Analysis of Selected Radiosonde Data from the ARM/NSA Site

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Introduction

The purpose of this study was to analyze differences in temperature and relative humidity (RH) profiles obtained from near-simultaneous radiosonde soundings made from different locations at and near the North Slope of Alaska (NSA) Cloud and Radiation Testbed (CART) site. The data for this study come from the Vaisala RS-80H radiosondes flown by Atmospheric Radiation Measurement (ARM) Program during the comparison periods, and from VIZ B2 radiosondes flown by the National Weather Service (NWS). We also have a few instances when the ARM RS-80H radiosondes were flown with Meteorlabor AG "Snow White" chilled-mirror hygrometer radiosondes.

The ARM radiosondes were launched from a site approximately 8 km northeast of the NWS launch site in Barrow, Alaska. We focused our analysis on data obtained below 2 km because we expected that differences resulting from the spatial displacement of the launch locations would vanish above that altitude. We also expected that differences between the responses of the sensors, RH in particular, to be minimized at the higher temperatures and absolute water vapor concentrations found near the surface. The ARM and the NWS sonde launches occurred at approximately 2300 Universal Time Coordinates (UTC); beyond choosing the same launch target time, we made no effort to coordinate the launches. This comparison involves the months of April, July, and December of 2001. April is cold, but has roughly 12 hours of sun, July is relatively warm and has 24 hours of sun, and December is cold with no sun. Because ARM/NSA currently launches only one sonde a day during regular working hours, this comparison does not include entire months of data. The number of sounding pairs included in each comparison are April (17), July (18), and December (12).

A separate comparison was also performed between the ARM Vaisala RS-80H and the ARM Meteolabor AG Snow White. The sondes were attached to the same balloon and released from the ARM site. This comparison was performed to test the accuracy of RS-80H sondes during the

international pyrgeometer and absolute sky scanning radiometer comparison intensive operational period in March 2001.

Comparison of Average Monthly Simultaneous NWS/VIZ and ARM/Vaisala Soundings: Data Processing

The programming language, interactive data language, was used to access and filter data. After the data files were opened, the data points were put through an initial filter in which grossly unrealistic values were removed; those falling outside of the ranges:

- Temperature range = -70°C to 50°C
- RH range = 3% to 103%
- Altitude range = 3 m to 30,000 m

Because the ARM and NWS data are reported with different temporal (and hence altitude) resolutions, we binned the data by height to compare them. We used a running median filter to remove outliers. The length of the filter was 11 samples (~15 s) for the ARM sondes and three samples (~12 s) for the NWS sondes. For each sounding pair, we accumulated the filtered samples into 100 m bins referenced to sea level and averaged the values in the bin. We assigned the average to the altitude of each bin midpoint. After checking the daily processed profiles for errors against the original data, we calculated monthly averages. The monthly results are plotted in Figures 1-12.

Results and Discussion

Data from the three months selected for the ARM/NWS comparison show that there is a persistent bias in the temperature data. All three monthly graphs indicate that ARM temperatures were ~0.5°C warmer than the NWS at altitudes above 300m. Below 300 m, the ARM sondes are warmer than the NWS sondes in December, but colder in both April and July. The standard deviation of the difference for all months is less than 1.35°C for all 3 months.

RH data shows greater variability than the temperature data. Average RH differences (difference = ARM-NWS) below 2 km are usually within ±10%. In December, there was a 28% average difference between the ARM and NWS humidity values in the 0-100 m bin (nearest surface). Surface humidity sensors at the ARM site agree with the NWS 0-100 m humidity data. It is believed that this discrepancy was caused by the ARM balloon launch procedure used at the time, which involved preparing the balloon in a slightly heated building without allowing the sonde to fully equilibrate with ambient conditions before launch. This implies that ARM sonde launch procedures needed to be changed (they have been).

Surface airflow data from the ARM 40 m meteorological tower and data from the NWS sonde in the lowest 500 m reports a dominant air movement from the northeast during April and December. July data suggest dominant surface airflow from the northeast, and also from the southeast at altitudes ranging from 300-500m. This is pertinent to the temperature differences observed near the surface in April and July.

Comparison of ARM/Vaisala RS80 and Chilled Mirror Humidity Soundings on the same Balloon and the Ground-Based MWRP

For the Meteolabor AG Snow White/Vaisala RS-80H comparison, no detailed analysis was prepared. Only graphical comparisons where made. Figure 13 shows three such soundings made in March of 2001. A microwave radiometer profiler (MWRP) was also deployed at the Barrow site during this period, and data from it is also plotted. Except for the MWRP humidity, the qualitative agreement is quite good below 2 km.

Conclusions

The ~0.5°C temperature bias reported above 300 m for all three months suggests a small but potentially significant temperature calibration difference between the VIZ 2B and the Vaisala RS-80H sondes. However, the temperature differences reported below 300 m during April and July seem likely to have been caused by launch location separation. Much of the year, with the wind coming off the Arctic Ocean from the east, the ARM site is slightly cooler than the NWS site which is in the city of Barrow proper, and further inland along the dominant wind direction. For December, the differences below 300 m appear to have been caused by a flaw in the ARM launch procedure, which has since been appropriately modified.

While these results are highly suggestive, they're incomplete. Work continues to analyze the sounding data for the remaining months of the year, and to 30 km in altitude.

Acknowledgements

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Figure 1. April 2001 Temperature vs. Altitude

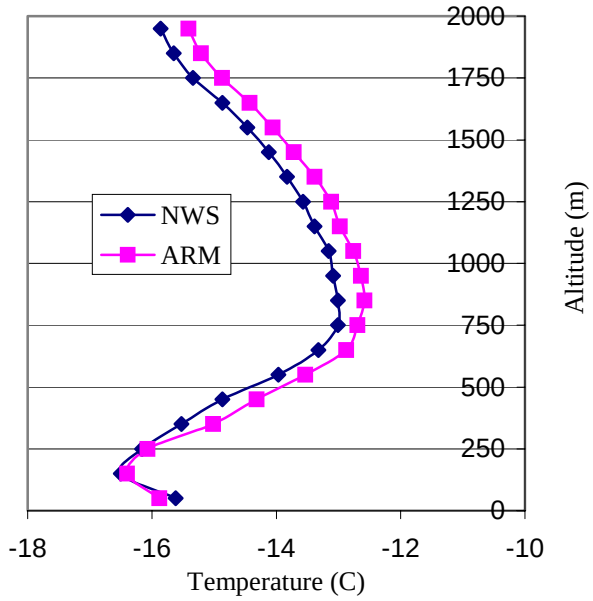


Figure 2. April 2001_Delta Temperature vs. Altitude : Difference = ARM - NWS

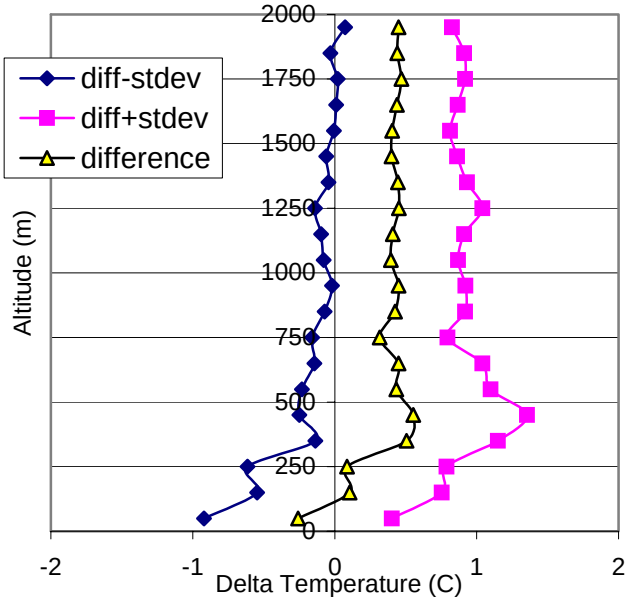


Figure 3. April 2001_ Relative Humidity vs. Altitude

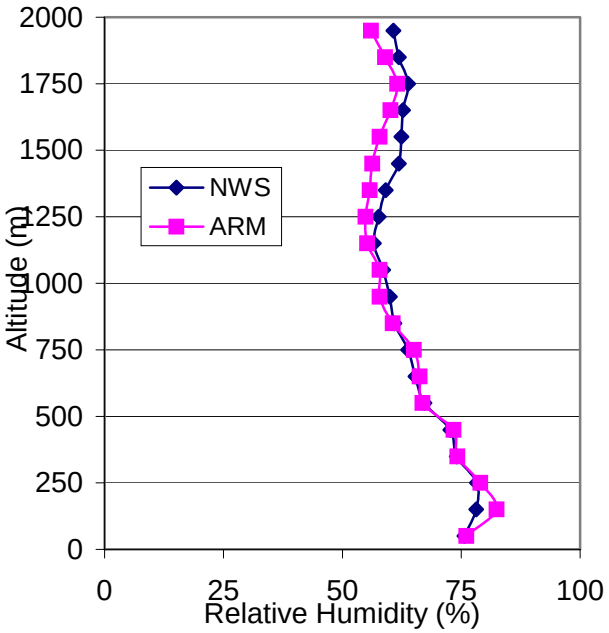


Figure 4. April 2001_ Delta Rel_Hum vs. Altitude Difference=ARM-NWS

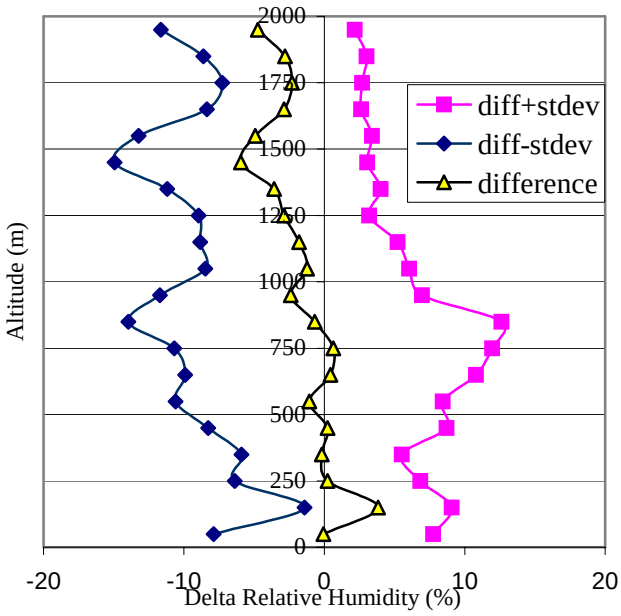


Figure 5. July 2001_ Temperature vs. Altitude

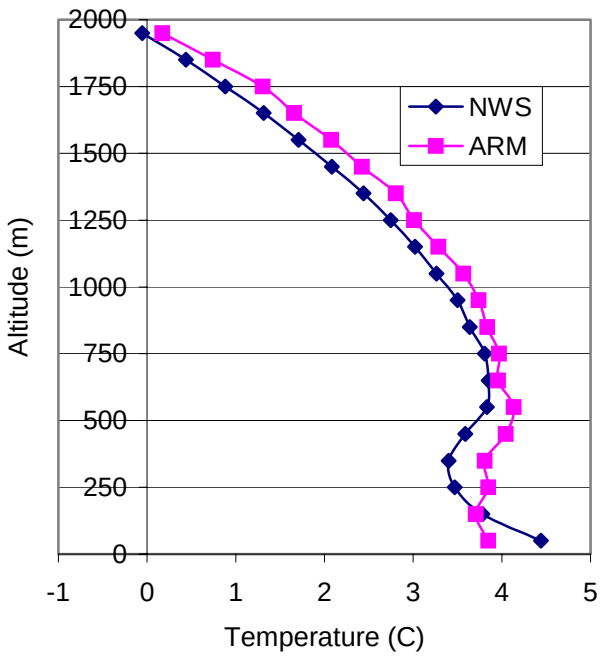


Figure 6. July 2001_ Delta Temperature vs. Altitude: Difference=ARM-NWS

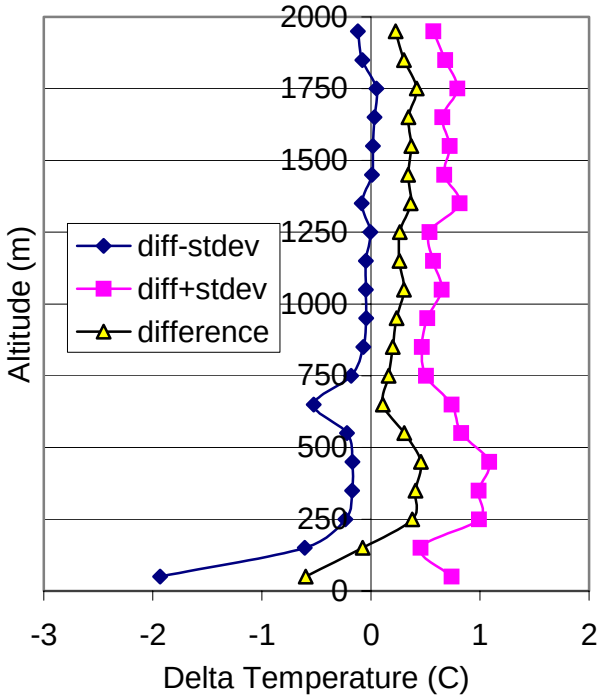


Figure 7. July 2001_Relative Humidity vs. Altitude

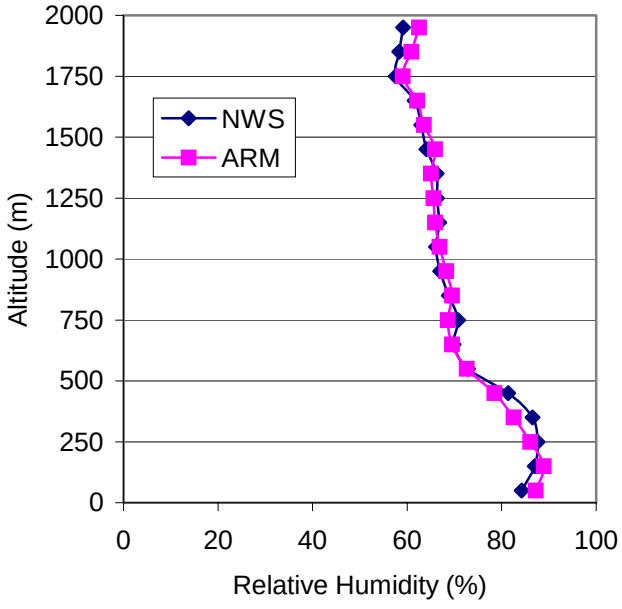


Figure 8. July 2001_Dlt Rel Hum vs. Altitude: Difference = ARM -NWS

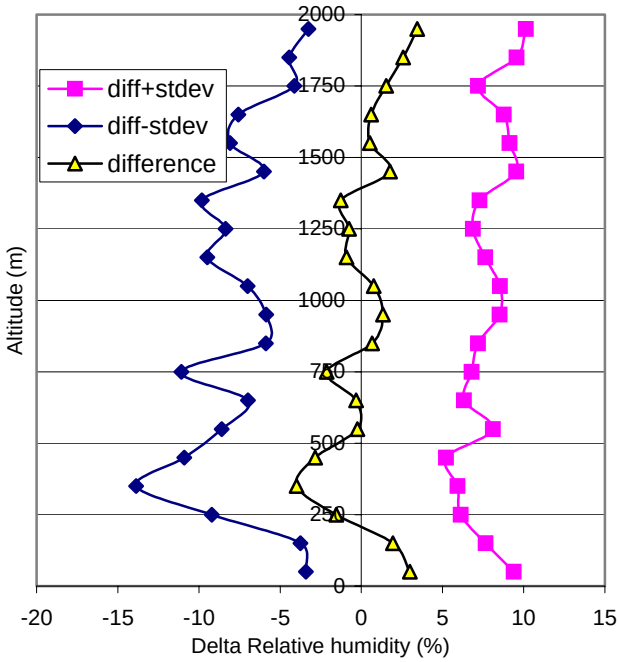


Figure 9. December 2001_ Temperature vs. Altitude

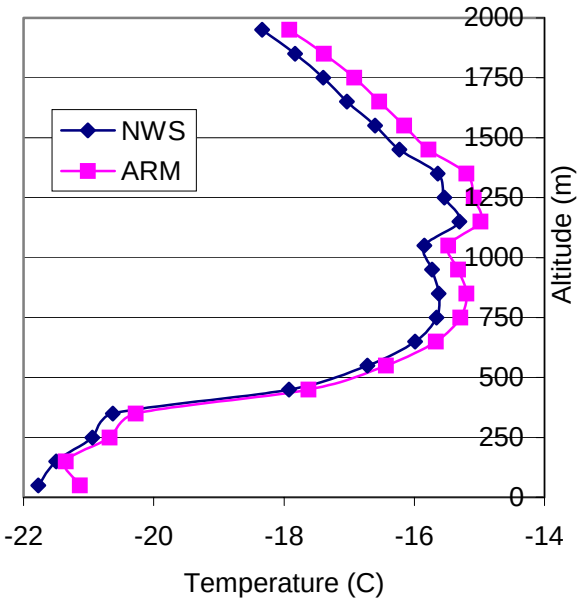


Figure 10. December 2001_ Delta Temperature vs. Altititude: Difference = ARM-NWS

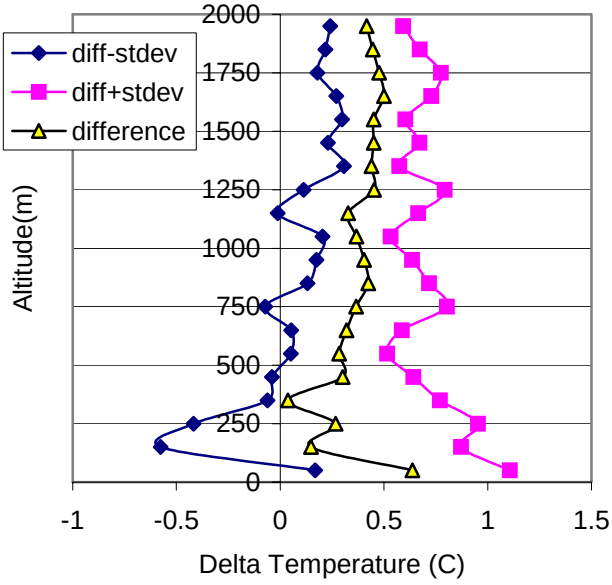


Figure 11. December 2001_ Relative Humidity vs. Altitude

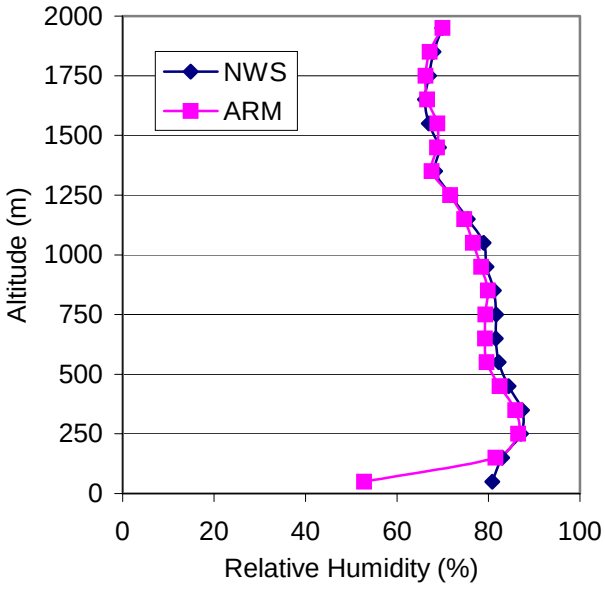
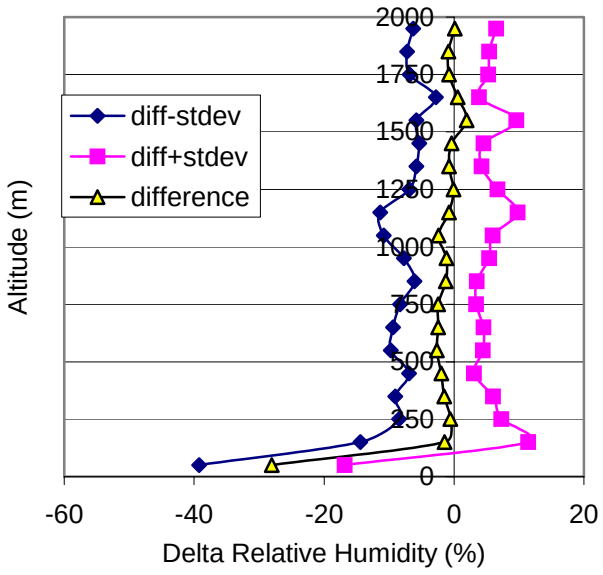


Figure 12. December 2001_ Dlt Rel Hum vs. Altitude: Difference = ARM - NWS



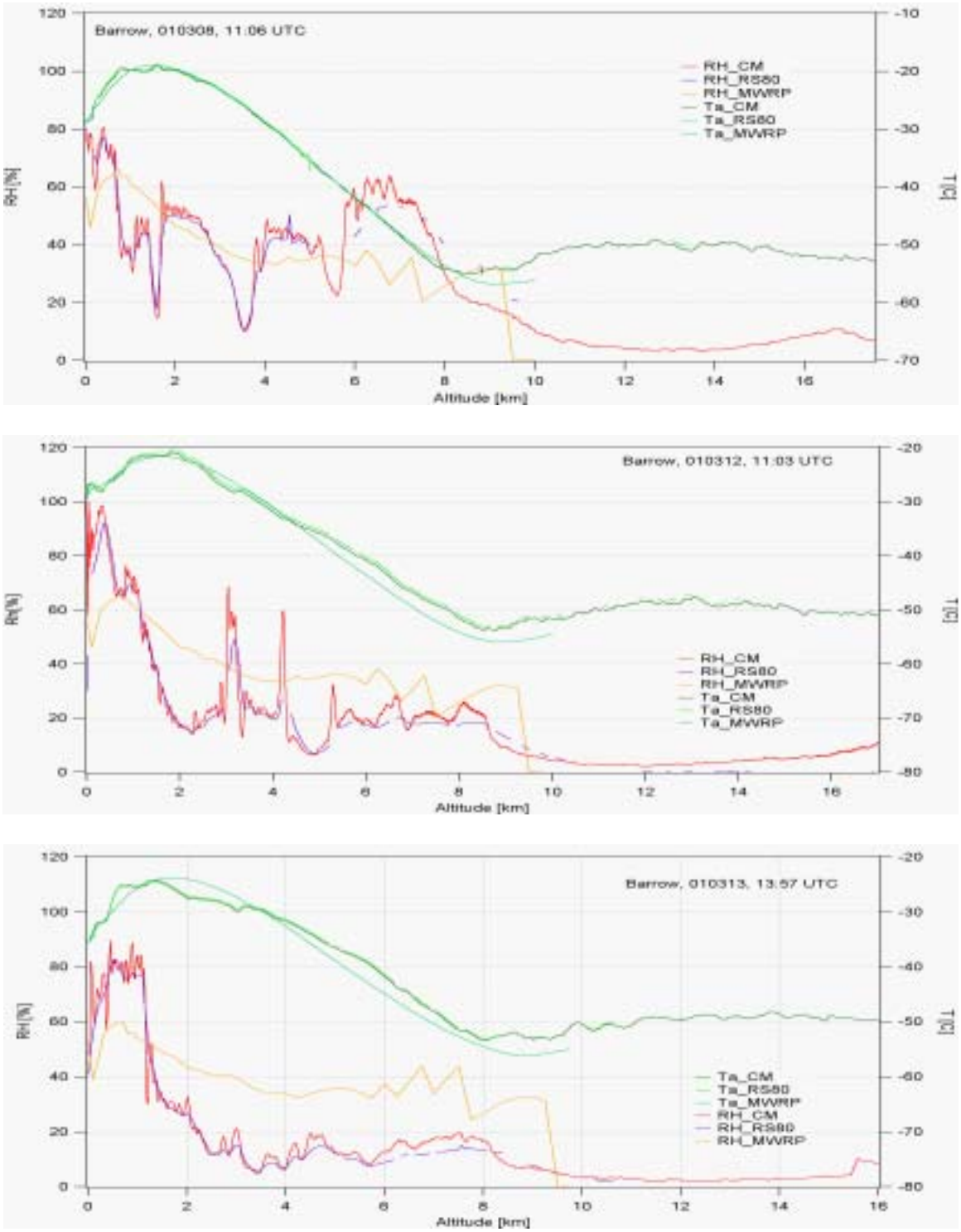


Figure 13. Graphical comparisons for the Meteolabor AG Snow White/Vaisala RS-80H made in March 2001.