3.3 TESTING RADIOSONDE REPLACEMENT SYSTEM (RRS) RADIOSONDES

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1. INTRODUCTION

The National Weather Service (NWS) is preparing the Radiosonde Replacement System (RRS) to replace its antiquated Micro-ART system, which has been in operation since the late 1980s. Currently there is one radiosonde vendor who will be producing 1680-MHz GPS radiosondes for the initial deployment of RRS. The radiosonde tested was the Sippican Mark IIA.

Before fielding the RRS in 2004, the NWS is conducting a series of field tests to understand the measurement characteristics of the RRS radiosonde and ground station. This paper will discuss some recent updates to techniques developed for these tests. Test procedures discussed here are the technique used to perform functional precision, functional comparison against a legacy MicroART radiosonde, and comparisons against the three-thermister system developed by NASA/Wallops at selected field locations during the winter and spring 2005. Refer to the section on reference for further information about each type of these tests. Examples of the types of data acquired during each of these tests will also be presented.

2. FIELD TESTS CONDUCTED

Field tests were conducted during the winter/spring of 2005 at three locations having diverse meteorological characteristics. The sites selected were Caribou, Maine, Quillayute, Washington, and San Diego, California.

2.1 Functional Precision/Comparison

An 800 or 1000 gram balloon was used with a flight train consisting of two parachutes, and 6-foot Styrofoam spreader-bar used for separating the two radiosondes from each other. The overall train length was 100 to 120 feet. Figures 1 and 3 show the flight train configuration for flying two radiosondes, simultaneously. Radiosonde transmitter frequencies were selected so that separation in the 1680 MHz band is sufficient to eliminate frequency interference between the two radiosondes. Detailed surface observations were used to compare surface conditions with the upper air measurements. Either the Automated Surface Observing System (ASOS) or the Radiosonde Surface Observing Instrumentation System (RSOIS) was used to perform this function.

To have a good statistical sample the NWS will usually fly forty to fifty dual radiosonde flights for a functional precision or comparison test. For these field tests there was only enough time to conduct between 10 and 20 flights at a given location. As such, the results are deemed as a first look at the data and should only be used as an indicator of the overall functional precision of the radiosonde. Once testing is completed at all sites and the data processed, data will be combined to have a more definitive answer of the functional precision, and also as a comparison against the legacy system. It will also provide a clearer understanding of the solar radiation correction being applied by the vendor.

The radiosonde data was collected from the vendor-supplied Signal Processing System (SPS) using the NWS written program "Protocol Interface Test Suite" (PITS). PITS files were then normalized into one-second intervals using an NWS utility called Convert PITS. Convert PITS is also used to calculate the geopotential heights, apply the surface pressure discrepancy and a newly adopted solar radiation correction scheme.

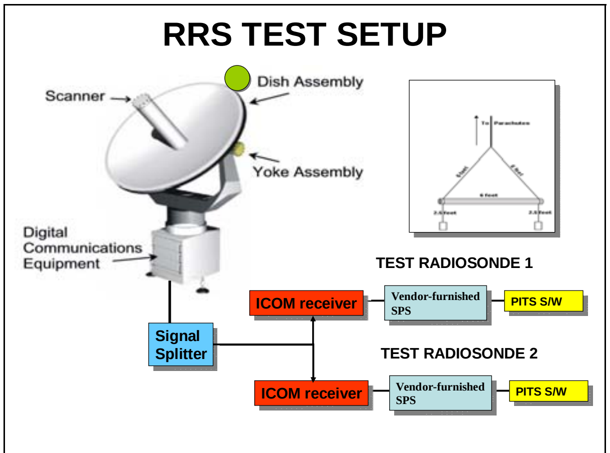

Figure 1. Test Configuration.

The functional comparability test, which is an inter-comparison between the operational Sippican B2 radiosonde and the Sippican Mark IIA RRS radiosonde, is another test to be performed. This test is conducted to determine biases between two different radiosondes. For this test the B2 radiosonde was tracked using your operational MicroART system and the Mark IIA was tracked using the Intermet CV1500C system. These flights were conducted at synoptic times. This test is also conducted using the spreader bar assembly.

2.2 Accurate Temperature Measuring (ATM)

This test was conducted to evaluate the accuracy of the RRS radiosonde temperature measurements and to validate the new solar radiation correction algorithms being used with the RRS radiosondes.

The ATM radiosonde has 5 temperature sensors; two white, two silver and one black. For the solution, only one of each color sensor was used. For each of the three different colored sensors the emissivity and absorptivity of the coatings have been pre-determined. This information is then used to solve simultaneous equations to determine the true temperature. This process eliminates the effects of the solar radiation and provides a true temperature measurement. This true temperature is then compared against the RRS radiosonde that was flown on the same balloon. For this test, the ATM radiosonde was tracked with the Sippican W9000 system, which has a multi-element yagi antenna. The Sippican Mark IIA was tracked with the InterMet CV1500C Meteorological sounding system. The radiosondes were flown using the spreader bar assembly.

3. SAN DIEGO, CALIFORNIA

The purpose of conducting this test in San Diego was to look at the performance of the RRS radiosonde as it passes through the marine layer that is commonly present. There were three different tests conducted in San Diego, the first of which was a Functional Precision Test. Functional precision tests were conducted to determine the amount of measurement variability that exists between two identical instruments and several. Functional comparison tests were also conducted with the legacy system. The third tests were inter-comparisons with the NASA developed ATM radiosonde.

3.1 Methodology

The system used at San Diego to track the two radiosondes was the InterMet CV1500C Meteorological sounding system instead of the larger RRS. The signal coming out of the Low Noise Amplifiers in the pylon on the front of the dish was split and sent to the two ICOM receivers in the office just like in Figure 1.

3.2 Data Analysis

An example of the comparison between an ATM flight and the test radiosonde is shown in Figure 2. Note, the multiple plots shown in this figure depicts the different outputs from the black, white and gray-colored temperature sensors along with the RRS radiosonde. Several more plots are derived along with difference plots to complete the solution. Then a composite difference plot by time is generated indicating the expected difference between the two systems throughout the atmosphere. In this way, users of the data can understand the amount of solar radiation correction being applied to the actual temperature measurement.

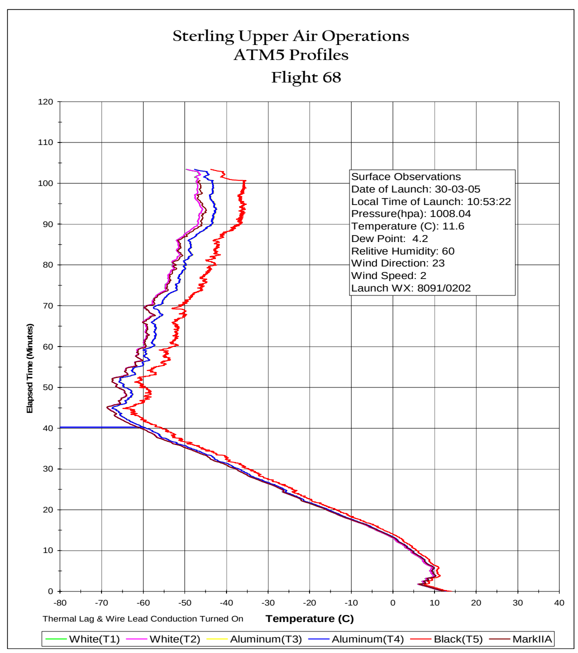

Figure 2. Example of ATM comparison flight.

Figure 3. Simultaneous Radiosonde Launch at Caribou, Maine.

4. QUILLAYUTE, WASHINGTON

Quillayute was selected to evaluate the radiosonde in the maritime polar air mass which usually dominates the weather over the coastal areas of the Pacific Northwest during the winter months. Conditions expected for the test were cool temperatures with overcast low clouds and rain.

4.1 Methodology

The system configuration used at Quillayute to track the two radiosondes was the same as that used in San Diego, except the NASA ATM was not used.

4.2 Data Analysis

Time-synchronized engineering plots for the paired flights were generated for the radiosonde parameters including: temperature, corrected temperature, pressure, corrected pressure, relative humidity, the u and v components for GPS-derived winds, and geopotential heights. Figure 4 illustrates an example of temperature and relative humidity profiles plotted for identical times for a paired flight.

A similar activity was performed for comparison flights with the legacy system Micro-ART coincident with the synoptic times.

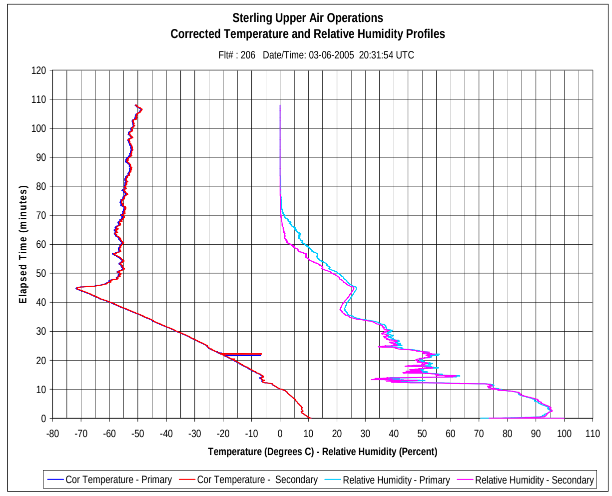

Figure 4. Example of time-based plots.

5. CARIBOU, MAINE

The goal of the Caribou field test was centered on winter weather, since performance of the RRS radiosonde in snow and very cold temperatures was very important to assess.

5.1 Methodology

The RRS was modified as described in Figure 1 to receive signals from two radiosondes. Functional precision and comparison tests were then conducted.

5.2 Data Analysis

To evaluate RRS performance atmospheric profiles and derived parameters using the RAOB* program were produced in addition to the time-synchronized engineering plots. The advantage of the RAOB program is that it can display the soundings in ways the meteorologist can understand the upper air data. Rawinsonde coded messages are decoded by the RAOB software and the soundings displayed in one of several forms. See Figure 5 for an example of one of the Caribou plots. The temperature and dew point plots are color-coded for distinguishing the different soundings and wind barbs are displayed for each on the right side. To the left are derived parameters such as the thickness values, LCL, CAPE TOTALs, etc. for both soundings.

* RAOB, *the complete rawinsonde observation program*, is produced by Environmental Research Services, ©, 1994-2004.

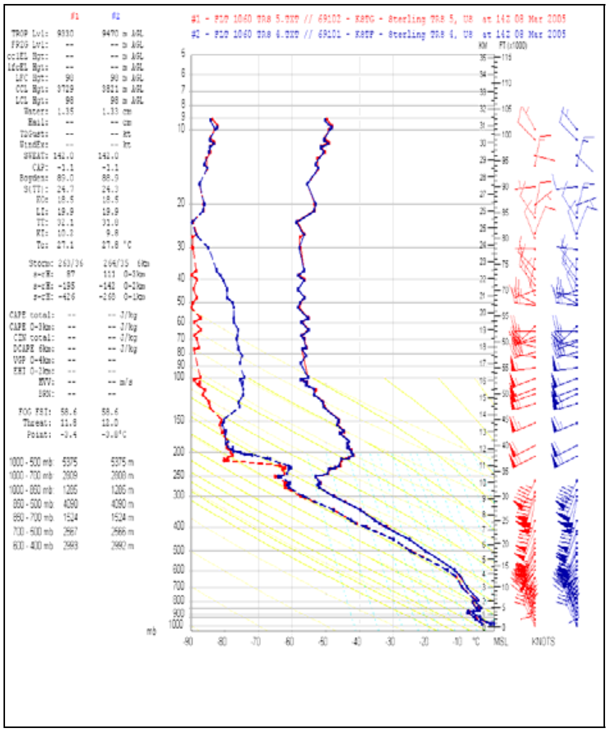

Figure 5. RAOB dual sounding at Caribou.

6. Conclusions

The purpose of this paper was to inform the meteorological community about the types of tests being performed on radiosondes prior to being introduced into the upper air network. Once the tests discussed in this paper has been completed, reports will be generated summarizing each of the tests conducted.

In addition to the test discussed in this paper, the NWS will be conducting functional comparability and precision tests for the new radiosondes for at least three seasons after the system has begun deployment.

7. References

World Meteorological Organization 1996: Guide to Meteorological Instruments and Methods of observation. Sixth Edition WMO-No. 8, Geneva.

Schmidlin,F.J., Luers, J.K., and Huffman, P.D. 1986: Preliminary Estimates of Radiosonde Thermistor Errors. NASA Technical Paper 2637. Wallops Island, Virginia

NOAA Technical Report, NWS 44: Functional Precision of National Weather Service Upper-Air measurements Using VIZ Manufacturing Co. “A” Radiosonde (Model 1492-510)

ASTM Standard, E 177, Standard Practice for Use of the Terms Precision and Bias in Test Methods.
ASTM Standard, D 4430, Standard practice for Determining the Operational Comparability of Meteorological Measurements.

AMS Extended Abstract, Testing Radiosonde Replacement System (RRS) Radiosondes – Part 1, Jim Fitzgibbon, and Joe Facundo, Office of Operational Systems, Silver Spring, Maryland

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