

# Comparison of AMSU-B Brightness Temperature with Simulated Brightness Temperature using Global Radiosonde Data

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## Abstract

We present a comparison of brightness temperature measured by AMSU to radiative transfer model calculations based on radiosonde data. The forward model used is the stable version of the Atmospheric Radiative Transfer Simulator (ARTS), a general purpose radiative transfer model which can handle many different remote sensing instruments in the millimeter to infrared spectral region. The atmospheric profiles used are the Met Office - Global Radiosonde Data taken from the British Atmospheric Data Center (BADC). As a first step, the comparison is done for Lingenberg, Germany which uses Vaisala RS80 radiosondes and Kem, Russia which uses Goldbeater's skin radiosondes.

As the forward model ARTS has already been validated against AMSU brightness temperatures using high resolution radiosonde data from Lindenberg which is a reference station for German Weather service (DWD), the main aim of this comparison is to check the quality of the radiosonde data from the different stations.

## Introduction

Upper tropospheric humidity (UTH) is a crucial parameter for meteorology and climate research. There are two global and continuous data sets for this parameter, one from polar orbiting meteorological sensors, the other from synoptic meteorological radiosondes. The basic idea of the study is to compare satellite and radiosonde data. The atmospheric radiative transfer simulator - ARTS [1] is used to generate simulated AMSU measurement from the radiosonde data.

The aims of the study are, to develop a robust methodology for such a comparison and to pave the way for a systematic comparison of all stations in the global radiosonde network to satellite data. This will allow an intercomparison and quality control of the different radiosonde stations, assuming that the satellite instrument's properties are stable during a few orbits. In this article a comparison between two mostly used radiosonde instruments namely Vaisala RS80 and Goldbeater's skin radiosondes is demonstrated.

## Data Used

### Radiosonde data

To develop the methodology for the comparison we used radiosonde data from Lindenberg (52.22°N, 14.12°E) which is a reference station of the German Weather Service, DWD. This station uses RS-80 Vaisala radiosondes for routine operations. The reason for selecting this particular station is that the data are subjected to a number of corrections as

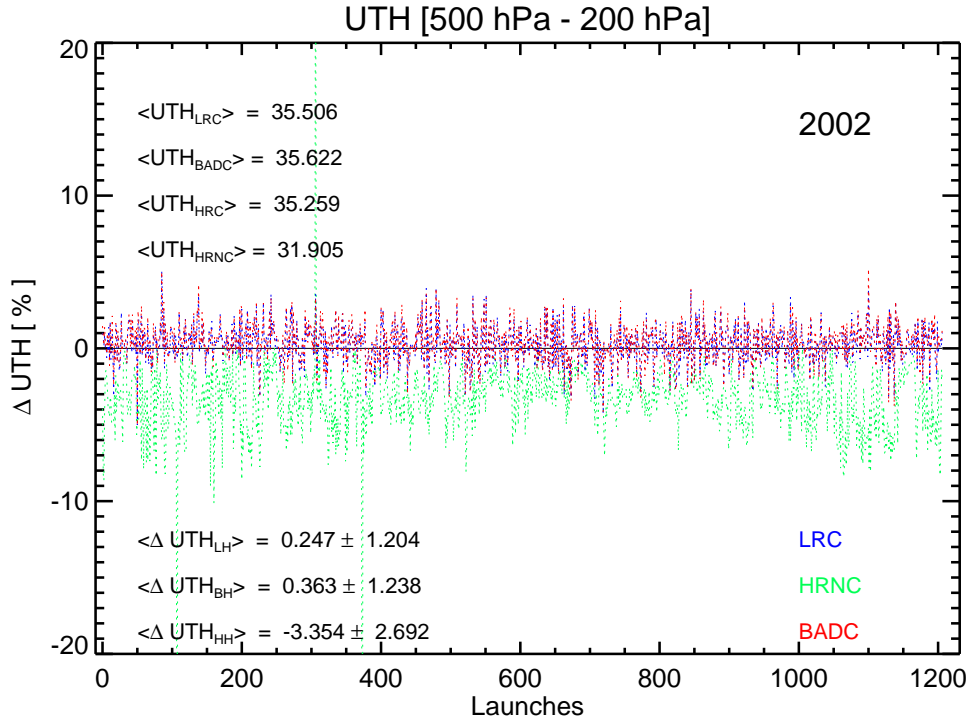


Figure 1:  $\Delta UTH$  for different versions of the Lindenberg radiosonde data for the year 2002 with HRC as the reference.

described in [3]. Three versions of the data have been received: a) High Resolution Not Corrected (HRNC), High Resolution Corrected (HRC), and Low Resolution Corrected (LRC). Another version of the data set can be obtained from British Atmospheric Data Center (BADC). Figure 1 shows a comparison of upper tropospheric humidity (UTH) of the different versions of the data.

The uncorrected version of the data shows a significant dry bias [6] in UTH but the other two versions (LRC and BADC) do not show any significant difference in UTH.

### AMSU data

Advanced Microwave Sounding Unit - B (AMSU-B) is a cross track scanning microwave humidity sounder [4]. The footprint size is  $20 \times 16 \text{ km}^2$  for the innermost scan positions, but increases to  $64 \times 52 \text{ km}^2$  for the outermost positions. Figure 2 shows an example of AMSU data from Channel 20. This is an overpass over the station Lindenberg. The circle represents a 50 km area around the station and the pixels in this area are used for the comparison. If there is a cloud over the station, there will be a large inhomogeneity among the pixels as shown in the figure 2.

AMSU-20 ( $183.31 \pm 7\text{GHz}$ ); May 15, 2001 16:14

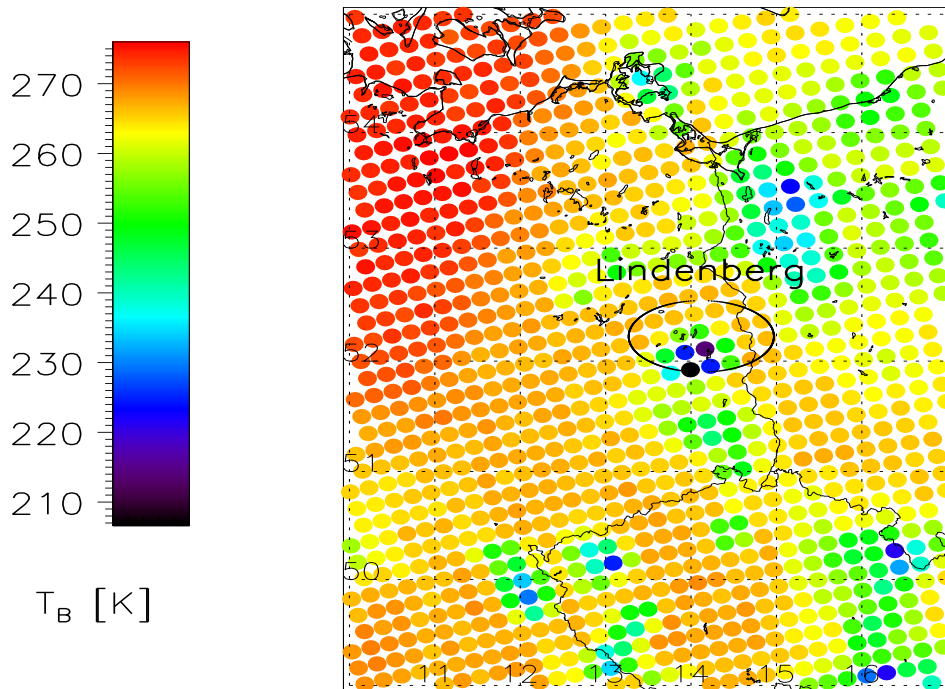


Figure 2: An AMSU overpass over station Lindenberg. The circle drawn around the station has a radius of 50 km.

## Results and Discussion

The methodology of our comparison, the validation of the RT model, and the intercomparison between different satellites can be seen in [2]. Figure 3 shows the comparison for the two stations Lindenberg, Germany and Kem ( $64.95^\circ\text{N}$ ,  $34.65^\circ\text{E}$ ), Russia for the year 2001. There are significant differences in channels 18 and 19, the two channels which are sensitive to the upper tropospheric humidity. The bias, slope and offset were calculated as explained in [2].

There is a slope in the channel 18 for Lindenberg. The possible explanation for the slope is that the correction of the data is not sufficient enough in extremely dry conditions. Therefore the modeled brightness temperatures are higher than the measured ones because the weighting functions peak lower in a drier atmosphere.

A large bias exists in the case of Kem for channels 18 and 19. The modeled brightness temperatures overestimate the measured ones because there is a wet bias in the radiosonde humidity measurements using Goldbeater's skin radiosondes [5].

In order to translate the bias in brightness temperature to bias in relative humidity we made a sensitivity chart. This is shown in Figure 4. It can be seen that a bias of about 7 K in channel 18 is equivalent to that of 10–12 % in RH. This result is consistent with the results of Soden and Lanzante [5].

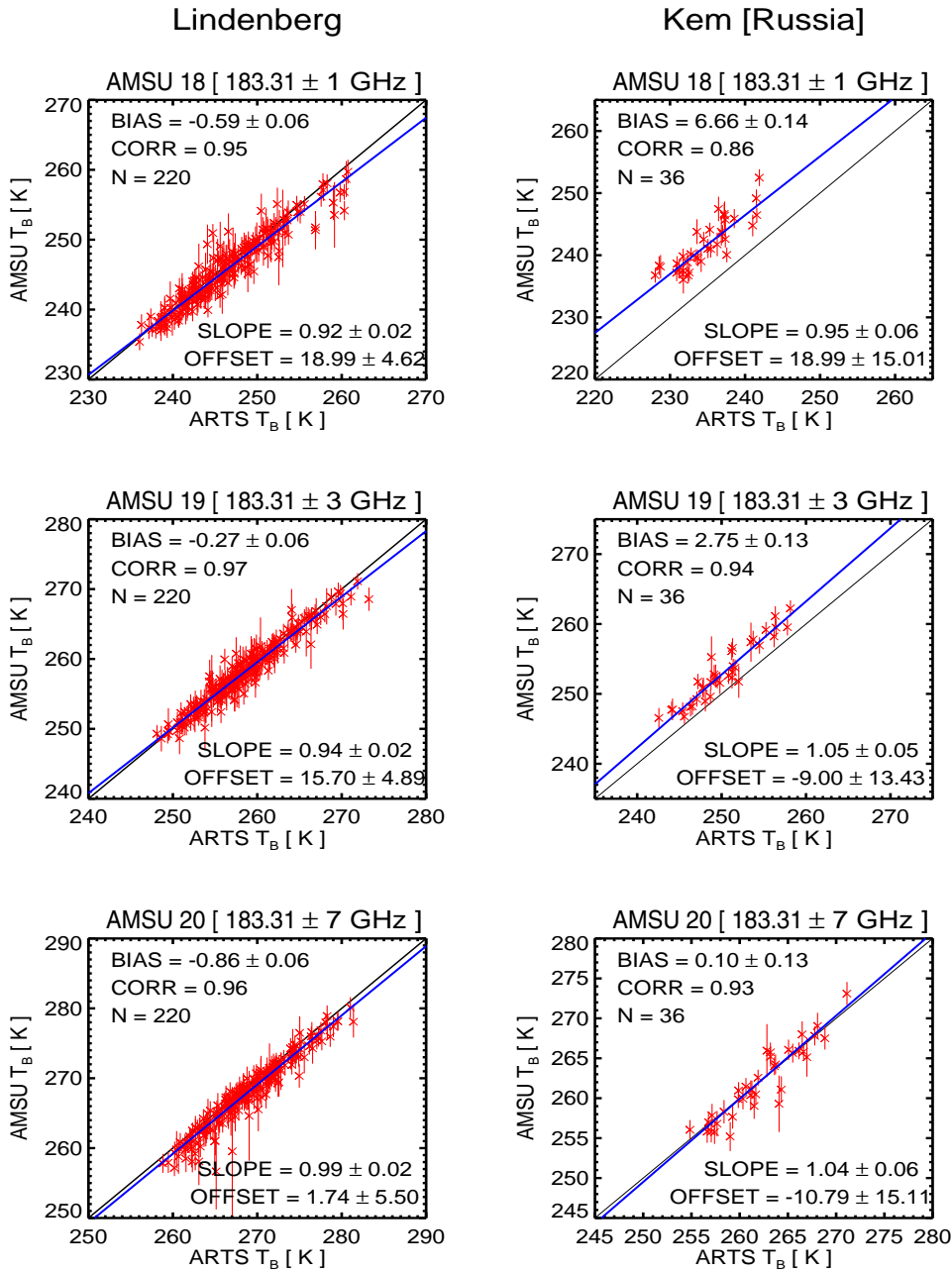


Figure 3: Comparison between modeled and measured radiance for Lindenberg and Kem. Year: 2001, Satellite: NOAA-16. The blue curve shows a linear fit of modeled and measured radiance.

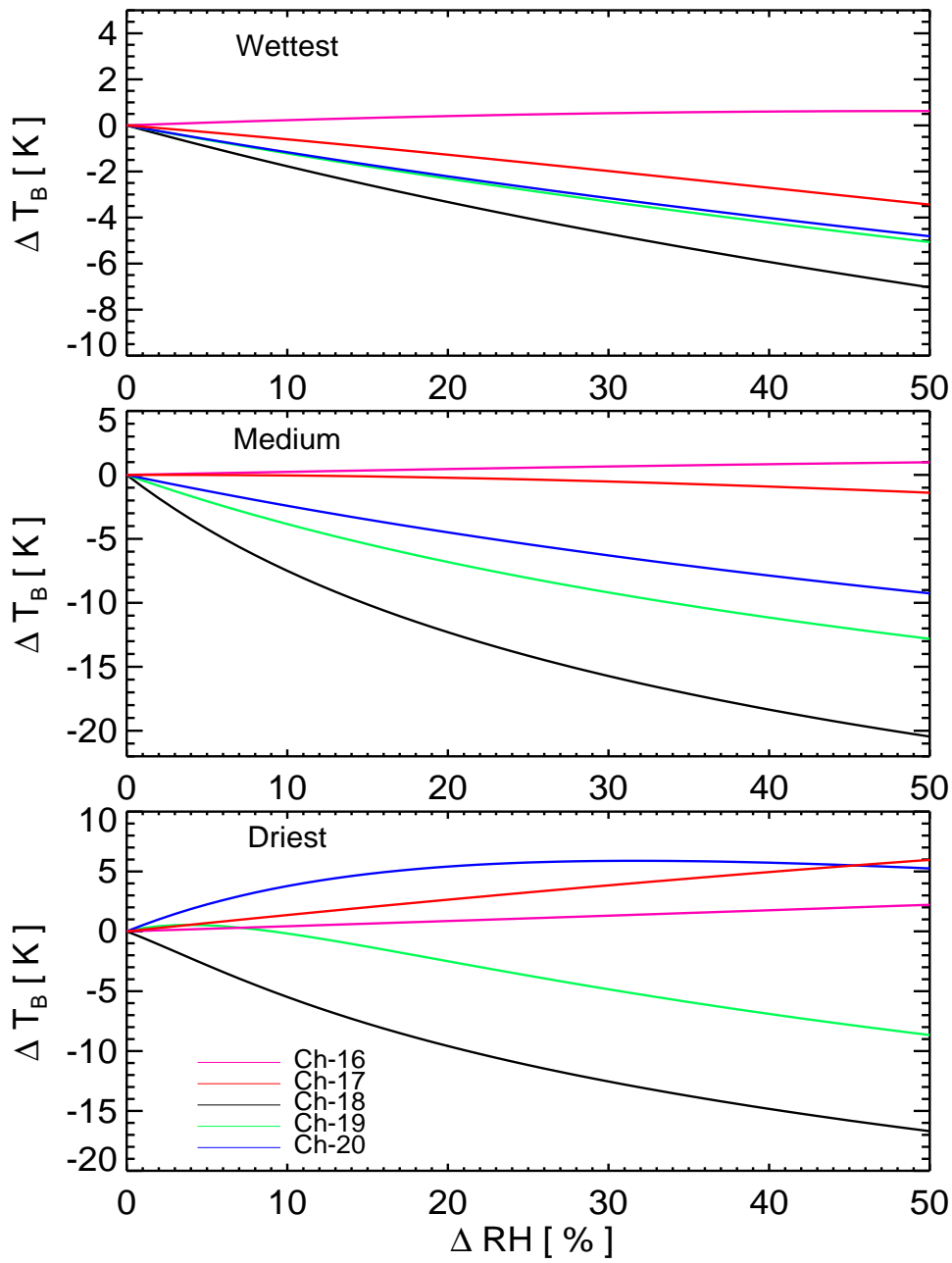


Figure 4: Sensitivity of  $\Delta T_B$  to  $\Delta RH$  for the AMSU-B channels. These profiles were selected based on the total water vapor content labelled as wettest, medium, and the driest.

## Summary and Future Work

A robust methodology is developed for the comparison of satellite microwave humidity data with radiosonde data. This method is sensitive to the dry and wet biases in the radiosonde humidity measurements taking the satellite measurement as reference.

We plan to apply this method for other stations and types of radiosonde sensors to find the possible biases in data set.

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