Review of: Climate and ice sheet evolutions from the last glacial maximum to the pre-industrial period with an ice sheet – climate coupled model by Quiquet et al

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Quiquet and colleagues investigate the last deglaciation in the Northern Hemisphere using a coupled ice sheet - climate model. They use a climate model of intermediate complexity and a hybrid ice-sheet-shelf model. Overall, they simulate a deglaciation in good agreement with reconstructions. If they consider all the amplitude of the freshwater flux from the melted ice sheets, then the AMOC shuts down and is not able to recover. However, if they reduce these freshwater fluxes or consider additional mechanisms, such as brine rejection, then the AMOC can recover. Additional experiments show the sensitivity of their model to key parameters.

This is a very valuable effort and well suited for the scope of Climate of the Past. The manuscript is well written and easy to follow and I don't think that additional simulations are needed, but I have some comments and questions.

General comments:

Reference experiment:

I am curious about the selected parameters of the reference experiment. Were they chosen to simulate a realistic last glacial maximum (LGM) state? Have you tried to tune your present-day (PD) state? If so, what type of LGM state do you obtain/expect?

Spin up

You simulate separately the LGM state for the ice-sheet-shelf model and for the climate model. Then, your DGL experiment starts at 26 kyrBP, I guess to reach a sort of LGM equilibrium state for the coupled experiments. Do you obtain an equilibrated state? Have you tried to run an equilibrated LGM state with both models coupled from the start?

Glacial isostatic adjustment:

In P7 L204 it says:
" We use a recent implementation of the last glacial maximum bathymetry at 21 kaBP (Lhardy et al., 2020), which is left unchanged for the duration of the experiments."

When I first read this, I understood that the bathymetry was set constant for the whole experiment, including the deglaciation. However, in P14 L422 it is written:

"At this time, the bedrock is still depressed below sea level over the northern most part of America but slowly returns to its present-day value."

Indicating that the bedrock responds to changes in the load. I agree with the other reviewers opinion, that the GIA model needs to be described. Also, its potential implications in the retreat of part of the Eurasian and the Laurentide Ice Sheet should be discussed.

Oceanic forcing

You use in your ice-sheet model a linear melting law and you double the value for floating points in contact with the grounding line. I'm not very familiar with the most suited melting laws for the Greenland Ice Sheet, but I guess that in order to be more realistic, more complex processes should be taken into account, such as the plume formation or frontal ablation (*Slater et al., 2019, 2020*).

As I am more familiar with the Antarctic Ice Sheet, I know that a linear law is the least appropriate as it doesn't account for the positive feedback between the sub-shelf melting and the circulation in the ice-shelf cavity (*Favier et al., 2019*). Also, applying higher melting rates close to the grounding line for coarse resolution, as it is here, can overestimate the rates of grounding-line retreat (*Seroussi and Morlighem, 2018*). Perhaps, you may add one or two sentences on this point.

Antarctic ice sheet

P5L129: “*It is important to mention that only the Northern Hemisphere ice sheets are interactively simulated, while the Antarctic ice sheet topography and ice mask remains prescribed.”*
Prescribed to what? Present day? Last Glacial Maximum?

Also, if prescribed to LGM state, then you don't consider its potential sea-level rise which could accelerate grounding-line instabilities in your model.

Brine rejection

I found very interesting your results when you consider brine rejection in your model. I like this finding, maybe you can add a sentence on this in the abstract.

Sensitivity experiments

Do you run a new spin up for every sensitivity experiment? If so, how is it possible that all start at ~-100 msle in Figure 11?

Technical comments:

- You may cite here *Simms et al., 2019.*
- P8L227: *"With have performed ..."* Do you mean "We have performed..."?
- Figure 4: Color scale is missing in (a)
- Figure 5: If you draw temperature differences as in Figure 4 (b) then I would use the same color scale for consistency.
- Figure 11: Same as before. I would use the same colour for DGL_noFWF as in Figure 3 for consistency.
- P10 Table1: Although you explain in the manuscript what every parameter means, I would repeat it again in the description of the table.

References:

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- Simms, A.R., Lisiecki, L., Gebbie, G., Whitehouse, P.L. and Clark, J.F., 2019. Balancing the last glacial maximum (LGM) sea-level budget. *Quaternary Science Reviews*, *205*, pp.143-153.