

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

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The remote sensing of atmospheric water vapor contents is an important problem in climate research, especially in regions characterized by low amounts of IWV, such polar regions. Therefore I found the comparison of in-situ, satellite and ground-based remote sensing IWV measurements presented in this work very interesting. I have however a few comments/inquires concerning this manuscript.

My first comment is about the IWV data set obtained from radiosonde measurements. Radiosondes launched from the AWIPEV research base, used in this study, are of three different types: Vaisala RS-80, Vaisala RS-90 and Vaisala RS-92. All Vaisala radiosonde humidity sensors suffer from the same type of measurement errors, but the magnitude of each error depends critically on the specific radiosonde model (Milo-

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shevich et al., 2004). Several studies have been carried out to assess water vapor measurements accuracy of the different radiosonde types produced by Vaisala and to develop some corrections that improve this accuracy (Paukkunen et al., 2001; Wang et al., 2002; Miloshevich et al., 2001, 2004, 2006). These studies pointed out some important aspects:

1) RS-80 radiosondes are affected from three measurements errors. A temperature-dependent error that can be reduced using a temperature-dependence calibration model, a contamination error that induces a dry bias in the measurements and can be moderated with a statistically correction, and a time-lag error that affects the sensor ability to reproduce the vertical structure of the humidity profile that is smoothed by slow sensor response at low temperature. A numerical algorithm, developed and validated by Miloshevich et al. (2004) in order to reduce the time-lag error, has been shown to recover the real vertical structure in the humidity profile.

2) RS-90 and RS-92 radiosondes are essentially equivalent humidity sensors in terms of calibration accuracy and time response. Their sensor response time is improved and both contamination and temperature-dependent error are strongly reduced with respect to RS-80 sondes.

3) RS-90 and RS-92 are therefore considered greatly more accurate and less variable than RS-80. However, recent studies (Vömel et al., 2007; Rowe et al., 2008) have shown that both RS-90 and RS-92 sondes suffer from a strong solar radiation dry bias, whose magnitude and SZA dependence is not yet well known.

None of these many aspects concerning radiosonde humidity sensors is commented, nor the related publications cited, in Palm et al.. I would like to know if these differences among various radiosonde models have been considered by the authors and whether any correction was applied to their humidity profiles in order to obtain a uniform data set.

Other comments concern the method used to retrieve IWV values from measurements

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carried out by the microwave spectrometer.

1) The authors state that tropospheric opacity is regularly derived during the analysis of O₃ emission line at 142 GHz observed by RAM. However, the technique used to derive the opacity is not explained. Since the technique is not new, it might be helpful to give at least some references on it (e.g., de Zafrá et al., 1983; Parrish et al., 1987; and more recently, Fiorucci et al., 2008) along with a short explanation. In particular, it could be interesting for the reader to have more information about RAM operational characteristics, since they influence spectral and temporal resolution of opacity measurements. For example, nothing is said about the intermediate frequency, bandwidth of spectral window and configuration (single or double sideband spectrometer). I would like to know the frequency range over which tropospheric opacity is determined and whether the opacity can be considered constant over this range. Moreover, I would like to know the integration time of RAM. I am guessing it is about 2 hours and I wonder whether this time resolution is appropriate considering the rapid variations of IWV at Ny Ålesund.

2) At the frequency where RAM is operated, atmospheric opacity is due almost entirely to oxygen and water vapor. The authors performed the conversion from opacity to IWV by means of the linear relation (1), where the contribution of oxygen to the opacity and the water vapor cross section are determined using the radiative transfer model MWMOD. However, in this spectral region, there are several other absorption models which show remarkable differences in the oxygen (dry component) but in particular in the water vapor component of the absorption (Liebe and Layton, 1987, Liebe et al., 1993, Rosenkranz, 1998, 1999, 2003, Liljegren et al., 2005). I think it could be useful to consider these differences and discuss their impact on the retrieval of IWV values.

Another consideration is about the time matching criterion used in the comparison of different IWV data sets. The authors stress the high variability of water vapor content above Ny Ålesund, stating that "the change within 4 h is regularly more than 50%". They also point out that the particular topological structure of the island, with high mountains arising to more than 1000 m, is expected to alter the direction and the

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speed of air masses causing a non homogeneous distribution of water vapor in the region. Therefore, I think the matching criterion of ± 2 h used in the comparison of IWV measurements from passive remote sensors to values obtained from radiosonde could be too long. This is especially true since "the major part of the IWV is in the lowest few kilometers which are traversed by the radio-sonde in a few minutes" and it does not really matter where the sonde goes over a two hour time span. I wonder whether it is possible to modify these matching criteria in order to select data sets in a more accurate way. Otherwise, I think it could be worth discussing this point more thoroughly.

Finally, for what concerns FTIR measurements, the authors state that they are conducted in "largely cloud-free sky". But IR spectra are very sensitive to clouds and can be influenced even by sub-visible cirrus clouds. Therefore this statement seems too vague and I would like to know what kind of cloud-screening has been used.

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