Response to RC1: 'Comment on egusphere-2025-2829'

October 22, 2025

We are grateful to the reviewer for taking the time to review our manuscript and for offering such valuable feedback. Your observations and helpful recommendations contributed to enhancing the clarity and quality of our work. Please find below the response (in blue) to your comments (in black)

The authors have undergone an extensive modelling study to understand the impact of several factors (sea ice extent, wind speed, SST) on the emission of speciated PMOA over the last several decades. They have done the analysis on a regional basis and searched for trends relating decreases in sea ice area to increases in PMOA emissions. As they discuss in section 5, all of this is very difficult to do considering the lack of PMOA seawater and atmospheric aerosol data, especially speciated, in the Arctic. Given the lack of data and the many uncertainties involved, the paper advances the understanding of factors controlling the emission, seasonality, and trends in Arctic PMOA.

1. Lines 184 – 185: Were open leads and melt ponds considered in estimating PMOA concentrations?
   Leads and melt ponds were not included in the model; we have added a sentence at line 186 to explicitly state this: "However, in the present study, open leads and melt ponds are not included in the model simulations."

2. Table 1: Is an analysis of annually averaged data justified since there is so much seasonality in the factors controlling emission flux, burden, and deposition?
   We agree, annually averaged data would not be justified in this case given the strong seasonality shown, for example, in Fig. 5. However, Table 1 does not show the annual average values, but rather the multi-year average over a period of 15 or 30 years of total annual emissions over the Arctic. Since the table header was misleading, we changed it as follows: "Table 1: Total emission flux, atmospheric burden, and deposition of marine aerosol particles, calculated by summing daily values across all Arctic grid cells and averaging yearly totals over the two 15-year periods and the full 30-year period." Following this comment, and for consistency with Table 1 and Table

3, we also decided to show total seasonal emissions as just explained in Fig. 5 and Fig. 11 for July-August-September, and Fig. F5 for April-May-June. Additionally, for better alignment with Fig. 9, Fig. 10 shows the trends of regionally averaged emission fluxes.

3. Lines 318: Is there a reference for the SST correction factor for the SS emission flux?

   The sea surface temperature (SST) dependence of the sea spray emission flux is implemented following Sofiev et al. (2011). This reference has now been included in the text.

4. Figure 5: The order of figures for e) and f) is different than what is stated in the caption.

   We have corrected this error in the figure caption.

5. Lines 339 – 341: It is stated on lines 301 – 302 that SS emissions from the model are a sum of both the accumulation and coarse modes. Earlier in the paper it says that PMOA fluxes are based on SS fluxes which are based on temperature. Yet, it is stated here (lines 339 – 341) that the SST correction factor used in SS model simulations remains relatively similar for the accumulation mode. Is only the SST correction for the accumulation mode used for the speciated PMOA fluxes? It seems confusing if the speciated PMOA fluxes are coming from size independent (accumulation + coarse modes) SST emissions but size a dependent (accumulation mode only) SST correction.

   PMOA is only emitted into the accumulation mode, based on SS emission of the same mode, which depends on SST. PMOA is not emitted into the coarse mode directly, and the mass emission fluxes of PMOA do not encompass the coarse-size particles. In contrast, SS is additionally emitted into the coarse mode. Hence, the SST correction only affects the accumulation-mode PMOA emissions while for SS, it influences both the finer and coarse modes.

   In the model output, the emission fluxes are not mode-dependent. Therefore, in lines 301 – 302, we specify that the SS emissions are not accumulation mode alone but also coarse mode.

   To make these aspects clearer, we modified lines 339-341 as follows: "Overall, SST ranges between -2 to 6 °C. Within this temperature range, the Sofiev et al. (2011) SST correction factor used in the SS model representation remains relatively similar for the particles in the accumulation mode, which is the only size class contributing to PMOA emissions. Therefore, in this case, SST has a lesser effect on marine emissions. "

6. Figure 8: Should this be Beaufort Sea for (b)?

   That is correct, it should be Beaufort Sea. We have changed this in the figure caption.

7. Line 611: Change "along" to "alone".

   Thanks for pointing this out. We corrected it.

References

Sofiev, M., Soares, J., Prank, M., de Leeuw, G., and Kukkonen, J.: A regional-to-global model of emission and transport of sea salt particles in the atmosphere, Journal of Geophysical Research: Atmospheres, 116, https://doi.org/10.1029/2010JD014713, 2011.