

Dear Martin Rückamp and co-authors,

Many thanks for providing this new version of your manuscript. I went through the manuscript and have provided final feedback that I would like you to consider when re-submitting your files. The list may seem somewhat long at first, but most comments should be very easy to incorporate. Once these final suggestions are addressed, we should normally be able to proceed to the acceptance of the manuscript.

- 1.3: "...we explore the dynamics consequences..." → "we explore the dynamic consequences of using simplified approaches by...": i.e. suggest being a bit more specific here.
- 1.9: "...whereby the BP model overestimates..."
- 1.11: "...and the basal drag, where neglected stress terms in BP become important"
- 1.16: "computationally intensive" → "computationally expensive"
- 1.17: "...because FS effects (vs. sim models) only occur at higher resolutions"
- 1.18: "...in the last decades allowed for ice flow models to directly rely on FS equations or approaches with only few simplifications"
- 1.20: "require an accurate representation of stresses, e.g..."
- 1.21-22: "...necessary for long time..." (i.e. remove "e.g." here)
- 1.25: "neglects several components of the full system": would be good to mention which ones here
- 1.32: IPCC, 2013: true, but bit outdated. I guess a similar statement was made in SROCC or in AR6? Refer to one of these reports instead?
- 1.34: "...was explored: e.g. in ISMIP-HOM..." (and remove second bracket on 1.37)
- 1.37: "...focused on..."
- 1.38: "...show a smaller spread..." (i.e. remove, "much")
- 1.38: "...and with available analytical solutions" (remove "one")
- 1.39: "...was not possible..."
- 1.43: "...cost when running FS models..."
- 1.45-46: "...simpler models was tested on..."
- 1.59: "...on FS and BP..."
- 1.59: "more frequently used": compared to what? FS/SIA? Would be good to be more specific here to avoid possible confusion
- 1.62: "FS and BP intercomparison, stepping away from synthetic scenarios, and performing a high-resolution..."
- 1.66: "Our study does not treat the..."
- 1.68: "...12.8 km to a resolution of..." (i.e. remove "down")
- 1.71: given the importance of the full-Stokes (FS) equations in your storyline, would it make sense to also explain shortly how this relates to navier-Stokes, which may be more familiar to those outside the glaciological community?
- 1.104: not sure if can have colours in equations in final document. Needs to be seen with copy-editing. Suggest adding a note to flag this.
- 1.117-118: "...van der Veen and Whillans"
- 1.122: "reduces the computational demand": could you give an indication by how much this is the case?
- 1.126: "...alternative way to align with the BP stress regime, thereby directly allowing to compare FS and HO model simulations": the second part of the sentence that I suggest to add is not a must, but think it would be nice to explicitly mention this here to conclude this section.
- 1.130: remove bracket after "2"
- 1.132: "...in order to align with the BP stress regime"
- 1.133: "That means that" → "Through this approach,..."
- 1.130-140: nicely formulated. Very clear, also for non-expert!
- 1.159: "increases" → "increase"

- 1.163: "...which requires more computation time and working..." (or less computation, in case I did not understand this correctly. There's some room for misinterpretation in actual formulation, therefore good to change also)
- 1.183: "Exp. C is a parallel-sided slab"
- 1.187: "In the parallel direction, 15 layers...": in general, many instances throughout the text where a "," could/should be added. Could check for this, although will normally be done through copy-editing phase.
- 1.193-194: "reveals distinct differences between FS and lower order approximations": not entirely clear here: is this FS vs. HO? Or vs. SIA? Would be good to be more specific here.
- 1.195: "On those": shorter time scales? Would be good to specify what those refers to here
- 1.197: "... we found a good agreement with the original ISMIP-HOM contributions and within our own model versions": not sure if with the latter 'within' the sentence expresses what you wanted to say. But thought this'd be clearer than original formulation. If disagree, feel free to leave as is of course
- 1.203: "...focuses on..."
- 1.204: "The second region also includes the..."
- 1.207-208: "bed and surface topography": what is source for surface topography in BedMachine?
- caption figure 1: "overlay on each other" → "overlap"?
- 1.214-15: when referring to the 'shock': suggest to also directly refer to the ISMIP initialization experiments (Goelzer et al., 2018, TC) here, as they clearly make this point
- 1.218: "...allow for a better comparison"
- 1.220: "...is assumed to be:"
- 1.229: density of the ocean water. Possibly add a reference for taking this value?
- 1.236: "slip-free condition"?
- 1.238: "For those outflow boundaries..."? Not sure, but would be good to specify what the "those" refers to here
- 1.242: "...ZI; where..."
- 1.253: "...from a few seconds to several hours": also the upper limit does not seem to be a lot. How does this align with the statement made in the previous line which refers to this being expensive?
- 1.260: "is computed by Cuffey and Paterson" → "is computed following Cuffey and Paterson" + also further in sentence when referring to Lliboutry and Duval (1985). Otherwise sounds like Cuffey and Paterson calculated this themselves... For the reference to the value by Cuffey and Paterson, suggest to also include the Table where this comes from in the book (if I'm not mistaken there's several values suggested there, no?)
- Table 1:
 - "...MPI) are kept constant between..."
 - "...hybrid mode, meaning the process..."
 - "Each production node has 362 GB RAM and..."
- 1.268: "ice-stream region for l=6400 m and 100 m is provided in Fig. 3"
- 1.269-270: "... (Fig. 3b,e) at higher resolution reveals... a rapidly varying bed" (remove "in the finer resolution" at end of the century)
- 1.278: "...could certainly be..."
- 1.285: "The largest impact of using a BP-like solution results from the surface flow velocities, which are up to 43 ma⁻¹ faster (..."
- 1.290: "...spread in differences is more pronounced for..."
- Fig. 5 caption: "...for E = 0.1,...": remove "or"
- 1.311-312: split in two sentences: "(Fig. 6c,f). However..."
- 1.316: "difference is" or "differences are"
- Fig. 6 caption: not easy to follow. Suggest putting the references to the panels before the explanation: i.e. "(a) slope of bed topography, (b) basal friction coefficient for E=1 and (c) simulated surface..."

- Fig. 8 caption: “For those”: which ones? Please specify
- 1.332: “Overall, the BP-like model results in higher discharge than FS, while the opposite is true for 79NG and ZI.”
- 1.344: “Due to the hyperbolic...”
- 1.345: “...which smooths the sharp gradients...”
- 1.347: “Recalling values”: what are these? Not entirely clear. Possibly reformulate?
- 1.352: suggest removing “certainly”
- 1.359: “hinge zone”: what is this? Would be good if you could explain this here
- 1.361: “...complex composition of ice dynamic...”
- 1.364: “...flavour of the origins...”: not sure what you are referring to here. Could you specify?
- Figure 10: “Lower shows...” → “Panels (c) and (d) show the...”
- 1.365: “Figure 11 and 12 shows” → “Figure 11 and 12 show”
- 1.370: “...lower in some larger areas”
- 1.374: “...in the majority larger...” → “...is generally larger for...”
- 1.379: “weak” and “strong” setup: is not entirely clear what this is here.
- 1.386: “..., in the BP-like...” → “, the BP-like”
- 1.387-388: “Similarly, the difference between FS and BP is most pronounced in region with a high slip ratio..., while with a higher resolution...”: not sure about the second part (“while with...”), as the sentence was not entirely clear to me. If not correctly reformulated, try to opt for slightly different formulation to better reflect what you mean here.
- 1.391: “0 to 0.05, the higher bed undulations lead to larger errors at higher resolutions; however it...”: not entirely clear to what the last “it” refers here: (the neglect of) the bed slope?
- 1.393: would be good to also briefly refer to work on (mountain) glaciers that has shown this also. Particularly thinking of Le Meur et al. (2004, <https://doi.org/10.1016/j.crhy.2004.10.001>) for this.
- 1.397: “are to date rarely used...”: would be good to specify this, as will change in the (near) future
- 1.398: “we found distinct differences” + 1.399: “these differences”: not entirely clear, would be good if you could specify differences in what?
- 1.400: “...that at a higher resolution the disagreements would be more substantial, but...”
- 1.400: bedrock topography database: how is this linked to the disagreements you mention before? Not entirely clear. Suggest reformulating.
- 1.401: “...computationally expensive, it...”
- 1.402: “...that are currently being run within the ice sheet modelling community”: see comment above also
- Figure 11 caption:
 - “Pas” → “Pa s”?
 - “that range from E=1 to E=6”
- Figure 12 caption: “...equivalent fields but for m=3”, correct?
- 1.409-410: “Figure 15 (panels a and c) shows the...”
- 1.414: “...that is for most areas higher...”
- 1.416: “...made to BP...”: not entirely clear here. Maybe simply omit?
- 1.432: “...using the geometry from...”
- 1.434: “...respond somewhat similarly (see...)”
- 1.435: “...coverage or the fact that ZI has...”
- 1.438: “...and analysing how the...”
- 1.467: “...must be investigated in future studies”
- 1.468: “...within a thermo-mechanical model?”
- 1.469: “...ice flow. Additionally, there...”: as is not really in contrast with what you have said before it seems. Seems more like an extra suggestion.
- 1.480-481: suggest omitting “An intriguing effect was identified” at start of the sentence and also reformulate in general: “In the ice stream region, when considering a rheology with much

softer ice ($E=6$) than typically considered, and enhanced spread...and BP-like was modelled”:
than typically considered → why is this?

- 1.481: “In contrast, stiffer ice ($E=0.1$)_leads to...”: was not clear what the reference is for 10 time stiffer. Therefore suggested removing this.
- 1.484: “...as important surface velocity differences occur (up to ...of 79NG). Numerical...”
- 1.485-486: “...to the choice of friction type; model differences are particularly important when a power-law friction is applied (as opposed to a linear approach)”
- 1. 491: “...results from non-FS models...”: otherwise a huge range of models is possible (e.g. SIA, SIA-SSA,..etc)
- 1.492: “...software that is not freely...”
- 1.494: remove “(“ before “Larour”
- Acknowledgments: please acknowledge the input from the reviewers

Best regards,
Harry