Atmospheric
Measurement
Techniques

Open Access

Discussions

Interactive comment on "A model-based approach to adjust microwave observations for operational applications: results of a campaign at Munich Airport in winter 2011/2012" *by* J. Güldner

J. Güldner

juergen.gueldner@dwd.de

The thoughtful comments by Reviewer 1 are greatly appreciated.

Comment 1: The regression method presented minimizes radiometer retrieval bias with respect to radiosondes. However, systematic radiosonde humidity error has been identified (Miloshevich et al, 2009) and microwave radiometer data are used to correct this error (Cady-Pereira et al, 2008). This should be discussed.

Reply to comment 1: A discussion of the radiosonde humidity error as one aspect of regression operator calculation is added (Page 6, line 11) in any further versions of the

paper as follows:

However, regression methods use radiosonde measurements (REGobs), which have their specific error characteristics. A striking example is the strong dry bias of RS92 radiosondes daytime observations induced by solar radiation. Vömel et al. (2007) quantified the average dry bias increasing from 9% at the surface to about 50% at an altitude of 15 km applying data of a campaign in Costa Rica in summer 2005. This means that the amount of water vapor in the tropical upper troposphere is underestimated by the Vaisala RS92 up to a factor of 2. Considerable efforts have been made to develop correction methods including an approach that uses the integrated water vapor content(IWV) derived from microwave radiometer measurements to adjust radiosonde humidity profiles at the ARM SGP site in Oklahoma (Cady-Pereira et al., 2008). Currently, in the frame of GRUAN (GCOS Reference Upper Air Network) activities are forced to provide long-term high-quality climate records. For this purpose an agreed correction method is applied to radiosonde data from all GRUAN sites to provide observations with reference quality, including complete estimates of measurement uncertainty (Immler and Sommer, 2011). These profiles could be used in forthcoming studies to validate retrievals. Nevertheless, the solar radiation induced dry bias in the upper troposphere is the most signifcant inaccuracy of radiosonde data used in our experiment. In general, the vapor density in the upper troposphere is very low whereas in the lower troposphere the observation error is comparatively small. Looking at the intercomparisons of the humidity retrievals displayed in Fig.1, it seems more likely, that radiometer or calibration inaccuracies cause a varying humidity bias of the NN retrievals in different years and not the quite constant radiation-induced dry bias.

Comment 2: The observation error typically assigned to radiosonde data when they are assimilated into numerical weather models (Cimini et al, 2011) should also be discussed. This would provide useful perspective on the relative magnitude and importance of radiometer bias with respect to radiosondes.

Reply to comment 2: I fully agree that the 1-DVAR approach studied in the paper

of Cimini et al. (2011) is an issue that should be discussed (Page 7, line 13 (b)). Furthermore, I bring up a paragraph how the bias problem is handled if satellite data are assimilated in NWP models (Begin of section 2, page 4, line 11 (a)).

a) The importance of the observation bias problem has been recognized for many years. In particular, the increased use of satellite data in numerical forecast models have led to the development of methods to remove systematic radiance differences between computed values and observations (Eyre, 1992, Dee, 2005). The assimilation theorie assumes the presence of random and zero-mean errors to optimally combine model predictions with observations. While purely random effects can be handled by filtering methods within an assimilation scheme, observation biases can systematically damage the data assimilation scheme (Auligne et al., 2007). In contrast to the bias of specific satellite instruments, which have regionally a similar structure, the biases of data from ground-based observations in a network can differ from site to site. However, here as well, unbiased measurements are assumed for the application of retrieval algorithms developed to derive vertical profiles. Experiences obtained ...

b) However, other approaches have also been tested to study the impact of microwave radiometer observations. Variational methods to retrieve profiles of temperature and humidity provide an optimal estimation of combining observations with a forecast model background (Hewison, 2007). The 1-DVAR technique was applied by Cimini et al. (2011) to radiometer measurements during the Vancouver 2010 Winter Olympic Games. Generally was stated that the temperature and humidity retrieval accuracy in the upper troposphere depend primarily on the model analysis, and those in the boundary layer and lower troposhere on the radiometer, respectively. Although the 1-DVAR retrieval skill depends on how well the estimated error-covariance matrices of the background and the observations represent reality, it is expected that the approach avoids inherent retrieval errors to some extent as it benefits from recent data assimilated in the NWP model. The rms errors obtained for 1-DVAR retrievals with and without brightness temperature bias correction, respectively, are quite similar. The

C936

comparisons show rms differences within 1.5 K for temperature and 0.5 g/m3 for water vapor density. The error is then lower as error assigned to radiosonde data by the numerical model, which is ranging between 1.2 and 2 K for temperature and decreasing from 2.5 g/m3 at the surface to 0.8 g/m3 at 10 km height for humidity. Nevertheless, the presented study is focussed on the harmonization of microwave observations within a network and on the preparation of data for subsequent use in NWP models or other applications. This means that measurements at various sites with different bias characteristics are adjusted to provide data showing site-independent and almost homogeneous error features.

References:

Auligne, T., McNally, A.P., Dee, D.P.: Adaptive bias correction for satellite data in a numerical weather prediction system, Quart. J. Roy.Meteor. Soc., 133, 631–642, 2007.

Cady-Pereira, K.E., Shephard, M.W., Turner, D.D., Mlawer, E.J., Clough, S.A., and Wagner, T.J.: Improved daytime column-integrated precipitable water vapour from Vaisala radiosonde humidity sensors, J. Atmos. Oceanic Technol., 21, 873–883, doi: 10.1175/2007JTECHA1027.1., 2008.

Cimini, D., Campos, E., Ware, R., Albers, S., Giuliani, G., Oreamuno, J., Joe, P., Koch, S.E., Cober, S., and Westwater, E.: Thermodynamic Atmospheric Profiling during the 2010 Winter Olympics Using Ground-based Microwave Radiometry, IEEE Trans. Geosci. Rem. Sens., 49, 12, doi: 10.1109/TGRS.2011.2154337, 2011.

Dee, D.P.: Bias and data assimilation, Q. J. R. Meteorol. Soc., 131, 3323–3343, 2005.

Eyre, J.R.: A bias correction scheme for simulated TOVS brightness temperatures, Technical Memorandum 186, ECMWF, Reading, UK, 1992

Hewison, T.J.: 1D-VAR retrieval of temperature and humidity profiles from a ground-based microwave radiometer, IEEE Trans. Geosci. Remote Sens., 45, 2163–2168, doi:10.1109/TGRS.2007.898091, 2007.

Immler, F.J. and Sommer, M.: Brief description of the RS92 GRUAN data produkt (RS92-GDP), GRUAN Tech. Document GRUAN-TD-4, 2011, (http://ww.gruan.org).

Vömel, H., Selkirk, H., Miloshevich, L.M., Valverde-Canossa, J., Valdes, J., Kyrö, E., Kivi, R., Stolz, W., Peng, G., and Diaz, J.A.: Radiation dry bias of the Vaisala RS92 humidity sensor, J. Atmos. Oceanic Technol., 24, 953–963, 2007.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 2935, 2013.

C938