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Atmospheric Measurement Techniques Discussions
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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.

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We thank the reviewer for his suggestions and, in particular, for specific prompts to clarify some fundamental issues. Our detailed replies can be found below in after the "REPLY." label. Changes in the manuscript are highlighted in blue text.

Major comments: 1 The author used the fixed calibration offsets for the snowfall experiments, which is not reasonable. Since those observed Ze-S relationships are the reference relationships for selecting the optimal aspect ratios, it is important to correct

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Discussion paper

the errors in radar reflectivity considerably. The attenuation at Ka and W bands due to the liquid water and snow can be significant and is heavily profile-dependent. We need to calculate the attenuation at Ka and W bands due to the cloud liquid water and snow for each profile, even the author only used the near-surface bin. I understand that the reliable source of cloud liquid water profile might not be available for the datasets used in this paper, but we should at least correct the attenuation due to the snow using a better method. See the reference: Kulie, M. S., M. J. Hiley, R. Bennartz, S. Kneifel, and S. Tanelli (2014), Triple frequency radar reflectivity signatures of snow: Observations and comparisons to theoretical ice particle scattering models, J. Appl. Meteorol. Climatol., 1080–1098, doi:10.1175/JAMC-D-13-066.1.

REPLY According to Kulie et al. (2014) the W-band attenuation due to snow ranges between 0.2 and 1 dB kmˆ-1. Since, we are taking measurements close to the ground, and the expected attenuation is between 0.08 and 0.4 dB. Therefore, the attenuation due to snow can be ignored. The attenuation due to supercooled liquid water is expected to be 1 to 4 dB kmˆ-1. That means that at maximum we expect the liquid water attenuation of around 1 dB. Given the uncertainty in the attenuation correction, we have decided not to apply it.

A potentially significant source of attenuation, is the radome attenuation. Because of this, the radar cross calibration was performed before and after the events and cases where these estimated values were different were ignored. Furthermore, the radar noise power was analyzed to identify radome attenuation.

2 Please clarity the definitions of “fluffy” and “rimed” snowflakes and why the author separated the snow events into these two types? Did the author try to study the “unrimed” and “rimed” snowflakes”? the “rimed” snowflakes are usually associated with high density, while the “unrimed” snowflakes can be considered as low-density particles. In this way, it is better to explain why two snowflake habits have different Ze-S relations.

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REPLY. Thank you for pointing out the problem. In the modified manuscript we are using microwave observations of liquid water path (LWP) to separate events into lightly, moderately rimed and heavily rimed snow. Even though LWP is not a direct measure of degree of riming, LWP and riming are related as shown for example in (Moisseev et al., 2017). We also agree with the fact that the original definition of rimed and unrimed snowfall was vague and not properly explained but now we have heavily modified it.

3 Do you have the Ze-S relationships for DDA results? Since you choose the riming particle model, it is good to compare the DDA results using the riming particle model with the TMM results and the observations. Please add the DDA results for Fig. 3 to 6.

REPLY. The comparison of TMM backscattering cross sections with DDA has been performed for validation purposes. We are aware of the limitations of TMM and then we wanted to check our results. However this comparison is not the central point of the study and we think that adding further curves to the plots would make them very confusing. On the other hand a parallel study is under preparation that further explore the link between the microphysical and scattering properties of snow where this comparison can be better addressed.

4 “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 not correct, if you restrict the particle size range, you usually don’t see this compensation.

REPLY. We are not using unrestricted sizes, the particle size range is restricted to 2.5 D0. Minor comments:

5 Page 2, line 35, from from, delete one

REPLY. Done.

6 Page 3, line 31, change 64x48 to 64$\times$48

REPLY. Done.

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Thank you again for the questions, the supplement to this comment contains the revised AMT manuscript. Changes in the manuscript are highlighted in blue text.

Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2017-485/amt-2017-485-AC3-supplement.pdf

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