Atmos. Chem. Phys. Discuss., 5, S1142–S1146, 2005
www.atmos-chem-phys.org/acpd/5/S1142/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Comparison of microwave satellite humidity data and radiosonde profiles: a survey of European stations" *by* V. O. John and S. A. Buehler

V. O. John and S. A. Buehler

Received and published: 11 June 2005

Response to the comments of Holger Vömel
==========

We thank Holger Vömel for very useful comments on several issues of this study.

» This paper is a very interesting study comparing the upper
» tropospheric humidity measured by radiosondes with AMSU
» observations. Both data sets are heavily used in weather
» forecasting systems as well as climate models and the

» comparison of these data sets is very important. The
» comparison between the AMSU instruments and radiosondes
» implicitly assumes that the different radiosonde types
» used in this study behave similarly. However, this is
» not the case and the results clearly depend on the type
» of humidity sensor that is used.

The type of humidity sensors used by each station during the study time period is given in Table 1. This information is based on http://www.metoffice.com/research/interproj/radiosonde/. An instrument change is documented only for Herstmonceux-west-end of UK and a shift in bias is also observed in our results for this station. Since we did not mix the data from different radiosonde stations for computing statistics, the data from different instrument types are also not mixed up, at least not in our knowledge. A small discussion regarding this is included in Section 2.2.

» There are two types of Vaisala radiosondes that are used
» in this study, i.e. the Vaisala RS80 and the Vaisala RS90.
» The Vaisala RS80 comes with two different humidity
» sensors, i.e. the A type humicap and the H type humicap.
» The A type humicap has a well documented temperature
» dependent dry bias which is based on the improper calibration
» of this sensor at cold temperatures. This temperature
» dependent calibration error has been corrected in the H type
» humicap. The A type, is a slightly faster sensor, which means
» that biases due to time lag are less pronounced compared to
» the H type. There is no clear statement, whether the time lag
» induces a dry bias or a wet bias, since this depends on the
» shape of the RH profile. In radiosonde archives it may not

ACPD
5, S1142–S1146, 2005

» possible to distinguish, which humidity sensor was used,
» but it may be assumed that the majority of RS80 soundings
» use the H type sensor. The RS90 has a much faster response
» as well as a slightly better calibration model and the study
» should clearly separate between the RS80 and the RS90
» comparisons.

See the above paragraph for comments. We included most of the above mentioned points in the introduction.

» Humidity sensors may also suffer from a radiation
» error, which most likely would lead to a systematic dry bias
» in daytime soundings. This has been indicated in a few studies,
» but not yet well documented. Sine the NOAA-15 and NOAA-16 have
» orbits that are shifted by 6 hours, it may be speculated that
» this radiation error on the humidity sensor shows up differently
» for the two satellites. It would be most useful to separate the
» comparison at least for day/night over passes or better still
» for solar zenith angle if there is a sufficient statistics to
» do that.

This is an interesting point and we thank Holger Vömel for pointing this out. We calculated biases for both satellites by separating morning / evening (NOAA-15) and noon / midnight (NOAA-16) matches. The exercise revealed a large systematic difference between noon matches and midnight matches. We added a detailed discussion in Section 4.2 and the bias values for different stations are given in Table 2. The difference in bias between noon and midnight matches is about 1.5 K which is a systematic dry bias in day time soundings and is consistent for all stations. This corresponds to an error of 11% in UTH. This confirms that the main reason for the

ACPD
5, S1142–S1146, 2005

difference found between the two satellites is the time dependent measurement errors in the radiosonde data, for example, radiation error. The difference between morning and evening matches are not as large as the difference between noon and midnight matches. The difference in radiances of satellites also may be there, but it is hard to see in this kind of comparisons due to large errors in the radiosonde data.

» In 2000 Vaisala began shipping their RS80 radiosondes
» with a protective cap, which significantly reduced the
» contamination of the humidity sensor. The H type humicap
» was very strongly impacted by this contamination dry bias,
» the A type humicap was also impacted by this effect, although to
» a lesser extent. If a radiosonde site had used sondes in 2001,
» which were shipped in 2000 without the protective cap, then this
» would contribute to a larger scatter in the comparison with the
» satellite observations in 2001. One can probably assume that by
» 2002 only radiosondes that had been shipped with protective cap
» were used.

These points are included in the manuscript.

» It would be most useful if the authors could specify, which
» altitude range contributes most to the measured radiances since
» the humidity sensor biases are strongly temperature and therefore
» altitude dependent.

The sensitive altitude of AMSU-B Channel 18 depends on the atmospheric water vapor profile. For a tropical atmosphere the sensitive altitude is approximately from 6 to 11 km with a peak at about 8.5 km and for a subarctic winter scenario the sensitive altitude is from 4 to 7 km with a peak at about 5 km. The sensing altitude depends also

ACPD
5, S1142–S1146, 2005

on the instrument viewing angle. Since this study is for midlatitude stations, a figure which shows the sensing altitudes for midlatitude summer and winter scenarios and for different instrument viewing angles is added in Section 2.1.

» The introduction mentions the
» "capacitive hygristor". This should be "capacitive humidity
» sensor" or "polymer sensor".

Done.
» The introduction should also mention the work
» by Miloshevich et al.: Miloshevich, L. M., A. Paukkunen,
» H. Vömel, S. J. Oltmans, Development and validation of a time-lag
» correction for Vaisala radiosonde humidity measurements,
» J. Atmos. Ocean.Technol., 21, 1305-1327, 2004.
»
» Miloshevich, L. M., H. Vömel, A. Paukkunen, A. J. Heymsfield,
» S. J. Oltmans, Characterization and correction of relative
» humidty measurements from Vaisala RS80-A radiosondes at cold
» temperatures, J. Atmos. Oceanic Technol., 18, 135-156, 2001.

Done.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 1529, 2005.