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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Linkage among Ice Crystal Microphysics, Mesoscale Dynamics and Cloud and Precipitation Structures Revealed by Collocated Microwave Radiometer and Multi-frequency Radar Observations" *by* Jie Gong et al.

Anonymous Referee #4

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General comments:

I would like to begin by commending the authors for their extensive and innovative work carried out in this study. I'm grateful for the opportunity to review it.

The combined usage of active and passive measurements is clever. Passive measurements polarisation difference provides information on the orientation of the ice particles and the active sensors provides information on the vertical structure of the clouds. This

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allows for the disentanglement of various microphysical processes in the convective and stratiform cloud systems. The paper demonstrates the value of passive polarization sensors and is scientifically very important. I don't have any major objections to the scientific content, apart from the comments given below.

The structure and analysis of the paper is clear. Figures are generally informative and relevant; I found all of them interesting. Importantly, the limitations of the used data are clearly presented.

Unfortunately, the paper is lacking significantly in terms of grammar and phrasing. Some sentences are difficult to read and understand. Examples are found under grammar/technical comments below. Careful proofreading is required before publication.

Major comments:

1. While theoretical calculations are not the focus of the paper, only meant to augment the analysis, I think they could be described in more detail. For instance, what particle size distribution was assumed in the triple frequency calculations? More information can be given on the habits and the assumptions made for the riming model. This should not need more than two paragraphs I believe.

2. There is a lack of discussion regarding the sample size of the used data. Naturally, the amount of collocated GPM and CloudSat measurements of relevant cloud types are limited outside the polar regions. However, there is a lack discussion on how this could affect the analysis. There are only 62 high PD samples in total (table 1), meaning that features visible for the low PD data might not be captured for high PD data (in figure 6 for instance). How does this affect the credibility of the conclusions made in this study?

Specific comments:

1. L132: Could you please provide some motivation or background for the regime limits, especially the 150 K limit for deep convection.

2. L198: "Because the KuPR reflectivity does not saturate with particle size as rapidly

as Cloudsat, we can also infer large ice particles high in the atmosphere in the deep convective and low PD cases...". Do you mean that the limited sensitivity of KuPR to smaller ice hydrometeors indicates that high altitude KuPR reflectivities are due to large particles? Perhaps this could be phrased better.

3. L209: Could you perhaps use some other word than regime? Regime is already used (high-PD, deep convective, etc), so this caused some confusion for me. Perhaps "mode" is better?

4. L215: Please rephrase the sentence. Suggestion: "The latter scenario indicates the late stage of a convection life cycle, where the convective cell disappears and a stable stratiform layer forms to dominates the whole column."

5. L262: What types of observations are referred to here? Reference?

6. L283: Should not the unit of the reflectivity ratio be unitless (or dBZ)? Confusing.

7. L294: I think it is prudent to also refer to Toyoshima (2015), for the DPR thresholds (Yin et al. (2017) added the CPR threshold).

8. L294: Forgive me if I've missed this, but I can't find any description on the graupel spheroid in Leinonen and Szyrmer (2015). I suggest you provide at least a short description of both the habits and also on how the riming is modelled. I also find it contradictory to talk about a graupel spheroid under no-riming conditions, since graupel implies growth by riming.

9. L296: Why is repositioning of the theoretical curves necessary? To augment the analysis? Please explain.

10. L339: How is density defined in this context?

11. L344: Sentence is very long and difficult to read.

12. L354: "evidences" -> "evidence". However, given the limitations (including sample size), I wonder if it would not be more prudent to use "indications" instead. I don't think

this would take away from the novelty and importance of this work.

13. Section 6: I'm of the opinion that this section could better summarize the key conclusions and future work, in a more concise way. As it is now, it is rather a summary of what was presented and discussed in the paper. What are the take-home messages of this article?

14. Figure 3: Could this figure include standard deviations (in dashed lines for instance)?

15. Figure 5: I found it surprising that high PD signals are prevalent even in the presence of high wind speeds. Shouldn't high wind speeds promote random orientation? Just a comment.

Grammar/technical comments:

1. L14: "ambient environment" -> "the ambient environment"

2. L15: "...impact up to the future climate projection and down to the details of the surface precipitation". Needs rephrasing. Suggestion: "...have on impact on climate projections as well as on the details of surface precipitation".

3. L18: Remove "are".

4. L43: "cloud" -> "clouds"

5. L55: "tornado" -> "tornados"

6. L72: Sentence needs rephrasing. Suggestion: "With swath widths typically over 1000 km and footprint sizes of 7-15 km, their combined usage can readily generate ice hydrometer producton temporal and spatial scales that suits the needs of both weather and climate studies."

7. L77: Problematic sentence. Suggestion: "While some of the recent products have advanced from using spherical ice models to more realistic habits, random orientation

is still nearly always assumed, as it reduces computational complexity and decreases the degree of freedom for the otherwise severely under-constrained inversion problem."

8. L81: "putting" -> "put"

9. L162: Sentence difficult to interpret. Should it be: "For example, Yin et al. [2017] used collocated CPR-DPR reflectivity profiles from this dataset to study the discrepancies found in triple frequency radar signatures and inferred different microphysical processes in convective and stratiform regimes."?

10. L245: Sentence difficult to difficult. Please rephrase.

11. L253: It is difficult to understand what "which" refers to in the previous clause. Please rephrase for more clarity.

12. L297: "property" → "properties"

13. L303: Try use a more formal word than "blob". Perhaps "accumulation"?

14. L356: "signal" -> "signals"

15. L365: Problematic sentence. Suggestion: "It is well established that anvil clouds are likely associated with low-PD signals, while high-PD signals are instead linked to stratiform layers."

16. L400: I think fig. 10 is introduced a bit suddenly here.

17. L415: Sentence is difficult to understand. Please rephrase.

References:

Toyoshima K, Masunaga H, Furuzawa FA. Early Evaluation of Ku- and Ka-Band Sensitivities for the Global Precipitation Measurement (GPM) Dual-Frequency Precipitation Radar (DPR). SOLA 2015;11:14–17.

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