Atmospheric Chemistry and Physics Discussions

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Comment on acp-2022-136

Anonymous Referee #2

Referee comment on "Highly supercooled riming and unusual triple-frequency radar signatures over McMurdo Station, Antarctica" by Frederic Tridon et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-136-RC2, 2022

General Comment

First, I apologize for my delay in posting comments. The manuscript well explained the techniques of the retrievals used in this study and entire methods of the measurements and retrievals and also evaluated the techniques well including uncertainties owing to observational limitations and assumptions used in the techniques. I really appreciate those descriptions; this helped to interpret the observed features. Figures are all beautiful at high resolution. I had expected more analyses and/or discussions about physics and characteristics of Antarctica, such as mesoscale, microphysical and dynamical processes, as the manuscript had been submitted to ACP (not AMT).

Specific comments

1. expected a little bit more discussions and/or analyses for the following points at least:

1) The analysis results from the Antarctica data were compared with data from only a site. Is this enough to discuss the characteristics of the Antarctic microphysics? Can you take into account other environments such as continental, maritime, coastal, arctic, mountain, etc.?

2) What are the environmental characteristics of the site in terms of temperature (like lines 536-538), humidity, wind, vertical velocity, etc.?

3) Can the triply-frequency signatures be expected to be generalized for other sizes in Antarctica?

4) How can the fewer but larger supercooled liquid droplets (lines 144-146) contribute to riming? I guessed that fewer droplets could restrain riming since the chance of collision and accretion could be reduced.

5) Seasonal variability (I know that the data were limited, though…).

6) Line 528-530: Why the narrow rime ice PSD is characterized over polar regions?

7) Lines 536-538: Can you explain a little bit more why the DWR signatures can be characterized as a unique signature over Antarctica?

2. Please provide a bit more explanation about BAECC; location, period, radar frequencies, case descriptions... This should help to characterize the observed features in this study.

3. This manuscript analyzed one 'extraordinary' case study. Does this represent the other cases listed in Table 1? Need descriptions of the generality of the results from the detailed analysis among the selected cases.

4. Line 215-216: This sentence did not make sense to me. Maybe a few more explanations would be needed.

5. What could bring the situation of slightly pointing off-zenith?

6. Figure 6 and Figure 7: The data points were distributed to a large range. I wondered how such grid points with low density data are significant.

1) Please provide the total number of sample size.

2) Because of the noisiness, it seems to me that any lines from the particle models cannot

represent the observation data for any plots.

3) I supposed that the data to plot those figures came from the long time period (~4 hours), which period possibly included a variety of microphysical processes; not only riming, but also depositional growth, different degree of riming, aggregation, etc.. Those data could be plotted into a panel. So I was not sure of a meaningful of those plots; what is the purpose of overlaying the lines from the particle models; why the only selected particle types from models were plotted.

4) Because of those, it was unclear for me what is the 'unusual' triple-frequency signatures. It would help if the signatures were highlighted in the plots.

5) Lines 372-373 "At the top of the layer…" This sentence does not make sense to me. Please provide more explanation.

7. Line 428-429: Please explain this process more in details.

8. Figure 10:

1) Please highlight the location of the supercooled liquid layer

2) Add a plot and discussion of vertical velocity.

3) Why Z_Ka < Z_W below 1 km?

9. Lines 520-521: Does this mean the retrieval's error or radar forward simulator's error?

Technical comments

- I really appreciate the high-resolution images; those included much information. However, sometimes I could not identify locations of what mentioned in the text; such as: Line 372 "reasonably homogeneous"; Line 416-417; Line 501 "W-band reflectivity intensification"

- Line 416-417: Which one is the supercooled cloud layer signature? The signature should be identified by a large gradient of backscatter, but I cannot see it well.
- Sometimes it was unclear for me that which Ka-band radar (KaSACR or KAZR) was used to estimate DWR_X/Ka and DWR_Ka/W? I suppose that KAZR was used throughout the study; why wasn't Ka-SACR used? I expect that the use of Ka-SACR can reduce the beam mismatching error at least for DWR_X/Ka.
- Table 1: Add a temperature range for each case.
- Just I was surprised that WACR had a huge offset in reflectivity (19 dBZ)… Was the sensitivity of the radar enough?
- Figure 4e: Why is this plot dark?
- Line 213-214: I cannot identify vertical stripes. Can you add marks to the figure?
- Figure 9: How did you estimate the standard deviation from one profile?