Review of “Contribution of blowing snow sublimation to the surface mass balance of Antarctica” by Gadde and van de Berg

General comments

The manuscript entitled “Contribution of blowing snow sublimation to the surface mass balance of Antarctica” by Gadde and van de Berg presents an update of the blowing snow model implemented in the regional climate model RACMO. The authors modified several equations and parametrisations. New model runs are compared to observational data from site D47 in Adélie Land, East Antarctica, to validate the results. The study highlights the importance of blowing snow sublimation to the surface mass balance (SMB) of the Antarctic Ice Sheet and provides a valuable contribution to better account for blowing snow sublimation in models. The addressed topic is within the scope of TC and discusses a relevant and current glaciological question.

Below, I provide some specific comments and suggestions for further improving the manuscript that should be addressed prior to publication in The Cryosphere.

Specific comments (major)

Overall, the manuscript is well structured and presents the changes made to the model as well as the results. The introduction ends with an overview of the content of the individual chapters and offers the reader a clear structure. However, the individual descriptions of the changes in the model and the results are very detailed and sometimes lengthy. In general, the text could be shortened and formulated more precisely in many places. Repetitions occur in various sections but should be avoided. The discussion is too brief, and the results of this specific model are only briefly compared with another model (section 4.6). This would be an interesting comparison and further validation of the results presented here. Unfortunately, the manuscript falls short on this comparison and the main conclusions, while other descriptions are very detailed. I suggest shortening the manuscript (especially chapter 4) and discussing the relevance and implications of the study in more detail. Furthermore, the language could benefit from proofreading.

The authors mention that the model runs are available, but it is not clear where the data can be found. I encourage the authors to make the data as well as the updated model code available via an open repository.

Specific comments (minor)

- L. 35: *continent-wise* – should it be *continent-wide*
- L. 40: RCM is already defined in l. 36. Please use abbreviations once they are introduced.

- L. 50: Are you referring to specific observations here or just generally saying that RACMO was evaluated against observations?
- L. 52: What is the difference between RACMO2.3p1 and p2 and why do the different versions suggest different blowing snow fluxes?
- L. 54: To which RACMO version are you referring here, i.e. which blowing snow module in RACMO?
- L. 64: which RACMO version? 2.3p2?
- L. 103: It should read: ..serves *as* the boundary condition.
- L. 111: It seems that the verbs are missing in this sentence.
- L. 113: Please rewrite this sentence; it is hard to follow.
- L. 123: It is again a long and nested sentence. It might be easier to follow shorter sentences.
- L. 125: How do you justify setting d = s = 0.5?
- L. 145: What is different in the PIEKTUK-D compared to the PIEKTUK model? Please explain.
- L. 147: It should read: ..follows *a* two-parameter gamma distribution.
- L. 164: I am missing a reasoning why you made exactly these six updates to the model. Can you provide a short explanation for that?
- L. 169: Please change the order of the Equations → (5) and (6)
- L. 170: Please mention and/or explain the entire method, not only mention the abbreviation DNS.
- L. 183: There is a *t* missing in constitutes.
- L. 192: What did you test in the sensitivity analysis? Did you compare the results to observations? How did you quantify that a time step of *10 seconds produces reliable estimates*?
- L. 214: Please provide references when mentioning, that it's widely used in the literature.
- L. 221: You could add a wind rose or another type of graphic to illustrate the directional consistency of the katabatic winds.
- L. 231: Please add a space character between *up* and *to*.
- L. 236: The description in this paragraph is a bit confusing for me. To clarify: The observations of wind speed are measured at a height of 2 m and the model results are obtained using the Monin-Obukhov theory to calculate from the first atmospheric level in RACMO (which height is this?) to a 2 m wind speed. Is this correct?
- L. 239: Which RACMO version was used for RpNew? RACMO2.3?
- L. 250: Are you referring to high annual mean wind speeds or high wind speeds during events? You introduced the data already in section 3. Please avoid describing the observational data at several places in the manuscript.
- L. 251: Are the values in the table mean values for the period 2010-2012? Is there a seasonality in the model-data agreement/disagreement?
- L. 252: I am not aware of the word *underprediction*. I would suggest using the word *underestimates* instead of *underpredict* here as well as in the rest of the manuscript. Same for *overpredicted* in l. 265.
- L. 256: Please provide a better description when you are talking about which model/model result.

- Figure 3: You are providing many numbers after the decimal point. I personally would suggest to only show two numbers to keep the plot simple and clear.
- L. 275: I agree that the modified model RpNew shows better agreement between observed and simulated values. However, if you write about significant improvements, I would like to see p-values and/or a measure of the significance of the results.
- L. 286: R^2 would be 0.57 if rounding from 0.5683 as given in Fig. 3e.
- L. 286: Please provide statistical evidence when mentioning significant improvements. Just mentioning an R^2 of 0.57 is not sufficient.
- L. 293: Here, you are referring to RACMO2.3p2. In the previous paragraphs, you often only mention RACMO. Are you referring to RACMO2.3p2 when writing RACMO? Please either specify each time the version you are referring to or mention once that you are referring to a specific version.
- L. 298-304: Please provide correlations, R^2 or another statistical measure to prove that RpNew predicts *reasonably well* the magnitude and occurrence of the blowing snow or that RpNew *successfully predicts blowing snow mass flux reliably*.
- L. 314: Please stay consistent throughout the manuscript and use Eq. instead of equation.
- L. 322: Again, please provide statistical evidence.
- L. 348-351: Are you referring to Antarctic winter or Nov – Jan winter months? Same for summer.
- L. 356: What is the reasoning that you investigate the year 2011 and not 2010 or 2012?
- L. 362: Please provide a height estimate for *the upper part of the boundary layer*.
- L. 368ff: The given study investigates an area with high katabatic winds and it is highlighted how important the wind speed estimation is. Please elaborate why this case study provides sufficient and reliable estimates to transfer and extent the results from this study to continent-wide estimations of blowing snow sublimation, especially in areas where the wind speeds are low throughout most of the year.
- Figure 6: Please provide a version of this plot with colourblind-friendly colours (for instance in the appendix).
- L. 386: You are mentioning that there are differences between the studies, but they are still comparable. Please, if you mention differences, then elaborate on them and provide a reasoning, why they are still qualitatively comparable.
- Figures 7 and 8: The colour scales are not colourblind friendly and, in several cases (e.g. Fig. 8e), it is hard to see which colour indicates 0.
- L. 434: How do you explain that your model has the maximum blowing snow sublimation slightly shifted in its location compared to the result from Palm et al.?
- L. 443: Remove *to* between *RpNew* and *lead*.
- L. 463: Please specify what months are considered as winter and summer.
- L. 477: Please quantify *large differences*.
- L. 495: Why is the period here 2000-2010 while the simulations are from 2000-2012?

- L. 511: Here, you mention that the results are for the period from 2000 to 2010. In l. 249, you are referring to a period from 2010 to 2012 which is confusing to me. Why are you using different time periods for different comparisons?
- L. 534: I am again confused by the time frame of the experiments. Here, the period 2000-2010 is mentioned while in l. 249 values are reported for the period 2010-2012. Please clarify.