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Interactive comment on "Integrated water vapor above Ny Ålesund, Spitsbergen: a multisensor intercomparison" *by* M. Palm et al.

M. Palm et al.

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We would like to thank for the constructive and informative comment. In the revised publication which is currently being worked on, we will consider the remarks made in the short comments as well as the publications cited.

Comments to the use of the sonde measurements

Q) Errors of the radio-sondes

A) The paper does not deal with the assessment of the sonde performance but uses the sonde measurements as an independent variable because they are regularly available. For quality discussions we refer to Treffeisen et al. (2007) who investigate in great detail the radio-sonde measurements of relative humidity at Ny Ålesund. The problems cited

in the comment refer mostly to conditions which are excluded from the comparison to the remote sensors or which do not influence the column anymore:

- The optical instruments SCIAMACHY and FTIR provide IWV only under cloud-free conditions. The importance of evaluating the definition of “cloudy conditions” for the SCIAMACHY sensor is stressed in chapter 3.3 of the publication.
- While the microwave sensors are able to measure IWV during overcast situations, thick water or ice clouds, precipitation, fog etc. rule out the use of the measurements.
- The studies conducted in e.g.Miloshevich et al. (2006) are to establish the validity of upper tropospheric water vapor. The contribution of this region to the IWV is very low, because both the temperature and relative humidity are very low.
- Treffeisen et al. (2007) show the difference between the corrected RS-80 sondes and the RS-90 sondes in Fig. 3 for temperatures below -40 °C and derive a linear fit $1.4 * x + 1.9$ for the difference between raw values of relative humidity and the corrected value. They also found that for temperatures above -40 °C the difference is negligible. Applying the equation $1.4 * x + 1.9$ to all relative humidity values x recorded by the RS80 subtype for temperatures below -40 °C lead to a scatter in the IWV compared to the uncorrected sonde data of less than 0.1 %. It can be concluded that all radiosondes are good enough for a comparison of IWV as conducted in the study.

Comments to the use of the microwave measurements

Q) How is the opacity derived from the microwave measurements?

A) As stated in the paper, the OZORAM microwave radiometer is not dedicated for the measurements of IWV. The main purpose is to measure an ozone profile in the

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stratosphere. In the configuration used in this work it measures at a bandwidth of 1 GHz with a resolution of about 1.6 MHz cantered at 142.175 GHz, which is a prominent ozone emission. Part of the retrieval scheme is to estimate the opacity and the offset radiation stemming mainly from water vapor in the troposphere. The estimation of the opacity is performed by fitting the MPM93 (Liebe et al., 1993) continuum model to the spectrum together with the ozone radiation and instrumental artifacts. This model is part of the radiative transfer model ARTS (Bühler et al., 2005) which is used in the analysis.

Q) Differences in the derived IWV according to the continuum models used.

A) The publication uses an established and investigated method to derive IWV from the measurements.

The radiative transfer model MWMOD has been used by Wohltmann (2002) to establish the relationship between the estimated opacity and the sonde measurements at the same time using a linear regression. Moreover, it was not the intention of this work to refine the IWV retrievals from the measurements of the microwave sensor.

The comments made will however be taken as an important hint in order to refine IWV measurements from the microwave sensor OZORAM which is referred to a future publication.

The authors are well aware that there are better and more accurate methods to estimate the IWV by means of microwave radiometry. However, such instruments are not available in Ny Ålesund.

Q) Justification of the matching criterion.

A) The matching criterion is clearly a compromise between close proximity in the time domain and the number of matching pairs. The matching criteria have been chosen to be comparable for all remote sensors with respect to the sonde measurements. It has also been checked how the results vary with the variation of the time criterion. It

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has been found that for the microwave sensor a more narrow time window for choosing matching pairs does not change the results. This can be understood by the fact, that while the IWV may change quickly and by a large amount, this is a rare event compared to the amount of matches of sonde and microwave measurement.

Comments to the use of the FTIR measurements

Q) What is meant by cloud-free?

The judgment of “cloud-free” conditions is made by the operator of the FTIR spectrometer. An objective definition of this criterion is difficult to establish and a major concern in the FTIR community.

However, the FTIR in solar absorption geometry measures the transmission of the atmosphere. Clouds have broad spectral features and are easily distinguished from absorption by gases. Therefore the presence of non-visible clouds is not a problem for the measurement of IWV in solar absorption geometry.

References

Bühler, S., Eriksson, P., Kuhn, T., von Engeln, A., and Verdes, C.: ARTS, the atmospheric radiative transfer simulator, J. Quant. Spectrosc. Radiat. Transfer, 91, 65–93, doi:10.1016/j.jqsrt.2004.05.051, 2005.

Liebe, H. J., Hufford, G. A., and Cotton, M. G.: Propagation modeling of moist air and suspended water/ice particles at frequencies below 1000 GHz, in: Proc. AGARD 52nd Spec. Meeting EM Wave Propag. Panel, pp. 3.1 – 3.10., Palma De Maiorca, Spain, 1993.

Miloshevich, L. M., Vömel, H., Whiteman, D. N., Lesht, B. M., Schmidlin, F. J., and Russo, F.: Absolute accuracy of water vapor measurements from six operational radiosonde types launched during AWEX-G and implications for AIRS validation, J. Geophys. Res, 111, 2006.

Treffeisen, R., Krejci, R., Ström, J., Engvall, A. C., Herber, A., and Thomason, L.: Humidity

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8, S11400–S11404, 2009

observations in the Arctic troposphere over Ny –Ålesund, Svalbard based on 15 years of radiosonde data, Atmos. Chem. Phys., 7, 2721 – 2732, 2007.
Wohltmann, I.: Ozone depletion, chlorine activation and water vapor observed in Spitsbergen, Ph.D. thesis, Universität Bremen, 2002.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 21171, 2008.

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