Minor Review of the paper “Coupling the regional climate MAR model with the ice sheet model PISM mitigates the melt-elevation positive feedback”, by Delhasse et al.

Additional editor’s private note (visible to authors and reviewers only):

LIST OF COMMENTS:

- P4L22: longitudinal stresses —> membrane stresses
- P4L23-35: Remove sentence starting with ‘This approximation is suitable for slowly flowing ice …’

Thanks for your 2 comments, we considered these corrections in our manuscript.

- P4L25: Please motivate the choice for E=3 and refer to other studies as requested.
- P4L25-26: I would not speak of the softness of the ice. Use specific terminology (viscosity, fluidity, rate factor)

We adapt our sentences to the two last comments as follows:
“The softness of the ice, affecting its flow velocity, is modulated by an enhancement factor, which we set to E = 3 in our experiments.”

is changed to:

“The viscosity of the ice, affecting its flow velocity, is modulated by an enhancement factor E. We set E = 3 in our experiments, a value typically used for the GrIS (Aschwanden et al. 2012, Beckmann et al., 2023). “

- P4L28-29: Please check terminology on longitudinal stress and membrane stresses and revise sentence (cf. Hindmarsh, 2006, https://www.jstor.org/stable/25190296).

Adapted sentence:

Faster flowing ice, such as ice streams, glaciers, and shelves, is typically approximated using the SSA. In this case, longitudinal stretching dominates, and **membrane** and **transverse** stresses must be taken into account.

- P4L29-30: If you assume the SSA, you can speak of plug flow. The full ice column moves at the same horizontal speed.

We corrected the sentence as follows:

“The ice base is assumed to be slippery, and velocities at the bed equal velocities at the surface, allowing for depth averaging in the SSA equations.”

Changed to:

“The ice base is assumed to be slippery, and the full ice column moved at the same horizontal speed. This plug flow allows for depth averaging in the SSA equation.“

- P5L2: I would not use ‘therefore’ here. Just omit this adverb.

Thanks for your comment, we considered this correction in our manuscript.

- P5L6-7: Check consistency between q=0.6 and the Mohr-Coulomb sliding law as requested by the reviewer.

This section has been adapted as requested (changes in blood):

“The speed of basal sliding is determined by the sliding law, typically a power law relating to the basal shear stress (**$\mathcal{T}$b**) and yield stress (**$\mathcal{T}$c**). **We use an exponent of q = 0.6 in our “pseudo plastic” sliding law (Eq. 2)**.

$$\boldsymbol{\tau}_b = -\tau_c \frac{\mathbf{u}}{u_{\text{threshold}}^q |\mathbf{u}|^{1-q}},$$

To determine the yield stress ($\mathcal{T}$c) we use the mohr-coulomb criterion in PISM. The model considers basal resistance based on the hypothesis that the ice sheet rests on a till layer. The yield stress represents the strength of this aggregate material at the base of an ice sheet. When yield stress is lower than the driving stress (**$\mathcal{T}$c < $\mathcal{T}$d)** there is likely to be sliding, and thus faster velocities can be observed. The driving stress in turn is dependent on the ice thickness (H) and surface gradients **(hs)** of the ice: **$\mathcal{T}$d ∝ H hs.** The thicker and steeper the ice, the higher the driving stress and most probably the ice velocity.”

- P5L18-28: The symbology of Eq. 2 is confusing. Either correct or omit the section on the calving law and refer the interested reader to relevant literature. The article does not focus on the calving aspect anyway.

We adapted the equation in the main text as well as its description:

$$c = ||v|| \frac{\sigma}{\sigma_{max}}$$

where ||v|| is the velocity perpendicular to the ice front, σ is the von Mises stress for ice (Morlighem et al., 2016), and σmax is a threshold.

- P7L12: Please add to the paragraph that this spin-up ends again in the period 1961-1990 when the ice-sheet is assumed to have been in a quasi-equilibrium … (this was asked during the review and I think it is useful to mention the endpoint).

We completed the paragraph as follows (changes in blood):
“Starting in SIA-only mode, and an 18 km grid at -125 000 years, we refined our grid to 9 km at -25 000 years, and to 4.5 km at -5 000 years. For the last -1 000 years, we maintained a fixed resolution but introduced SSA to the SIA stress regime to represent the behavior of fast-flowing outlet glaciers. **Note that the initialisation of PISM ends after the reference period 1961-1990 when the ice sheet is assumed to have been in a quasi-equilibrium.“**

- Fig. 2: Omit the line from the left box 2 to the right box 1 in the lower right corner. It is redundant to the line from left box 1 to box 2.
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Thanks for your comment, we considered this correction in Fig.2.

References

Aschwanden, A., Aðalgeirsdóttir, G., and Khroulev, C.: Hindcasting to measure ice sheet model sensitivity to initial states, The Cryosphere, 7, 1083–1093, https://doi.org/10.5194/tc-7-1083-2013, 2013.

Beckmann, J. and Winkelmann, R.: Effects of extreme melt events on ice flow and sea level rise of the Greenland Ice Sheet, The Cryosphere, 17, 3083–3099, https://doi.org/10.5194/tc-17-3083-2023, 2023.