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Atmospheric Measurement Techniques Discussions

Interactive comment on "Characterising optical array particle imaging probes: implications for small ice crystal observations" *by* Sebastian O'Shea et al.

Anonymous Referee #2

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As pointed out in the manuscript, in situ measurements of ice particle size distributions (PSDs) have been made to a large extent by optical array probes (OAPs) and they are still in frequent use. These probes have indicated high nμmber concentrations of particles at sizes below 100 μm. It has been shown that this is partly an artefact of shattering of larger particles. Measures to remove the impact of shattering have been developed. The question is if PSDs derived from these optical probes now are roughly correct, or if there still exist basic issues?

It seems that this study is motivated by remaining discrepancies between PSDs derived by OAPs and another type of sensor, HALOHolo, observed for some flights by the

FAAM Bae-146 research. By developing and applying measures to remove the impact of particles out of focus, that then are mis-sized, the discrepancies are largely removed.

The analysis behind the measures to avoid mis-sizing is ambitious and appears to have been performed in a solid manner. The change in PSDs for particles below 30 μm varies but can reach orders of magnitude. Such changes in PSDs have broad implications for the radiative transfer involving ice particles, both inside atmospheric models and inversions of observations.

The overall analysis has intrinsic value and is sufficient to make the article highly relevant. However, it would of course be nice to know if we now can trust PSDs derived from OAPs (if measures to avoid mis-sizing are applied)? The authors do not claim this, but the much-improved agreement with HALOHolo still hints in this direction. Anyhow, the agreement with HALOHolo works as a proof of concept and that makes the quality of the HALOHolo PSDs important.

In sμmmary, I find the manuscript very interesting and having an overall high quality.

General comments:

The manuscript is relatively long. There is already a supplement and I suggest moving some figures to the supplement. For example, despite it is nice to see the hardware, Figure 2 did not help me to understand the measurement setup. It is sufficiently well described in the text. It could suffice to just show one of Fig, 5, 6, and 7 in the manuscript. Maybe the same for Fig 12 and 13.

On the other hand, I would like to see an extension around HALOHolo. As discussed above, the accuracy of HALOHolo PSDs is quite crucial for the final interpretation of the results. Could HALOHolo in any way miss particles of 10-30 μm size? Maybe a naive question, but I don't know anything about HALOHolo and the manuscript does not give any hints. Adding some reference(s) is a basic demand, but I would prefer to also see a critical discussion.

I can not find any clear rule on how to name variables in the AMT guideline, but I would still suggest using letters for variables instead of acronyms. A basic problem with using acronyms is found in e.g. Eq 2. Is ER here a variable, or the product between E and R? Maybe OK in an equation but can cause severe confusion on the text (e.g. page 27, line 15). In any case, variables shall be typeset in a consistent manner, and not be different between text and equations.

Section 3 should be renamed to "Results and discussion".

Smaller issues:

The text is in general very clear. The only part I could not follow is the first paragraph on page 33. The problem is likely the start sentence.

More or less the same for figures. I don't understand the right panel of Figure 16 (also on page 33!). Why is it needed? And are the two panels really consistent? Further, CDP seems to disagree above 50 μm, in contrast to what is written at line 12.

Some even smaller issues I leave for the copy editing.

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