

This work uses atmospheric modelling combined with a marine biogeochemical model to investigate the drivers and evolution of primary marine organic aerosols in the Arctic, in the context of the changing sea-ice. The topic is very relevant and an important contribution to the community. The methods are well described and the figures are overall clear.

My main concern is the very high level of detail provided in the manuscript, which sometimes makes sentences and paragraphs hard to follow, and distracts from the important messages of the paper. I provide a few examples below, along with a few minor/specific comments. The scientific contents of the paper are otherwise good and it deserves publication in ACP.

Specific comments

- L177: "The biomolecule ocean concentration serves as boundary condition for ECHAM-HAM, as explained in the previous section" - if it is explained in the previous section, no need to say it again. Please try to get rid of all similar occurrences of "as previously explained" throughout the manuscript.
- L186–195: please try to find a more direct way to explain your sea-ice mask. I am not sure I understand it. Suggestion of rewording "[... prevents bubble bursting at the surface.] Although sea spray emissions can occur in the marginal ice zone and within the sea ice pack through open leads and melt ponds (REFS), these sources are not considered in this study for lack of model of their emission fluxes. Therefore, because we cannot include these sources, we apply a sea ice mask that considers only the open ocean grid cells (SIC<10%, Arrigo et al., 2008) when, and only when, we present average parameters over the Arctic. [Additionally, for a more profound understanding...]" This is 78 words instead of 162 and I think this conveys the same message but in a more direct and clearer way. I encourage the authors to try to do the same exercise for the excerpts referenced hereafter and more generally throughout the manuscript. The quality and impact of the manuscript would be greatly improved.
- L210: "... for the compounds simulated in the present study..." is unnecessary, it is clearly understood that this is going to be the compounds simulated in the study. Instead simply say "The simulated biomolecule ocean concentrations are shown in Fig. 2 as a multi-annual..." is enough and less distracting. Same as above, try to get rid of unnecessary pieces of sentences.
- Section 3.2 - Although this part is interesting, an ACP paper should focus on the atmosphere. I think this section should therefore be trimmed to the very minimum, with as few numbers as possible and only the main important results that will shed light on the analysis of the atmosphere that is coming afterwards. Also you talk a lot about the sea ice and central Arctic in this section but since emissions into the atmosphere are only considered for open ocean this part is not very relevant for the analysis. This section could largely go as a supplement.

L342–357: this description of SIC and SST is too detailed and does not bring much to the paper. Please condense/synthesise to keep only the main information relevant

for the next part on aerosols.

L358–371: this is about sea salt emissions, not specifically organics, but in the next paragraph you say that organics and SS have different seasonalities. Therefore I wonder if this paragraph and Table 2 should be made organics specific and not sea-salt oriented only. In addition, since the relationship between wind speed and SS emissions is not linear, I do not expect a Pearson correlation coefficient to accurately represent the influence of wind speed on SS. I would use Spearman correlation instead. How is this correlation computed anyway? Is it on the 12-hourly output values of the model?

L422–424: I do not understand what you are trying to say in these two sentences

Section 4.1: again this part focuses a lot on oceanic concentrations of precursors, which I agree the paper should address, but not to that extent for an ACP publication. I would expect an analysis where oceanic biological activity is considered a driver of atmospheric emissions and is therefore described not as the main object of study but more as an explanatory variable for emissions. For example, schematically I would expect: "We observe a trend in emissions of organics in the XX sea, which is driven by changes in biological activity in the ocean, related to changes in SIC...". Therefore I would summarise 4.1 down to essential information, maybe not with detailed regional analysis, to offer context for the analysis of emissions that follows, but not much more.

L523–525: how do you compute average SST and how is it affected by changes in sea-ice? You say there is a positive correlation between SST and emission anomalies but SST is known to have a relatively small (and still debated whether it is positive or negative at low temperature) effect on emissions. Isn't this correlation you find simply because SST trend is related to SIC trend?

L568: I do not understand this sentence.

Comments on figures and tables

- Table 1: The deposition flux of organics is systematically larger than the emission flux. For sea salt it is the opposite. Can you explain / comment on this difference? SS and organics are co-emitted so does that mean that transport/activation in clouds is different? How are PCHO, DCAA and PL activated as CCN/INP? Same as SS?

- Table D1 contains the same information as Table 2.

- Figure 7: I do not understand what dot size corresponds to.

- Table 3: I assume this is surface concentration? This should be clearly stated.