Review about

“Development of an in situ Acoustic Anemometer to Measure Wind in the Stratosphere for SENSOR“

by

Song Liang, Hu Xiong, Wei Feng, Yan Zhaoai, Xu Qingchen, and Tu Cui

The manuscript describes the development of a homemade ultrasonic anemometer for use on a drifting balloon for stratospheric wind observations. Ground-based intercomparisons with a commercial available ultrasonic anemometer are presented, followed by one flight example with a stratosphere balloon drifting in about 20 km height. First of all congratulations to this general success, I have a rough sense of the technical requirements to develop such a device and get it airborne. However, at several points in this manuscript I have the feeling that I read more a technical progress report instead of a publication for a broader audience. Within the introduction I would expect a deeper discussion of what kind of environmental conditions I have to deal with and why is a device of the shell not suitable? Furthermore, what are specific scientific questions you want to answer with the new device? This would immediately set the bounds for the desired specifications for a new device. Historically, ultrasonic anemometers have been developed to resolve atmospheric turbulence and state-of-the-art sensors have time response of 10 ms or so – it might be due to the low pressure conditions that your ultrasonic is limited by 1 Hz resolution but this issue has to be discussed in detail. Furthermore, a deeper discussion of the principle problems of measuring with ultrasonic anemometers under stratospheric conditions should be the main motivation. In the current state I cannot suggest to consider this manuscript to be published in *Atmospheric Measurement Technology.* I will provide more detailed comments and suggestions for a revised version below.

<u>Detailed Comments and Suggestions:</u>

1. Abstract: At the end of the abstract you mention, “*Further analysis of the wind data will be presented in a subsequent paper”.* I immediately ask myself why not presenting more analysis in this paper? The analysis here is somewhat superficial and even if you want to convince the reader that you have developed a nice instrument this can be done best by a more detailed data analysis. Furthermore, if you realize that the sensor needs improvements so why wait until you have solved all issues before publish the results?

2. Introduction line 43ff: a drifting balloon definitively provides useful insight in the structure of the stratosphere and has several advantages but also disadvantages compared to remote sensing such as problems with instationarity – this should be discussed here.

3. Introduction (general): the structure of this paragraph should be improved; you jump a little bit between motivation, technical requirements and scientific goals.

4. Introduction line 56ff: You explicitly mention that the anemometer should be designed for small-scale observations in the stratosphere, please specify the requirements for the new device!

5. Introduction line 65ff: You mention the extreme environment in which the device should work: please specify!

6. Introduction line 68ff: you cite the work of Ovarlez et al., 1978: Why is this ultrasonic anemometer not suitable for your application? Or what want you doing better compared to their device?

7. Section 2.1: The introduction provides a lot of material you can read in most textbooks about ultrasonic anemometers, the comment on line 106 about the measurement of wind speed in a moving reference system is a general challenge with airborne wind measurements. Please provide at least one citation. However, with a more or less tracer-like floating balloon this is an even more interesting problem because the balloon motion is quasi-Lagrangian – this should be discussed in much more detail as it introduce an interesting point.

8. Section 2.1: There is no discussion at this point how v_g is measured on the balloon

9. Section 2.2 line 119 ff: Here you mention the first time which kind of technical problems and challenges you have with the anemometer under low pressure and temperature conditions. I think this is the key motivation for developing such a system – otherwise you could use a device off the shell – right? This information should be – with much more details – presented at a more prominent place in the manuscript!

10. Line 137: here you mention the first time typical temperature conditions for your device – I suggest putting it much earlier.

11. Section 2.2 includes in general a lot of technical – and partly trivial - details that apply for all sensors such as the information that you used a fuse to protect you system. I am more interested in aspects like what is different to other acoustic anemometers and how did you solved problems related to the extreme environment of the stratosphere.

12. Section 2.3 "Data processing": Similar comment as above: the information you have provided here applies to all ultrasonic anemometers and is generally valid, but not specifically for your device - at least I don't see any information that refers to the problems caused by low temperature or pressure.

13. Section 2.4: Ground Experiment: The argumentation that both sensors experience the same airflow is somewhat vague; I think one can learn something about the sensors but here it is the first time you mention the temporal resolution of you device which I consider as remarkable low for an ultrasonic anemometer, however, the "reference" system is even slower with a resolution of 10 s? Usually, ultrasoncis are considered as turbulence sensors with sampling frequencies of up to 100 Hz – what are your technical limitations? It might be that your device is slower to meet the conditions of low pressure but you should explain it?

14. A technical question: In Fig 5 it seems that the mechanical structure is quite robust but have you considered effects such as flow distortions or transducer shadowing effects which are a key issue for sonics? – Maybe with a lower resolution this is not an issue but you should at least consider such hazards.

15. Section 2.4 line 216ff: is the observed wind speed the range you expect as relative airspeed for your balloon experiment? Why do you provide four digits for mean wind speeds? What is the useful resolution (absolute accuracy) of the both sonics?

16. Section 2.4: I am not sure what I can learn from this intercomparison experiment but this is partly also due to the fact that I don't know what you expect from your new device.

17. Section 3 "Results": I have serious problems with interpreting the wind measurements at all – despite any technical problems such as the observed spikes: I assume even a zero-pressure balloon with a mass of 400 kg (gondola) does not exactly moves with the mean flow but what are the differences? You measure a relative flow speed but how should I interpret the red line in Fig 7b? By the way, here you only show the zonal wind vector component but you mentioned earlier that you have developed a three-dimensional wind measurement device – right? What about the other components and how is the 3d-motion of the balloon be measured? Are you determine also the angular rates and attitude angles?

18. If you have a radiosonde available for comparison: why not compare wind speeds? From my point of view, this would be the most obvious thing to do and one could discuss the topic of the quasi-Lagrangian observation in more detail.