**Response to Review:**

Overall, the authors have done a very good job addressing my points. The separate uncertainty section is good. There was one minor exception where they perhaps misunderstood the question, discussed below. I am fine with recommending this to be published, but have a couple minor points that the authors might want to consider, discussed below.

We thank the reviewer for the helpful comments that have improved the quality of the paper. Below, we respond to the comments in red.

(Original comment)
4. I recommend that the authors either include in the analysis or cite other relevant datasets. a. For example: L421: "This further highlights the need for observations in other regions to better understand the impacts of lead emissions." I believe there are other observations. For example, Villum Research Station has historic Na data.
The 2008 NASA ARCTAS campaign has Br concentrations. There may also be
data from ship campaigns and other aircraft campaigns as well.
--> (Author's response)
- The model data is monthly-mean output that is not at a sufficient temporal resolution for meaningful comparison against aircraft data (like NASA ARCTAS). We therefore prioritize long-term stations instead.
- There is a gap in data from 2003-2007 at Villum, which is a majority of our study period. Additionally, Villum data is not publicly available.
We include Pallas (see Figures 7 and 8 in the main text) as an additional station with observations available from 2003-2008. We add a description of the Pallas observations within Sect. 2.3 and include it in our model evaluation in Sect. 3.3.
--> --> (Reviewer's response)
Great that Pallas is added! It is an inland site though. The authors might consider discussing the implications of that on the data interpretation. Fair enough about Villum. In case it is relevant for future projects, my experience is that the Villum folks tend to be pretty open to collaboration if one asks for access to their data. Regarding the aircraft data, that's fine, especially in context of Figs. 7 & 8. But I would argue that it is not always true that monthly mean output is not of sufficient temporal resolution for a meaningful comparison to campaign data - it depends on the question being asked.

We include this clarification within this sentence (Lines 446-449): “There is minimal change in SSA concentrations where Pallas is located, explaining the near equal Na+

concentrations for the standard + leads and standard simulations which results in the overlapping lines in Fig. 7d, suggesting minimal influence from leads at this site likely due to its inland location."

(Original comment)
11. L172: Probably worth mentioning here that in the wintertime Arctic, there isn't a lot of rain deposition or convective precipitation. Also probably worth mentioning that precipitation is notoriously hard to predict correctly in the Arctic. Please comment on how this latter fact might influence your findings.
--> (Author's response)
"In this study we do not predict precipitation but instead use a reanalysis product MERRA-2 which includes observations. We clarify what MERRA-2 is with the following description: "GEOS-Chem and HEMCO are driven by Modern-Era Retrospective Analysis for Research and Applications (MERRA-2) (Gelaro et al., 2017) meteorological fields from the NASA Global Modeling and Assimilation Office (GMAO), which is reanalysis meteorological data assimilated from various observational sources (i.e., satellite, aircraft campaigns, and ground stations) providing variables such as temperature, wind, precipitation, and humidity." Lines 175-179".
--> --> (Reviewer's response)
I think part of my point was misunderstood here. First, a clarification: reanalysis products assimilate what information there is on precipitation and meteorology from satellite data and some other data sources, but they use a model to predict precipitation where there are no observations or where the observations are incomplete/have high uncertainties. The Arctic has very few ground observations of precipitation, particularly over sea ice. So MERRA-2 precipitation predictions in the area of this study are mainly based on model information and satellite data. But the satellite data are sampled incompletely, are particularly uncertain over sea ice due to low thermal contrast between clouds and the surface, and even in good conditions have large uncertainties in things like snowfall, particularly near the surface. Like other models and reanalysis products, MERRA-2 comparisons to actual observations of cloud properties (such as presence and phase) are often way off (e.g., Taylor et al., 2019), and thus so is precipitation. This is well known in the field of polar cloud research. So to restate my point here, I think it is worth mentioning at this point in the text that precipitation over the study area can be hard to predict, even with a reanalysis product, and I still recommend commenting on how this uncertainty influences your findings (maybe in the new uncertainty section?). If the authors feel it is more appropriate, the comments on this uncertainty could be framed in the sense of recommendations for future work.

We include this as a source of uncertainty in the uncertainty section (Lines 560-564): “In addition, there are sparse ground observations of precipitation in the Arctic, and while the MERRA-2 reanalysis uses both model and satellite data to fill these gaps, Arctic cloud properties and precipitation can still be difficult to predict (Barrett et al., 2020; Taylor et al., 2019), which could affect the accurate simulation of aerosol deposition and, in turn, our simulated SSA concentrations.”

(Original comment)
Fig. 1: There is not enough contrast between the white background and the light blue colors. Please redo the figure so that a readers can clearly see the lead area fraction and related percentages. Maybe a rainbow color scheme instead of just a blue-based color scheme would help?
--> (Author's response)
The rainbow color scheme is not color-blind or black-and-white print friendly. We change the Figure 1 colormap to the scheme in python called “inferno” as it shows the lead area fraction more clearly than the blue.
--> --> (Reviewer's response)
I hate to seem picky, but I think this color scheme makes it even harder to see the details. Maybe something more like Fig. 1b in Willmes, S., Heinemann, G., and Schnaase, F.: Patterns of wintertime Arctic sea-ice leads and their relation to winds and ocean currents, The Cryosphere, 17, 3291–3308, https://doi.org/10.5194/tc-17-3291-2023, 2023?

We change the color scheme to a similar scheme shown in the linked paper. The change is reflected in Fig.1.

(Original comment)
Figs. 4, 6, S5, and S7: Please enhance the contrast in the land border color in the figures relative to the figure colors. Right now the black thin borders cannot be easily seen, making it harder to distinguish feature locations.
--> (Author's response)
We add thicker black borders for better contrast in each of these figures.
--> --> (Reviewer's response)
That is better, but perhaps consider a white border to enhance contrast? Might be better. Just a suggestion.

We attempted the white border which improves contrast slightly over purple regions but makes regions covered in lighter colors and yellow (e.g., Fig. 6c, d, and f) very difficult to see. We therefore retain the black borders.

(This comment refers to the new, modified text)
"Sea salt aerosols (SSA) affect Arctic climate by scattering incoming solar radiation and acting as cloud condensation nuclei and ice nuclei (DeMott et al., 2016; Pierce and Adams, 2006; Quinn et al., 1998). In the Arctic, these processes are relevant during the fall and spring, but negligible during polar night, when there is no sunlight. "
- CCN and INP still impact clouds during polar night, and can impact longwave cloud processes, so have more than negligible effects during polar night.

We rephrase this sentence for clarification (Lines 60-61): “While in the Arctic there is no sunlight during polar night to scatter radiation, cloud condensation nuclei and ice nuclei can still have impacts on clouds and longwave radiation.”

Reference:
Taylor, P. C., Boeke, R. C., Li, Y., and Thompson, D. W. J.: Arctic cloud annual cycle biases in climate models, Atmos. Chem. Phys., 19, 8759–8782, https://doi.org/10.5194/acp-19-8759-2019, 2019.