

### **Reply to Anonymous Referee #3**

The authors appreciate the time and effort that Anonymous Referee #3 has dedicated to providing extensive and valuable feedback on our manuscript to improve the work. We are grateful for your continued insightful comments on our paper.

Major comments:

1). In the first review I made several comments on the design of the probe, asking for more detail and documentation of testing. I agree with the authors that adding all of this detail can add significant length to the manuscript. While I personally would rather see these details included directly in the manuscript to demonstrate a rigorous procedure in validating the data, I am ok with the author's decision to provide this information in an external resource that is available to the reader.

That being said, I still have some issue with the presentation of the thermal data from the probe. While the author's answers to my questions/points are reasonable, the fact still remains that the thermal data is significantly lagged compared to the ambient environment. While mathematically a lag correction can be applied to the data, I strongly question the applicability of such a correction in this context given the magnitude of the correction. While radiosondes are generally corrected using a thermal lag treatment as the author's point out, it is on the order of a few degrees rather than ~ 75 degrees as is the case here. The sheer fact that the ambient flow rate inside the probe over the sensor is around  $0.17 \text{ ms}^{-1}$  is concerning given that it essentially disconnects the probe from the ambient environment. With these factors in mind I have strong reservations about utilizing the thermodynamic data for any scientific purpose.

My preference and suggestion would be to remove presentation of the thermodynamic data from this manuscript. The authors mention changes to the probe design that will be utilized going forward with the sensors mounted on the exterior of the probe, thus making the data significantly more connected to the ambient environment in the future which is good. However, if the authors feel that the data shown here is still worthy of publication (which they do), then I suggest that a statement expressing the limited utility of the data be included to indicate that there are some strong assumptions being made regarding the thermo data and that it is largely being shown for completeness and to illustrate the intent behind the probes mission. Something along the lines of:

“While the thermodynamic data presented here is interesting and unique, it is important to note that significant corrections were required in order to align the data with reasonably expected values. In this correction are several assumptions that may or may not be valid in these conditions. Furthermore, the correction applied to the data is considerable and is largely beyond the level to which corrections are generally applied. With this in mind, careful consideration of the thermodynamic data is warranted and the data presented here is largely done so for illustrative purposes to showcase the potential of the probe. Future designs of the probe will ideally minimize these potential

error sources and lead to more representative data without the need for excessive correction.”

I think this could easily fit in the conclusion section. I believe that this or a similar statement which gives the reader caution of utilizing the presented thermo data too much, is a good middle ground in regards to the author’s hard work in collecting and publishing their findings, and my reservations regarding the magnitude of the correction. If such a statement is included, I believe the manuscript is ready for publication and I commend the authors in their efforts to work through the review process, as grueling as it can be.

We appreciate the reviewer’s suggested text, and have added it with some minor amendments to the end of the conclusion, including specifying the temperature data, as pressure was not impacted and relative humidity data was excluded anyway:

”While the thermodynamic data presented here is interesting and unique, it is important to note that significant corrections were required to align the temperature data to reasonably expected values, which was due to the lack of airflow past the sensor in pseudo-Lagrangian flight. In this correction, several assumptions were made that may not be valid in these conditions. Furthermore, the correction applied to the data is considerable and is largely beyond the level to which corrections are generally applied. Careful consideration of the temperature data is warranted and the data presented here is largely for illustrative purposes to showcase the potential of the probe. A future design of the probe minimizes this potential error source without the need for this level of data treatment.”

Minor comments:

Line 299-301: I would add a statement at this point explaining that the additional experimental data can be found there which further describes the performance of the probe. The current text doesn’t explicitly state that and could be missed by a reader. Something like this following the initial sentence:

“Data from these controlled experiments, including additional documentation as to the process used in testing can be found in an additional resource as cited by Simpson and Timmer (2019).”

This has been changed to:

“Controlled experiments (Fig. 13) were conducted to compute the thermal time constant ( $\tau$ ) of the probe within the enclosure, the probe outside the enclosure, and the self-heating effect. A fan, handheld anemometer, deep freezer, and ice-bath calibrated thermocouple were used for this purpose. Data from these controlled experiments, including additional documentation as to the processes used in testing can be found in the following citation: (Simpson and Timmer, 2019).”