General comments:

I am very pleased to see a paper describing how an icebergs model can be implemented in an Earth System Model (ESM) and what are the effects on the oceanic mean state. This is clearly an important contribution that is relevant for the climate modelling community and for other groups that plan to do the same.

When interactive icebergs are introduced into an ESM, one of the critical aspects to address is the management of Antarctica runoff. It's worth noting that not all readers may be familiar with the surface runoff scheme used in the AWI ESM for Antarctica. Therefore, I believe it would be beneficial to begin by describing the existing AWI ESM surface runoff scheme for Antarctica and how the four components of Antarctica fresh water flux (surface mass balance, surface runoff, ice shelf basal melt, and icebergs) are managed it term of both fresh water and latent heat flux. Then add a more detailed explanation of the changes that occur once interactive icebergs are incorporated into AWI ESM. This information could prove relevant to other research groups that plan an integration of interactive icebergs into their ESMs.

There appears to be a gap in the description of the experimental runs. I found it challenging to understand how the reference 'surface' runoff is adjusted once interactive icebergs are introduced (or part of it like in ICB_{HF} or ICB_{FW}), particularly concerning the heat fluxes. Throughout the manuscript, I had an ongoing question: whether the quantities of heat fluxes (specifically latent heat) and freshwater fluxes remain consistent across the various experiments, with the differences being attributed solely to the locations where the icebergs melt. This ambiguity in the experimental setup has made it difficult to fully grasp certain results and their implications. Clarifying this aspect would greatly enhance the understanding of the study.

Because of missing information about realism of the simulation, I encountered difficulties in assessing the applicability of your results to the real world or to other climate models. To address this concern, I suggest including a brief validation section focusing on the Southern Ocean. This validation could include key indicators such as gyre strength and extent, the Antarctic Circumpolar Current (ACC), sea ice extent, bottom temperature and salinity (S), and atmospheric circulation.

Furthermore, because you use an ESM, it would be beneficial to go a bit further in the analysis by investigating how the introduction of interactive icebergs influences these key indicators and the resulting feedback on atmospheric circulation, Antarctic surface mass balance, and surface runoff.

Style and Figures:

I found the paper to be well-written. The selection of figures is appropriate. The quality of the figures is high.

Specific comments:

Here are some specific comments.

Section 1:

- L57-67: Much of this paragraph appears to resemble the 'model description.' Please consider moving it, either in full or in part, to Section 2.

Section 2:

- L81: Add a reference to ‘COREII’ mesh. For many readers, COREII is more an atmospheric forcing set than a mesh. So, it could be worth adding some precisions here or a reference.
- L92-95: Could you also clarify whether there is a surface mass balance at the air/iceberg interface and specify the temperature, salinity, and velocity values used to calculate the different types of melt (surface or in-depth values)?
- L97-98: Do the icebergs remain stationary if they enter a saturated cell, or is only their velocity towards the saturated cell set to 0? What happens if calving takes place within a saturated cell? Are icebergs relocated away from the saturated cell?
- L98: Is there an iceberg grounding scheme? If yes, how this scheme works?
- L105-115: I believe this paragraph would be more appropriately placed at the end of line 135, where the total calving is mentioned.
- L109: What is the rationale behind fixing the compensation of freshwater constant in time as opposed to having it updated at the iceberg time step frequency depending of the instantaneous melt?
- L110: You balanced the discrepancy between the iceberg melt and the constant fresh water removed from the total runoff at every time step (?). Could you provide specific details on how this correction was implemented? Was the constant correction spread evenly worldwide or confined to the Antarctic runoff area?
- L110/L134: Your constant is the annual total calving flux (1,731 Gt/year). I am curious about the necessity for this correction. When examining your total water budget, it should be balanced at each time step if you consider the iceberg volume and the ice within the buffer used to replenish the category before icebergs are released within your model. Could you provide some insight into why the correction is still required in this context?
- L116: In the introduction, you mentioned Greenland but not later in the paper. Please add a sentence somewhere explaining that the study focuses solely on Antarctic icebergs and provide the reasoning behind this choice.
- L120-121: and Figure 1: The calving rate map appears unrealistic in certain areas. For instance, there is calving within the Ross Ice Shelf along the Trans-Antarctic Mountains, calving along the grounding lines of Getz and Amery, but no calving at Pine Island Glacier or Thwaites Glacier ice front. Additionally, there is calving almost at the Weddell Sea continental shelf break and hundreds of kilometers away of the coast line in Amundsen sea. These discrepancies raise questions about the accuracy of the calving rate data.
- L120: Could you provide more details about the highest calving rate mentioned in the paper? Does it refer to an entire ice shelf or to a particular point? If it is the second, the reported rate appears exceptionally high, almost at the level of an entire ice shelf, which requires further clarifications.
- L120-121: Is the calving rate assumed to be spatially constant within each sector by the model? If so, does this imply that there is effective calving of icebergs of one category in the model for all cells within the same sector simultaneously?

- L125: In the work by England et al. (2020), they use a similar iceberg size for the largest tabular icebergs and the same power law for the distribution. Therefore, it's challenging to understand how the iceberg melt pattern in your model could be realistic without considering the possibility of fragmentation.
- L127-128: I don't see how the prescription of iceberg thickness described in L126 prevent iceberg to be instantaneously grounded when created.
- L130: Could you give more details on the iterative process?
- L130: You described the iceberg size distribution by area bin. Could you mention what is the size of the icebergs released by the model for each category? If it is a very different method (size randomly generated, …), please give extra details because I found unclear how the effective iceberg size in the model is chosen.
- L130: reference is Fig. 1b not 1a.
- L132: Could you give precisions of where the calving occurs in the model by adding reference about which coastline you used. Is it the same as in Figure 1? If yes, how the discrepancy between observed and PISM coastlines (and thus calving location) affect the overall results?
- Table 1: Add units for 'run length' column and 'cpl. Frequency' column. Furthermore, it could be worth adding clarification about how the iceberg fwf and heat fluxes are managed for each simulation in the table with something like: interactive / absent / surface runoff for heat and fresh water iceberg fluxes.
- Figure 1b: I can only reproduce your number here by using a normalized power law distribution like the Pareto distribution. Furthermore, when I integrate the one in the appendix from x_{min} to infinity, I have more than 1. I found this weird for a distribution.
- Appendix A: I am surprised to see case A>1000 km^2 because you mentioned in section 2 that the maximal iceberg size is 400 km^2.

Section 3:

- L146-152: When you begin to describe the differences between observed and modeled icebergs, it would be pertinent to mention that the modeled icebergs tend to be overly confined along the coast and do not exhibit the behavior of escaping the current along the Kerguelen Plateau.
- L174: Do you have insights into the reasons for the increase in salinity offshore in the Amundsen Sea? Is it a direct effect of icebergs, or does it result indirectly from changes in mean circulation or sea extent?
- Figure 3: revert colorbar (red > 0, blue < 0).
- Figure 3,4,5: To ensure the relevance of the processes in other climate model and 'real' world, it would be helpful to have the CTL (or ICB) fields displayed alongside the World Ocean Atlas 2018 fields, potentially in the initial comments of Section 3
- L199: As you pointed out, salinity plays a crucial role in controlling seawater density around Antarctica. Additionally, you mentioned in line 162 that icebergs do not melt on-site but further north. Given these considerations, I'm somewhat surprised by the relatively small differences in ICB_{FW} compared to ICB_{HF} on the Antarctic continental shelves, and on the modeled increased stratification in Figure 6. Intuitively, I would have expected the opposite effect. Could you please provide clarification on this discrepancy?

Section 4:

- L215-217: You briefly compared model icebergs to quickscat in section 3.1. Probably you should move this to section 3.1.
- L220-224: Fragmentation is missing in your model. You should mention this here.
- L229: Add a reference for ‘size distributions vary at different location’.

Section 5:

- L287: Some ESM already contains an active Lagrangian iceberg model like UKESM.