Review of revised:
"Characteristics of the contemporary Antarctic firn layer simulated with IMAU-FDM v1.2A (1979-2020)"
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Reviewer: C. Max Stevens

General comments:

I thank the authors for their thorough responses to my and the other reviewers' comments on the previous draft of their manuscript. The edits have made this paper substantially better. Most notably, the authors have taken care to add much more quantitative analyses of their model results and added context in which to interpret those numbers. Additionally, the clarity of the paper improved dramatically. The paper now presents both an update to the IMAU firn densification model and an impressive suite of model experiments and sensitivity tests. These results will be helpful for those looking to quantify uncertainty in firn model applications. I am happy to recommend the paper for publication in The Cryosphere after the authors address a few lingering issues. These are listed below in a line-by-line fashion, and I believe most are small changes that will improve clarity.

The largest issue that must be addressed is the definition of the "AIS" (Apologies to the authors that I did not catch this in the first review). I think the authors are using the term 'AIS' as shorthand for the entire continent, including both the ice sheets (WAIS and EAIS), the ice shelves, and distinct glaciers and ice fields on the Antarctic Peninsula. Strictly, the term AIS refers only to the ice sheets, and the authors define AIS as the Antarctic Ice Sheet in the first sentence of the paper. But, then throughout the paper it seems that the analyses are including ice shelves and the peninsula. This leads to some confusion in the paper. For example, the authors mention on line 344 that 99% of the AIS has a firn layer. Is this figure strictly for the ice sheets, or is the peninsula, which contains distinct glaciers, included in the 99%? How about the ice shelves? I think it would be good to specifically define the area(s) included in the study. For example, "We use the term AIS broadly to include the East and West Antarctic Ice sheets, as well as distinct glaciers and ice fields on the continent and the ice shelves".

Line by line comments:
(line numbers should refer to main manuscript, not the tracked changes version, but I may have made mistakes with that a few times.)

13: is losing → has been losing

37: comma after climate

63: change 'this study' to 'that study' to clarify that you are not talking about your own paper.

130: consider specifying 'requires dimensionless correction terms'

Section 2.3: Consider mentioning in this section that v_bedrock also contributes to ice-sheet elevation change but is not included in IMAU-FDM.

305: clarify 'without MO corrections' – does that mean that you just used the Arthern et al. (2010) equation, i.e. Equation 3 in your paper? Or that you ran the model using the updated RACMO forcing but the MO values from Ligtenberg et al. 2011? (Table 4 does not make it clearer to me).

315/Table 4: I got a bit confused here because you refer to FDM v1.1p2, which is not listed in Table 4. From Table 1, I gather that v1.1p2 is the model using RAMCO2.3p2 and the Ligtenberg MO values. To clarify this section, it may be as simple as altering the first and third lines of Table 4 to read, "MO$_{550}$FDM v1.1p1/v1.1p2" and adding a second R^2 value. Then, add a note in the caption explaining the notation and reminding the reader that v1.1p2 uses the RACMO2.3.p2. Alternatively, you could add 2 more lines to the table. As a reader, I was alternating between the text and Table 4 while reading this section, and so I was a bit thrown off when I had to go searching to remind me what v1.1p2 was. I realize there is a risk of redundancy (ie., you did define v1.1p2 earlier), but given the number of model variations that are included in your study I as a reader find it helpful to have reminders throughout the text of what the variations are.

325: Similar to my last 2 comments – I am again confused by your naming scheme. Which is the 'reference FDM v1.2A'? That is not included in Table 1 or Table 4. If one of the runs you are referring to is the -log run, refer to it as you have defined it previously.

329: Specify: "if we only include Antarctic cores from the…"

329: change to, "we find similar model fits to the data for the logarithmic model (R^2=0.67) and the power model (R^2=0.68)."

330: Change to 'Another difference between FDM v1.2G and v1.2A is that in …'

337: Coming from the previous section that discussed many model variations, it would be useful here to specify, "Using the improved firn model FDM v.1.2A, we simulate…" This will make it very clear to the reader what to refer to in Tables 1 and 4.

344: specify: "In line with observations, FDM v1.2A predicts that nearly all…"

352: remove word 'especially'

361-362: The sentence about the large spread of timescales in the firn is vague – either add more detail of how these add to our understanding or remove this sentence. I think the spread in firn ages in Antarctica is reasonably well documented in the ice-core literature. I am not sure

if you are implying that your findings help with process understanding (e.g., processes operating on different timescales) or implying that your statistics (25% vs 15% RMSE for firn age and depth) can provide new insights – if so, what are those?

371: Define CFM; please cite

373: Related to comment above – make sure each instance of referring to AIS is consistent or explained. Here – did the values in the previous paragraph not include ice shelves?

376: spatial → spatially

420: This sentence needs punctuation and/or to be broken into multiple sentences to clarify. Also consider referring to figure panels in the sentence. Something like: Figure 7 shows time series of the entire AIS (7a) and above/below 2000 m (7b/7c). Each panel includes integrated FAC and the cumulative surface temperature and surface velocity anomalies. The surface velocity anomalies are broken down into their components.

487: change to plural: "find substantial positive residual-altimetry trends at locations"

494: updated MO fits – perhaps change language in this section to refer to the model versions, e.g. v1.2A, v1.1p2, etc. Then the reader can refer directly to tables to remember which one you are referring to.

518: 'increases the surface elevation change rates of both signs' – please clarify what you mean here.

546: clarify that this is the mass change of the firn column, not the entire ice sheet. Also, clarify "lower" and "higher" mean for changes, e.g. for West Antarctica, does "1.2 Gt/yr higher" mean that the mass change was -3.8 Gt/yr instead of -5 Gt/yr (I made those numbers up to illustrate; in this case higher refers to position on the number line) or higher mean that the mass change was -6.2 Gt/yr instead of 5 Gt/yr (in this case 'higher' means greater mass loss)?

594: Change wording: "forcing or forcing during" reads oddly.