

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## Comment on acp-2022-280

Anonymous Referee #1

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Referee comment on "Collective geographical ecoregions and precursor sources driving Arctic new particle formation" by James Brean et al., Atmos. Chem. Phys. Discuss.,  
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**General comments:** This manuscript analyzes atmospheric particle formation and growth rates for six Arctic sites. Back trajectories are used to examine the potential locations for particle precursors. The manuscript provides a useful scientific contribution since there remains considerable uncertainty about sources and processes associated with new particle formation (NPF)/growth in the Arctic. The following questions/concerns should be satisfactorily addressed prior to final publication.

### Specific comments:

Figure 1: Please consider adding numerical labelling to the vertical axis for GR, CS, and Q. Currently there is only 1 tick labelled for the GR, CS, and Q panels.

Figure 4: To help with the interpretation of Fig. 4, which of these differences are statistically significant? For example, for GRU and ZEP, there does not appear to be any appreciable difference between NPF and non-NPF trajectories. However, for ALE, TIK and VRS, there are increases in the trajectory fraction over sea and land for NPF versus non-NPF, but it is uncertain if these differences are statistically significant. Likewise for UTQ, there is an increase in time over sea ice for NPF versus non-NPF, but is this a statistically

significant difference?

Figure 5: The schematic is helpful to visually indicate the variety of sources. There are aspects of the figure that are somewhat confusing and could be modified for a cleaner presentation. What do the vertical red and grey bars near CML and SML indicate – are they needed? What is the meaning of the large grey box – is it needed? Could the number of arrows on the figure be reduced? Why are some arrows longer than others? The grey box appears to list the precursors, but it is unclear if they are meant to be vertically aligned over certain sources.

Table S1: Please replace BAR with UTQ for consistency with the rest of the manuscript.

Figure S1: The meaning of the faint lines is unclear.

Figure S4: Is the hour of day in local time?

L26: The authors comment that the mean frequency and particle formation rates vary greatly between sites. How much of this variability can be attributed to differences in the years that measurements were available for the various sites?

L42: How do the predicted and observed temporal trends for cloud cover differ?

L47: The authors draw focus to neglect of iodine nucleation in models – are there other mechanisms that are also often neglected as related to organics etc.?

L68: At what spatial scale are the eco-regions defined? Please clarify here about which eco-regions will be employed for this analysis.

L78: There is mention of a lack of 'simultaneous' comparisons – 'simultaneous' seems redundant here.

L110: How reliable are the measurements between 10 and 20 nm for the various instruments?

L122: How is CoagS<sub>dp</sub> calculated?

Eq. (4): What is the definition of  $\lambda$ ? How could these calculations and conclusions differ if the particle growth was driven by vapors other than sulphuric acid? The residence time in each cell is used in the calculation of the concentration-weighted trajectory – does this assume that at all times, the vapor source rate will be the same for all grid boxes?

Please clarify and if so, how does this assumption impact the conclusions?

Section 2.4: 3-day back trajectories are used to examine the regions that the air mass has passed over prior to arriving at the time of NPF. To help with interpreting these trajectories, please indicate the expected lifetime of the precursor vapors. How do vapor aging processes impact this calculation?

L151: How does the 1x1 degree resolution of the grid cells impact the results?

L157: How does neglect of trajectories above 1 km impact the conclusions?

L167: Why does the condensation sink not appear greater in the Arctic Haze season? This seems unexpected – what contributes to this lack of difference between seasons?

L174: Is this local time?

L209: What is the driver of NPF at VRS if there appears to be no link to any specific eco-region?

L220-221: Please check the wording here – it is not clear that the concentration-weighted trajectories can conclusively show that vapours driving particle growth “come from all the surrounding open ocean and sea ice regions”. Certainly, there is the potential for contribution from any of these regions – but is it possible that some regions might contribute more strongly than others in a manner that is not considered by this analysis approach?

L234: ‘strongest vapour source’ – do you mean ‘...source region’?

L239: Should this association of the sea ice with the oil fields be indicated in caption of Fig. 4 to indicate that sea ice regions and oil-field regions could not be separated?

L242-245: Consider merging this 1-sentence paragraph with related text elsewhere.

L252: ‘calculated values are similar’ – where is this shown?

L253: ‘strong source regions’ – please indicate what is meant by ‘strong’ – is there a certain magnitude?

L261: Are there any other potential reasons for slow particle formations rates, in addition to iodine oxoacid related NPF?

L266: The potential vapour source from the coast of Greenland is interesting – could there be other sources in addition to DMS here?

L290: Regarding the influence of sea ice on NPF – what is the potential of vapors from open leads in the sea ice to also make a contribution?

L290: The sentence starting with 'Increased melting of permafrost...' seems not to fit in this discussion on sea ice – would text this fit better elsewhere?

L307: 'likely varying wildly' – are there references that could support this speculation?