

Reviewer responses are given in blue.

Reviewer 2

In this study, filters collected during the MOSAiC cruise in the Arctic were examined. DNA analysis was done to examine the present bioaerosols, together with measurements of INPs (ice nucleating particles). The data was amended with data from filters from other Arctic samples such as seawater, sea ice, snow etc. . Backward trajectories were also analyzed to zero in on the sources of bioaerosols and INPs.

As results, the by now well-known seasonal cycles of INP concentrations were presented, together with seasonal cycles for bioaerosols. Also, some ideas on possible sources, specifically for the bioaerosols, were given. For the latter, both long-rang transport as well as local influence was observed. While some terrestrial influence on the bioaerosols was seen throughout the year, in the summer month most bioaerosols clearly came from marine sources. Nevertheless, the fungal contributions predominantly point to terrestrial sources. Also, a comparison to INP concentrations from Svalbard shows closeness of the data for most of the time, which is interesting given that the distance between the ship and Svalbard was varying and sometimes large.

This all adds nice bits and pieces to things the community already understood about bioaerosols and INPs, and certainly merits publication. The methods are all sound, the text is well structured and well written. It only occurred to me if this is not better published as a measurement report rather than a full scientific publication. But this is a decision the editor should make.

There is one really unsettling information in the manuscript, which is the discrepancy between the INP concentrations published in Creamean et al. (2022) and in here, which both come from samples collected onboard the Polarstern simultaneously. I suggest below to include a comparison with other Arctic data to learn which of the two datasets may be closer to these. This may be included in the main text or the SI. But it should be done.

As the number of my comments and remarks below is rather small, they are all just given one after the other. And, as said, publication can certainly be granted once these few small and the one larger issue are taken care of.

Thank you to Reviewer 2 for the helpful responses to improve this manuscript. We have made all suggested changes, added clarification, and improved the discussion surrounding the measurement discrepancy. We address the discrepancy between Creamean et al. (2022) and our findings in the response below.

Comments:

Line 185-186: There is a “,” missing between “productivity” and “sea”. - Also, you mention “less snow coverage” – where was that (as you were on a ship)? Are you referring to snow on land? Please clarify.

The text now reads: “The heat labile maximum in summer is reflective of enhanced biological productivity, sea ice minimum, glacial retreat, and less terrestrial snow coverage.” (Lines 192-193)

Line 209: Change “wasn’t” to “was not”.

The text now reads: “The alpha diversity of the aerosol samples was not significantly ($p < 0.05$) different between seasons (Fig. S5), despite increased variability in the spring and summer, providing further evidence that the bioaerosols were diverse taxonomic mixtures.” (Lines 217-219)

Line 275: Please add a number for what you consider are “higher INP concentrations”.

Thanks for the suggestion. The text now clarifies the value in reference to the filter collected during November 18-21: “After November 18-21, *Polaribacter* was not detected again until May 2020, and higher INP concentrations at $-15\text{ }^{\circ}\text{C}$ ($>1.8 \times 10^{-3}\text{ L}^{-1}$) were not detected until January.” (Lines 287-288)

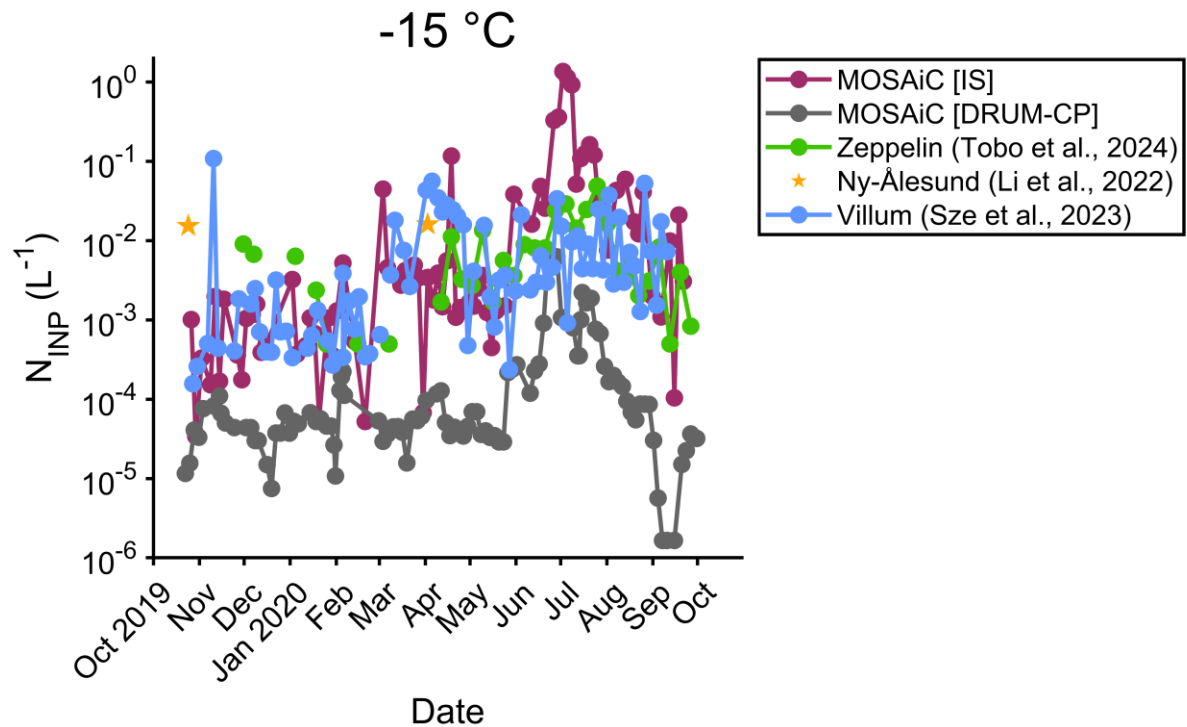
Line 289: Add to this sentence where the *Polarstern* was, compared to Svalbard, in June and July, or at least point to Fig. 6 where the distance between both can be seen.

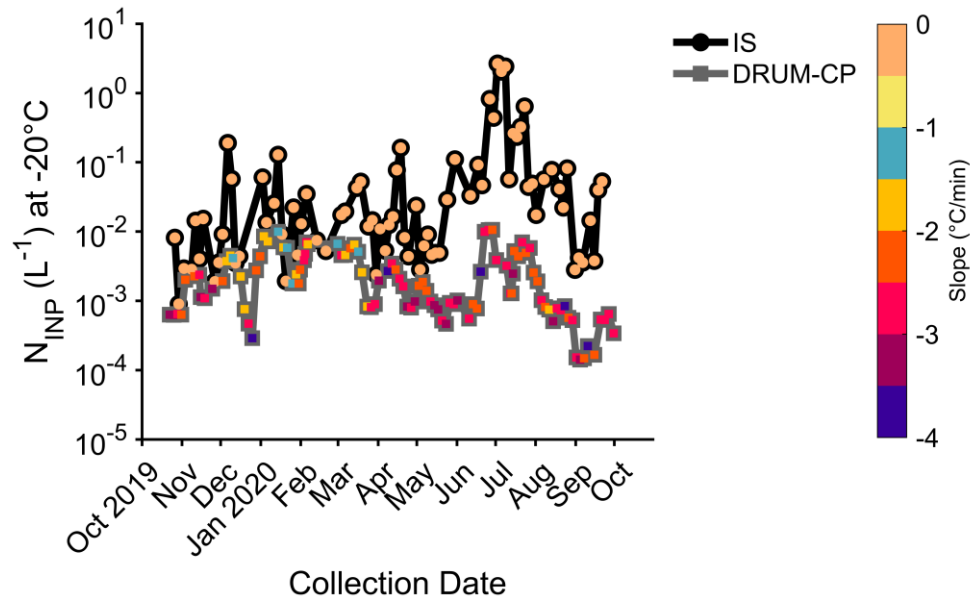
Thank you, the text now reads: “Mean concentrations at $-15\text{ }^{\circ}\text{C}$ differed between the sites only by a factor of around 2 in the fall, winter, and spring, but, at MOSAiC, were as much as an order of magnitude higher in late June and early July (up to 1.4 L^{-1} at $-15\text{ }^{\circ}\text{C}$), when the *Polarstern* was an average of 450 km away from Svalbard (Fig. 6).” (Lines 298-301)

Line 291-292: The mentioned difference between your two datasets (one published earlier and the one included here) is unsettling. In the previous part you argue that INP concentrations quite similar between Svalbard and the *Polarstern*, no matter the distance between the two. And it is likely adequate to assume a somewhat repeatable annual cycle in INP concentrations. There were other Arctic long-term data published before, for land-based INP sampling, connected to parameterizations (e.g., Li et al., 20; Sze et al., 2023; the latter having data taken simultaneously to your measurements in northern Greenland). It would be very instructive to compare your data with these and see if either of your datasets matches, and which one. Please add this comparison to your manuscript or to the SI.

Thank you for the suggestions. We have added one new supplemental figure (Figure S8), adopting the suggestion to additionally compare to Li et al. 2022 and Sze et al. 2023 as they were both collected in the same time frame as MOSAiC. Additionally, we include another figure, a measurement cooling slope comparison figure in this response. Although we don’t expect the concentrations to match entirely since they were collected near ground level and near land, these two added studies are still much closer to the polycarbonate filters collected on the *Polarstern* than the DRUM. In addition, we also added to the end of Text S1: “This different cooling rate was a function of some DRUM samples (primarily spring and summer) being analyzed in a different laboratory with a $\sim 15\text{-}20\text{ }^{\circ}\text{C}$ colder ambient temperature. The sample integration time differences (24- versus 72-hour) could result in short term concentration discrepancies but should not influence the seasonal averages. Comparisons with two other Arctic ground studies that made

measurements at the same time as MOSAiC (Li et al., 2022; Sze et al., 2023) revealed much better agreement with the polycarbonate filters analyzed with the IS (Fig. S7), which gives confidence in this dataset as representative of both the central and wider Arctic basin. Comparison tests and investigations of this unexpected result are ongoing. When DRUM samples were run on the IS, the agreement was generally much better to the total aerosol filters, suggesting measurement techniques account for at least some of the discrepancies (Fig. S7). Overall, the INPs from the DRUM and cold plate analysis should be viewed as a lower bound or subset of observed total aerosol INPs. The use of only the total aerosol INPs for future studies is recommended as it is more representative.”





SI, line 20: Sampling time typically is taken care of when INP concentrations are calculated. That parameter should not show up in seasonal average values, unless there would be clogging of the filters for the longer sampling times, which, given the environment in which you took your samples, is unlikely. Remove the “sample integration time” from your list of possible differences, and maybe explain in a separate sentence that this should not influence the results if measurements are done properly.

We agree and have removed that from the sample integration time, and added the clarification sentence: “The sample integration time differences (24- versus 72-hour) could result in short term concentration discrepancies but should not influence the seasonal averages.” (Lines 24-26)