

Review of “Roles of marine biota in the formation of atmospheric bioaerosols, cloud condensation nuclei, and ice-nucleating particles over the North Pacific Ocean, Bering Sea, and Arctic Ocean” by Kawana et al.

General comment

This study evaluated if the marine biological activity present in the North Pacific Ocean, Bering Sea, and Arctic Ocean can impact biological aerosol particles formation, and the distribution of CCNs and INPs. To answer this, a large set of measurements were performed between September 27 and November 10, 2019 in an oceanographic cruise. The author found that bioindicators, fluorescent particles, INP, and CCN correlate positively, indicating that marine biota contribute substantially as a source of bioaerosols and cloud formation via INP and CCN over the remote Arctic Ocean during periods of high biological activity. The results are of high importance for this remote, valuable, and uncertain region. The measurements were properly performed and the data analyses are correct and consistent. Although the is well-written several parts can be improved. The present manuscript can be accepted for its publication in ACP after the following comments are properly addressed.

Major comments:

1. All the correlations indicated along the manuscript need to be defined as statistically significant or not.
2. The discussion of the present results with literature data needs to be improved avoiding redundancy and trying to be concise and clear.
3. Some figures need to be improved.

Minor comments:

P1, L23: Why the CCN concentration for the Arctic Ocean is indicated as a single value (36 cm^{-3}) and not as a range?

P1, L26-27: “The averaged INP concentration (N_{INP}) measured at temperatures of -18 and -24 °C with marine sources was $0.01-0.09$ and $0.1-2 \text{ L}^{-1}$, respectively” Please indicate the region or period you are referring to.

P3, L6: I am not sure that the term “biomaterials” is appropriate. Please reconsider this.

P6, L20: I am not sure that the term “number densities of INPs” is appropriate. Please reconsider this.

P7, L15: should “P3, 11–27 October 2019” be “P3, 10–27 October 2019” as indicated in Table 1?

P8, L20, L26 and a long the text: I think it would be more appropriate to call “bloom” and “autumn bloom” as “phytoplankton bloom”.

P11, L2-3: “suggesting the possibility of dependence on phytoplankton communities in the different oceanic regions”. What is reported in the Literature?

P12: In line 13 “Previous studies” is mentioned; however, only Park et al. (2020) is cited. Please add more studies.

P13, L6: I think “such as dicarboxylic acid (i.e., oxalic acid)” should be “such as oxalic acid”.

Section 3.4. The discussion related to CCNs is very confused and hard to follow. Please improve this part.

P15, L14: “INP formation”. Aerosol particles can form but not an INP. An aerosol particle is capable or not to act as INP.

P17, L3: Why κ value for the accumulation mode is indicated as a single value (0.57) and not as a range?

P17, L23-29: I have the impression that this paragraph is repetitive.

P18, L20: Why averaged NCCN at 0.4 % SS for the Arctic Ocean is indicated as a single value (36 cm⁻³) and not as a range?

Tables 2 and 3: indicate if the correlations are statistically significant or not.

Figure 1: The can different periods P1 to P5 be distinguished in the cruise track?

Figure 2: Add labels to panel a, b, c, and d. Also, change the color for EC and NO₃ as they look very similar.

Figure 4: I am not sure if panels c and d can be more useful with scatter plots?

Figure 7: y-axis in panel f should go in log scale and y-axis in panel (f) should read "INP concentration".

Technical comments:

P2, L5: Add a reference after “processes”.

P2, L10: Add a reference after “(INPs)”.

P2, L19: “(TEP and protein-containing Coomassie stainable particle (CSP)” It seems that a bracket is missing.

P3, L1: Add a reference after “INPs”.

P3, L3-4: “Some CCN grow to giant CCN”. Is it not possible to have a primary GCCN?

P3, L11: Add a reference after “observations”.

P5, L14: Add a reference after “state”.

P8, L13: I think “...contents and suggesting...” should be “...contents, suggesting...”

P9, L12: “total” of what?

P9 L20: “fraction” of what?

P11, L9: Add a reference after “ocean”.

P11, L29: “study” should be “studies”.

P13, L4: Add a reference after “range”.

P13, L32 to P14, L4: Please improve the punctuation here. This is a very long paragraph.

P14, L19: “(Fig. 8d)” should be “(Fig. 7d)”

P14, L25: I think “lower than elsewhere (i.e., North Pacific Ocean).” Should be “lower than in the North Pacific Ocean.”

P14, L30: Add a reference after “INPs”.

P15, L17: I think “but still significant” should be “but still strong” or something similar.

Figure 4: I think “(black line) and fluorescent” should be “(black line), fluorescent”