The Cryosphere
Discussions

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# *Interactive comment on* "Simulated retreat of Jakobshavn Isbræ during the 21st century" *by* Xiaoran Guo et al.

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General comments:

The model approach resembles previous studies by Muresan et al. 2016 by using ocean temperatures as a forcing to a dynamic ice flow model. However, Xiaoran Guo et al. expands the approach by going into more detail on seasonality and viscosity changes, while also starting their model in 2004 (not in 1990 as Muresan et al does) where they provide evidence that there is a shift in flow regime. Thus, there is a scientific advance within the field, by exploring ways to improve methods for modelling the behaviour of fast flowing ice streams.

These types of model studies requires a lot of technical settings and tuning of the model

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[Discussion paper]

which is very complicated and hard to explain in an easy-to-understand way. However, in order to satisfy the demand of traceability of results, this is the most important part of the paper. The model setup sections are not doing this sufficiently, in their current state.

Specific comments:

Model description sections: Initialisation and calibration should be improved to make it clearer exactly what has been done. In particular I am missing information about what basal and surface geometry is used in the inversion process and also how values for basal friction and ice softness are derived. Furthermore, I am curios about the mesh resolution used in the model and in particular how this looks across the shear margins.

Basal geometry: It is not stated anywhere what basal geometry is used. As, the authors also state in the discussion, geometry is the most important factor for ice stream stability and thus the results of the retreating calving front should furthermore be mapped on top of a basal geometry map in 2d plan view (seen from above). The retreat pattern relation to basal geometry should be discussed in relation to other studies modelling the future behaviour of Jakobshavns Isbræ.

In relation to starting in 2014: To my understanding, and also what you describe for the model, a stiff ice mélange has a butressing effect. Thus, it seems strange to me that the glacier is stable from 2004 and onwards, if it just lost an important butressing?

Line by line comments: Section 1 Generally, there is confusion about the definition of a floating ice shelf and a stiff ice mélange throughout the section.

Line 70-72: Needs a reference

Section 2 Line 102: what basal map do you use? Line 123-124: Please refer us to a study where the method of solving the inverse problem where two unknown is discussed (or explain in detail here how that would work, and how you can trust the outcome). I think this is an important point as viscosity is non-linear.

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Section 2.2: Should just be titled Forcing (and not climate forcing) Line 135: What is CTD? Line 136: At what depth is the ocean temperature a good approximation? Line 153: Use alpha1 and alpha2 in stead of the calibrated numbers Line 157-160: MAR is used to estimate the runoff in equation 10. Later on Racmo is used as forcing. It is not clear why you use two different models, and when they are used. Line 169: Make it clear that it is your model your are talking about Line 169: Write out SMB Line 174-177: Please state in what equation this ocean forcing goes into

Section 2.3

Line 187: The dataset described here is only 2d, your model is in 3d, so I am not sure what you are using this for? Line 188: to my understanding, the sudden disappearance Line 202: please remind us what beta is Line 209-210: What does similar mean? How far off are we talking here? And please state why you use the 1998 profile when the model is starting in 2004. Line 214: Why is it the 8th, needs clarification. Line 217: Aha, good to know already in line 209-210 Line 218-219: The glacier is definitely not in steady state in 2004, please rephrase 2.4 Model calibration This section is very confusing to me. I think it needs a rewrite to become clearer.

Line 235: rephrase sentence Line 235-245: I am confused about this whole paragraph. The following paragraph (Line 246-259) is better structured, could this perhaps be the start of the section? Line 274-284: This whole paragraph needs clarification.

Figure 5A: How is the calving front retreat defined? Is it just a comparison at points along a center flowline? And it this representative of the general retreat?

Section 3 Figure 7: I would be more interested in seeing the retreat from above, the center flowline bedmap does not explain the stop of retreat.

Line 322: Make it clear that you are talking about you model version of Jakobshavn Isbræ

Section 4 It confused me a bit that you called this Discussion as a lot of important

results are also presented here.

Line 370-372: This sentence does not make sense to me, does freshly calved ice bergs really provide any resistance?

Line: 376-377: here you call it a stiff ice mélange, I think you should use this term throughout, especially in the intro

Section 4.2 I am a bit confused, are the results of changes in the effective viscosity shown in figure 8 results from your forward run? And if so, how does the fact that you are keeping ice softness constant influence these results? I think there must be an effect in the softening from the thermodynamics as well?

Section 4.3 Good to have comparisons with previous results, I think a key point, which you focus very little on, is that the retreat stops in the same area in all the studies (if I understood this correctly)? I think that if you also add figures showing basal geometry and retreat as suggested earlier, this point is easily added.

Line 498-499: What do you mean by two-dimensional ice flow patterns?

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Interactive comment on The Cryosphere Discuss., https://doi.org/10.5194/tc-2019-7, 2019.