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The Cryosphere Discussions
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Interactive comment on "Kinematic response of ice-rise divides to changes in oceanic and atmospheric forcing" *by* Clemens Schannwell et al.

Anonymous Referee #1

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This study is an advance in modeling ice-rise evolution and sets a new state-of-the-art from which to understand more. The modeling work is clearly a strong contribution and it is interesting to contrast the response of the ice-rise divide to surface mass balance and to oceanic forcing. My overall reaction is that a stated goal of advancing modeling capabilities was to be able to interpret ice-rise stratigraphy as a function of the history of forcing (based on the abstract and introduction). The modeling shows many cases that indicate how forcing may be imprinted on the ice rise, but doesn't focus directly on the stratigraphy. The discussion mentions general features of the Raymond stack in relation to these calculations but doesn't address how specific histories may be inferred, and even if that goal is now accessible because of this type of advance

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in modeling or if data limitations are still significant. In particular, I couldn't connect all the results about divide migration to the overall goal of inferring past forcing and the resulting ice-rise evolution (including divide migration) without relating what is possible and what has been recorded through the stratigraphy. If the main point is how much the divide and triple junction may migrate at all, then the motivation could be reworked to emphasize that the timing and magnitude of migration is something that we need to know, maybe just even for the overall evolution and stability of ice rises less than the imprint on stratigraphy and how that history may be inferred in future work. The conclusions seem to summarize best the main takeaways and it would help if the abstract, introduction, and figures better guide the reader through all of the model results in a more cohesive way to showcase these key points.

Also, if this type of work on triple junctions is completely new then I would highlight that more. I think that it is because 3D models have not been applied like this to ice rises before – so, what do these results mean for 2D interpretations? Are triple junctions commonly observed on ice rises?

I think the conclusions and outcomes of this work would be stronger if the authors can better bridge between what has been done here, and where this can go interpreting ice-rise data and/or understanding ice-rise evolution in general. As a step towards making this point more clear in the text, it may be necessary to rework figures and/or text so that these main messages are clear and that the information shown in the figures is understood to be supporting a particular overall result (or results), as well as displaying specific calculations. As it is now there are a lot of specifics presented and it is hard for the reader to know the best way to use all of the results outside of this work. But, it is clear that the work is a strong contribution and hopefully this feedback can help to strengthen the presentation and therefore the impact of these results within the wider community.

Specific comments:

Pg. 1, Line 4: “other archives are missing” – if space, I’d be more specific about what archives you are referring to that are currently unavailable

Pg. 1, Line 18: Clarify that ice rises are independent of the main ice sheet but what seems important here is that they are isolated from the ice shelf

Pg. 2, Line 18: Suggest rephrasing “It appears higher Glen flow indices than n>3” since that is redundant and not as directly written as could be

Figure 1: Seems like it would be more clear in the figure to use smaller dots to represent ice-rise locations

Figure 2: Type that is in dark-colored brown parts of the figure cannot be seen very well. I printed in black and white and it is unreadable. It is a matter of preference, but I think it helps the reader to have a), b), c) listed before you say what they show, rather than after.

I’d be clear in what you are showing for perturbed cases in Figure 2 that these are isochrones and geometry for new steady state subject to these perturbed conditions

Would be worth more fully referring to Figure 2 in the text, as it isn’t completely clear how much of a cartoon this is vs. an illustration of the two cases you’ll try

Pg. 4, Line 11: Are these ice shelves larger than typically found or can you qualify “large” here for better context?

Pg. 4, Line 15: in this question does it have to be “or”, could it be “and” among all three controls that you mention?

Pg. 4, Line 24: I’m not sure what is meant by “. . .belong to the larger ice rises in Antarctica. . .” – but here is where you give context to size in relation to other ice rises, maybe worth mentioning earlier?

Equation 1: Isn’t there a minus sign missing?

Pg. 6, Line 7: Is there a physical meaning to the tuning parameters that can be shared simply here without having to go back to Favier et al. (2016)?

Pg. 7, Line 16: Check formatting of ; and)

Pg. 7, Line 23: Need to fix so that subscripts are for both B and C for each parameter

Pg. 7, Line 25: I'm not sure that I'd call L-curve analysis a way to "calibrate" the regularization parameters, really it is a way to pick them following a set of assumptions

Pg. 8, Line 2: What do you mean by "data inconsistencies"?

Also, would be good to clarify that the simulation length you are referring to is the relaxation simulation (10 years), as in the table you show 1000 years

Figure 3: Axes labels and text in figures a) and b) are small and hard to read without zooming in; colors for velocity misfit are hard to map back to the colorbar because the circles are small

Would be worth discussing if these misfits are reasonable and how that is evaluated, not just that the misfit is minimized without overfitting

Pg. 8, Line 10: Are you referring to the magnitude of the SMB? It isn't clear in this sentence

The following point ". . .we adjust the SMB using the observed model drift following the relaxation simulation" also isn't clear to me what you have done, would be good to elaborate more and to explain better why this is reasonable to do

The following sentences are also not clear to me, especially "we treat the unadjusted SMB as a simulation with a perturbed SMB" – are there some words missing?

Table 2: Is there a misplaced mention to "Run 6", or what does SMB forcing mean here?

Figure 4: In this case the text fonts are so big it is almost distracting to what you are

trying to show (but readable!). Mesh elements should be two words.

Pg. 10, Line 3: I know that it is used, but “inverted basal drag coefficients” sounds funny, so maybe state that these are found by solving an inverse problem

Do these two cases use the same regularization parameters? Is an order of magnitude difference as significant as it sounds?

Pg. 10, Line 8: Would rephrase “in divide proximity” to be “in the proximity of the divide”, or even better “near the divide”

Pg. 10, Line 9: What should the reader take away from the statement “Thinning rates were much smaller when using the FS forward model” – what lowering rate was estimated and how did you know that was “good enough”?

Figure 5: Panel b) title should be “FS” and not “NS”

Is there no way to have these on the same color scale? Or, use a different color range as it is just too tempting now to compare them side-by-side

Axes labels are too small to read.

Pg. 11, Line 5: should be “exceeds”

Pg. 11, Line 7: Would be helpful to say the duration of the simulation here (1000 years?)

Pg. 12, Line 9: By “disparity” used here do you just mean “difference”? Is there more to say about why the flux is so different between east and west, other than that was the forcing that was setup?

Figure 6: I spent a long time trying to figure out what is plotted here, so for what that is worth it may be better to plot and/or describe this differently. - the concept of a swath profile wasn’t completely clear, or at least would be good to explain more about why the swaths were chosen in these locations - I didn’t understand what was meant in the

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caption by “backward migration” - Would help to explain more about what the values of balance flux mean in relation to understanding about how different forcing imprints a different history on the ice rise - axes labels are too small

Also, why have these four panels together, would it be better as two figures with two panels each? Or, explain more what we learn by looking at the time series of balance flux as I had a hard time connecting to the point there.

Figure 7 was also hard to take in all the information shown, especially with such a bright color scale I had to zoom more to see the lines and try to relate them back to the different runs and what was shown in the other figures. I appreciate this is hard to plot, but more text around what you are plotting – and why – would help.

Also, how and why were “selected times” chosen?

Figure 10 also took awhile to work through. Some comments: - “total mean divide migration” isn’t clear how this was calculated, especially vs. “mean divide migration” - axes labels are too small - the units of the GL flux perturbation aren’t intuitive – is the relative difference what is important here?

Pg. 21, Section 5.2: I’m sorry if I lost the point here, but is these ice rises have been stable for 9ka then why investigate divide migration here over 1kyr timescale? It would be helpful to connect what you are constraining about this specific site’s history to all the calculations that have been done investigating generalized forcing. I guess that I thought some of these cases may have happened here, but if not that should be really clear (and sorry if I missed it)

Pg. 24, Line 10: Do you mean “cause” larger divide migration rates, or that these configurations could experience larger migration rates?

Pg. 26, Line 10: Should be “prove useful”

As a general question, is this work all about understanding past behavior, or can this understanding of how physical mechanisms drive divide migration inform us about the

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sensitivity of ice rises and possibly some ice rises that have configurations that make them more vulnerable to ungrounding. Or, is the divide migration focused on here not significant enough to affect ice-rise stability?

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