Response to the comments from Dr. Chengyan Liu (Reviewer #1)

(NB *italicized text in box* is comments from the reviewer. Some numbers with bold fonts were inserted for our convenience in addressing the comments.)

> *General comments:*
>
> *This paper presents an investigation of the ocean-cryosphere interactions off the Sabrina Coast of Wilkes Land, East Antarctica. Based on a coupled ocean–sea ice–ice shelf model, the authors studied the sea ice evolution, the basal melting of ice shelves, the properties of water masses and circulations, modified Circumpolar Deep Water (mCDW) intrusions over the shelf, the oceanic heat and volume transports, and the meridional overturning circulations within the sub-ice-shelf cavity around the Sabrina Coast.*
>
> *The state-of-the-art topography data over the Sabrina Coast have been constructed and introduced in the coupled model, and the overturning ocean circulations within the sub-ice-shelf cavities are also shown in this study for the first time. The mechanism responsible for the differences in temporal variability between the basal melting of the Totten Ice Shelf and Moscow University Ice Shelf has been discussed, and the authors found that both mCDW intrusions and sea ice production contribute to the regional differences between the two sub-ice-shelf cavities. More interestingly, the model has captured an eastward undercurrent over the continental slope, which may significantly regulate the simulated seasonal variabilities of onshore heat transport.*
>
> *It is very topical because ocean-cryosphere interactions around the Sabrina Coast are key processes for the marine ice sheet instability around East Antarctica, which has global implications for climate change and the sea level rising. I believe that this manuscript is very interesting to the Antarctic science community. My comments are given below, and I recommend the manuscript for publication in TC after minor revision.*

Thank you very much for your careful reading of our manuscript and your constructive comments. We are pleased to hear that you find our work interesting, and that you recommend publication in TC. Your feedback is invaluable for improving the quality of our paper, and we are committed to addressing your comments and suggestions.

Note: In the following, "L" means Line.

Specific Comments:

(1) *L165: 'We used observation-based coefficients of the thermal and salinity exchange velocities for the ice shelf (γt=1.0×10−4 ms−1, γs=5.05×10−7 ms−1, Hellmer and Olbers, 1989)'*

A fixed frictional velocity has been employed by the model. It would be nice if the authors could make a few discussions about the potential discrepancy of the fixed frictional velocity for the thermal and salinity exchanges at the ocean-ice shelf interface, by comparing it to the parameterization of the velocity-dependent scheme.

(1) Thank you for your comment on the velocity-independent ice-ocean parameterization used in our model. We appreciate the suggestion to discuss the potential impact of the choice of parameterization. In the revised manuscript, we will add sentences about why we opted for a velocity-independent parameterization in the Method section. Additionally, in the Discussion section, we will include sentences on how a velocity-dependent scheme could alter the model's ice-shelf melting, citing literature.

L168–176 (in Method section)

We used observation-based coefficients of the thermal and salinity exchange velocities for the ice shelf (γ_t=1.0×10^{-4} ms^{-1}, γ_S=5.05×10^{-7} ms^{-1}, Hellmer and Olbers, 1989), and applied one-tenth coefficients for landfast ice to consider the difference in the tidal speed between the ice-shelf cavity and the open ocean in the parameterization. In our previous ocean modeling for Lützow-Holm Bay, we confirmed that the magnitude of landfast-ice melting did not significantly affect the variability of the inflow of mCDW onto the continental shelf (Kusahara et al., 2021). Regarding the ice-ocean parameterization, it is worth noting that many ice shelf-ocean modeling studies utilized velocity-dependent coefficients for solving ice-ocean interactions (Holland and Jenkins, 1999). Given that the magnitude of ocean velocity under ice shelves can be strongly influenced by both horizontal and vertical grid resolutions (Gwyther et al., 2020), we opted for a velocity-independent scheme to minimize dependencies arising from the model's grid configuration.

L614–620 (in Summary and Discussion section)

There is also a limitation regarding the bathymetry under the ice shelf in this model, and very recent research by Vaňková et al. (2023) has underscored the influence of under-ice-shelf bathymetry on ice-shelf basal melting. For instance, the accuracy of the bathymetric data underneath ice shelves can greatly affect the representation of circulation under the ice shelf. The ocean velocity at the base of the ice shelf has an impact on both the patterns and magnitude of ice-shelf basal melting. This effect is especially pronounced when a velocity-dependent parameterization is used for thermal and salinity exchanges at the ice-ocean interface (Mueller et al., 2012; Dansereau et al., 2014). It's worth noting, however, that this study employed a velocity-independent parameterization. Incorporating the updated datasets,…

(2) *L485-500: The analysis of inflow and outflow transport across the southern boundary of the Slope Box is missing (Fig. 18). The Slope Box is different from the Sabrina Depression box since the Slope Box has an open southern boundary. Therefore, the transport balance between the inflow and outflow of the Slope Box can not be explained by the calculation confined within the western, northern, and eastern boundaries. The author may add the calculation and description of inflow and outflow at the southern boundary of the Slope Box in Fig. 18.*

(3) *L490: The authors calculate the inflow and outflow from the surface to 800 m.*
Does the vertical transport across the bottom boundary at 800 m depth have some influence on the balance of the inflow and outflow? It would be nice if the authors could have a short discussion on this.
Technical Corrections:
(4) *L115: 'there remains large uncertainties' should be 'there remain large uncertainties'*

(2) Thank you for pointing out the need to analyze the inflow and outflow transport across the southern boundary of the Slope box. In this revision, we will add a description noting that the outflow and inflow across the southern boundary of the Slope box essentially mirror the flows across the northern boundary of the SD box. Furthermore, for clarity, we will include the boundaries of both the Slope and SD boxes in the insets of the corresponding figures.
L461–464
The western, eastern, and northern boundaries of the Slope box were set to 117° E, 121° E, and the 2500-m depth contour, respectively. The Slope box's southern boundary shares a large part of the SD box's northern boundary, and thus the inflow and outflow across the Slope box's southern boundary corresponds to the outflow and inflow across the SD box's northern boundary (Fig. 9e and 9b), respectively.

(3) As you pointed out, the vertical transport across the 800-m interface contributes to the total water mass balance of the Slope box. A simple estimation based on the annual-mean transport balance indicates that there should be downward transport of approximately 250 mSv across the 800 m interface. However, the results of the downward transport would be sensitive to the control box definition. In the revised manuscript, we will add the reason why we focus on the lateral inflows and outflows.
L464–471
We only calculated the inflow and outflow transports from the surface to 800 m, to focus on water mass exchange across the shelf break, which has a depth of less than 650 m. On an annual-mean basis, there is a substantial inflow from the eastern boundary into the Slope box, with the total transport over 1000 mSv (Fig. 12c). Balancing this annual-mean inflow transport, there are outflow transports exceeding 400 mSv at both the western and northern boundaries (Fig. 12d–e), southward transport to the SD box (Fig. 9b and 9e), and downward transport across the 800 m interface. As shown later (Figs. 13 and 14), offshore water flowing across the shelf break to the continental shelf region resides on the upper continental shelf. Therefore, in this section, we focus on the lateral inflow and outflow patterns. The lateral inflow/outflow pattern …

(4) We will correct it.