

We thank the Editor and Reviewers for their insightful comments. We have revised our manuscript according to the suggestions of the Reviewers' comments and our responses to the comments are as follows: Reviewers' comments are in black, authors' responses are in blue, and changes to the manuscript are in red color text.

Editor decision:

Comments (line number refer to the latest version of the manuscript w/o track changes):

- Line 36: SSA should be explained here at its first occurrence and not in line 63.

Author reply:

We have made the necessary revisions to ensure that SSA is properly explained at its first occurrence.

- Line 36-40: There is some repetition here with respect to CCN.

Author reply:

We have carefully reviewed the manuscript to eliminate any unnecessary repetition.

- Line 99: Figure or Table S1?

Author reply:

We have revised the manuscript accordingly, and the correct response is "Fig. S1."

- Line 124: Are the RH and T-ranges measured or technically given/fixed?

Author reply:

The RH and T ranges are technically given parameters in the experimental setup, and actual measurements fall within these specified ranges during the experiments.

- Line 130: I would give the mean and standard deviation of the measured RH (since you measured it).

Author reply:

The measured RH during the experiments was $34.2 \pm 3.9\%$. This has been updated in the revised manuscript.

- Line 133: particles -> particle

Author reply:

Revised.

- Line 136: Better “<20 cm⁻³” (remove the hashtag)

Author reply:

The hashtag has been removed and replaced with "< 20 cm⁻³".

- Line 155: Add “a” before “muffle”

Author reply:

We have added "a" before "muffle" accordingly.

- Beginning of Sect. 3.1: This should be part of the methods and not the result section.

Author reply:

We have moved the content to Sect. 2.3 as suggested.

- Table 1 caption: add “the” before “experiments”

Author reply:

We have revised the caption of Table 1 accordingly by adding "the" before "experiments".

- Figure 1: Please describe properly the box plot. What are the whiskers showing? How many data points are included in each box? 3 points is not enough (as suggested in the caption).

Author reply:

We have provided a more detailed description of the box plot in Fig. 1, specifying that each box contains 14 data points. The whiskers represent the maximum and minimum values, respectively.

Lines 685–688:

Fig. 1. Measured surface tension values of natural seawater and aromatic acid-containing seawater: benzoic acids (A), benzenedicarboxylic acids (B), hydroxybenzoic acids (C), *p*-hydroxybenzoic acid, vanillic acid, and syringic acid (D). The dark spots represent the mean values of at least 9 data points, the boxes represent the ranges of 25th–50th–75th percentiles, and the whiskers represent the maximum and minimum values.

- Figure 2: “SW” is not properly defined. Is it the ambient sea water or the artificial sea water (which in the text is abbreviated as ASW). Please make sure that all abbreviations are properly defined.

Author reply:

"SW" refers to the ambient seawater in our study. We apologize for any confusion caused by the abbreviation. We have defined all abbreviations properly throughout the manuscript.

Lines 690–692:

Fig. 2. Number concentration distribution of sea salt particles and SSA particles containing benzoic acids (A), benzenedicarboxylic acids (B), hydroxybenzoic acids (C), *p*-hydroxybenzoic acid, vanillic acid, and syringic acid (D). SW represents natural seawater.

- Figure 3: Define "SW". It is really hard to see difference in the circle size. In the caption, make clear that "numbers above the points give the geometric mean diameter (in nm)". Errorbars are standard deviation?

Author reply:

In Figure 3, "SW" refers to seawater. We have made sure to define this abbreviation in the figure caption. Regarding the circle size, we have improved to enhance the visibility of the differences. Additionally, we have clarified in the caption that the numbers below or above the points represent the geometric mean diameter in nanometers (nm). The error bars in the figure represents the standard deviation. We have made these clarifications in the revised manuscript.

Lines 693–697:

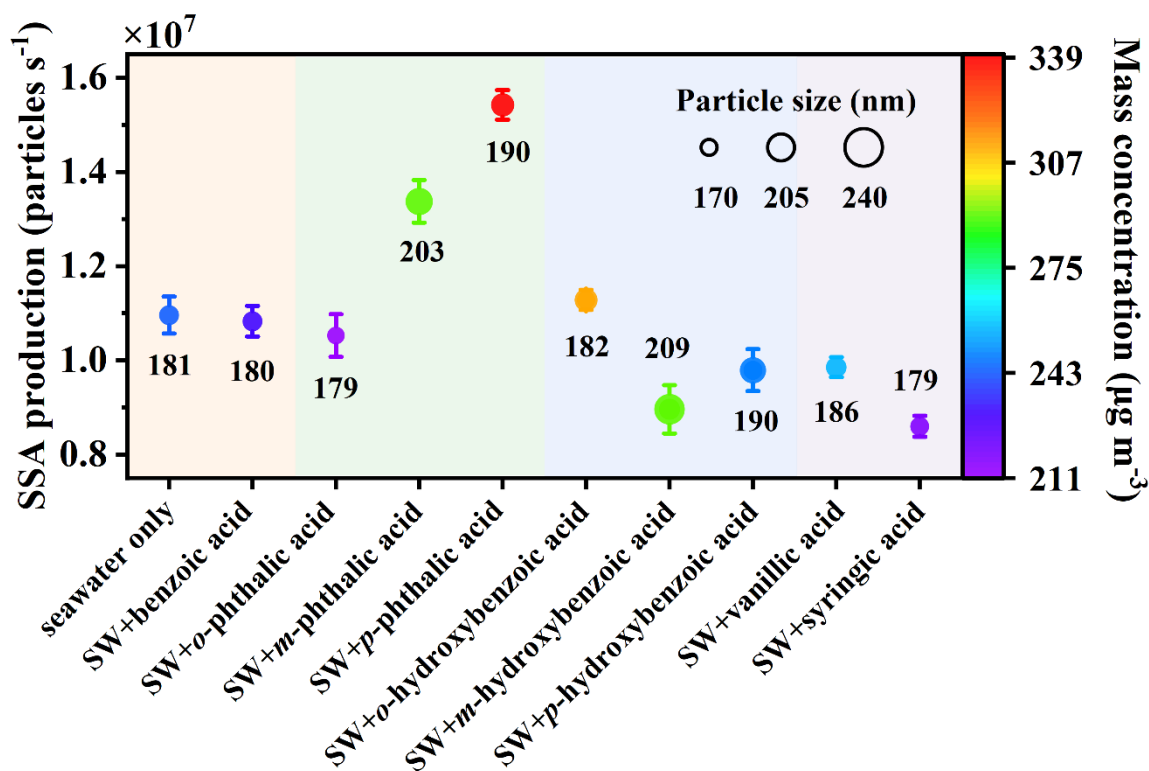


Fig. 3. SSA production, particle size, mass concentration distribution of aromatic acids. The symbol size represents the geometric mean diameter of SSA particles, with the numbers below

or above the points giving the geometric mean diameter (in nm), and the error bars are standard deviation. The symbol color indicates the particle mass concentration, with SW representing natural seawater.

- Figure 7: Harmonize if you use “tons” or “tonnes” within the figures and text.

Author reply:

We have made the necessary adjustments and made usage of "tons" both within the figures and the text.

Lines 708–711:

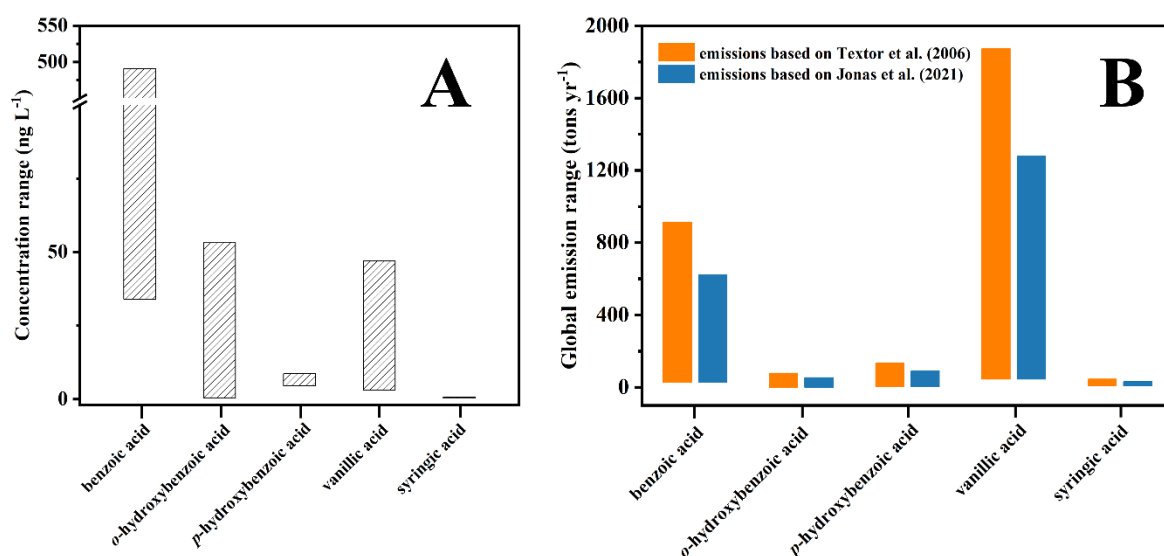


Fig. 7. Concentration range of aromatic acids in seawater (A) and the estimated range of annual global aromatic acids emission (tons yr⁻¹) via SSA (B). Yellow and blue stacked columns represent emissions based on Textor et al. (2006) and Gliss et al. (2021), respectively.

- Supplement:

o All figures and tables in the SI need to be also referenced in the main text. I could not find S5, S9 and S10 in the main text! Otherwise remove them.

Author reply:

We have included references to all SI figures and tables in the main text accordingly:

Line 96: Table S1, Line 112: Table S2, Lines 130–131: Table S3, Line 326: Table S4, Line 364: Table S5, Line 380: Table S6.

Lines 100–101: Fig. S1, Line 109: Fig. S2, Line 117: Fig. S3, Line 168: Fig. S4, Lines 194 and 218: Fig. S5, Line 223: Fig. S6, Line 256: Fig. S7, Lines 282, 299, and 310: Fig. S8, Lines 321 and 345: Fig. S9, Line 361: Fig. S10.

o Figure S5: Please increase font size and check the y-labels.

Author reply:

We have increased the font size and reviewed the y-labels.

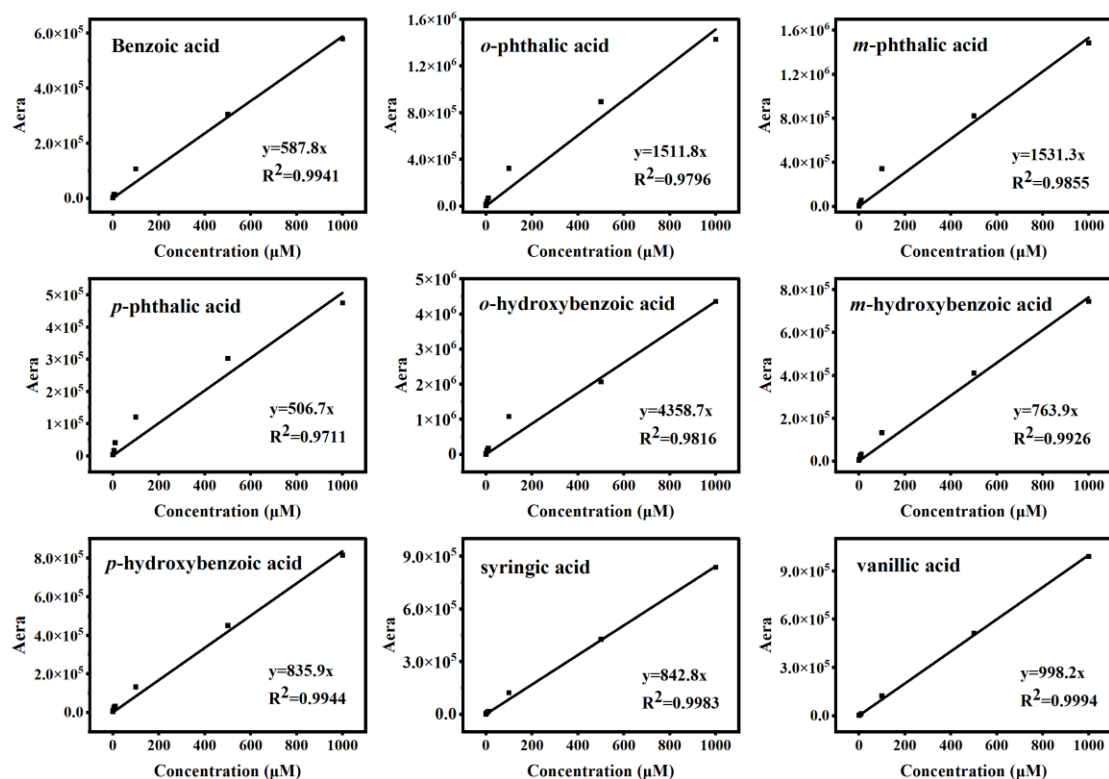


Fig. S4. Standard curves for aromatic acids were constructed within a concentration range of 0.01–1000 μM , with more than seven data points.

o Suggest to use normal page numbers and not S1, S2, etc. to not confuse with the figure and table labelling.

Author reply:

We have revised the page numbering to use normal page numbers.

- Data availability: I strongly recommend to make the data publicly available and follow the data policy of ACP (https://www.atmospheric-chemistry-and-physics.net/policies/data_policy.html).

Author reply:

We have arranged the data to be made publicly available and to comply with the data policy of ACP.

Lines 408–409:

The data used in this study can be found online at <https://doi.org/10.5281/zenodo.10903140>
(Song et al., 2024).

Reviewer #2:

I want to thank the authors for their persistence with this manuscript. I think their efforts have borne fruit. I believe the manuscript is now close to achieving the quality required for publication in ACP. However, there are still a few presentation issues that the authors would be advised to resolve. For example, there are several instances where the authors should have begun a new paragraph. An example of this can be found in line 55 where the authors should start a new paragraph with "Recent laboratory studies have shown...".

Author reply:

We have addressed the presentation issues raised by the Reviewer, including starting new paragraphs at line 55 with "Recent laboratory studies have shown...", at line 69 with "Recent data indicate that the surface activity...", and at line 212 with "Unlike the order of seawater surface tension...".

Also, there are several instances of incorrect referencing. For example, in Line 376 it should be "Gliss et al. (2021)" rather than "Jonas et al. (2021)". I would urge the authors to double-check all references. The authors would be wise to read thoroughly through the entire manuscript and double-check the presentation.

Author reply:

We have carefully reviewed the entire manuscript to ensure correct referencing. We have also read through the entire manuscript and double-check the presentation.

Reviewer #3:

The revised version has improved a lot and is in my opinion suitable for publication after the following minor issues are addressed:

Line 57 et al.: The concept about the “missing aromatic acids” is not clear to me and is not evident from the part “recent laboratory studies have shown that personal-care products, especially sunscreen (e.g., o-hydroxybenzoic acid), are reduced in levels during algal blooms (Franklin et al., 2022). “ Please clarify.

Author reply:

Our intention to use "missing aromatic acids" was to highlight that the levels of o-hydroxybenzoic acid, commonly found in sunscreen products, decrease during algal blooms, but the reasons for this reduction are not yet clear. We speculate that these missing aromatic acids may be transported to the atmosphere through SSA.

Lines 56–57:

Recent laboratory studies have shown that personal-care products in SW, especially sunscreen (e.g., o-hydroxybenzoic acid), are reduced in levels during algal blooms (Franklin et al., 2022).

The language has strongly improved, however, there are still articles missing (in the newly introduced parts), such as

Line 69: “The” is missing: Moreover, "the" molecular structure

Line 79: to "the" molecular structure

Line 287: of "the" salt particles

Line 342: by "the" compound concent

Please check again carefully.

Author reply:

Thank you for pointing out those missing articles. We have revised them in the current version of the manuscript.

References

- Franklin, E. B., Amiri, S., Crocker, D., Morris, C., Mayer, K., Sauer, J. S., Weber, R. J., Lee, C., Malfatti, F., Cappa, C. D., Bertram, T. H., Prather, K. A., and Goldstein, A. H.: Anthropogenic and biogenic contributions to the organic composition of coastal submicron sea spray aerosol, *Environ. Sci. Technol.*, 56, 16633–16642, 10.1021/acs.est.2c04848, 2022.
- Gliss, J., Mortier, A., Schulz, M., Andrews, E., Balkanski, Y., Bauer, S. E., Benedictow, A. M. K., Bian, H., Checa-Garcia, R., Chin, M., Ginoux, P., Griesfeller, J. J., Heckel, A., Kipling, Z., Kirkevåg, A., Kokkola, H., Laj, P., Sager, P. L., Lund, M. T., Myhre, C. L., Matsui, H., Myhre, G., Neubauer, D., Noije, T. v., North, P., Olivié, D. J. L., Rémy, S., Sogacheva, L., Takemura, T., Tsigaridis, K., and Tsyro, S. G.: AeroCom phase III multi-model evaluation of the aerosol life cycle and optical properties using ground- and space-based remote sensing as well as surface in situ observations, *Atmos. Chem. Phys.*, 21, 87–128, 10.5194/acp-21-87-2021, 2021.
- Textor, C., Schulz, M., Guibert, S., Kinne, S., Balkanski, Y., Bauer, S., Berntsen, T., Berglen, T., Boucher, O., Chin, M., Dentener, F., Diehl, T., Easter, R., Feichter, H., Fillmore, D., Ghan, S., Ginoux, P., Gong, S., Grini, A., Hendricks, J., Horowitz, L., Huang, P., Isaksen, I., Iversen, T., Kloster, S., Koch, D., Kirkevåg, A., Kristjansson, J. E., Krol, M., Lauer, A., Lamarque, J. F., Liu, X., Montanaro, V., Myhre, G., Penner, J., Pitari, G., Reddy, S., Seland, Stier, P., Takemura, T., and Tie, X.: Analysis and quantification of the diversities of aerosol life cycles within AeroCom, *Atmos. Chem. Phys.*, 6, 1777–1813, 10.5194/acp-6-1777-2006, 2006.