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Atmospheric Measurement Techniques Discussions

Interactive comment on "Evaluation of Windsond S1H2 performance in Kumasi during the 2016 DACCIWA field campaign" *by* Geoffrey E. Q. Bessardon et al.

Anonymous Referee #2

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This paper presents an evaluation of a relatively new low-cost radiosonde system against a well-established and widely used radiosonde based on measurements performed in June and July 2016 during a field campaign in Ghana - Western Africa. The low-cost radiosondes were recovered by the operators and reused up to 8 times, which allows the authors to analyse a relatively high number of ascends. It is shown that under "simple" atmospheric conditions temperature, humidity and pressure measured by both systems compare reasonably well, but as soon as larger vertical inhomogeneities occur the low-cost radiosonde suffers from slow sensor response and hysteresis. GPS-derived wind from the low-cost system is of very bad quality.

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Discussion paper

Unfortunately, the paper suffers from several weaknesses starting by the design of the measurements, missing technical information, lack of measurements under laboratory conditions and a very limited analysis of the data. The authors miss to cite and discuss relevant literature e.g . Legain et al. 2013 doi:10.5194/amtd-6-3339-2013 and Nash et al, 2010 WMO Report No. 107 Instruments and Observations. The weather situation is not sufficiently discussed and taken into account. Overall it seems to me that the paper is a kind of side product produced with minimal effort.

I think that the paper will not warrant publication as long as a mayor revision is done which addresses the following comments.

Specific comments:

Page 2 The first section is a marketing analysis which is mostly irrelevant if you want to discuss a reusable low cost sonde that is limited to 6000 m altitude. Sonde costs are fixed - price differences for launches in different regions depend on logistics and local labour.

If the sounding program had the objective to evaluate the Windsond performance already from the beginning please explain the following: 1) Why is there only one tandem flight reaching higher altitudes performed 2) Why are all low altitude intercomparison flights performed only at 0600 and not distributed over day and night or at least over the launch times shown on figure 2. As the sondes were recovered no significant additional costs would have been created. 3) Why are the RS42 and Windsond not tied together for the low altitude intercomparison flights – the resulting spacial difference makes it impossible to separate instrument errors from atmospheric variability.

Page 3 Please us UTC or LT but not AM / PM Is Fig. 2 really needed ? Please explain what you mean with simultaneous launched (see above)

Please give more information about the calibration of the Windsond. Do sondes have individual factory calibrations stored on the sonde or does the manufacturer rely on the

quality of its sensors only ? How is the multi sonde reception realized – please give details on the receiver technology. Please use Kelvin instead of °C for Accuracy and Resolution in Table 2

Table 3-5 Anders Petersson is affiliated to the manufacturer of Windsond. You should be able to give detailed information about the sensors used in Windsond and their performance instead of “not available (to be assessed)”. Is the given value for pressure accuracy valid for Vaisala or Windsond? Why is the Wind speed accuracy relative to the wind speed?

Page 5: Pressure sections: Please include in the discussion the results of the WMO radiosonde intercomparison 2010 about direct pressure measurements vs. derived pressure.

Page 6: Please explain uncorrected data vs data correction for all parameters for the Windsond. What was the procedure to “adjust” ground pressure altitude and temperature? Wow large were these “adjustments” and why was this not done for humidity?

I am still astonished that only one tandem flight to higher altitudes was performed! A larger number of such flights under different weather situations as well as during day and night would have improved the evaluation significantly. The flight was in 2016 and not 2006. Since all flights were performed during night or early morning radiative effects cannot be evaluated. Experimental design needs to be explained in more detail. What was the length of the line connecting the sondes to the balloon? How did you tape the sondes together? Is it excluded that waste heat of one sonde influenced the other? Why did you set the Windsond acquisition to 3 seconds - according to table 1 the measurement cycle is 1s for both sondes. Please give details about the weather situation.

5.1.2 Should be renamed to Signal processing for low altitudes – Boundary layer higght was not detected - I would expect a boundary layer height around 100 m at the launch time of the sonde rising up to 1500 m during the day in this region during the monsoon

period.

Page 7: Can you explain why you have chosen different ascent rates and non-attached sondes for evaluating the reproducibility ? I can't see any sense in this procedure since natural atmospheric variation will be at least in the same range as the instrument error.

Profile comparison – It would be nice to have a profile plot if you do profile comparisons! Instead of showing scatter plots it would make much more sense to plot vertical profiles of PTH as well as wind for both sondes with an additional profile showing the vertical profile of the difference (Vaisala – Windsond) for each parameter together with the accuracy as stated by the manufacturer's datasheet. This would allow a meteorological interpretation. How do you measure cloud top temperature above the cloud top – The RS41-SG sensors are detecting the cloud top temperature and humidity before the S1H2 . . ...????

Page 8: Change reply time to response time

The atmosphere is characterized by vertical inhomogeneities, inversions and clouds – radiosondes therefore have to have sensors with low response time and neglectable hysteresis – if this is not the case the sonde is simply not suitable as radiosonde – or only for nice weather well mixed cloud free boundary layer.

Page 9: More recent versions of the Windsond firmware certainly correct the altitude bias - have you checked this? Is it possible to reprocess the measurements to verify? To me it is not shown that newer firmware versions correct the altitude bias.

The conclusions are too favourable – Windsond cannot handle inhomogeneities due to the high response time of the sensors, GPS derived wind error is far above the 5% error given by the manufacturer and to my opinion useless. It is not shown that at least the altitude correction in the latest versions of Windsond improve the systematic altitude error. As the WMO intercomparison results and the Vaisala sonde show pressure sensors are not needed any more for radiosondes – the "robust performance" of the

pressure sensor us unfortunately only of minor importance.

Page 10:

The experimental design shows several weaknesses – as already addressed the fact that the sondes were not tied together during the ascends makes it nearly impossible to separate instrument error and atmospheric variance. I would recommend to test each sonde prior nest launch instead of a simple visual inspection.

I would strongly recommend to perform additional measurements with a larger number of sondes under laboratory conditions to determine sensor accuracy and inertia over a wide range of temperature and humidity and to compare the results to the sondes datasheets first.

Reproducibility can also better be tested in a combination of repeated tandem flights and climate chamber measurements – this would allow the separation of sensor degradation and atmospheric influence in real atmospheric conditions.

Table 6 is unreadable – it extends 4 pages – please consider a condensed way of presentation.

Page 11:

Please give the percentage of unsuccessful flights and flights with sondes that did not cut off. Is the number of data from sondes that did not cut off large enough to do a representative evaluation for altitudes between 650 and 1000 m?

It is nearly impossible to separate the different markers in Fig. 8. Maybe separated figures would help.

As you have a large number of flights over several days available I would recommend to do not only a statistical analysis based on scatter plots and regressions but also a more meteorological where you create classes of different weather situations e.g. with and without low level clouds and analyse the behaviour of the sondes along the vertical

profile.

Fig. 9 – why do you use lines to connect the markers?

Page 12: A check of the sonde sensors before reusing it should be the standard procedure – see my comment to page 10.

A system for low altitude rapid soundings using high quality radiosondes was already introduced and tested by Legain et al. 2013. The questions to me is if a low cost and unfortunately low-quality system like the Windsond really makes sense with all the weaknesses we have seen in your evaluation especially - considering the fact that higher quality sondes can also be recovered and reused so that the cost difference between the sondes gets even less important. Please discuss!

Please change longer answer time to response time.

It would be nice to know if newer Windsond firmware really has corrected the problems with GPS derived wind and pressure. I therefore strongly encourage you to perform the further performance evaluations and include their results into a revised version of your manuscript.

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