Reviewer Comment

October 7, 2025

The manuscript provides a good use case of connecting ice-nucleating particle (INP) measurements with synoptic conditions. The study is scientifically relevant and it will be interesting to see future more extensive measurements. The structure is clear and the used methods are explained well. The data is available online and in parts also published on Zenodo.

The manuscript needs some minor clarifications, but after adressing those, it will be a good and important addition to the journal.

1 General comments

1. Lines 109-110: Could you clarify what you mean with "the trajectories might not have completely passed Melpitz"? Trajectories are always associated with some uncertainties and also of course depend on the input data.

2. Lines 127-128: This is quite a large pore size with a high flow rate as well. Checking the literature (e.g., Cyrs et al. 2010), Nuclepore filters are to my knowledge typically used at lower flows to also make sure that particles are collected within the pores due to a longer residence time. Can you elaborate on this, how you make sure that 1) the Nuclepore filter does collect a representative aerosol sample from ambient air, and 2) what the pressure drop across the filter is? These Nuclepore filters are quite elastic and might be impacted negatively by a larger pressure difference across itself.

3. Line 152: Could you elaborate on the temperature measurement? It sounds like you use the temperature of the cryostat for your measurements. Did you ever check if there are inhomogeneities in the ethanol bath, which might lead to a temperature inhomogeneity within the PCR plates? This could also be answered by citing a relevant publication, if it exists.

4. Lines 163-170: Did you check the validity of the backward trajectories? I.e. calculation of the integration error using forward trajectories or investigating the change by moving the receptor some km in latitude and longitude direction? The trajectories are of course only an indication, but this indication could be increased in significance with additional quality checks.

5. Lines 251-255: I agree that heat-labile INPs can be seen as a proxy for biological INPs, but heat-labile INPs are not necessarily biological INPs and vice versa. Are you able to provide additional information to show that those are biological INPs, especially since you already measure them in early January, where the biological activity should be at a minima in Germany. I think you should either formulate it a little bit less strict, i.e. heat-labile is a proxy for biological, or you need to provide additional indications for the nature of the INPs.

6. Lines 281-285: You discuss here well, that you see a larger ice crystal number concentration compared to the concentration of INPs that can be actived at the given temperatures. Do you consider any secondary ice production processes, which could also be an explanation for what you observe?

7. Lines 289-291: See my comment above regarding the equivalence of biological and heat-labile INPs. Also try to be consistent with the use of biogenic and biological.

8. Line 302: Could you elaborate on what you consider a significant difference? Or is it just a visual check?

2 Specific comments

1. Line 34: “Mineral dust becomes effective as an INP at temperatures...” since mineral dust is used as a singular here.

2. Line 40: “Given there is such an INP available and is immersed in a droplet at a temperature where the INP is active, the droplet freezes immediately.” The sentence reads not nicely to me. Maybe it could be reformulated in a bit simpler terms, i.e. “Upon the availability of an aerosol particle, which is immersed inside a supercooled droplet, at temperatures where the aerosol can act as an INP, the droplet freezes immediately.” To me it makes most sense to discuss an aerosol particle, which can act as an INP below its activation temperature.

3. Lines 104-105: “The distance between the two stations is 250 km.” Saying that a distance is between two points sounds wrong.

4. Line 105: Planetary boundary layer has already been defined as PBL above. Insight should also be insights, since you are not just getting a single insight from your measurements.

5. Line 106: wihtin PBL -> within PBL.

6. Lines 108-109: ...which is located approximately 440 km northeast of Hohenpeißenberg.

7. Line 122: Can you provide the conditions you refer to as standard? This can be widely different for different fields and groups and would provide needed information for comparison.

8. Line 145: Are there plans to make the Python code available online or publishing it on i.e. Zenodo?

9. Line 150: You discuss that you filled tubes with your sample, but then discuss wells of PCR plates. I assume you mean the same, therefore I would suggest to use wells throughout.

10. Lines 157-158: The sentence could be structured differently to make it a bit more clear that the heating removes the ability of heat-labile INPs to induce ice nucleation, i.e. “Afterwards, the PCR plates were heated to 90 °C for 30 min to remove the ability of heat-labile INPs, which are a proxy for the fraction of biological INPs, to induce ice nucleation.”

11. Line 183-184: Above ground could be abbreviated via a.g.l., same as above ground level.

12. Line 201: Above ground could be abbreviated via a.g.l.

13. Line 226: Heating causes -> Heat treatment causes.

14. Line 258: Above ground level could be abbreviated via a.g.l.

15. Line 266: are around -> is around.

16. Line 272: You already abbreviate ICNC in the previous paragraph, therefore I would suggest that you do not need to do it here again.

17. Line 306: colder temperatures -> lower temperatures.

2.1 Comments on tables and figures

1. Table 1: There should be spaces around the equal sign in the third column.

2. Figure 3: Using the rainbow colormap has been the standard for remote sensing data, but I would recommend to use a colormap that first of all can be understood by readers with colour vision deficiencies. This is not given with the currently used colormap. In addition, the rainbow colormap has numerous other issues, for example the linearity, which is not given for example the lightness of the colormap (e.g., Kovesi 2015). This is especially pronounced when looking at the yellow or cyan color of the colormap. These are quite sharply separated from the other colors and therefore the data itself looks different due to the used colormap. I would recommend a perceptually uniform colormap, such as viridis or cividis.

3. Figure 5: This is a nice graphic and really helps the reader to understand the different scenarios. I do have some questions regarding the uncertainties. Could you elaborate on the calculation of the uncertainties for the different instrumentation? It seems like the relative uncertainty lowers for higher INP concentration, which I guess is related to using Poisson statistics? The second part is just a bit of curiosity. When looking at panel (h), the heated samples from Hohenpeißenberg shows a very similar slope compared to the other locations at around -12 °C, but then the curve almost falls flat with only around 10 freezing events. Do you have any idea, why that could be or what that could indicate?

4. Figure 6: Same comments apply for the used colormap as given for Figure 5.

3 Technical comments

1. Line 20: space is missing between number and unit.
2. Lines 23-24: space after author last name should be removed.
3. Line 24: space is missing between number and unit.
4. Line 31: space is missing between number and unit.
5. Lines 34-36: space is missing between number and unit.
6. Line 67: space is missing between number and unit.
7. Line 69: space is missing between number and unit.
8. Line 82: latin phrases should not be hyphenated.
9. Lines 79-81: coordinates need a degree sign and a space when naming the direction (e.g. 30° N, 25° E).
10. Line 92: space is missing between number and unit.
11. Line 94: space is missing between number and unit.
12. Lines 102-103: coordinates need a degree sign and a space when naming the direction (e.g. 30° N, 25° E).
13. Line 108: coordinates need a degree sign and a space when naming the direction (e.g. 30° N, 25° E).
14. Line 113: latin phrases should not be hyphenated.
15. Line 121: units should be written upright and not italic.
16. Line 122: units should be written utilizing exponents.
17. Line 124: space is missing between number and unit.
18. Line 127: units should be written upright and not italic.
19. Line 128: units should be written utilizing exponents.
20. Line 133: space after CDC should be removed.
21. Line 141: units should be written upright and not italic.
22. Line 143: units should be written utilizing exponents.
23. Line 149: units should be written upright and not italic.
24. Line 153: units should be written utilizing exponents.
25. Line 157: space is missing between number and unit.
26. Line 181: earlier you used a single unit when showing a range (i.e. line 42), this should be consistent.
27. Line 194: earlier you used a single unit when showing a range (i.e. line 42), this should be consistent.
28. Line 245: North-Germany is not capitalized and should probably be “northern Germany”.

29. Line 259: earlier you used a single unit when showing a range (i.e. line 42), this should be consistent. In addition, there is a space missing between number and unit.

30. Line 268: space is missing between number and unit.

31. Lines 278-279: space is missing between number and unit.

32. Lines 280-281: latin phrases should not be hyphenated.

33. Line 334: Cloudlab is capitalized before (see line 75), this should be consistent throughout the manuscript.

References

Cyrs, W. D., D. A. Boysen, G. Casuccio, T. Lersch, and T. M. Peters (2010). "Nanoparticle collection efficiency of capillary pore membrane filters". In: *Journal of Aerosol Science* 41.7, pp. 655–664. DOI: 10.1016/j.jaerosci.2010.04.007.

Kovesi, P. (2015). "Good Colour Maps: How to Design Them". In: arXiv: 1509.03700 [cs.GR].