We thank the anonymous reviewer for their thoughtful comments and suggestions. We address each one directly below and outline changes that will be made to the revised manuscript.

Reply to Anonymous Reviewer #1

Specific comments:

Abstract, line 28: Please specify "data production rate of 10 SSA formed from one snow particle".

Answer: we rephrase that sentence to 'If we assume ~10 SSAs can be generated from one snow particle during the evaporation process, then model could reproduce the observations'

Line: "very similar results" is too vague, please specify: Something like "Although both mechanisms generate very consistent results with respect to observed aerosol number densities."

Answer: Thank you, it has been changed according to your suggestion.

Introduction: You can remove line 30: A brief conclusion is presented in section 6.

Answer: Done

Section 3.1: line 23: "from the " appears in bold in my version.

Answer: corrected

You said "The control run for open ocean sea spray is SI_Base_OO, following the scheme by Jaeglé et al. (2011)". But this run is denoted OO_Jaeglé in Table 1, right ?.

Answer: There are three experiments regarding open ocean sea spray in Table 1: OO, OO_Jaeglé and OO_Caffrey. Both OO and OO_Jaeglé apply Jaeglé et al. (2011) scheme, but they are slightly different. OO result is used in cruise data-model comparisons. OO_Jaeglé is only used for Figure 7, as it is driven by fixed meteorology data, e.g., with a fixed wind speed of 12m/s.

Section 3.3.4: Be carefully (remove) with abbreviations NH (northern hemisphere) and SH (southern hemisphere) since you already used SH for high salinity.

Answer: Thank you for pointing out this issue. In the revision, we will use 'southern hemisphere' and 'northern hemisphere' to replace SH and NH respectively.

Section 3.3.7, line 14: Please correct «single»

Answer: Done.

Section 4.2: Here or in figure 5 caption, may be good to indicate references for the observations at the different polar sites.

Answer: The aerosol data are from the following sources: Alert, Barrow and Palmer = AEROCE-SEAREX network (Savoie et al., 2002); Neumayer = Weller et al. (2011); Halley= Rankin et al. (2004); Kohnen = Weller and Wagenbach (2007); Concordia = Legrand at al. (2016); Summit = Mosher et al. (1993) but after Rhodes et al. (2017). References for the observations used in Figure 5 will be given in the revised version.

Conclusion:

I think the sentence "However, the aerosol concentration (Frey et al., in preparation) gradient observed between near surface (~2m above snow surface) and ~29 m will not allow *us to conclude robustly where the SSA is produced." is an important new information that would appear earlier in the manuscript (the conclusion is not exactly the right place for such a new information).Whereas I fully agree with your conclusion "Thus, this highlights the need for further in-situ observations and laboratory investigation to fill this gap.", but it may be nice to be more precise here. For instance, did the study of the size segregated chemical composition of sea-salt aerosol that can cover the range between 0.03and 20 micron diameters can help ?*

Answer: Good suggestion. In the revised version, we discuss this issue in section 5 (Physical mechanism of SSA production from blowing snow) with a new paragraph shown below.

'Cruise data show that blowing snow particle number density decreases significantly, e.g., by more than an order of magnitude from near surface (~2m above snow surface) to ~29 m. However, aerosol number densities between these two levels do not show such a large gradient as observed for blowing snow. For example, observed data indicate (Figure 5 in the companion paper by Frey et al., acp-2019-259) that during drifting snow episodes aerosol number densities increased significantly especially of sub-micron sized particles at both measurement heights, with a lightly greater increase near the surface (number density up to 10^7 m^{-3} for diameter <2μm). During blowing snow number densities showed similar increases as during drifting snow, however at 29 m concentrations were higher and particles were larger (at diameter >9 μm) than at 2 m. This observational evidence prevents us from deriving any robust conclusion regarding where SSA is generated: in the near surface layer where *RH* is saturated or at the top of the blowing snow layer where *RH* is under saturated. If SSA is mainly produced near the surface layer, then snow particle evaporation will be controlled by the 'curvature effect' (following the SI_Base corresponded mechanism). However, if SSA is produced in the sub-saturated condition, e.g. at the top layer or above the blowing snow layer, then water evaporation will be controlled by the SI_Classic corresponded mechanism.'

Model experiments with the above two mechanisms implemented (e.g., SI_Base_A and SI_Classic_AX10) can produce roughly the same number density at size range of 0.375-10 μm. However, at SSA size <0.375μm diameter, their results are quite different as shown in Figure 3c and Figure 4a. For example, at diameter of 0.1 μm, SI_Base_A has a mean SSA number density almost an order of magnitude larger than that of SI_Classic_AX10 and SI_Classic_BX20. Therefore, a precise observation of SSA at sub-micron size mode can help to diagnose which micro-physical mechanism(s) dominates the SSA production. A systematic measurement of the size segregated chemical composition of SSA over a size range of 0.03 to 20 μm diameter, together with a complete spectrum of blowing snow particle size will help to distinguish which mechanism dominates SSA production from blowing snow (also refer to reply to reviewer #2 comments).'

In addition to extend the information towards the smallest particles, such chemical information (the sodium to sulfate fractionation for example) would permit to investigate the mixing between particles emitted from open-ocean and from marginal ice.

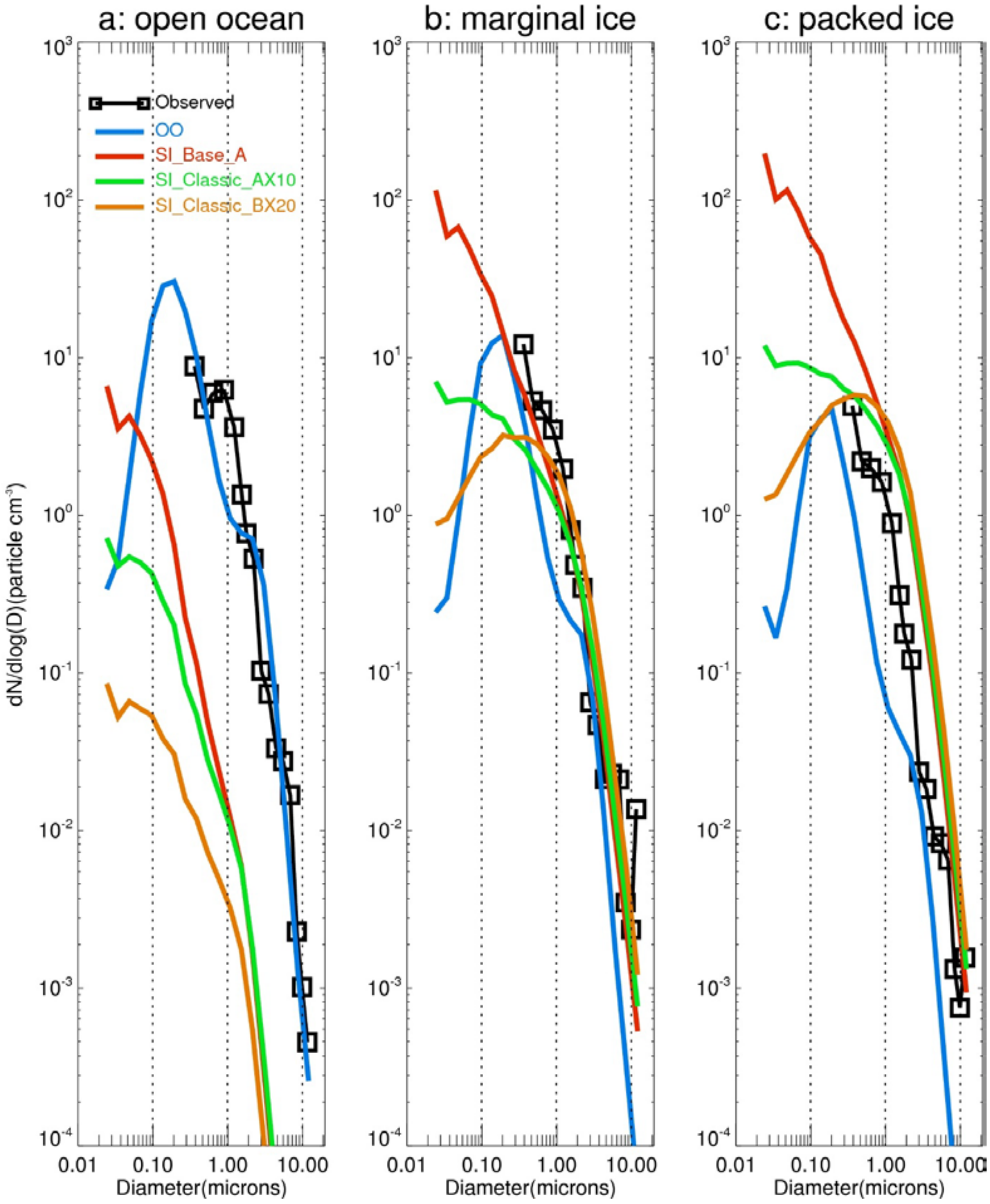
Answer: When information of non-sea-salt sulfate contribution is well known, the sodium to sulfate fractionation analysis would help in investigating the mixing between particles emitted from open ocean ad from sea ice. Otherwise the Na/SO_4 ratio isn't that helpful. Measuring sulfur isotopes on the sulfate maybe needed in addition.

Figure 1: Please introduce also the green line (open ocean) in the caption.

Answer: Done

Figure 3: The vertical scale (10-4to 103) is the same for the three panels so, removing the numbers in panels b and c, would permit to increase the horizontal scale and to better see the difference in the observations between panels a, b, and c. If not (or in addition), please add a vertical dashed line at one micron on the three panels.

Answer: Vertical dashed lines for diameter of 0.1, 10 and 10 µm have been added to panels in Figure 3 (and Figure 4).



Updated Figure 3.