Recent Radiosonde Temperature Comparisons with NASA's ATM Reference Radiosonde

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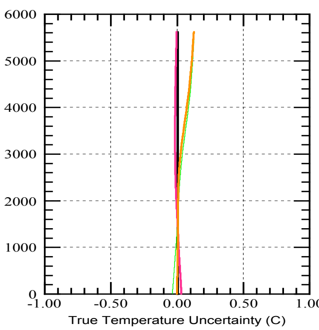
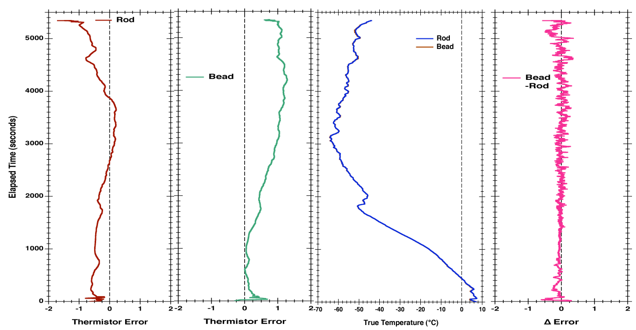
The multi-sensor technique for determining radiative error of a sensor has been known for over four decades. We first successfully used the method of three thermistors on a NASA meteorological rocketsonde in the early 1970's. The expense of the rockets inhibited extensive testing, so the method was never used operationally, although the issue of thermistor correction at 60-70 km is still with us. In the mid 1980's, the multi-thermistor method was flown on a radiosonde, conceivably the instrumentation was less expensive and the balloon-radiosonde combination is a much more desirable platform compared with the harsh launch of a rocketsonde. At that time, two standard radiosondes, VIZ Model 1394, were modified by eliminating the relative humidity sensor and replacing it with a thermistor. Early test data consisted of two white, one aluminum, and one black thermistor distributed on the two radiosondes, and data reduction was labor intensive because of the use of chart recorders. Development of the digital radiosonde VIZ (now L.M. Sippican, Inc.) MKII, allowed the method to evolve to the use of more than three thermistors, permitting redundant solution for the true temperature. Today the NASA ATM Reference radiosonde has been used by the World Meteorological Organization in Phase 3 of the radiosonde intercomparison, by the US Air Force to certify a new radiosonde for use with Space Shuttle requirements, and is currently used by the National Weather Service. Most importantly, the system developed is inexpensive while still usefully effective as a reference.

1



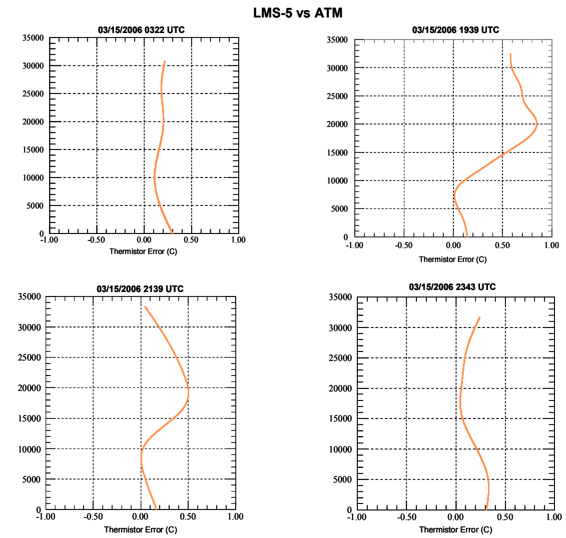
The ATM radiosonde when five thermistors are used provides four solutions of the true temperature. The sensor combinations of white and aluminum tend to group as shown above. Imperfections in coatings, calibrations, mounting, and other causes are the reason for the uncertainty. These sources of the uncertainty limit the ATM radiosonde accuracy to about 0.2°C. Efforts are continuing to reduce the uncertainty.

2



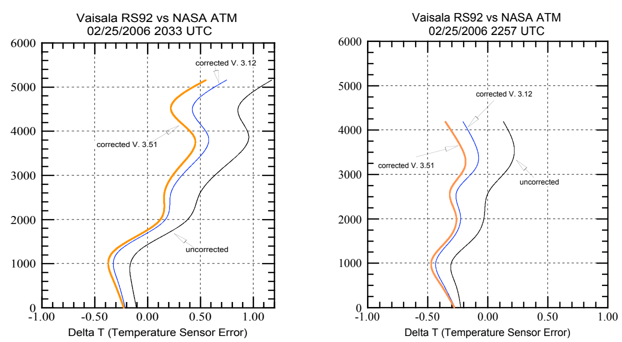
Other thermistor types and sizes also will produce the same true temperature profile as illustrated above. A single ATM radiosonde was flown. Three rod thermistors and three 2.5 mm bead thermistors with the same color coating combinations were used (different color coatings will produce similar results). The white thermistors gave different measurement profiles as shown by the panels labeled thermistor error. The left panel illustrates the error of the white rod thermistor determined from the rod thermistor combination. The panel next to it (to its right) is the error determined for the bead thermistor combination. The resulting true temperature is shown in the third panel. The right-most panel illustrates the small difference between the two true temperatures. The scatter is from the high 1-second sample rate. In spite of the scatter, the profiles clearly show agreement between the rod-bead combinations, within the limit of the technique as discussed in the previous illustration labeled 1..

3



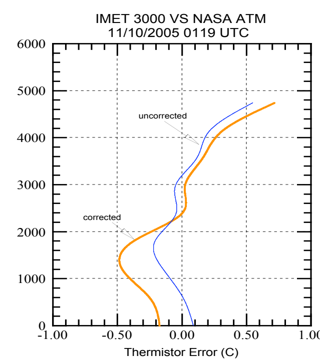
Comparison between the Sippican LMS-5 and the NASA ATM Reference radiosondes indicates nighttime error is 0.2C or less, while daytime errors were found to be larger and more variable. The work was a result of USAF request for comparison with ATM.

4

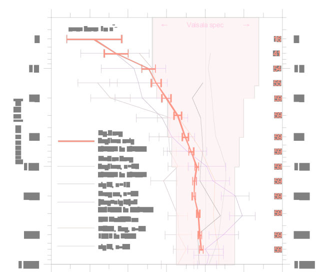


Comparison between the Vaisala RS92 and NASA ATM Reference radiosondes obtained at the DOE ARM Southern Great Plains site. Flights on same day indicate different temperature corrections. The observation at 1736 UTC occurred near local noon and the 2257 UTC observation prior to sunset. The actual daytime corrections at the surface that may be employed in the software are unknown and must be consulted before assuming the small differences between uncorrected and corrected temperatures are artifacts of the curve fit.

5



Time-based comparison between Intermet 3000 and NASA ATM radiosondes. Near 1800-2000 seconds there appears a jump in the correction that is not explained. The reversal of the correction profile near 2200 seconds needs further examination.



Comparison between Vaisala RS-80 and RS92 radiosondes at Höhenpiessenberg, Lindenberg, and Prague between 2003-2006. Courtesy of Wolfgang Steinbrecht, Deutscher Wetterdienst. This figure presented at the 2006 EGU Conference in Vienna, is included because it illustrates the necessity to compare a replacement instrument with the current instrument to insure against step change in the long-term data record. This is true of all instrumentation changes.

SUMMARY:

1. The foregoing figures are important because they indicate regardless of the radiosondes ability to obtain good data, a climate network needs to consider ways to maintain the same quality production without changing any component or software. An example of software change affecting measurements is shown in illustration 4.

2. The figures indicate that the current radiosondes are not capable of providing 0.1°C accuracy with stability of 0.05°C.

3. Fixed corrections from lookup tables must be carefully considered for their utility. Fixed table corrections tend to change the measured value to another value, which also may not be right. Fixed corrections can not, presently, account for interference on the thermistor from the background environment.