Sensitivity Study of Relative Humidity Profiles Obtained by Radiosonde and Microwave Radiometer

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Introduction

Currently, the operation of radiosondes is the most common technique used to characterize vertical profiles of temperature, water vapor mixing ratio and relative humidity. However, radiosondes are launched only two to three times a day because of the high cost of each one. The attempted solution to this problem is utilizing a Microwave Radiometer (MWR). Microwave radiometry allows for continuous retrievals of temperature profiles by measuring brightness sky temperature at different zenith elevations.

The focus of this study is the sensitivity of Relative Humidity Profiles obtained from both instruments. This will be accomplished by using Temperature profiles from the MWR and radiosonde. The result of these comparisons will allow for the study of the sensitivity of the relative humidity profiles obtained by radiosonde and those obtained combining temperature profiles from the MWR and the Water Vapor mixing Ratio from the radiosonde. These Relative Humidity profiles will then be compared to Relative Humidity profiles from the Radiosonde. The data used in this study was acquired from the Howard University Beltsville Campus during the Discover AQ campaign in the summer of 2011. The result of this project will be used as a baseline for evaluating uncertainties in the study of aerosolhHygroscopic growth by means of LIDAR measurement.

Instruments

Vaisala Radiosonde RS92-SGP

Uncertainties:
Temperature +/- 0.25 C
Pressure +/- 0.5 mb Relative Humidity 1.5%
Wind Accuracy +/-0.5 m/s

A radiosonde is a small instrument package attached to a weather balloon. As the balloon ascends, the radiosonde takes a vertical profile of the atmosphere recording temperature, atmospheric pressure, relative humidity and wind velocity.

ARM TR-016 Microwave Radiometer (MWR)

Uncertainties:
Sky Brightness Temperature- 0.018 K

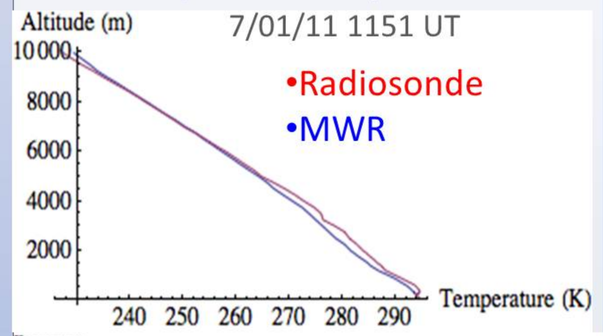
The MWR is an instrument that measures the microwave emissions of the vapor and liquid water molecules in the atmosphere.

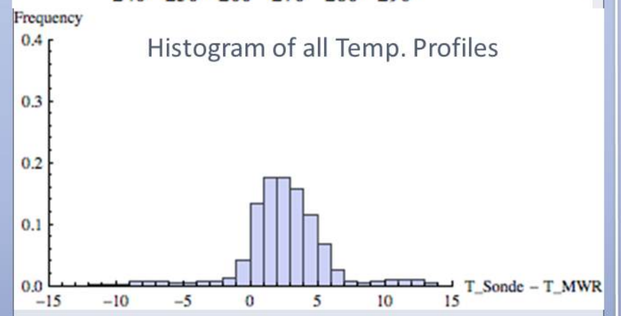
It measures Sky Brightness Temperature and using radiative transfer algorithms various surface and atmospheric parameters can be calculated including temperature and the total amount of water vapor and liquid water in the atmosphere among other things.

MR= Mixing Ratio (g/kg)
RH= Relative Humidity
P= Pressure (mb)
es= Saturation Vapor Pressure (mb)

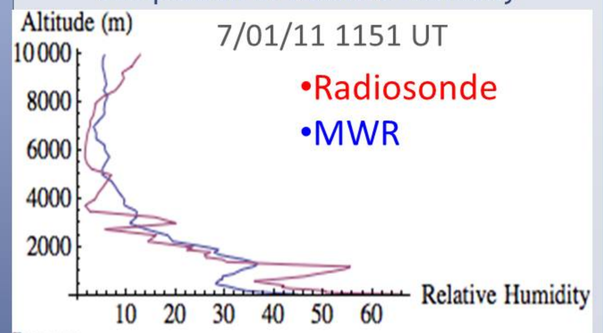
Methods

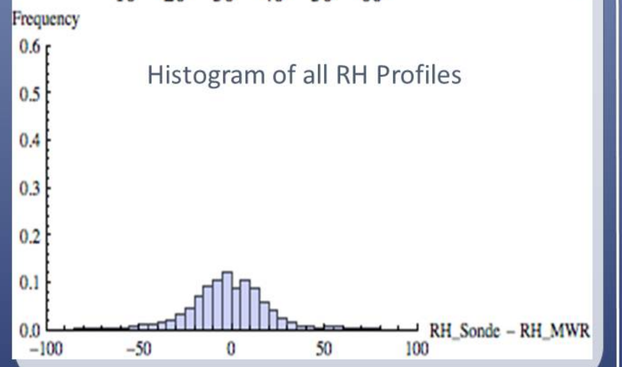
Comparison of Temperatures





Comparison of Relative Humidity





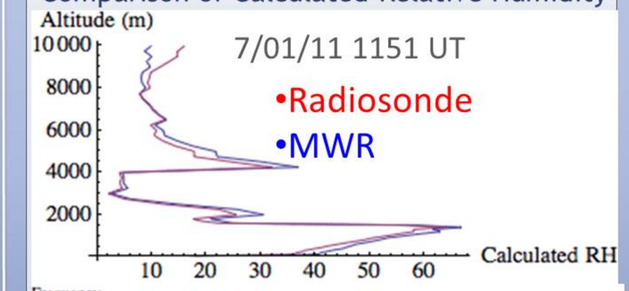
Calculating Relative Humidity

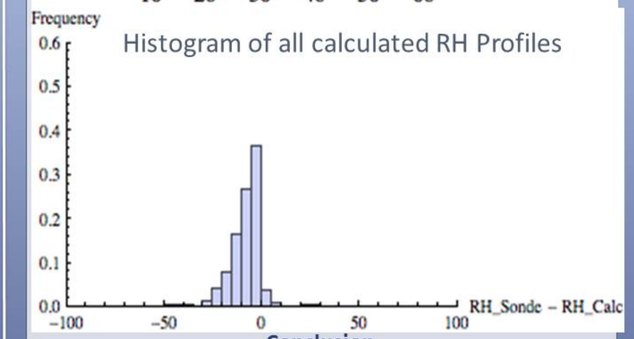
Temperature From Microwave Radiometer	Pressure From Radiosonde Mixing Ratio From Radiosonde

$$es = 6.112e^{\wedge}\left\langle \frac{17.67T}{T+243.5} \right\rangle$$

$$RH = \frac{100(P)(MR)}{es(621.97+MR)}$$

Comparison of Calculated Relative Humidity





Conclusion

Microwave Radiometer temperature profiles agree with radiosonde temperature profiles. However, the MWR RH Profiles do not agree with radiosonde RH Profiles. By combing Temperature profiles from the MWR and MR from the Radiosonde a new technique for Computing accurate RH is presented.

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