

Author response to RC2

August 8, 2025

We are grateful for the helpful comments and suggestions from the reviewer. Below the reviewers comments are in blue with our responses in black directly below.

The manuscript presents a novel dataset on ice-nucleating particle (INP) concentrations obtained during the Pallas Cloud Experiment (PaCE) 2022 in Finnish Lapland.

The study provides valuable altitude-based INP concentration data, and the dataset uniqueness contributes to understanding the INP variability in the region and model evaluation.

The study is scientifically relevant, and the methodology is well described and designed. The data are open, of high quality, and supported by a careful uncertainties assessment.

Some minor clarifications may improve the quality of the manuscript, but it is absolutely appropriate for publication.

The main points of clarification include:

1 General comments

Line 5: Although the meaning of INP is clear throughout the manuscript, consider to specify the acronym also in the abstract.

We have updated the abstract to include the specification of INPs. We also updated the amount of filters that have an overlapping temporal range. Previously, the data flagged with an ERROR were included as well due to an error in the code (see also comments to reviewer 1). We also added a table in the Appendix of the manuscript to provide some more information on the samples included in this dataset.

old The dataset contains 14 INP spectra that feature a temporal overlap at both altitudes, a handling blank filter to assess possible contamination during handling and one additional sample from both setups without the temporal overlap.

new The dataset contains 9 ice-nucleating particle (INP) concentration spectra that feature a temporal overlap at both altitudes, a handling blank filter to assess possible contamination during handling and additional samples from both setups without the temporal overlap.

Lines 8-9: The abstract could be improved including some numerical values, also as range, mostly when mentions the variability of INP concentrations in time and altitude.

We have added some numerical values to the abstract regarding the INP concentration at 253 K.

old

new The INP concentration at 253 K varies between $0.15 \text{ l}_{\text{std}}^{-1}$ and $3.06 \text{ l}_{\text{std}}^{-1}$ on the ground, and between $0.48 \text{ l}_{\text{std}}^{-1}$ and $1.69 \text{ l}_{\text{std}}^{-1}$ at higher altitudes.

Lines 18-19: The sentence is a bit unclear, mostly the last part. Vertical resolution may be misleading, consider to reword this part.

We have adjusted this sentence to be more clear about our intention:

old The nature and sources of atmospheric INPs are understudied, especially with a vertical resolution (e.g., Schmale et al. 2021).

new The nature and sources of atmospheric INPs are understudies. This is especially true for the vertical distribution of INPs in the lower atmosphere (e.g., Schmale et al. 2021).

Lines 36-37: Despite, Finnish Lapland is well-known some additional information could be extremely valuable, for instance a small map of the area with the observation site. Or otherwise a short sentence that may help readers to identify the location (e.g. coordinates).

We have added some additional information and also provided a map, that describes the location in more detail.

old

new The Sammaltunturi station is located at 67°58'24" N, 24°60'58" E, while the measurements with the UAV were conducted above an open space (68°1'10" N, 24°8'52" E), indicated in fig. 1.

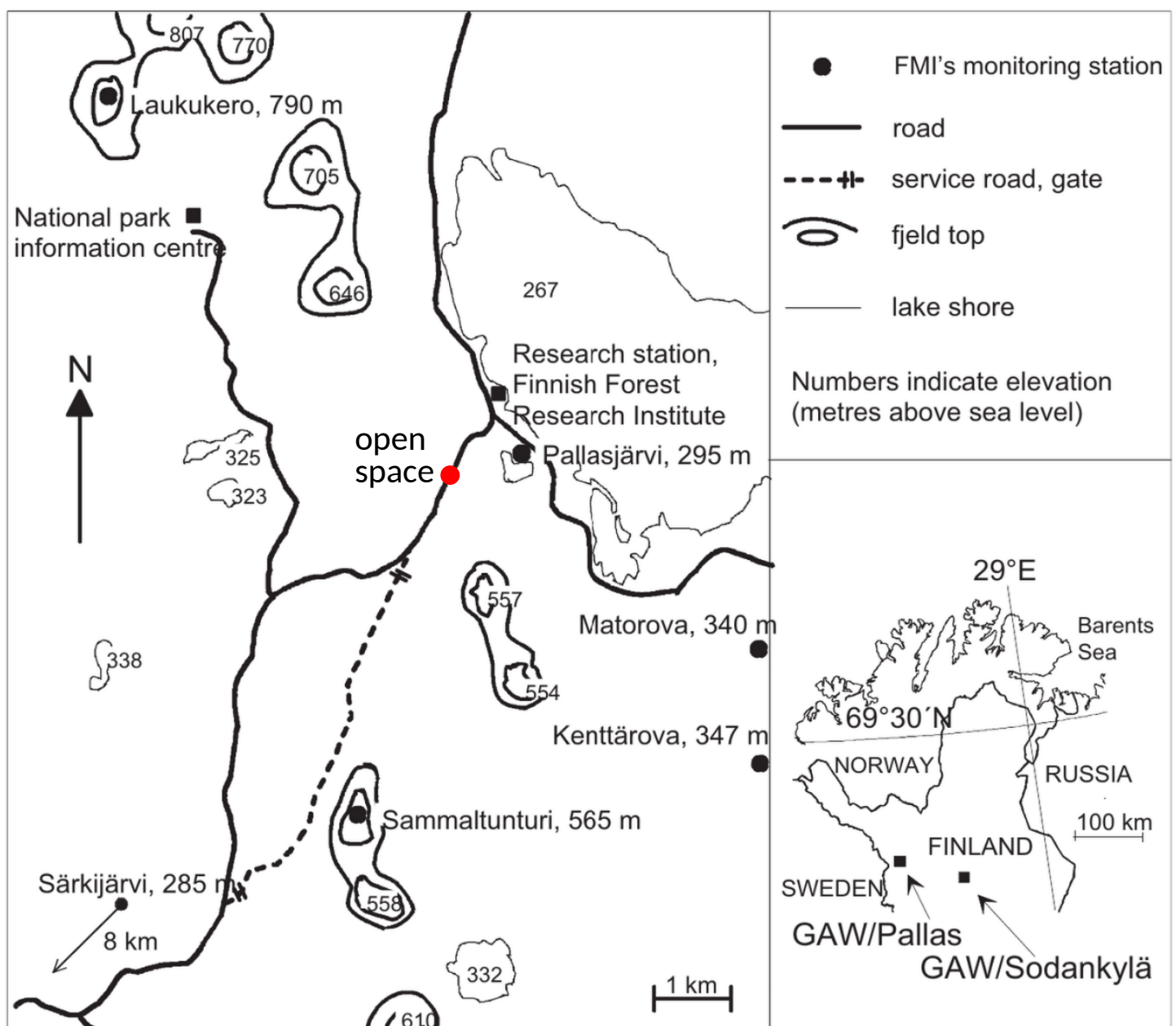


Figure 1: Location of Pallas (lower right) and Sammaltunturi (left). The red dot marks the location of the open space used for the UAV operation during PaCE-2022. Figure adapted from Hatakka et al. 2003.

Lines 46: Which is the altitude of the UAV measurements?

The designated altitude of the UAV measurements was not constant during the campaign. The individual altitudes are provided in the metadata of the NetCDF files. We have also added a sentence on the range of altitudes measured, which was suggested by reviewer 1.

old The altitude for the flight was designated to be just below cloud base to determine the INP concentration close to the cloud.

new The altitude for the flight was designated to be just below cloud base to determine the INP concentration close to the cloud. The dataset contains data from the UAV between 405 m and 906 m above mean sea level, resulting in a maximum altitude of 598 m above ground level (agl).

Lines 74-75: What do you mean for "homogenized dataset"? Consider to better clarify what you mean, being "homogenized" rather misleading.

With homogenized dataset we mean a dataset that has the information on the different dilutions removed. We have adjusted the wording to explain it more clearly.

old Finally, in Figure 3 the information on the different dilutions is removed and a single homogenized dataset is shown.

new Finally, in Figure 3 the information on the different dilutions is removed and a single dataset per filter, describing the INP concentration as a function of the nucleation temperature is shown.

Lines 105-111: In conclusions, a specific guidance for future research directions is not so clear. Seems to be better explained in the abstract than in conclusions.

We have added a sentence to give some more clear guidance for the future research direction regarding vertical measurements of the INP concentration.

old Since the data is given based on freezing events, the differential spectra can be calculated, obtaining characteristic nucleation temperatures for the aerosol sampled.

new Since the data is given based on freezing events, the differential spectra can be calculated, obtaining characteristic nucleation temperatures for the aerosol sampled. The measurement of the INP concentration at different vertical levels in the lower atmosphere should be extended in the future. Connecting these measurements with ground-based measurements might prove vital in understanding the impact of INPs on weather and climate via primary ice nucleation in mixed-phase clouds.

References

- Hatakka, J. et al. (2003). "Overview of the atmospheric research activities and results at Pallas GAW station". In: *Boreal Environment Research* 8.
- Schmale, J., P. Zieger, and A. M. L. Ekman (2021). "Aerosols in current and future Arctic climate". In: *Nature Climate Change* 11.2, pp. 95–105. DOI: 10.1038/s41558-020-00969-5.