The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2018-19-RC1, 2018

The Cryosphere Discussions
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Interactive comment on "Brief communication: "Oldest Ice" patches diagnosed 37 km southwest of Dome C, East Antarctica" *by* Olivier Passalacqua et al.

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Received and published: 21 March 2018

The authors present a new modeling study that further characterizes the ice-flow and subglacial conditions that could combine to best preserve ice up to 1.5 million years old near Dome C. The study builds on previous work by applying a 3-D model and by using the latest available bed topography. The authors identify candidate drill sites that attempt to balance needs of the oldest ice possible with the age-resolution desired for ice-core analyses.

This was a nice piece of work that advances understanding of the Dome C environment; modeling like this is key to picking a drill site for the "Oldest Ice" ice-coring effort.

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I have more substantive comments on the style of the manuscript, and relatively minor comments on the modeling. Both are given below, and by line number as appropriate.

I suggest that the authors work together to improve the writing style (including title, abstract, main text, and summary statement). The manuscript can be understood but the language used is often non-descript, and I think detracts from the impact of the work. Sometimes it is a subtle use of an inappropriate word, and sometimes (at least to me) it gives a context to the sentence that may or may not be intended. I appreciate that this may be a simple translation situation – and in my attempts to learn French I am very sympathetic to how difficult this could be – but, again, I think it is worth rewriting this carefully using different expressions so that the work is clear and has the most impact for all readers. Hopefully all of the authors can work together to achieve this.

Line 2: “prevent basal melting” – suggest “limit”

Line 3: “ensure” is strong, really you are making the best estimate

Line 4: “ice archive is sufficient” – sufficient for what? It hasn’t been made clear what is needed, there is a disconnect between first sentence and following sentences

Line 5, title, and throughout: I am not against the use of the term “patches”, but the term doesn’t tell the reader much. Since this is in support of ice coring, one impression is that a patch could be a few meters, or since the study area around Dome C is tens of km+ maybe this is the scale? I would clarify what area a patch covers up front, and I also suggest making a somewhat more general title (why is 37 km so important?). I think “area” is a better term than “patches”, but the authors can justify what is best based on use in the community.

Title: “diagnosed” is not incorrect, but isn’t the way I would expect it to be used. None of these have to be used, but some title suggestions could be: “Candidate areas of 1.5-Ma ice southwest of Dome C, East Antarctica”, “Flow-model constraints on locations where 1.5-Ma ice exists southwest of Dome C, East Antarctica”, . . . something more

general, and yet specific to the needs of “oldest ice” seems better.

The stated challenge with this is that the model is only as good as the boundary conditions that may vary in space and/or time. I understand the need to say something strong about the presence of 1.5-Ma ice so that the next steps toward a drilling program can proceed. I think the authors acknowledge this but I’m left with the tension on whether it is better to state the results more confidently, or less. Perhaps this is where language comes in again, for example:

Lines 9-10: “Several precise locations of potential 1.5-Ma-old ice are proposed, to nourish the collective thinking on the precise location of a future drill site.”

I suggest that this sentence is revised to state directly what the community should do with these results – or, is already doing with them! If the results are really just something to think about, I guess that is it. But, if they are the state-of-the-art in modeling and what will in fact be used going forward as a community, say that. (And, “nourish” isn’t the right usage here and gives too loose a sense of the value of this work.) Also, from the conclusions it sounds like this modeling has informed where to collect new radar data, right?

Also, why is this a “Brief communication”? It seems awkward for a modeling paper that should contain enough detail to evaluate the merits of putting results to use in planning would be published as a “brief”. Again, this was hard to evaluate because it wasn’t entirely clear how the results from this work should be used. Are they really just something to think about as the other work on this moves forward? Why is this a valuable step? I think that the results will in fact be used more directly hand-in-hand with new data collection, rapid-access drilling, and eventual deep drilling – again, I suggest the authors frame their results more directly in context with the community effort.

Line 17: Might want to elaborate on whether processes under consideration are external, internal, or both. And, seems that there would be more references other than

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Clark et al. (2006), so give as “e.g., “ or list a few more that are relevant – possibly splitting out after points in this sentence where the references apply.

Line 25: What is “IGE”?

Line 35: “inverts” is not used correctly here, and I would state more directly that this approach solves an inverse problem, making clear the model parameters that are inferred

Line 37: “definitely not vertical” – suggest as “. . . are not only vertical”

Line 53: “security margin” – suggest other phrasing, and while I understand there is no better estimate, is that really true? What about ice-flow conditions between candidate sites in this work and Dome C drill site may inform if 60 meters is an under- or over-estimate? Did you try other values if there is a chance this is an underestimate (as stated)? Line 56: “defavourable” is not a word, here it would be “unfavourable”

Line 58: missing “the” between “Finally, the location. . .”

Line 59: Define the “water limit”, I think I understand but since it is used often need to be clear what this is and how it is estimated

Figure 1: A scale bar would be helpful

Figure 1 caption: I would refer to this a “context map” instead of a “situation map”. Language of “the hold of the domain” sounds off, and I suggest “. . . shows the domain used for the calculation, and the blue rectangle at the top of the image is the location of Figure 2”

Line 61: Refer to Figure 1?

Line 66: Is the firn really “accounted” for? I would say that your model is in ice equivalent and you adjust the surface height using an assumed density profile to convert the firn layer to an ice layer. It should be clear that you don’t include a process model of firn. Where did your density profile come from? (Assume Dome C, but did you apply

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that everywhere?)

Does the model resolution as a function of depth vary linearly, exponentially, ?

Line 77: “were” should be “where” I suggest using “not present” instead of “null”

Line 84: Instead of “heavy”, suggest “excessive” – and is that really true for the limited domain of your model given that it is steady state? Is the issue that you can’t solve the time-dependent problem and therefore a coupled thermomechanical model doesn’t add much in steady state?

Also, it could be worth noting that it is non-trivial to extend a multi-dimensional limited-domain model from a steady-state calculation to a transient one. Without modeling the full continent you need to impart information to this regional model about how ice-thickness changes and ice-flow changes inside and outside of this domain correspond to changes in the rest of the ice sheet in which it is embedded. So, for the goal of regional modeling you are minimizing even more assumptions (and challenges in setup and computation) by starting in steady state.

I looked at this for 2.5-D (flowband) models: Koutnik and Waddington (2012), Well-posed boundary conditions for limited-domain models of transient ice flow near an ice divide, Journal of Glaciology 58, 1008-1020.

Line 94: Instead of “more influent”, suggest “has more influence”

Line 110: State as 1/lambda?

Line 113-114: This sentence wasn’t clear to me starting with “The way ice strains. . .”

Line 143: What do you mean by “a logic combination”?

Figure 2: x-axis and y-axis numeric labels are way too small in the top panels, and probably also too small in the bottom panel. Axis labels are missing. I am not really sure where to read the numbers from each panel and without those they don’t say much – the caption needs to be improved to make sense of these panels, or maybe

the top four are not shown? It looks like there would be more overlapping areas, or is it just that age resolution is limited?

Make sure the caption clearly guides the reader through this and that all box colors are identifiable. For example, it took me awhile to see the blue box showing location of Van Liefferinge results.

Seems like colored crosses should receive more discussion in the text. Pros / cons of each choice could be takeaway points. Again, how should the community use these results?

Putting these results in better context with the Van Liefferinge et al. (2018) results seems necessary. Especially that this work is still in The Cryopshere Discussion, the reader is not necessarily sure what to make of these parallel efforts. I might have missed it, but I think the first citation of this work is in the caption of Figure 2. Section 3.5 goes into more depth between the approaches but could be worthwhile to put this context up front, and as part of the framing of why your results matter to the community. Is there really no way and/or no effort underway to combine these two approaches? Is the limitation only computational? At what point might this be possible? (Or, what are the next steps that can be taken by the modeling community in this effort to find the best drill site?)

Line 182: I suggest rephrasing “oldest-ice challenge” – even “the challenge of finding the oldest ice” sounds better, somehow the other sounds too loose, and therefore does not have as much impact.

Line 187: “appropriate ice”, suggest rephrasing what you mean by “appropriate” or using the phrase “candidate drill sites”

Line 190: suggest using another word than “risks” (there are other usages that I’d also change”; maybe the word is “chance”

Line 190: By shorter trajectories you really just want to be closest to the dome / ridge-

line

Figure 3: Why not give the x-axis in km? All labels are very small

Is the bed topography the most important boundary condition in your modeling? What resolution would be ideal to be confident from modeling on where to pick a drill location?

Line 210: How can these results really be benchmarked against Van Liefferinge et al. (2018) given that they use a very different approach? All you have done is qualitative comparison, right?

Line 214: should be “constraint”

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