Comment on tc-2022-215
Niall Gandy (Referee)

Referee comment on "Simulating the Laurentide ice sheet of the Last Glacial Maximum" by Daniel Moreno et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2022-215-RC2, 2022

Review of “Simulating the Laurentide ice sheet of the Last Glacial Maximum” by Moreno et al.

Moreno et al. present a series of simulations of the North American Ice Sheets, exploring the resulting ice sheet volume, area, and velocity pattern from varying the ice sheet sliding law. While the results show only limited variation in the ice sheet volume and area, the ice sheet velocity pattern is sensitive to the sliding law used.

This manuscript is well presented, with clear text and figures. Most importantly, the work as been clearly and comprehensively described, and the results are presented and discussed in good detail. I recommend that the manuscript is published following minor corrections/clarifications (detailed below).

I hope you have a good Christmas break, and I hope to reading a revised or published version of the manuscript in the new year.

General Comments

A direct visual comparison between the ice stream dataset from Margold et al and your results here would be useful. Essentially, it saves the reader flicking between browser tabs, and I expect it would show clearly the match you have described in the text. Within this it would be good to discuss the potentially transient nature of some ice streams, and how this might effect the empirical mapping, your modelling results, and the comparison between the two.
I think it is reasonable that you have run your simulations to equilibrium, but it will probably have an effect on your results, given ice stream sensitivity to climate forcing. This should be discussed in the text.

**Minor points**

Title: While I would often refer to the ice simulated here as the “Laurentide”, more formally I would opt for “North American Ice Sheets”. Laurentide is neater, North American Ice Sheets is clearer. If you stick with Laurentide consider a very brief mention in the Introduction.

Ln 25: “Strictly speaking”… This sentence isn’t clear to me, please rephrase

Ln 28: References for the initial assertion? Perhaps Calov et al., 2002, Tarasov and Peltier, 2004, or others?

Ln 36: Extension > extent – and other uses later in the manuscript

Ln 36: “largely differ” > “differ largely”

Ln 44: If the variable ice thickness is through a surging/instability mechanism say this explicitly. This paragraphs touches on the idea that ice stream instabilities could significantly influence the ice sheet configuration, but more detail/references would be appreciated.

Ln 71: Please provide some further justification for these parameter values.

Ln 95: It’s pretty typical to ignore horizontal water transport, but not always (e.g. Gowan et al., 2018). It’s worth justifying this simplification.

Ln 104: What happens to excess water beyond the 2 m limit? Does it accumulate but is ignored, or disappear?

Ln 173: By averaging 11 PMIP simulations you remove the consistent climatology provided
by a single model. Is this important?

Ln 173: Are all 11 PMIP simulations using the same ice sheet reconstruction?

Ln 196: As your climate forcing in Figure 1a and b inherently contains a previous ice sheet reconstruction which broadly matches the empirical reconstruction, how surprising is it that your simulated extents are okay?

Figure 2: It would be good to see a direct visual comparison to the Margold ice stream reconstruction. It would also like to see one section of the ice sheet in more detail to show the nature of ice streaming at the margin. Maybe there could be a separate plot of the Hudson Bay and surrounding ice streams?

Ln 256: A table summarising key statistics of Linear, plastic, and coulomb simulations might be helpful to compliment the description in the text. A quick lookup for the equilibrium fluxes, mean/min/stdev velocities would be appreciated, perhaps an extension to Table 2?

Ln 275: Quantitative or Qualitative?

Figure 6: This is a very useful figure. There seems to be an edge effect stripe in panel b and c (around 100m Hice). Do you know what is causing this?

Figure 7: This figure is good at showing the model’s behaviour in general, but the visual comparison between sliding laws is tricky? Perhaps you could experiment with plotting curves from multiple simulations on the same panel.

Ln 341: ICE-6G

Ln 410: Where will the data from the simulations be available?