

Review of: "Occurrence of seeding multi-layer clouds in the Arctic from ground-based observations" by Achtert et al.

Overall impression and rating

The authors describe the observations and evaluation of seeding events in multilayer clouds during the MOSAiC ship campaign. Although the MOSAiC observations and evaluations are “only” a snapshot of a specific period of time, they are nevertheless very valuable because they are carried out in a region that is rarely observed. In particular, the combination of radiosondes and radar observations in the region is unique for analysis and difficult to achieve with other observation methods. The manuscript reads very well, the illustrations are clear and understandable, and the interpretation is comprehensible. I only have a few minor questions, but no major comments. I can therefore generally recommend the manuscript for publication by ACP.

Specific comments/questions:

- Temporal evolution of a cloud: You wrote in the appendix that the criterion of 50% radar returns has a major influence on the results. In principle, this goes hand in hand with the temporal development of a cloud. Couldn't this criterion create a bias toward cloud types with certain crystal sizes that seed over longer time scales, i.e., with smaller crystal? This would mean that clouds that seed only for a short period of time or with larger crystal in a smaller part of the cloud would be filtered out. Perhaps you could give your opinion on this.
- Representativeness and inter-annual variability: E.g. Page 16, lines 335-344: Please indicate an example of inter-annual variability (e.g. standard deviation) for example of the cloud free fraction or other fractions of one of the long term datasets to better get a feeling how large the variability actually is. Even if the inter-annual variability is not the focus of the paper and basically not shown here, it would give the reader an idea of how representative the observations and derived fractions of the MOSAiC campaign actually are even if the location not the same.
- In Ansmann et al. 2025, they reported about "Aged Siberian wildfire smoke polluted the tropopause region over the central Arctic during the entire winter half year of 2019–2020." These heterogeneous formed ice particles are generally larger and sediment to lower altitudes which could also lead to seeding of a second cloud layer. Would that effect your results in comparison to other years

with less INP around and how does that fit to your statement on page 10 line 215-218 ?

Technical comments/suggestions:

- Figure 8: I would suggest to add the words "seeding" and "non-seeding" in the label of the colorbar. I.e. "Number of cases" to "Number of seeding cases". Then the reader can see immediately which row belongs to which class.
- Page 16, line337: Please change "(no shown)." to "(not shown)."
- Page 19, line 388: Please change "now warm " to "no warm"

References

- Ansmann, A., Jimenez, C., Roschke, J., Bühl, J., Ohneiser, K., Engelmann, R., Radenz, M., Griesche, H., Hofer, J., Althausen, D., Knopf, D. A., Dahlke, S., Gaudek, T., Seifert, P., and Wandinger, U.: Impact of wildfire smoke on Arctic cirrus formation – Part 1: Analysis of MOSAiC 2019–2020 observations, *Atmos. Chem. Phys.*, 25, 4847–4866, <https://doi.org/10.5194/acp-25-4847-2025>, 2025.