

Interactive comment on “Evaluation of CloudSat snowfall rate profiles by a comparison with in-situ micro rain radars observations in East Antarctica” by Florentin Lemonnier et al.

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Revision of the research article tc-2018-236 Florentin Lemonnier
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Dear reviewer,

The authors thank you for the review of the manuscript. To clarify our answers to the reviewers comments, the following color scheme is used: comments of the reviewer

are itemized, our answers are denoted in black and quotes from the revised text are in blue. A version of the PDF file showing the differences with the original paper is also included. Please find the answers to the questions you have addressed below.

Sincerely,

Florentin Lemonnier

- It appears as though the terms 'dataset' and 'data set' are used interchangeably, please standardise.

It has been corrected and standardized.

- What is 'seconds-short-time'?

'Seconds-short-time' is used for the satellite because it only observes a weather system by overflying the studied areas in a few seconds. We rewrote that by defining this term: [P2-L1 – and short-time \(a few seconds\) scales](#)

- More explanation is needed about the number of overflights (CloudSat) vs the number of events investigated. I assume that the other overflights that coincided with MRR operation occurred outside of precipitation events? Maybe state this explicitly, the current wording on P3 / 15 was unclear as to whether there was another reason.

Indeed, on all overflights only 4 recorded a precipitation event by both instruments (CPR and MRRs). We explained it: [P3-L15 – With the aim of improving CloudSat radar uncertainty estimates using ground-based observations, CloudSat snowfall retrievals](#)

over Dumont d'Urville and Princess Elisabeth stations were compared with MRR data on a total of 4 concurrently recorded snowfall events. During the MRR observing periods, there were 14 overflights over DDU and 63 over PE. These overflights are short, typically a few seconds, explaining why we actually detect snow for only 4 of them.

- The 'Methods' sub-section for CloudSat is quite short, it might be useful for the readers if more information such as the revisit time for each station was included. Conspicuously absent is the height AGL of the lowest CloudSat bin used - 1200 m is mentioned in the introduction but it appears as though 960 m is used in Figure 3 a/b but maybe 1050 m is used in c/d.

Indeed, we mentioned the level at 1200 meters above local surface, but this is an average level for the whole continent firstly used by Palerme et al., 2014. The CloudSat vertical bins are relative to the geoid and depending on the altitude where the stations are located (as shown in the following diagram), the height of the first exploitable bin of CloudSat varies significantly (at PE, the 5th bin is at 1043 m above the surface). Moreover, as we move closer to the ocean, the maximum ground clutter altitude is lower than above the ice cap and the first exploitable bin is generally closer to the surface (at DDU, we are using CloudSat profiles from the 4th bin, which is located at 961 m above the surface). We have also added a paragraph on the characteristics of the satellite, as the phase of the orbits : P3-L32 – The satellite is characterized by a period of 16 days, so it exactly overpasses a location every 16 days. DDU is overpassed by a descending orbit whereas PE is overpassed by ascending and descending orbits which are less than 10 km away. The CloudSat vertical bins are relative to the geoid and depending on the altitude where the stations are located, the first exploitable bin (out of the ground clutter alteration altitude) varies significantly. Moreover, above and near the ocean, when the ice does not interfere much with the radar signal, the ground clutter layer is thinner and lower bins can be used. We are using at DDU CloudSat profiles from the 4th bin, which is located at 961 m.a.g.l. At PE the first exploitable bin

is the 5th, which is located at 1043 m.a.g.l.

C4

CPR_DDU_PE.png

Schematic diagram of a section of the Antarctic ice cap representing the position of

- It would be worth adding the 2500 m ceiling used in the MRR data to the MRR method sub-section. It would also be useful to know the spatial extent of the MRR data used for comparison with CloudSat (was it the entire 10 km radius circle used or a subset along the CloudSat track or something else?) Note that it was not abundantly clear what the range of the MRR sensor was, this had to be inferred (assuming it was 10 km).

We added the maximum altitude of confidence in the MRRs data in this sub-section. This type of radar is characterized by a vertical beam scanning the sky right above him. We have added some technical information on the MRRs, such as the beamwidth: [P4-L10 – The MRR is a vertically profiling Doppler radar operating at a frequency of 24.3 GHz \(K-band\) with a beamwidth of 2° \(around 50 m in diameter at 3000 m\). At both stations, the resolution was set to 100 m per bin ranging from 300 m – first valid available measurements – to 3000 m. However, we only consider the data up to 2500 m because of the change in the snow microphysical properties above this altitude \(Grazioli et al., 2017a\).](#)

- On P12 / 8, you already allude to the fact that these calibrations are different, and the supporting references used elsewhere in this paper (primarily Souverijns et al 2018b) state this. Please clarify the wording here.

We made sure that there is no calibration between the ground radars and CloudSat in our paper. [P4-L26 –For this study, the used MRR2 data are processed with the Maahn and Kollias \(2012\) algorithm. Unlike Souverijns et al. \(2017\), we did not calibrate the ground radar dataset with CloudSat reflectivities because \(1\) we want an independent evaluation of the CloudSat CPR dataset, and \(2\) we do not consider surface precipitation rate comparisons..](#)

- P12 / 13 It would be very useful to verify whether this is the case, is data on this

available? It would also be useful to see whether these values continue further up the CloudSat profile or at other times when the MRR reports 0.

This is a good point and we thank the reviewer for bringing it up. This kind of study has never been done, however we observed on the CloudSat profiles that very light snowfall is recorded up to about 4 km, and in the cases of Fig.3b,c&d when MRR is extinct. Further studies on the CloudSat measurements at higher altitudes would be interesting but this is out of the scope of this paper.

- P1 / 9 : ', respectively' not needed here

This has been corrected: [P1-L9 – located in the Dronning Maud Land escarpment zone.](#)

- P9 / 9 : 'first lowest' did not make sense to me, maybe pick one?

This has been corrected, we kept 'first': [P9-L20 – Anyway, here MRR measurements are considered and compared to equivalent CloudSat vertical bins only in the first 2500 m of the atmosphere.](#)

- P12 / 7 : what do you mean by 'higher dispersion'?

It was an oversight in the writing, in fact there is no greater dispersion in CloudSat records: [P12-L7 – This difference of measured values suggests a difference in sensitivity even if these small measured rates are above the MRR detection limit.](#)

- Figure 1: Colour scheme of inserts of antarctic continent make it a bit hard read, it would be better if these stood out more (maybe blue for land mass and/or circular semi-transparent background?)

This has been improved.

C8

- Figure 2: a/d/g/j inserts of antarctic continent are small and hard to read, given Figure 1 exists these could probably be removed

This has been removed.

- Figure 3: Altitude often refers to height above MSL, but in this case appears to refer to height AGL, please clarify

This has been corrected, all altitudes refers to height AGL.