The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2018-153-RC1, 2018




# *Interactive comment on* "The vertical structure of precipitation at two stations in East Antarctica derived from micro rain radars" *by* Claudio Durán-Alarcón et al.

**Anonymous Referee #1**

Received and published: 2 October 2018

General comments:

In the manuscript by Durán-Alarcón et al. multi-year micro rain radar observations at two observatories in Antarctica are analyzed. The main focus of the paper lies on the description and interpretation of the statistics of vertical profiles of radar reflectivity, mean Doppler velocity, and spectral width for the two sites. The profiles were separated with respect to occurrence of precipitation on the ground versus virga clouds as well as with respect to different seasons.

Overall, I find this a relevant study of how radar profiles change within the blind zone of most space-borne radar systems. This is very relevant considering snowfall retrievals and climatologies over Antarctica as well as for providing statistical guidance for numerical models of how precipitation is altered close to the ground. I have some questions and suggestion mainly related to the methodology of the analysis which I described in more detail below. I think extending and clarifying the methods will help to better understand the analysis applied as well as for interpreting the results; it will also help to make the results easily reproducible. After these revisions I can support the paper for publication in The Cryosphere.

Specific Comments: (Page, Line)

6, Section 2.5: I have a couple of questions regarding how the averaging and other statistics are exactly done. I would like to see these methods described in more detail. For example: When you estimate the effect of the different averaging windows, how do you deal with periods when you have no clouds or periods when you have clouds for example at high altitude (2-3km) but clear sky further below (1-2km)? Wouldn't you need a continuous cloud/precipitation system throughout the maximum 12h averaging time in order to have the same sample size at each height within the 3km range? Are you excluding events when the cloud is only lasting for 10h since you cannot average in this case over 12h? Also Equation 2 is not completely clear to me: What is the average VPR (Ze-bar)? Is it the average over all heights or the average of Ze for all cases for a specific height? But then for which integration time? In the end you identify a 1h integration time as optimal but again, how do you deal with profiles which are not continuous over the full 3km range and/or events which are shorter than 1h?

6, 25: I agree that you will probably eliminate variations due to fall streaks with a 1h integration time. But your argumentation with the fall velocity of snowflakes is not correct. The integration over the observation time of the radar is not simply related to the sedimentation time of the hydrometeors. For example, let's imagine there is no horizontal wind shear. This would result in the radar time-height plot in a perfectly vertical fall streak which passes the radar within one sampling time interval (or shorter dependent on advection speed). The fall streak would look exactly the same no matter how long the particle needs to sediment over a certain altitude range. Quite often, fall streaks are mis-interpreted as trajectories which they usually are not.

7, 5-10: Please specify the Ze-threshold you use to define precipitation detected by MRR. I assume it is the same threshold for both MRRs? Do both systems have similar sensitivities?

8, 5: Again it is not clear to me when do you count a measurement as a valid profile. For example, if you observe precipitation in just two range gates, is this counted as a profile? If yes, would you then normalize height regions with sparse data with the same profile number as regions with high number of observations? Do you have specific reasons why not plotting your data as colored frequency by altitude diagrams (CFADs) where you normalize by the actual number of observations separately for each altitude? I am not sure if this might be superior for your analysis, but I would like to better understand your choice.

10, Eq. (3) and description: Are you actually correcting your Doppler velocity measurements with this air density correction? I think this would be easily possible as you have radio sonde profiles available (as you mainly need pressure and temperature for this correction, also model profiles for example ECMWF reanalysis should work for a first order correction). Since PE is at 1392m a.s.l. I think you should apply this correction for a better comparison of the profiles from the two stations since simply the shift in altitude and hence air density will have a non-negligible effect on the fall velocities. Looking at your plots, this correction would even enhance the differences you find between both stations!

10, 22: I would add something like "For a vertically pointing radar, spectral width. . .." since spectral width depends in general on the variability of radial velocity of the targets.

12, 5-10: I am not convinced that only sublimation of the smaller ice particles in virga is increasing your Doppler velocity towards the surface for DDU. Certainly, this is one possible scenario. But I would expect the spectra also to become narrower due to sublimation of the small ice but in your plots I see sigma increasing. In my opinion this could also indicate that riming/aggregation is also present in virga cases at DDU. Skewness could maybe help to investigate this further since in case of size dependent sublimation, one side of the spectrum should decrease faster than the other.

18, 29-32: You might also want to mention here or in the introduction the recent AWARE field campaign organized by ARM/ASR which brought multiple radars and remote sensors to McMurdo station (https://www.arm.gov/research/campaigns/amf2015aware)

17, 4-10 and throughout the text: So far all your plots are a function of altitude above ground. I see the argument that you want to characterize the profiles in this low altitude region since most of this is missed by satellites. It's just a suggestion but since you have the radio sonde profiles, you could also plot the radar variables as function of cloud temperature instead of height. Considering the strong temperature dependence of aggregation and riming, I could imagine that you find some additional effects related to ice microphysics. Some of these plots could maybe just be added as supplemental information.

Technical Corrections/Typos: (Page, Line)

1, 3: Add comma before and after "however"

Throughout the text: I am always wondering whether "radio sounding" or "radiosounding" is more correct. The AMS glossary says it should be "radio sounding".

6, 2: As turbulence usually describes the effect of multiple eddies I think the plural form is unnecessary

8, 17: "ofaggregates"

9, 2: I think plural form of "remain" and "increase" should be used

10, 7: "hydrometeors . . . are represented"

10, 31: "shows"

11, 3: Is virga really a process or rather a phenomenon?

12, 3: add a “the” before “low troposphere”

15, Table 1: “virga with respect to the total number of vertical profiles during”

17, 33: “with respect to ice”

18, 8-10: Complicated and long sentence. Maybe split in two.

19, 8: “as function of”

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