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Atmospheric Measurement Techniques Discussions

Interactive comment on "Snowfall retrieval at X, Ka and W band: consistency of backscattering and microphysical properties using BAECC ground-based measurements" *by* Marta Tecla Falconi et al.

Anonymous Referee #1

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The manuscript presents observed power-law relationships between liquid-water-equivalent snowfall rate S and radar equivalent reflectivity factor Ze at X, Ka, and W frequency bands for four snowfall events. They found that the power-law Ze-S relationships are distinguishable between fluffy and rimed snowfall events. To better understand the connection of snowflake microphysics with their scattering properties, numerical scattering calculations were conducted using both soft-spheroid (TMM) and detailed (DDA) ice particles, with mass and size constrained by PIP measurements. They argued that soft-spheroid approximation overestimates the back-scattering cross

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Discussion paper

sections of small ice particles, but underestimates those of large ice particles; on average, soft-spheroid approximation with proper aspect ratio explains the observed Ze-S relationships.

Major comments:

I believe this paper represents a substantial contribution in not only collocating multiple-frequency radar observations with in-situ image measurements of ice particles, but also exploring the capacity of numerical scattering simulations with simplified spheroid models. However, a more detailed analysis of the four cases to show the clear difference between the two precipitation modes is needed. Furthermore, a discussion on the physical reasons of separating into such two precipitation modes would be more valuable. The specific major comments are as follows.

1. It is not clear what the definition of fluffy snowfall and rimed snowfall is. Based on the paper, fluffy snowflakes refer to small low-density ice particles, while rimed snowflakes refer to large high-density ice particles. However, low-density ice particles can be large if there is a high number concentration of ice crystals and they aggregates to large particles. Riming occurs when ice particles collect super-cooled cloud drops through a super-cooled liquid layer. So density can probably separate fluffy and rimed snowflakes, but not size. Please provide more information and evidence, e.g., PIP images, about the details on what exactly separate the two precipitation modes.

2. Discuss why the two precipitation modes have such a difference in a and b coefficients in the Ze-S relationship?

3. Page 13 line 12: “The latter consideration leads to the conclusion that the soft-spheroid approximation may work rather well for computing radar reflectivity since the errors for larger particles are compensated by those for smaller particles”. This conclusion is very questionable, because particle size distribution (PSD) does change and it changes the weight between small and large particles. The error might cancels out in specific cases, but not always.

4. Can you add the results from DDA simulation in Figs. 3-6 and 9-12? DDA simulation is only discussed at the end in Fig. 13 in terms of backscatter cross section as a function of size. It will be great to see how the detailed ice particles match with observations.

Minor comments:

1. Page 7 line 22-23: 'This is because the microwave backscatter properties do not depend on the small details, but mostly on the overall structure, at least at cm-wavelength'. This is not true. Backscatter cross section does depend on the details of the structure even at large wavelength.

2. Page 7 line 26: typo "looses" » "loses".

3. Page 7 line 27: typo "dendrities" » "dendrites".

4. Page 7 line 29-33: This sentence is not clear. Please revise.

5. Page 8 line 10: Dmax is obtained from PIP. In page 4 line 1, the disk-equivalent diameter DDeq is also obtained from PIP. Are they related? And how?

6. Page 9 last paragraph: The particles are randomly oriented from DDA calculations, while the spheroids of TMM are oriented horizontally with 10° standard deviation from Page 8 line 3. Please comment on how the inconsistency affects the scattering results.

7. Page 11 line 20: typo. "cleare" » "clear".

8. Page 12 line 19: typo. Remove "the" in "For the this case ...".

9. Page 12 line 23: typo. Remove "is" or "equals to" in "... is on an average equals to ...".

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