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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Microphysical Properties of Three Types of Snow Clouds: Implication to Satellite Snowfall Retrievals" *by* Hwayoung Jeoung et al.

**Anonymous Referee #2**

Received and published: 27 August 2020

General comments:

The authors conducted a comprehensive study on the microphysical properties of the snowing clouds observed during the ICE-POP campaign. They further analyzed the effect of the microphysical properties on snowfall rate retrievals through a Bayesian algorithm. The findings and conclusions from this study will benefit such communities as snowfall remote sensing and data assimilation. I recommend publication after minor revision as detailed below.

Specific comments:

- How generalized are the findings and conclusions? For instance, Kulie (2016) found



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that shallow snow cloud can be associated with strong convection and heavy snowfall while almost all the shallow (and near-surface) snowfall in this study is less than 0.5 mm/hr (Fig.6). Please add some discussions to answer this question.

- Line 279: Add a sentence about the common cause of near-surface snowfall. Is it usually convective?

- Line 320: What caused melting snow? What's the temperature profile like?

- Lines 321-325: Was riming also occurring during heavy snowfall? LWP was quite high at the time.

- Lines 356-359: The conclusion might be partially true for reflectivity between 2 and 10 but it's not universal. It looks to me that Fig. 8(b) mainly shows high LWP associated with large surface reflectivity, i.e. heavy snowfall. The text needs to be modified.

- Lines 359-361: Again, the conclusion is not universal, and the text needs to be modified.

- Lines 368-370: It's interesting that Fig.9(a) shows a concentration of data with high cloud top heights (>5 km) but GR between 50%-75% rather than close to 100%. Can you add some comments about the phenomena and maybe its cause?

- Lines 397-398: There is a shift in this tendency at 4km for deep snowing clouds: fall velocity becomes slower at 4km. There also seems a shift in the spectral width at this height. Is there an explanation for it? What's the significance of this height?

- Lines 445-446: Liquid water also has an impact on deep snowing clouds (Fig. 11 c and f) so underestimation is likely for this type of snowfall. Depending on the algorithm, overestimation is also possible for clouds with low LWP. This can be seen in Fig. 12(c) where S is overestimated below 0.2 mm/hr for low LWP. Suggest modifying this sentence accordingly.

- Figures 12 and 13: S is mostly underestimated if measured S is greater than about

0.7 mm/hr in deep snowing clouds. Please add some discussions about it.

- Figures 12 and 13: Besides R2, also calculate bias and RMS for the evaluation of retrievals.

- Lines 492-496: I can't fully agree with the statements here. First, low LWP (<50) snowfall is underestimated for near-surface snowing clouds but overestimated at the low end for deep snowing clouds so the magnitude of LWP does make a difference. Secondly, this study has shown that the type of snowfall (defined by cloud depth) instead of snowfall rate that has a significant impact on the retrieval skills.

Technical corrections:

- Lines 381-382: There are no (a), (b), and (c) in Fig. 10. Needs to be consistent with the figure caption.

- Line 471: Change 'merely sensible' to 'not sensitive'.

- Figure 12: Make (a) and (b) larger even if the axis ranges will be different from (c). Same with Fig. 13.

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