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Interactive comment on "Brief communication: Improved simulation of the present-day Greenland firn layer (1960–2016)" *by* Stefan R. M. Ligtenberg et al.

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Summary:

The paper presents an updated dataset of modeled firn air content and firn temperature for Greenland using the IMAU-FDM. The firn-densification model is the same as has been used for previous studies, but the model is forced using updated fields from the RACMO2.3p2 regional climate model. The paper demonstrates that using the updated forcing results in better model-data agreement in the zones that experience moderate summer melt.

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General Comments:

Overall, this is a well-written and well-organized paper, and it should be of interest to many members of the ice-sheet mass balance scientific community. Firn-model simulations are important for understanding the mass balance of Greenland, especially as the area which experiences summer melt grows, and the IMAU-FDM simulations are used by many research groups. These updated model products are thus a valuable contribution.

The paper makes a convincing case that the new results are indeed improved, and I recommend this manuscript for publication with minor revisions.

General points to address:

- In the abstract, it may be useful to clarify that the improvement is a result of improved atmospheric forcing data, not improved model physics (line3).

- (general curiosity; does not necessarily need to be addressed in the paper): The RACMO data begin in 1958; why do your model simulations begin in 1960?

- Firn air content (FAC) is the metric of choice. A few things to consider: When you report FAC for a site (or the whole ice sheet, as in Figure 3), it is important to note to what depth you are modeling. For instance, some groups' firn model domains do not extend to the depth where density becomes 917. For example, if considering Summit, the FAC at ∼80 m depth is ∼22 m and at ∼200 m depth is ∼25 m.

- You are reporting the r2 and RMSE (page 3, line 17), but can you expand on how you are generating those statistics? Is it how well the 1-1 line in figure 1A fits the dots, and RMSE is the error there? Or, is the r2 and RMSE calculated for each model depth/density profile compared to the data? If it is the former, how is RMSE skewed by cores that were not drilled to the firn-ice transition (related to the point above), or do you only consider full-thickness cores? For instance, a FAC RMSE error of 1.08 m might be small if you are considering cores with full FAC of 20m, but quite large if it is

from a 10-m core with only 5 m of observed FAC. Would there be a way of normalizing the cores for this metric?

- Considering the comparison of modeled 10-m FAC and 10m firn temperatures to the Harper data. Can you provide a more quantitative description of the model-data mismatch for RACMO2.3 and 2.3p2 simulations? I can clearly see the difference in Figure 2 but some metric for the difference would be appreciated. Also, why does 2.3p2 still predict a very cold 10m temperature zone (blue/purple in Fig 2F) at the western edge of the data, where the data do not show that?

Specific/technical corrections:

Page 1, Line 12: continues: change to "will continue"

Page 1, Line 19: perhaps IMAU-FDM should be written out prior to the acronym being used.

Page 1, Line 19: change sentence from passive voice: Kuipers Munneke et al. (2015 simulated the temporal . . . firn layer using the IMAU-FDM.

Page 1, Line 25: you say "more accumulation inland and less surface melt" - less surface melt where? Also inland? Ice-sheet wide?

Page 2, Line 11: perhaps specify here that liquid water percolation is modeled using a bucket scheme (you mention it later, but may be appropriate here)

Page 2, Line 25: please define the area you mean by inland. Above a certain elevation? KM from the coast?

Page 4, Line 5: downslope misspelled.

Figure 1:

- I think that instead of referring the reader to another paper to find the site locations, you could include them (the 5 plotted here, at least) on one of the panels in figure 3.

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-Do you have supplementary figures showing the improved/new modeled profiles for all 62 cores? I think it would be good if those were available somewhere.

- I know space is tight but having labels for the rows of numbers in the subpanels would be very useful to me. They could be as simple as b_dot, m_dot , and m_dot/b_dot.

- Since you have divided the firn into 3 regions (dry, moderate melt, high melt) it may be useful to choose a colormap that has 3 distinct zones, or to at least mark on the colorbar where the transitions between zones are.

- Since FAC is the metric you are looking at elsewhere, consider changing panels b-f to show FAC as a function of depth rather than density.

Figure 2:

- Can you show the location of the observed firn line in panels A and B for comparison to the modeled?

Figure 3:

- The color scale for the difference plots is a bit challenging because it is not linear; it does not clearly demonstrate your point that the biggest changes in FAC are in the moderate melt zone because the interior has some dark blue, but that is not nearly the magnitude of the red it turns out.

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