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Atmospheric Measurement Techniques Discussions

Interactive comment on "Evaluation of ARM Tethered Balloon System instrumentation for supercooled liquid water and distributed temperature sensing in mixed-phase Arctic clouds" *by* Darielle Dexheimer et al.

Anonymous Referee #1

Received and published: 29 May 2019

Dexheimer et al. presented a well-written manuscript about cloud microphysical measurements in a sparsely sampled region. The usage of a tethered balloon or balloon-kite is well motivated as airplanes cannot do this type of measurement in supercooled liquid water clouds due to icing. The authors have shown that using a distributed temperature sensing unit aboard a tethered balloon can provide vertical temperature profiles that are about as accurate as a radiosonde. Disparities in the measured supercooled liquid water content were discussed adequately. In general, this is a good manuscript that is definitely worth to be published. However, some clarification is

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needed in some places, and some (mostly technical) things should be fixed prior to publication.

I have only a few general comments for further improvement of the manuscript:

1) There are many nice figures in the paper, but not all of them are actually referenced in the paragraph describing them. A summary of the missing figure references is given in the detailed discussion.

2) The role of wind speed for the measurements should be discussed. Do you have measurements of wind speed on the TBS? It might be very helpful to see if some of the observed disparities are more common under specific wind conditions, and if there might be an influence due to the presence of the balloon in very low winds (e.g. seeding and cloud glaciation due to Wegener-Bergeron-Findeisen) or issues in the SLWC measurement due to strongly varying winds. If I interpret Hill (1994) correctly, constant but not too high wind speeds are preferred for the SLWC sondes.

Detailed comments:

Page 1, Line 14: Please provide a bit more clarification of which kind of in situ atmospheric measurements you did.

Page 6, Figure 2: The beginning of the second sentence in the caption seems to be redundant. If I understood it correctly, the Anasphere SLWC sonde next to the InterMet radiosonde is shown on the left, the Anasphere SLWC sonde above the Anasphere tethersonde is shown in the middle and the Reading SLWC sonde is shown on the right. I would ask you to reformulate the caption accordingly.

Page 7, Figure 3: Figure 3 provides a good qualitative comparison of the sonde pairs, but I would recommend to include an additional figure to compare the measured distribution functions of SLWC. For that I would use only those times where both sondes had valid, non-zero readings, calculate the cumulative distribution function (or probability distribution function, whatever you like better) for each sonde and put the CDFs /

PDFs for each pair of sondes in one plot.

Page 9, Line 10: I am pretty sure that you mean Fig. 4 instead of Fig. 7 for the figure reference.

Page 11: I do not see a figure reference to Fig. 6.

Page 12, Figure 6: There is almost no contrast in the data points showing the SLWC. I would suggest plotting the values below the detection limit either white or transparent to enhance the contrast for the data that actually matter.

Page 14: I do not see a figure reference to Fig. 8.

Page 17: I do not see a figure reference to Fig. 10, Fig. 11 and Fig. 12.

Page 19: I do not see a figure reference to Fig. 13.

Page 20: I do not see a figure reference to Fig. 14.

Page 20, Line 14: Please describe the radiation correction of the DTS in more detail (reference or equation, if possible). It might be best to explain the radiation correction in Subsection 2.3.

Page 21, Line 10: When looking closely at Fig. 15, I do not see an increase of the temperature with altitude by more than 1 to 1.5 degrees Celsius. Please clarify where exactly the 3-4 °C warmer layer is located. Could it be the wrong figure that is put in the manuscript?

Page 21: I do not see a figure reference to Fig. 15 and Fig. 16.

Page 22, Fig. 15 and 16: It is hard to actually see where the inversion is located in the vertical temperature profile. Would it be more intuitive to localize if you plot the potential temperature instead of the temperature? And is there an explanation for the high near-surface temperatures in Fig. 16 around 19:40 UTC?

Page 23: I do not see a figure reference to Fig. 17.

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