

Atmos. Chem. Phys. Discuss., referee comment RC2  
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## **Comment on acp-2021-927**

Anonymous Referee #3

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Referee comment on "The influence of multiple groups of biological ice nucleating particles on microphysical properties of mixed-phase clouds observed during MC3E" by Sachin Patade et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-927-RC2>, 2022

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## **Review of "The influence of multiple groups of biological ice nucleating particles on microphysical properties of mixed-phase clouds observed during MC3E" by Patade et al.**

General Comment:

The present study evaluated the importance of multiple groups of primary biological aerosol particles (PBAP) in the cloud microphysical properties of a mesoscale squall line event that took place in the 20 May 2011(USA) in 20 May 2011. Ground-based observations were combined with in-situ aircraft measurements to correlate observations with model simulations. The used model includes a new empirical parameterization for PBAP derived from observations at the central Amazon. The study is well motivated, it nicely fits in the journal scope and it is a good example on how field observations can be properly integrated into an aerosol-cloud model. Although the current results are very interesting, the document needs to be deeply improved before it can be accepted for its publication in ACP.

Major comments

- The manuscript is unnecessarily long. Several parts can be transferred to a Supplementary Material in order that the Results section can focus on the most important findings making the document more concise and readable. I think Figures 11, 12, and 13 together with the related text should be moved to the Supplementary Material. These results add little to the manuscript and make the document longer than needed.
- There is a clear lack of discussion. An extremely brief discussion of the results is included in the Summary and Conclusions section; however, I suggest adding a new Discussion section where the present results are deeply discussed and compared with previous studies providing clear explanations of the findings.
- The Summary and Conclusions section needs to be improved by being more concise.
- The PT21 empirical formulation for multiple groups of PBAP INPs were used in the present study to evaluate the role on PBAPs in cloud microphysics in a mesoscale squall line event in the US; however, the PT21 formulation are based on field observations over central Amazon. Therefore, I am wondering what could have been the impact of using tropical parametrizations to understand a mid-latitude event.
- The Introduction section lacks several key references. This part needs to be improved giving credit to previous work, including recent studies.
- I suggest to avoid repeating the same information along the text. Avoid redundancy as much as possible.

#### Minor comments

- Lines 363-364: "it was parsimoniously assumed that 50% of the insoluble organics were biological in origin". How realistic is this assumption?
- Lines 364-365: "The total PBAP loading was prescribed partly based on observations of insoluble organics and partly based on the assumed fraction". Please indicate the work on which this is based on.
- Line 381: The CCN measurements were performed at 300 m MSL while the predictions at 500 m MSL. It is well known that the aerosol concentration varies with altitude, therefore, I am wondering what the reason for this good agreement is.
- Lines 436 and 443: "are in good agreement". Provide a statistical evaluation to support this, being more quantitative.
- Line 524: "is dominated by black carbon". I am wondering why from the simulations BC is the dominant INP at these warm temperatures as it is well known that BC is not a good INP at such temperatures.
- Figure 6. I am not sure why homogeneous freezing is separated from primary ice as these type of particles are not from SIP. I suggest changing it to "Prim\_Het" and "Prim\_Hom" or something like this.
- Lines 572-573: "The simulated cloud droplet diameter is mostly smaller than 15  $\mu\text{m}$ ". Is this shown somewhere?
- Lines 574-575: "AC represents the observed dependency of rime-splintering on the concentration of droplets  $> 24 \mu\text{m}$ ". Is this shown somewhere?
- Line 575-577: Is this based on a previous study. If yes, please add the corresponding reference.

## Technical comments

- Line 33: Please add the used model.
- Line 41: ...and ice CLOUD microphysical
- Lines 46: Should "artificially prohibited" be replaced by "intentionally shut down"?
- Line 56: Although the "(Forster et al., 2007)" reference is appropriate, I suggest adding an updated one.
- Line 59: Add a reference after "formation".
- Line 61: Add a reference after "budget".
- Line 64: Add a reference after "INPs".
- Line 67: Add other references together with "(Heymsfield and Field 2015)".
- Line 68: Add a reference after "climate".
- Line 72: Add other references together with "(Matus and L'Ecuyer 2017)".
- Line 67: Add a reference after "lipids".
- Lines 78-79: Add the typical freezing temperature of *Pseudomonas syringae*.
- Line 81: ...many years; however,...
- Line 82: Add a reference after "debate".
- Line 85: Define "immersion freezing".
- Line 102: Add a reference after "atmosphere".
- Line 109: Add a reference after "clouds".
- Line 113: Add a reference after "mechanisms".
- Line 115: Please indicate what the authors mean with "by modifying the order of magnitude of ice particle concentrations".
- Line 128: Add a reference after "uncertain".
- Line 129: Replace "(e.g., Hallet-Mossop, 1974)" by "(Hallett-Mossop (HM), Hallett and Mossop, 1974)".
- Lines 132: Replace "the Hallet-Mossop (HM) process" by "HM process".
- Line 134: Please indicate what the authors mean with "generated by biologically active landscapes".
- Line 138: Add a reference after "activities" and "atmosphere".
- Line 140: Delete "(" after the comma.
- Line 156: Define "IN".
- Line 161: Add a reference after "issue".
- Line 161: Define "INA".
- Line 162: Add a reference after "nucleation".
- Line 163: Are there artificial biological INPs?
- Line 164 (and along the text): "real atmosphere".
- Lines 175-178: I suggest deleting these lines.
- Line 178-181: I suggest adding these lines to the previous paragraph.
- Line 184: "field campaign of observations" is unclear to me.
- Line 216: "*in situ* CLOUD microphysical"
- Table 1: Add the 2D-C, CDP, HVPS-3, King hot-wire probe, temperature probe, and Static pressure sensor manufacturers.
- Line 248: Add the model of the CCNC.
- Line 252: Please indicate what the authors mean with "the extended facility deployed at CF measured"
- Line 259: Please add the soundings times?
- Line 265: Fix "Giangrande et al. 2014."
- Lines 273-274: Please add the techniques/methods used to measure black and organic

carbon, salt, ammonium sulfate, and dust.

- Line 316: Should "IN" be "INP"?
- Line 343: Please double check the name of the diatom.
- Line 348: "domain" is repeated.
- Line 400: "ice CLOUD microphysical parameters".
- Line 403: Replace "liquid water content" with "LWC".
- Lines 439-441: "Overall, the mean values of 439 CDNC simulated for convective and stratiform regions are in good agreement with 440 observations." Delete these lines as the same information is repeated a few lines below.
- Line 459: Should "predicted" be "expected"?
- Line 478: Add a reference after "applied".
- Line 495: "illustrates" is repeated.
- Line 509: Define "PBL".
- Lines 522 and 523: "L-1" should be fixed.
- Line 535: Please clarify what the authors mean with "budget".
- Figure 6: Add units to the y-axis in panel A
- Figure 7: Swap items a and b in the caption to be consistent with the Figure.
- Figure 9: Swap items a and b in the caption to be consistent with the Figure.
- Figure 10. Add the units to the y-axis in both panels.
- Lines 773-774: Delete them as this was already mentioned.
- Lines 781-782. The stratiform region is also part of Figure 14.