I appreciate the effort the authors have made to revise the manuscript, including the revision of simulations under a modified set-up. The authors provided useful clarification on many of my initial questions about the simulation set-up; however key questions still remain or are raised by the new set-up that should be clarified before publication. The new dynamics examined by the manuscript are generally not explained clearly enough, particularly the driving forces behind the ice-shelf front circulation cell. Na et al. mention 3-d turbulent structures several times in the manuscript but do not describe them. I'd like to see descriptions of the eddies in the IOBL (mentioned on line 177) and those in the PISW. This could help readers understand the simulated dynamics. I appreciate that the authors have offered more information about the oceanographic observations, but the manuscript could still benefit from more discussion of the relationship of LES results to both the oceanographic observations presented and melt rate observations.

Major revisions:

Methodological questions/concerns that should be addressed in the manuscript text:

- Lines 135-139 do not provide enough detail on how the theoretical velocity profiles are utilized in the model and how this relates to the solution of friction velocity. These are really important details for understanding the momentum fluxes in the ice-ocean boundary layer, the validity of PISW results, and what the steady-state friction velocity means in Figure 2.
- I'm troubled by the momentum and heat flux profiles shown in Figure 9. These profiles appear to show that momentum and heat fluxes go to zero at the ice shelf base, implying that there is negligible melting and drag. I found the text addressing these fluxes (paragraph starting on line 279) hard to understand. Can you also relate these fluxes to the spatial evolution of PISW and IOBL as they are advected (i.e., are they gaining or losing heat or momentum)?
- The calculation of the freezing rate in the open ocean is not included in the methods. Is it permitted only at the surface or throughout the water column? There should be associated caveats in the Methods and Discussion about potential frazil ice effects not considered in your simulations, with citations to existing literature on frazil ice effects.
- You imply on line 329 that you aren't using a dynamic SGS model but on line 110 you have included a dynamic SGS equation.
- The thermodynamics of the ice-shelf front are not addressed. Do you allow lateral melting?

The introduction of an ice-front circulation cell warrants further explanation of these dynamics than is currently included in the manuscript. On line 187, the authors write "the development of this circulation is mainly induced by the downward force of salt flux by sea ice formation and the shear stress of sub-ice shelf plume." How does sea-ice formation relate to downwelling? I'd expect convective mixing. What role does sub-ice shelf plume momentum play? Since winds are excluded, how might the results change if winds were included? Is the hypothesized circulation cell compatible with observed sea ice advection patterns? How is this similar to or different from the role that ice-shelf meltwater plays in this study: Malyarenko, A., Robinson, N. J., Williams, M. J. M. & Langhorne, P. J. 2019. A wedge mechanism for summer surface water inflow into the Ross Ice Shelf cavity. *Journal of Geophysical Research: Oceans*. 10.1029/2018JC014594

The relationship between LES results and oceanographic observations also warrants further explanation. You say (line 216) that the signature of PISW is in the CTD profiles but it is unclear what this signature is in relation to Figure 4.

The agreement between the simulated ice-shelf melt rate distribution and the observed melt rate distribution also needs to be discussed.

The explanation for heterogeneous PISW upwelling is unclear to me. I think it would help to see a planar view of ice-shelf cavity circulation. I wonder if the boundary conditions imposed may be influencing the circulation to a greater extent in the high turbulent shear case.

189: “The circulation pushes the sub-ice shelf plume with downward forcing, making that stratification line near ice shelf is moved to about 350 m depth.” Clarify the relative importance of downwelling and mixing for deepening the halocline.

204: This paragraph would be a good place to include a comparison of PISW depth and meltwater fluxes between the 4 cases.

226: “Because the amount of the PISW in the strong turbulence case is larger than that in the weak turbulence case, its turbulence energy spectra within IOBL (297 m) is the lowest.” This needs more explanation.

243: “it is shown that the LES model adequately resolves the oceanic flow beneath the ice shelf with the proper thermohaline dynamics by the melting effect beneath the ice shelf and the freezing effect at the sea surface” This is a very general statement. What thermohaline dynamics do you have confidence in?

246: “there are shear forces caused by the momentum of the sub-ice shelf plume and the buoyancy force...” This is not adequately explained. What is the relationship between the stratification, momentum fluxes, and buoyancy? It’s worth reminding the reader that the ice shelf based is not sloped so buoyancy does not drive mean flow.

Figure 6: The x-axis appears to span the whole domain, but there should only be freezing at the sea surface in the open ocean part of the domain.

Figure 7: Specify whether this figure includes or excludes the region of underdeveloped turbulence.

The features we’re seeing in Figure S3 should be explained in the text. I wasn’t able to figure out the difference between right and left panels in this figure.

317: It sounds as if you’re saying that PISW is transferring momentum to IOBL in the ice-shelf cavity. Where is this momentum coming from?

322: Explain how the circulation is similar to centrifugal overturning.

330: How will the findings be used to interpret observations?

Minor revisions:

23: “which in turn slows sea level rise” This can be misleading because the rate of sea level rise may increase when ice shelves are removed but not necessarily when the ice sheet reaches a new equilibrium without the ice shelf.

The authors provided more detail about the CTD and ADCP data collection, which was appreciated. One remaining detail that would be useful to the reader is the distance between the ice front and the observations.

Specify t* in hours.

Thank you for clarifying the velocity orientation in this revision. I think it’s also worth pointing out to the readers that the zonal velocity is perpendicular to the ice-shelf front geometry (especially in the caption for Figure 3), even though this can be seen in the new figure.

128: I think the notation should be S(z_1) rather than Sa(z_1) since you use S_b.

261: The way this is written, there is an apparent inconsistency in the strong turbulence case that it has the smallest mean shear gradient, highest TKE, yet you say that TKE production is proportional to mean shear gradient and turbulent shear stress.

300 “we used the LES model with proper boundary conditions” “proper” isn’t appropriate here, as it is quite subjective.

Section 4.2. It would be helpful to mention the temperature difference between PISW as it exits the cavity and the sea surface freezing point.

319: “showing that this result is in agreement with the previous study of Jenkins (2016)” This is too general. It’s simply that both this study and Jenkins have Ekman layers below the ice shelf, right?

327: “constant turbulent coefficients in SGS model” Which coefficients? I thought you were using a dynamic SGS model.

335: It’s unclear what effects you’ll be examining with the “vertical distribution of pressure”

336: “With better understanding of various parameters on basal melting” Which parameters?

The schematic diagram (Figure 10) is a great addition to the manuscript. I do find it somewhat confusing to include katabatic winds in the schematic when they do not play a role in your explanation of the dynamics, particularly as they appear to be opposed to the ice front circulation pattern.

There are several places where the meaning of the text is unclear:

16: “In the strong turbulence case, there are distinct features in basal melting and flow characteristics.” This is too vague.

30 “The driving forces for basal melting in cold water cavity are shear force by tidal mixing and the thermohaline process by sea ice formation” Both of these forcings need more introduction and explanation here.

35 “Therefore, because driving forces from the ocean and opposite forces by the meltwater merge within the boundary layer” I don’t know what is meant here. What forces?

43: “Similar features for weak stratification” Which features are you referring to?

48: “controlling the shear impact of its momentum” Please clarify

57: “In order to find out the effects of various forcing clearly” Please specify which forcings

185: “velocities in two cases” Which two cases?

211: “upper streamwise direction” Would be more clear to put in terms of zonal/meridional or parallel/perpendicular to ice front

302: “Additionally, we set to ambient values” set what to ambient values?

356: “it means that stratified forcing by PISW has a nonlinear feature for flow shear by strong turbulence”

332: “this study can be improved by comparing LES results with observations and their feedback” “and their feedback” is unclear.

There are also several places where the grammar needs revision:

9. “but there is a poor understanding of the *fluid dynamic, thermohaline physics* of the IOBL flow”

11: “velocity’s theoretical profile” >> “theoretical profile for velocity”

28: “The sub-ice shelf oceanic environment can be divided into broad classifications” >> “The sub-ice shelf oceanic environment can be divided into two classes”

38: “physics in ice shelves” >> “physics below ice shelves”

69: “Nansen Ice Shelf (NIS; cold-water cavity)” >> “Nansen Ice Shelf (NIS), a cold-water cavity,”

72: “while remaining thermohaline forcing by the melting and freezing”

177: “are highly fluctuated in” >> “greatly fluctuated during”

178: “As turbulence within IOBL is stronger, the magnitude of fluctuation is larger.”

189: “Noticeable difference between the two cases” >> “A noticeable difference between the two cases”

194: “with different momentum along to streamwise direction in two cases.”

307: “for resolving the IOBL and oceanic flow in reality” >> “for simulating the IOBL and oceanic flow more realistically”