

# Author response to RC2 - 2nd round

February 25, 2025

We are grateful for the helpful comments and suggestions from the reviewer. The reviewers comments are in blue with our responses in black directly below. We have marked removed parts in red and added parts in green.

2nd round of review of “A novel aerosol filter sampler for measuring the vertical distribution of ice-nucleating particles via fixed-wing uncrewed aerial vehicles” by A. Böhmländer et al., submitted to AMT:

The manuscript improved somewhat, but there is still one open issue that needs to be addressed (1) and a few editorial comments (2). The editorial comments are minor and I try to improve readability by giving suggestions. But the one major issue is one I mentioned before, and which was not resolved sufficiently. Not much work is needed to resolve it, but it needs to be changed before I can recommend publication.

(1) One major issue Chapter 3.1 is called “Campaign 1”. In your review you state that all you have to say about Campaign 1 is, that this was only a feasibility study and that no data is shown. From how I understand that now, and also referring to the figure caption of Fig. 6, both plots, Fig. 6 and Fig. 7, show INP data from Campaign 2. As such, these should both be discussed in the Chapter 3.2 called “Campaign 2”. Right now, Fig. 6 (with data from Campaign 2) is introduced in the Chapter called “Campaign 1”. And that is not only very confusing, but also gives a wrong impression. It also means that the modifications you discuss in the beginning of Chapter 3.2 were already in place for the data you show in Fig. 6. Therefore, also the sequence in your text is wrong. You need to change your chapter names and content, so that the chapter titles reflect the content. And you need to state more clearly, that no data from Campaign 1 is shown at all!

We agree that this was not clearly described by us. We have combined the two chapters “Campaign 1” and “Campaign 2” into a single chapter, called “Campaign 1 & Campaign 2”, accordingly (Line 169).

old Campaign 1

new Campaign 1 & Campaign 2

We also adjusted the structure of the text to first give the changes on the setup, before providing the results obtained during campaign 2. We also added a sentence to clarify, that we do not show data from campaign 1 (Lines 170-195).

old Campaign 1 demonstrated the technical feasibility of the new UAV aerosol sampler in combination with the INSEKT INP analysis. To demonstrate the scientific feasibility, the frozen fraction of the UAV and ground filters are compared to their respective handling blank filters taken during campaign 2. Only one handling blank filter was taken for each setup. Figure 6 shows the frozen fraction as a function of the freezing temperature for all UAV filters, one blank filter, and its respective water background on panel (a). Panel (b) shows the same for the ground-based filters.

new Campaign 1 demonstrated the technical feasibility of the new UAV aerosol sampler in combination with the INSEKT INP analysis. *No data obtained during campaign 1 is shown here.* To demonstrate the scientific feasibility, the frozen fraction of the UAV and ground filters are compared to their respective handling blank filters taken during campaign 2, *when one handling blank filter was taken for the UAV and one for the ground.* For campaign 2, the setup was modified slightly (see Sect. 2.2), and in addition, the same filter was used for sampling during two consecutive flights. The flow over the filter is calculated by the mean pressures during sampling. The actual flow is the weighted arithmetic mean, where the weight is defined by the sampling time for each flight. Figure 6 shows the frozen fraction as a function of the freezing temperature for all UAV filters, one blank filter, and its respective water background on panel (a). Panel (b) shows the same for the ground-based filters.

Please note that the part in *italic* was changed due to one of the editorial comments (see below).

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## Editorial comments

Line 117: “(see e.g., Barry et al., 2021).” Should be “, see e.g., Barry et al., (2021).”

We have changed the citation to match this comment.

old For a more detailed description of potential contaminations and procedures during filter handling  
`\citep[see e.g.,][]{Barry2021}`

new For a more detailed description of potential contaminations and procedures during filter handling  
`, see e.g., \citet{Barry2021}`

resulting in

old For a more detailed description of potential contaminations and procedures during filter handling (see e.g., Barry et al. 2021).

new For a more detailed description of potential contaminations and procedures during filter handling, see e.g., Barry et al. 2021.

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Lines 148-151: It is still weird that you first give a number for an estimation that you then reject, while afterwards describe an improved estimation but not give a numeric value for that better estimation. I suggest to at least rephrase everything from “This detection ...” to “... earlier estimate” with something like: “This rough detection limit is, however, is still dependent on the fraction of the whole suspension used for an analysis. When accounting for the analysed water fraction, an improved detection limit results from:”

We have rephrased the wording and hope that it is now more clear. We also added a sentence to provide an example.

old This detection limit **also depends on the analysis, since** only a fraction of the whole suspension is used for one analysis. **Therefore, a better** estimate of the lower detection limit is given by the product of the analysed water fraction and the earlier estimate

$$c_{\text{INP},\text{low}} = c_{\text{INP},\text{low}}^* \frac{V_{\text{sol}}}{V_{\text{well}} n_{\text{filled}}} , \quad (3)$$

where  $n_{\text{filled}}$  is the number of wells filled with the suspension.

new This **rough** detection limit **however, does not factor in that** only a fraction of the whole suspension is used for one analysis. **When accounting for the analysed water fraction, an improved** estimate of the lower detection limit is given by the product of the analysed water fraction and the earlier estimate

$$c_{\text{INP},\text{low}} = c_{\text{INP},\text{low}}^* \frac{V_{\text{sol}}}{V_{\text{well}} n_{\text{filled}}} , \quad (3)$$

where  $n_{\text{filled}}$  is the number of wells filled with the suspension. **For a typical solution volume of 5 ml and 64 wells used for the analysis, the improved estimate is around 1.5 higher than the rough estimate.**

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Line 172: The new sentence somewhat destroys the flow of the text (i.e., “Only one handling blank filter was taken for each setup”). I suggest to instead do not insert this new sentence, but replace this new sentence with: “, when one handling blank filter was taken for the UAV and one for the ground.”

We have changed the sentence accordingly.

old To demonstrate the scientific feasibility, the frozen fraction of the UAV and ground filters are compared to their respective handling blank filters taken during campaign 2. Only one handling blank filter was taken for each setup.

new To demonstrate the scientific feasibility, the frozen fraction of the UAV and ground filters are compared to their respective handling blank filters taken during campaign 2, when one handling blank filter was taken for the UAV and one for the ground.

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Line 204: “by increasing the sampled air” should better be “by increasing the volume of sampled air.”

We have changed the sentence.

old The INP detection limit can further be decreased by flying the same filter multiple times, therefore increasing the sampled air.

new The INP detection limit can further be decreased by flying the same filter multiple times, therefore increasing the volume of sampled air.

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Lines 218-219: “..., divided by the number of flights per filter, and dependent on the flight altitude.” Both of these statements are confusing in the way how they are presented: The number you give in the first part of the sentence is for one flight. This detection limit you give is not yet “divided by the number of flights”, but has to be if several flights are collected onto one filter. It would be good to start a new sentence on that topic where the citation above starts. And for “typical detection limits ... around ...”, the flight altitude may not merit to be explicitly mentioned - its mention was more confusing than helpful.

We have removed the second part referring to the dependence on the altitude and started a new sentence to make it clear that the detection limit given can be improved by using the same filter on multiple flights.

old Typical detection limits for the setup for one flight are around  $c_{\text{INP,low}}^* = 1 \times 10^{-3} l_{\text{std}}^{-1}$ , divided by the number of flights per filter, and dependent on the flight altitude.

new Typical detection limits for the setup for one flight are around  $c_{\text{INP,low}}^* = 1 \times 10^{-3} l_{\text{std}}^{-1}$ . This detection limit can be decreased by sampling the same filter on multiple flights.

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## References

Barry, K. R. et al. (2021). “Pragmatic protocols for working cleanly when measuring ice nucleating particles”. In: *Atmospheric Research* 250, p. 105419. DOI: 10.1016/j.atmosres.2020.105419.