

# ***Interactive comment on “Resolving the size of ice-nucleating particles with a balloon deployable aerosol sampler: the SHARK” by Grace C. E. Porter et al.***

## **Anonymous Referee #1**

Received and published: 15 January 2020

This work reports on a new technique for measuring size-resolved INP number concentrations using an aerosol sampling system, SHARK. The SHARK system uses two different types of impactors for collecting aerosol samples for INP measurements. Then, they compare the sized-resolved INP number concentrations obtained using these two impactors and demonstrate that the results were almost the same. This result is very important and valuable, because one of the impactors use a high flow rate up to 100 L min<sup>-1</sup>, indicating the possibility that this impactor may be useful for collecting sufficient amounts of aerosol samples for INP measurements efficiently during a limited sampling time of tethered balloon measurements. However, it is still unclear whether the SHARK system is indeed a reliable technique for measuring size-resolved INP number

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concentrations at high latitudes, because the results presented here are based on only several measurements near the ground level at Hyytiälä, Leeds, Longyearbyen, and Cardington. I would strongly suggest that the authors include the results of balloon-borne measurements at higher latitudes ( $\sim 100$  m above ground level or more) in the revised paper.

General comments:

1) I couldn't find any detailed descriptions regarding a campaign in the High Arctic. When and where were the samples shown in Figures 4 and 5 collected? Why didn't you report any results of INP number concentrations using the SHARK during a campaign to the High Arctic?

2) Because the objective of this paper must be to report a new technique that can measure size-resolved INP number concentrations using a balloon deployable aerosol sampler, the authors need to evaluate the performance of the impactors used for the SHARK system at high altitudes and provide evidence that it can indeed be useful for INP measurements even at higher altitudes (at least, more than 100 m above ground level).

Specific/technical comments:

3) What do you mean by the description "short battery lives of 10s of minutes (Line 79)"?

4) Line 264: "While the particle number concentration increases roughly linearly with size": It seems that the concentrations decrease with increasing the size.

5) Although the authors describe that "the spectra in the four locations have very different characteristics (Lines 345-346)", the spectra may also show some seasonal variations. For examples, recent field studies (e.g., Santl-Temkiv et al., Environ. Sci. Technol. 2019; Tobo et al., Nat. Geosci. 2019; Wex et al., Atmos. Chem. Phys. 2019) show the seasonal variation of INP number concentrations in the Arctic.

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6) Lines 358-361: Why did you speculate that the coarse mode INPs at this site were possibly pollen? In general, pollen grains have much higher sizes ( $>10\text{ }\mu\text{m}$ ). Also, why did you rule out the possibility of other possible sources, such as fungal spores, fertile soils, etc.?

7) I couldn't find the results of ice-active site density per mass ( $n_m$ ) (Line 185), while those per surface area are shown in Figure 10.

8) The authors should provide the more detailed information on the field samplings (locations, time, periods, etc.) at Hyytiälä, Leeds, Longyearbyen, and Cardington in Section 2 and/or table, and not Section 3.

9) Figure 2 caption: “ $100\text{ }\mu\text{L min}^{-1}$ ”  $\Rightarrow$  “ $100\text{ L min}^{-1}$ ” (?)

10) Figure 5: Where were the data from Hegg et al. (1996) obtained?

11) The y axis of Figures 6, 7b, and 8: [INPs]  $\Rightarrow$  INP concentration (?)

12) I would like to suggest that the authors show the comparison of INP number concentrations from stages 1d and 2d in Figure 7.

13) Figure 8: I would like to suggest including the information on the size ranges of “Sum of 2d & 2e” and “Sum of 1b, 1c, and 1d” in the figure legend.

14) As also mentioned by the authors, it seems that Figures 8 and 9 are essentially the same. I would like to suggest merging Figure 9 into Figure 8, or simply removing Figure 9 from this manuscript.

15) The y axis of Figure 10: “Activated fraction”  $\Rightarrow$  “ $n_n$ ”, and “Active site density”  $\Rightarrow$  “ $n_s$ ” (?)

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-457, 2019.

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