Atmos. Meas. Tech. Discuss., 7, C2342–C2347, 2014
www.atmos-meas-tech-discuss.net/7/C2342/2014/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Humidity sensor failure: a problem that should not be neglected by the numerical weather prediction community" *by* Y. Liu and N. Tang

Anonymous Referee #3

Received and published: 25 August 2014

This paper presents the results of a study of the data quality of one year of radiosoundings world-wide. It is found that for the period studied 5-15% of the soundings in the GTS archive are affected by a malfunction of the humidity sensor. This malfunction results in an unrealistic humidity profile which is constant and near-zero %RH for a range of up to several km in the free troposphere. This is an important finding which underlines the importance of uncertainty estimates and quality assurance for radiosonde data, or indeed any meteorological data set.

I recommend publication in AMT after the authors have addressed the following issues:

1. The authors should make a clear distinction between known error sources in radiosoundings, e.g. radiation dry bias or time-lag, which can in be corrected for, and malfunction of the humidity sensor which is the topic of this study. The introduction should be more balanced, currently it discusses in length these known errors and only at the end of the the introduction it becomes clear what the purpose/goal of the paper is.

2. The authors have done a good job in identifying the correlation between atmospheric conditions and the failure of the humidity sensor, however a real explanation for the cause of the effect is missing. Sudden transitions from high to low humidity are not limited to the sub-tropics. Is there a difference between nighttime or daytime soundings when it comes to the occurrence of the humidity sensor malfunction? Did the authors check that the effect is not caused by the manufacturer's processing software? For example, for the RS92 and for the GRAW DFM-09 raw measurement data are stored as well (provided these data are still available at the station that performed the sounding).

3. I would encourage the authors to include in the summary clear recommendations for the community regarding quality assurance of radiosounding data, so that in the future faulty data can be flagged before ending up in the radiosounding archives.

Detailed comments

p6626 l25-26: This sentence needs be rephrased. I assume you want to say something of the following effect: in the tropopause region the humidity sensor is not able to record rapid changes or steep gradients in the ambient humidity, which is mainly due to sensor time lag at low temperatures.
Please be aware that among different radiosonde manufacturers there is wide range of humidity sensor performance. For example, The RS92 performs quite well up to

the tropopause, whereas other radiosonde types become essentially insensitive to changes in the humidity profile at ambient temperatures below -40C as the result of time lag effects. The sentence should reflect this nuance, in its current form the sentence is too much of a sweeping statement.

p6627 l3: at this point it is prudent to refer to the official WMO reports on the Mauritius (2005) and Yangjiang (2010) intercomparison campaigns. (WMO Technical Documents 1303 and 1580).
p6627 l5: these large errors mainly occur in the upper troposphere.
p6627 l6: bad -> limited
p6627 l7-8: low humidity conditions and the occurrence of sensor icing seems a contradiction to me. An important error source, radiation dry bias, is missing here. Sensor aging and contamination are more the result of radiosonde handling/storage than being attributable to the conditions in the upper troposphere.
p6627 l10: please replace hygrometer by humidity sensor
updated -> improved
p6627 l18: deep -> thick
p6627 l19: RHs -> RH
p6627 l29: Tang et al 2013 is not listed in the bibliography, I assume this should be Tang2014, please check for this in other places in the manuscript as well.
p6628 l3: stratiformis -> stratiform
p6628 l19: please provide a reference for the GTS (a weblink will do)
p6628 l21: data -> profiles
p6628 l25: please rephrase. It should be clear that with the "new issue of humidity observation" you mean the above mentioned (temporary) failure of the humidity sensor.
p6629 l1: Please define RO. I know it is mentioned at the end of Sect 1, but it would be good to mention it again at this point.
p6629 l3: Please provide model name and reference.
p6629 l10-end of section: this extensive and detailed information should be moved to an appendix.

For temperature please use T instead of t.
Please be consistent in the use of the multiplication symbol x (e.g. Eq. 5)
Please provide references for equations 1,2,4,5.
For Eq 4 and 5 [Hofmann-Wellenhof, B., and H. Moritz (2006), Physical Geodesy, 2nd ed., 403 pp., Springer Verlag, Berlin, Germany.] might be useful.

p6630 l24: maximus -> maximum
p6631 l26:maximus -> maximum
p6632 l7: please specify the altitude range in which the RO data can be used/is valid.
p6632 l24: To my knowledge the Graw G sensor does not exist. Their currently available radiosondes are DFM-06 and DFM-09 please specify which type you refer to.
p6633 l7: Please use radiosonde type instead of manufacturer. Presumably you mean the RS92, or are data from the RS80 and RS90 also used in this study?
p6633 l10: quite few -> please provide a quantitative number, e.g. 3.5% as given in Table 2.
p6633 l10: capability -> quality
p6633 l15: evolvement -> evolution
p6633 l16: please provide a reference.
p6634 l4: which sensor are you referring to here?
p3364 l12-16: I am not sure whether these sentences contribute to the discussion.

References

In Bian2011: check spelling of Vömel and Lu

Tables

Table 1:
Define the latitude bands in the caption.
Mention Dec 2008 - Nov 2009 in the caption, use only DJF, MAM, JJA, SON in the season column.

Table 2: Please provide statistics for more radiosonde types, perhaps for all 6 radiosonde types that are shown in Fig 7. The three listed radiosonde types account for approximately 50% of the soundings used in this study.

Figures

Figure 2: The legend of the colorbar could do with less numbers. I don't think it is necessary to show 5 values between 23 and 53. It is not clear to me what at what frequency soundings are performed at the sites shown on the map. Presumably there is quite some variation in sounding frequency among the sites, this could skew the results as only absolute numbers are shown in the plot. How does the plot look like if you show the fraction of failure affected soundings instead of absolute numbers?
Caption: hollow -> open

Figure 5: Can you provide separate plots for daytime and nighttime observations?

Figure 6: Provide the station names. The last sentence of the caption: it has already been mentioned what the red and blue curves represent.

Figure 7: Please print the radiosonde type in the plots. Please provide station names and geographic coordinates Please abbreviate 12:00:00 to 12:00. I don't think it is necessary to mention the nationality of the radiosonde manufacturers, e.g. Vaisala RS92 would be sufficient. Graw radiosonde G should be DFM-06 or DFM-09.

Figure 8: No need to mention the nationality of the radiosonde manufacturers. There are a lot of "unknown types" soundings over Siberia. As these soundings seem not to suffer from humidity sensor failure, as shown in Fig 2., it would be interesting to know which radiosonde is used in that region.

Figure 9: Please add "according to satellite cloud climatology" to the caption. What quantity/unit does the color bar represent?

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 6625, 2014.