

## ***Interactive comment on “Captured Cirrus Ice Particles in High Definition” by Nathan Magee et al.***

### **Anonymous Referee #1**

Received and published: 19 August 2020

Overall recommendation This study reports not yet revealed and striking detailed morphologies of in-situ ice crystals in natural ice clouds by using the state-of-the-art technology (i.e., cryo-SEM) and somewhat classical balloon capture system (i.e., ICE-Ball). I enjoyed this manuscript and am sure that this study and expected following studies will help to advance our knowledge on complex and not well determined microphysical and radiative properties of individual ice crystals and ice clouds and hence their roles in Earth radiative budget. The overall quality of this manuscript satisfies the standard of the Atmospheric Chemistry and Physics and methods that were used in this study are solid (“seeing is believing”). I recommend this manuscript will be published on Atmospheric Chemistry and Physics with few minor corrections and answering questions listed below.

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1. I feel that the result and hence the analysis of this study are somewhat descriptive. More quantitative analysis is required in the following studies. If possible, could the authors add insight or any suggestion on how we can treat (or quantify) the vast variety of complex morphology of natural ice crystals shown in this study to improve parameterization in numerical models and retrieval algorithms in remote sensing?
2. I think that with the current methodology used in the ICE-Ball system it is hard to distinguish whether aerosol particles adhered to crystal surfaces in nature or ice crystals and aerosol particles were sampled separately in nature and then adhered within the collection tube. Can the authors make a comment on this? Do you have a plan to improve the device?
3. The authors need to define “microscale” and “mesoscale”.
4. Rework on references is necessary. E.g., van Diedenhoven et al. (2016a) should be Frindlind et al. (2016) in the References section.
5. Page 14, lines 393-194 I think that microscopic and mesoscopic scales are reversed, and “500  $\mu\text{m}$ ” should be “500 nm”.
6. Page 3, line 58 The optical resolution of CPI is 2.3  $\mu\text{m}$ .
7. Page 4, line 101 It is “2014-2018”, while it is “2016-2019” in the abstract.
8. Page 4, line 105 Please delete “authors Tussay, Lynn, and Zhao holding”. It is unnecessary and it is already stated in the caption of Fig. 1.
9. Units should be SI units In this manuscript, non-SI units (e.g., ft and kt) were used.
10. Page 7, line 181 I think that “ $\sim 160\text{ C}$ ” should be “ $-160\text{ C}$ ”.
11. Page 8, line 221 and Supplement 1.C (a) Figure S1.C.(a) is an obviously frozen droplet that is a dominant ice crystal generated by a homogeneous freezing process in the top portion of convective origin ice clouds. This figure is very valuable for the studies on the frozen droplet, frozen droplet aggregates, and homogeneous freezing.

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This manuscript will be strengthened by adding the following references:

Stith, J. L., Basarab, B., Rutledge, S. A., and Weinheimer, A.: Anvil microphysical signatures associated with lightning- produced NO<sub>x</sub>, *Atmos. Chem. Phys.*, 16, 2243–2254, <https://doi.org/10.5194/acp-16-2243-2016>, 2016.

Um, J., G. M. McFarquhar, J. L. Stith, C. H. Jung, S. S. Lee, J. Y. Lee, Y. Shin, Y. G. Lee, Y. I. Yang, S. S. Yum, B.-G. Kim, J. W. Cha, and A.-R. Ko, 2018: Microphysical characteristics of frozen droplet aggregates from deep convective clouds. *Atmos. Chem. Phys.*, 18, 16915-16930, <https://doi.org/10.5194/acp-18-16915-2018>.

12. Page 9, lines 262-264 Can the authors add the explanation of the habit classification method used here? Is it manual identification?

13. Page 10, line 272 Can the authors define “solidity” here or “solidity ratio” in Table 1?

14. Page 10, line 282 What does “wavelength” mean here?

15. Page 10, line 288 “panel c” -> “panel d” in Fig. 3. In Fig. 3, panel labels “(d)” and “(e)” should be exchanged.

16. Page 10, line 290 “secondary and backscatter” -> “secondary and backscattered electrons” would be clearer.

17. Page 12, line 346 “. . . as plate rosettes, . . .” Is it “. . . as bullet rosettes”?

18. Page 13, line 363 Fig. 4b is an ash particle.

19. Page 17, Fig. 3 I think that the panel labels “(d)” and “(e)” should be exchanged. “F” should be “(f)” in the figure caption.

20. Supplement 1.D The authors need to add panel labels. The “panel b” is called in the caption.

21. Supplement 1.D, caption Please add “(f)” after “. . . Complex mineral aerosol

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particles“.

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2020-486>, 2020.

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