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Atmospheric Measurement Techniques Discussions

Interactive comment on "First Light Multi-Frequency Observations with a G-band radar" *by* Katia Lamer et al.

Anonymous Referee #2

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Since Battaglia et al. (2014) there is a lot of excitement about prospects of using G-band radars for cloud studies. This study shows the first comparison of G-band radar observations to X, Ka and W-band radar observations. It is shown that the current technology allows to achieve measurements that are useful for cloud studies. The results are very promising. I find the manuscript to be clearly written. I have a few comments on how the readability of the text can be improved. I also have a couple comments on the reached conclusions and would like to see authors' response to these.

Comments: Lines 352-353: "The first period (7:45 – 8:12 UTC) depicted in Fig. 7a corresponds to the period we established had little to no liquid water and presented a high DWR slanted feature (referring back to Fig. 5)." I am not sure how this conclusion

was made. The lidar observations in Fig. 5 indicates presence of two liquid layers at this time, which you point out on line 285. These layers are not very optically thin but may affect the attenuation.

Line 358: "This suggests that the particles observed are not represented the scattering libraries used and calls for further research." This conclusion is not necessarily correct. The PSD of snow aggregates tend to be super exponential (Westbrook et al. 2004), i.e. the shape parameter is negative. The super exponential PSD will push the triple frequency curve to the left (Mason et al. 2019), so even for the given scattering models you may be able to reproduce the observations. Westbrook, C. D., Ball, R. C., Field, P. R., and Heymsfield, A. J. (2004), Universality in snowflake aggregation, Geophys. Res. Lett., 31, L15104, doi:10.1029/2004GL020363.

Mason, S. L., Hogan, R. J., Westbrook, C. D., Kneifel, S., Moisseev, D., and von Terzi, L., 2019: The importance of particle size distribution and internal structure for triple-frequency radar retrievals of the morphology of snow, Atmos. Meas. Tech., 12, 4993–5018, https://doi.org/10.5194/amt-12-4993-2019, 2019

Lines 399-401: "In the non-Rayleigh scattering regime, σ_b does not monotonically increase with D^6 but rather follows a lower power of quasi-periodic form with exponential damping of the oscillation (Fig. 4 of Kollias et al., (2007a))."

Are you describing the resonance scattering regime, or as sometime referred to as Mie scattering? If yes, just say that.

Line 405: The sentence starting as "Previous work has associated the top boundary..." is, in my opinion too long, and a bit difficult to follow. It would help if you could simplify it.

There are several new studies discussing how ML boundaries depend on radar frequency:

Li, H., and D. Moisseev, 2020: Two layers of melting ice particles within a single radar bright band: Interpretation and implications. Geophys. Res. Lett., 47, e2020GL087499. https://doi.org/10.1029/2020GL087499

And how ML radar signatures at different wavelengths depend on snow properties:

Li, H., Tiira, J., von Lerber, A., and Moisseev, D., 2020: Towards the connection between snow microphysics and melting layer: insights from multifrequency and dual-polarization radar observations during BAECC, Atmos. Chem. Phys., 20, 9547–9562, https://doi.org/10.5194/acp-20-9547-2020.

Line 433: "The other fact that SKYLER could also not observe the cloud top also speaks to the importance of operating sensitive X-band radars for cloud studies (liquid attenuation not being an issue at X-band)." You may want to generalize this statement to cm-wavelength (i.e. Ku-band or C-band) radars that are not suffering from significant attenuation as well.

Conclusions:

Line 459, point 2: While I agree with this conclusion, I miss a discussion in the results section that supports this conclusion. If it is not there, you may want to include it.

Line 466, point 3: While high sensitivity is important and you demonstrate that it is possible to achieve it, whether the Rayleigh plateau will be reached will also depends on attenuation. Therefore, it would limit this application to relatively optically thin clouds. The -20 dBZ requirement, as far as I remember, originates from one of Hogan's studies and is referring to unattenuated reflectivity. You should point it out in the discussion.

Line 487, point 7: I think this conclusion is not well supported. In addition to what I said above, you only have tested one single scattering library.

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