

Interactive comment on “How does the ice sheet surface mass balance relate to snowfall? Insights from a ground-based precipitation radar in East Antarctica” by Niels Souverijns et al.

Anonymous Referee #1

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The manuscript entitled "How does the ice sheet surface balance relate to snowfall? Insights from a ground-based precipitation radar in East Antarctica" deals with the very important issue of measuring the Surface Mass Balance (SMB) over the Antarctic Ice Sheet. In particular, the goal of this work is to quantify the different terms of the SMB at Princess Elisabeth Station (Antarctica) and investigate the relation between snowfall and accumulation.

The manuscript is for sure within the scope of the Journal and gives a systematic and rigorous analysis of the relation between snowfall and the accumulation at the considered site. Of course this work provides good results but many other sites must

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be analyzed to come to a more general conclusion.

Before the manuscript could be published, however, some points should be clarified.

p.3 l.5-9: "Both drifting snow sublimation and surface sublimation have been quantified for the PE station (Thiery et al., 2012). At the local scale, their significance can be fairly large (e.g. King et al., 2001; Bliss et al., 2011; Gorodetskaya et al., 2015; Grazioli et al., 2017b). However, this study mainly focuses on the relation between accumulation / ablation and snowfall. These terms, together with melt which is only relevant at coastal areas and ice shelves (Lenaerts et al., 2017), are therefore only quantified and not investigated in great depth." * "These terms" in this context seem to refer to accumulation/ablation and snowfall. But I guess those are not the terms the authors don't want to investigate in great depth. The authors probably mean "drifting snow sublimation and surface sublimation" terms, but the sentence should be reworded to be more clear.

p.3 l.10: "The total SMB or snow height" * The SMB is usually measured in unity of mass per surface or mm of water equivalent. If the authors want to link the concept of SMB to the snow height, the connection, although comprehensible, needs to be clarified. The same comment is valid for any time the authors talk about SMB height or height changes (p.3 l.19 or l.23 or p.5 l.24 as an example).

p.4 l.11: "This instrument is based on a high speed camera and able to obtain detailed information about snowflake microphysics." * "This instrument is based on a high speed camera and is able to obtain detailed information about snowflake microphysics."

p.4 l.14: "The net local SMB is measured directly by an AWS" * The authors need to explicitly describe or at least mention what kind of instruments are used for a direct measure of SMB. Acoustic height sensors are mentioned but there is no explicit connection with SMB measures.

p.5 l.20: "The local SMB constitutes of the sum of different components (Eq. 1), which can be estimated from measurements using the ground-based instrumentation listed

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in Sect. 2.1" * It would be useful here to summarize what ground-based instrument is used to measure each SMB component.

p.6 l.4: "(this corresponds to 1 cm of snow when the density of fresh snow equals 100 kg m⁻³)" * The snow height strongly depends on the density of the snowfall particles. In my opinion it is misleading to provide here a general conversion value being the precipitating particles over Antarctica so variable in shape and density.

p.6 l.11-12: "These measurements are processed following Gorodetskaya et al. (2013). Snowfall amounts are obtained from the MRR after applying the Ze-SR relation and methodology determined in Souverijns et al. (2017)." * Please provide here a brief description of Gorodetskaya et al. (2013) processing method and some more information about the Ze-S relationship determined by Souverijns et al. (2017). It is not necessary to provide a full description, but at least give to the reader enough information to be able to go on reading and understanding the methodologies without necessarily reading the reference (in my opinion references should provide a full detailed description of what the authors want to say but the text within the manuscript should be descriptive enough to allow a fluent reading). As an example, the Clear Sky Index methodology is briefly described (l.15-16) even if the proper reference is provided.

p.6 l.30: Again, few words about SANDRA optimization algorithm, why did you choose this one instead of another one? Describe at least the main characteristics that made the authors choose it.

p.7 l.3: Describe the Fast Silhouette Index, mentioning also within the text and not only in the S1 fig. caption that low values are good etc.

p.7 l.21: "that surface and drifting snow sublimation (SUs and SUDs respectively) are mainly negative." * Saying that they are mainly negative does it mean that they could be also positive? Fig. 2 caption says that they are plotted as ablation terms. . .

p.7 l.19: "This behaviour is also visible in the ERds" * It should be obvious being the

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ERds term just a residual term.

p.9 l.7: Does the "index" have a name? or a reference?

p.11 l.6: "(left side of the graph)" * (left side of the graph - negative pressure difference values)

p.11 l.17-18: . "Accumulation events are characterised by a larger temporal extent of the cloud structure compared to ablation." * It would be interesting here to report the temporal extent of the cloud structure relative to the snowfall event duration because we would expect the persistence of cloud structures at least during the snowfall event. According to AWS, for SMB+ the temporal extent of the cloud structure is 252% of the snowfall event duration, while for SMB- it is 263%, so higher. Opposite trend for ERA-I, with 277% for SMB+ and 243% for SMB-. So, absolutely speaking, accumulation events are characterized by a larger temporal extent of the cloud structure, but relatively speaking, some other considerations could be done.

p.12 l.13-14: "From this, the ceilometer was able to detect 486 cm (i.e. the sum of all height changes during events for which blowing snow was detected)" * The ceilometer is not able to detect the snow height, it can detect blowing snow and then the acoustic height sensor can measure the height changes. Please reword the sentence.

p.12 l.16-17: "During all snowfall events, a total amount of 230 mm w.e. (approximately 230 cm in case fresh snow density equals 100 kg m⁻³) was registered by the MRR, which is lower than the height changes recorded by the AWS (542 cm). This indicates the importance of the continuous movement of snow during snowfall events." * Without any information about snow density, the conversion of 1 mm w.e. to 1 cm cannot be considered realistic. PIP information should be used case by case to convert the w.e. to height and only after comparing the results to AWS measures. On the contrary, if in this work density information are used somehow for the conversion, it should be reported in the manuscript. Without clarifying this point, any conclusion made from this comparison cannot be considered reliable.

p.15 l.14: "The ceilometer was only able to detect 274 cm" * Again, the ceilometer detects the blowing snow, not the snow height.

p.16 l.5: "both accumulation as ablation" * "and" or "as well as"

p.16 l.7: "The distinction between accumulation and ablation events during snowfall was attributed to the duration of the event and the temporal cloud extent" * I would say "was related" or "we found a correlation between. . ." instead of "was attributed".

Supplement p.3 l.21: "influenced"

Fig.4a: "Wind rose showing the speed and direction of the snowfall events" * "Wind rose showing the speed and direction of the wind during snowfall events"

Fig. 5a: It is difficult to appreciate lines color differences, I would suggest to change the colorscale. Moreover, a legend describing the different lines would be useful.

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