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First Session

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PROGRESS REPORTS ON TESTING QUALITY OF NEW RADIOSONDES

The United States National Weather Service Progress Report on Testing Quality of New Radiosondes

(Submitted by Carl A. Bower, USA)

Summary and purpose of document

This document, presented by Dr Carl Bower (USA), describes the main results of the United States National Weather Service testing quality of new radiosondes MARK IIA and IMS 3010

Action proposed

The meeting is invited to take the report into account in discussion, in particular, under agenda item 3.4 and also under items 3.3, 3.5 and 9.1

The United States National Weather Service Progress Report on Testing Quality of New Radiosondes

1. Introduction

The National Weather Service continues development of the Radiosonde Replacement System (RRS). This overall system includes the Telemetry Receiver System (TRS), Signal Processing System (SPS), Radiosonde Workstation (RWS), and the Radiosonde Surface Observing Instrument System (RSOIS). The overall system design enables the NWS to use the generic TRS with any vendor's radiosonde through the use of the vendor supplied SPS manufactured to the NWS specification. The software for the RWS is developed and maintained by the NWS.

The radiosonde specified for the RWS is different from radiosondes previously manufactured. It calls for the first time integration of the GPS receiver with a 1680 MHz transmitter, a crystal controlled four- channel radiosonde transmitter, a circular polarized antenna for improved radiosonde transmission to ground receiver, and high-resolution four-dimensional data sets. Two radiosondes, the Mark IIA and the IMS 3010 were submitted to the NWS as candidate radiosondes for qualification and possible production. The sensor suite for the Mark IIA was changed from the Mark II with the addition of a chip thermistor as the replacement for the small rod, and a re-engineered carbon element hygristor with new transfer equations. The IMS 3010 sensor suite was new to the NWS except for the pressure sensor that was a variant of an SDC radiosonde pressure sensor the NWS had flown in the early 1990s.

2. Factory Testing

Vendor provided test data for the radiosondes and the associated sensor suites enabled the next step in the evaluation process which was the Government testing. Engineering tests on the radiosonde transmitter characteristics, GPS receivers, and sensor data were carried out prior to in-situ environmental testing by the NWS Upper Air Test Staff at the Sterling Virginia Test Facility. Factory test results are proprietary and will not be provided in the briefing that will accompany this synoposis.

3. NWS In-situ Testing and Data Evaluation

NWS in-situ testing focused on the following areas:

Mark IIA Functional Precision Flight Series

Mark IIA NASA ATM Comparison

Mark IIA Radiation Correction

IMS 3010 ATM Comparison

High-resolution, Rapid response Thermistors and the Impacts on WMO coded messages

4. Mark IIA Functional Precision Flight Series

The NWS completed a flight series on the Mark IIA prototype radiosonde. This series was conducted on radiosondes from several batches. The purpose of these evaluations was to make assessments on the reproducibility of the radiosondes rather than accuracy. The reproducibility numbers can provide some insight on accuracy but other tests are required to get a measure of the accuracy. The variability is determined from a series of two separate radiosondes of the same type flown simultaneously in the same environment. The functional precision of the measurements are determined from time-paired differences between pressure, temperature, relative humidity, geopotential height, and wind u and v components. For upper air test evaluation, the paired data can be compared by both time and pressure. Results for some of the parameters will be presented.

5. Mark IIA NASA ATM Comparison

The NWS has conducted two preliminary comparison series on the Mark IIA radiosonde against the NASA ATM system. The primary purpose of the preliminary comparisons was to determine the differences from the ATM during day and night conditions and for various solar angles. Additional flights will be flown for the second series to bring the total to 25 flights. Preliminary results from these flights will be shown.

6. IMS 3010 ATM Comparison

The NWS has conducted two preliminary comparison series on the IMS 3010 radiosonde against the NASA ATM system. The primary purpose of the preliminary comparisons was to determine the differences from the ATM during day and night conditions and for various solar angles. Early results from these tests will be presented.

7. Mark IIA Radiation Correction

The NWS policy is to provide radiation corrections to temperature data at the upper-air field sites. This is in keeping with WMO recommendations. Currently, the field sites for the RS80-57H radiosondes using the RSN-93 radiation correction algorithm supplied by the vendor provide the corrections. The corrections for the B2 radiosonde are provided by the NWS National Centers for Environmental Prediction. Current models are semi-dynamic. They include solar elevation angle as a function of time of year and time of day and a radiosonde ascent rate through the atmosphere to arrive at corrections to be applied to the radiosonde temperature measurements. At best, they are climatological and based on theory and empirical measurements. The mean corrections may be reasonable over time but on a day-to-day basis, the corrections can improve or make worse individual flight data.

To attempt to overcome the shortfall in current radiation correction algorithms, the NWS tasked the vendors supplying next generation radiosondes provide dynamic correction models based on physics-based energy balance models particular to the vendor’s thermistor. Additionally, the rudimentary information available from the WMO Cloud Code Group message reported with each observation was to be incorporated. Because the code group is comprehensive, transformations and adjustments were required to enable features such as cloud bases and thickness for each of cloud types consisting of low, middle and high clouds. The inclusion of the cloud information has the net effect of increasing the radiation correction required during cloudy conditions and decreasing the correction during clear conditions. Early results are promising and will be presented. More flights are required before determinations can be made on the amount of fine-tuning that may be required on the models.

8. High-resolution, Rapid Response Thermistors and the Impacts on WMO Coded Messages

All radiosonde thermistors are not equal. Older model thermistors used for years were generally larger and had more mass than the current generation sensors being incorporated on emerging radiosondes. The older sensors had slower response times to atmospheric change and did not show the higher resolution detail possible with current sensors. The new generation sensors are very small chips or beads with very fast response times. The fast response times exceed minimum requirements. Rapid response coupled with high-resolution one-second data and more stringent requirements for selecting significant levels for inclusion in the WMO coded message has created new situations. The use of more stringent levels selection criteria has led to the generation of more levels and the fast response thermistors show structure in the stratosphere such as super adiabatic lapse rates and level only a few hectopascals apart. These phenomena are being investigated as well as data noise. The features being observed are more pronounced during day flights than for night flights. It has not been determined if the noisy measurements are representative of the atmosphere or representative of the sensor. The features noted have been with one-second-non smoothed data. The incorporation of a data smoother may alleviate some of the features.