011, the test of temperature radiation correction algorithm to improve was done at the same place.

The results show that the temperature of improved the radiosonde of GTS1 type at night has a deviation of about 0.1℃. In daytime it is no more than 0.3℃.The measurement of Pressure is smaller than the radiosonde of RS92 type. Its accuracy is better than the radiosonde of GTS1 type. The sensor of humidity is responsive. The measurement result has good consistency to radiosonde of RS92 type. The bias between them is basically no more than 5%RH.

PREFACE

Every country in the world continued to adopt new technologies, new methods or their improvements to improve the detection accuracy and precision to meet the need of different observation.

In order to further meet the need of users, Chinese conventional sounding observations constantly used new technologies and new processes to change their appearance.

The radiosonde of GTS1 type is one of the China Meteorological Administration, which was operationally used in 2001.But after nearly 10 years in use, the technology had lagged behind the advanced technology abroad.

At the same time, the temperature measurement had lag errors, humidity resistance sensor quality was unstable, and qualified low humidity detection accuracy was worse than quality capacitors. The urgent technical improvements were needed.

In 2010, The radiosonde of GTS1 type based on original system was improved. Between September 2010 and December 2011, the Meteorological Observation Center of CMA carried out comparison test in Yangjiang upper-air station of Guangdong Province to assess the quality of the radiosonde of GTS1 type before and after improvement，explore its measurements gap，and promote the development of Chinese sounding detection business and technology.

1.BASIC SITUATION

The technological improvement of the radiosonde of GTS1 type (referred to as GTS1A type radiosonde) was based on technology system of the radiosonde of GTS1 type. GTS1A's technical specification, working method, and data format had not changed, aimed at improving the quality of its intrinsic sounding.

Specific technical improvements include: miniaturized transmitter processing, increasing the capacitance into a voltage circuits, eliminating the outsourcing carton and updating radiosonde sensors.

Among them, the most important technical improvement was the temperature, pressure and humidity sensor technology updated .They were shown in Table1.

Table1 radiosonde sensor comparison

	GTS1	RS92	GTS1A	Technical Features of GTS1A
Temperature	Rod thermistor	Beaded wire capacitance	Bead thermistor	Surface craft using aluminium
Pressure	Silicon pressure	Silicon Pressure	Silicon Pressure	Small treatment
Humidity	Carbon films humidity	Thin film capacitor, heated twin sensor	Thin film Capacitor	High sensitivity, hysteresis coefficient, etc.

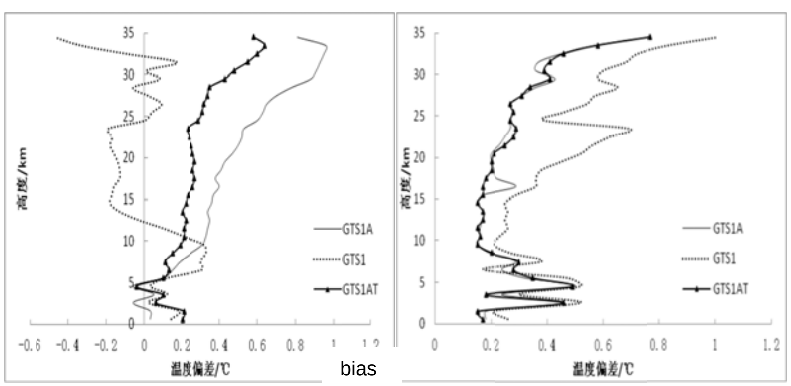
2 Experimental Design

Test time was divided into two phases. The first phase was comparison test from 4th to 9th in September 2010, casting 20 times balloon. The second phase is mainly for verification test temperature radiation errors again improved algorithm in December 2011, casting six times balloon. The radiosonde of GTS1 type and RS92 type were used as the reference standard, compared by the same casting.

Since the wind measurements of both GTS1A and GTS1 were based on L-band secondary wind radar and the potential height were calculated using the method specified in CMA, the comparative analysis only focused on the difference of pressure, temperature and humidity sensors measure.

3 Comparative Analysis

3.1 The temperature of daytime



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In daytime, solar radiation effect on temperature was the main consideration. In addition to surface coating, the most important thing is the radiation correction algorithm. The casting data in 4th～9th September 2010 was statistically analyzed.

The system error of temperature of the radiosonde of GTS1A type in daytime was larger. The system error is less than 0.1℃ below 5km and 0.3℃ below 16km. The system error can subsequently increase to 0.9℃ with height increasing. The standard deviation was less than 0.3℃ below 25km.

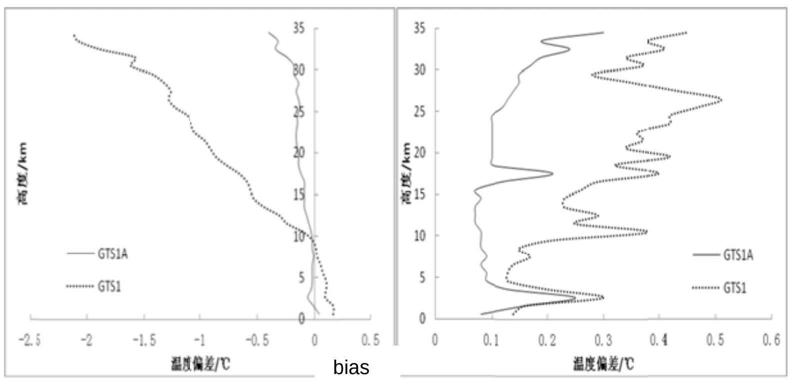
The standard deviation can subsequently increase to 1.0℃ with height increasing. The temperature radiation correction in daytime was not significantly enough.

So, the temperature radiation correction algorithm in daytime needed corrected. In December 2011, the verification test of algorithm was done six times in the Yangjiang upper-air station.

The test shows that the error correction algorithm to improve the radiation significantly reduced. The new radiation correction algorithm was used in the casting data in 4th～9th September 2010. The system error of temperature of the radiosonde of GTS1A type in daytime was significantly reduced.

There is little difference below 5km.The system error was less than 0.2 below 16km and 0.3℃ below 30km.The maximum was 0.6℃, the whole was within 0.3℃.The change of standard deviation was not very obvious. The overall was slightly reduced

3.2 The temperature of nighttime



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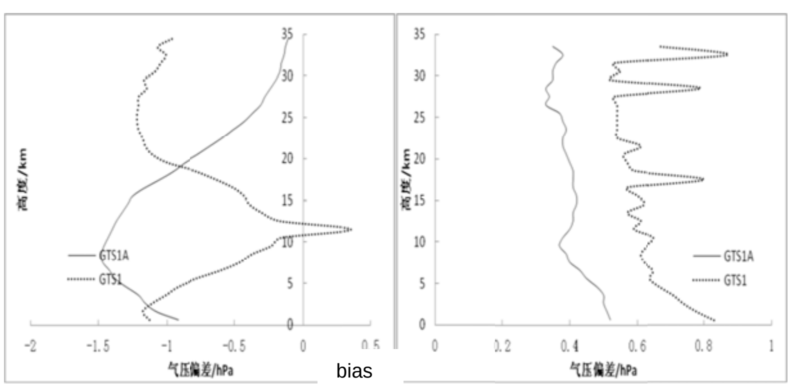
The atmospheric long-wave radiation correction in nighttime was the main consideration. But for smaller bead temperature sensor, if the surface is aluminized coating, the impact of atmospheric long-wave radiation cannot basically been considered.

The performance of the radiosonde of GTS1A type in nighttime was very good. The overall system error was about ±0.1℃. The standard deviation was about 0.2℃. It was significantly better than the radiosonde of GTS1 type. The performance of measurement was very stable.

3.3 Pressure



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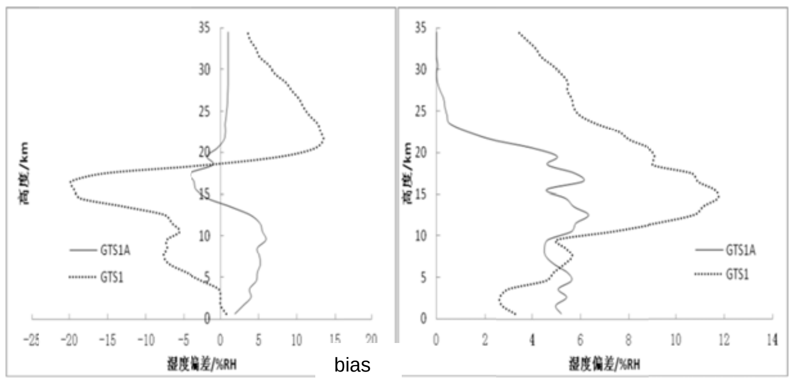
The pressure of the radiosonde of GTS1A type was smaller than one of RS92 type. The standard deviation was within 0.5hPa. It was less than the radiosonde of GTS1 type. The stability was better than the radiosonde of GTS1 type.

In addition, from the ground to 12km, the system error of the radiosonde of GTS1A type was between -1.2hPa and -0.8hPa. From 12km to 16km, the system error was between -0.6hPa and -1.2hPa, and bigger than the radiosonde of GTS1 type. The largest of the difference can reach 1hPa.

The accuracy slightly was worse than the radiosonde of GTS1 type. From 16km to top level, the system error was about between -0.6hPa and 0.1hPa. It showed a decreasing trend with height increasing, and was significantly less than the radiosonde of GTS1A type. The performance was not very stability.

3.4 Humidity



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Compared to the radiosonde of RS92 type, the system error and standard deviation of humidity of the radiosonde of GTS1A type were smaller than ones of the radiosonde of GTS1 type.

The whole range of systematic errors was basically within ± 5%RH, and the standard deviation of less than 6%RH. While the systematic errors of GTS1 type can be up to 20%RH, the standard deviation can be up to 13%RH.

Overall, the radiosonde of GTS1A type had good consistency to the radiosonde of RS92 type .Its stability and accuracy was better than the radiosonde of GTS1 type.

This related to its organic membrane capacitance humidity sensor, whose sensor was responsive and, dehumidifying sensitivity was significantly better than the radiosonde of GTS1 type.

4 Summary and Discussion

The radiosonde of GTS1A type was developed on the radiosonde GTS1 type. It reached WMO technical requirements. In this paper, the radiosonde of GTS1A type of temperature, pressure, and humidity sensor measurements were analyzed, and the preliminary conclusions was as follow:

1) The performance of temperature measurements of the radiosonde of GTS1A type was overall better than the radiosonde of GTS1 type. Compared to the radiosonde of RS92 type, its deviation was very small at nighttime, basically about 0.1℃.In daytime, its deviation was within 0.3℃ after verifying the radiation correction algorithm.

2) The pressure measurement of the radiosonde of GTS1A type was smaller than the radiosonde of RS92 type. Below 16km, there was a deviation of about 1hPa. Above 16km, its deviation was small, and its stability was better than the radiosonde of GTS1 type.

3) The humidity measurement of radiosonde of GTS1A type had good consistency to the radiosonde of RS92 type. Its deviation basically was within ±5%RH.Its sensor was responsive, and dehumidifying sensitivity was better and much better than the radiosonde of GTS1 type.