Review of “Coupling framework (1.0) for the Úa (2023b) ice sheet model and the FESOM-1.4 z-coordinate ocean model in an Antarctic domain” by Ole Richter, Ralph Timmermann, G. Hilmar Gudmundsson, and Jan De Rydt.

High-resolution is crucial to simulate both the ocean and the ice dynamics at the Antarctic ice sheet margins. While a few ice sheet ocean models have emerged in the last few years, no coupled model had analysed the benefits of unstructured meshes in both components at the same time. By exploring these aspects, this study introduces a novel modelling tool with great potential for projections of future Antarctic mass loss. I therefore recommend this paper for publication, but I have three main moderate suggestions (and several minor ones) that will hopefully improve this article.

Main comments:

Model Description: I find it difficult to find the information on the model parameterisations because the models are first presented in section 2, then more information on the parameters are given in the description of the MISOMIP configuration (section 3), and there is another part in section 4 to state that only one aspect differs in the Antarctic configuration. I would find it much easier to read if all the model parameterisations were described in section 2, and if only the specificities of either the MISOMIP or the Antarctic configurations were described in sections 3 and 4.

Coupling method: Other Z-coordinate models previously corrected velocities to cope with abrupt changes in the ice shelf geometry during coupling steps. Favier et al. (2019) claimed that they avoided the generation of spurious barotropic waves by imposing a conservation of barotropic velocities across the step change in the ice-shelf geometry, which was likely first implemented by Asay-Davis in POPSICLES. Smith et al. (2019, their Appendix A2) noted that this method could not be applied when an entire water column was grounded and that it often led to unstable numerical artifacts when used with realistic ice shelf geometries in UKESM1.0-ice. Therefore, instead of artificially constraining barotropic velocities, they artificially forced the three-dimensional divergence field to be unchanged across the change in discretization, for just the first timestep after coupling. This was done by adding artificial volume fluxes where necessary, which was claimed to prevent the formation of instabilities. Has anything similar been applied in the Úa-FESOM coupling? If not, can the authors show whether or not spurious barotropic waves develop at the coupling time step? My point is not to ask for a change in the coupling method, but to document it and discuss whether this is satisfactory.

Demonstration: In section 4, the authors choose to focus on the Amundsen Sea and Pine Island glacier, which is clearly a region of interest and a region difficult to represent at the resolution of usual climate models. However, given the Antarctic configuration of Úa and the global configuration of FESOM, it is surprising not to mention the coupled model behavior elsewhere. Is the model only good in the Amundsen Sea region? Even if this is the case, it is worth describing the biases and remaining challenges, at least briefly.

Minor comments and edits:

The title of subsections 2.4 and 2.5 should probably be "FESOM to Úa" and "Úa to FESOM".

Section 2.4: So nothing is done to conserve mass? I mean that the mass of meltwater injected into FESOM is not the same as the mass of ice lost by Úa. How strong is the imbalance at the scale of Antarctica?

L. 123-125: this should probably be moved to the ocean model description.

L. 130-131: If I understand correctly, the ice shelf front interpolated to FESOM isn't vertical in case of a vertical front in Úa, right? Doesn't this create spurious melting and currents at the front?

Table 1: Is the 10-30 m of vertical resolution in sub-ice shelf cavity due to the use of partial steps (Adcroft et al., 1997) or to the coarser vertical resolution at depth?

L. 215-221 & Figure 4: it may be worth explaining that the inaccuracy is estimated from the difference between the fluxes in FESOM and the fluxes in Úa.

Section 3.2 and Figure 4: In their description of the MISOMIP protocol, Asay-Davis et al. (2016) write "Models using volume or mass fluxes will need a strategy for removing mass in the open ocean to compensate for the volume of meltwater that enters the domain". Do I understand correctly that no such correction is applied? Furthermore, I think that another inaccuracy is the one due to the absence of volume conservation. For example, in the absence of melting beneath the ice shelf, if the grounding line retreats due to a reduction of the ice flow at the grounding line, sea level should drop and the ocean volume should remain constant, but I don't believe that this is the case with the proposed coupling method. Is there a way to estimate this and plot the inaccuracy in Figure 4b?

L. 246: "Wessem et al." should be "Van Wessem et al.".

Figure 7, about "Blue box visualises the resolution of a quarter-degree ocean model": most so-called quarter-degree global ocean models have a Mercator grid to ensure a nearly isotropic resolution by having $\Delta x = R_E \cos(lat)\, \Delta lon$ with $\Delta lon = 0.25°$, and Δlat varying with latitude so that and $\Delta y = \Delta x$ everywhere (e.g., Spence et al., 2014; Storkey et al., 2018). Such quarter-degree ocean models therefore have a resolution of 7.2km at 75°S. The blue squares in Figure 7d seem larger than that, and in any case, this should be clarified in the figure caption.

L. 279: not clear whether Cd is the drag coefficient/turbulent momentum exchange coefficient (also involved in the drag seen by the ocean dynamics) or a heat/salt turbulent exchange coefficient only used in the three equations at the ice shelf base (sometimes referred to as Γ or St).

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