Responses to Reviewer #1

The manuscript by Zhang et al. uses a 1-D coupled sea ice-ocean model to examine the impacts of melt water on sea ice melt and upper ocean stratification. Sensitivity analyses were run to compare how the percent of melt water changes the upper ocean stratification and sea ice melt/formation. The authors compare stations across the Arctic, from the strongly stratified Canada Basin to the weakly stratified Nansen basin. This is a novel and important study that sheds light into how stratification and sea ice melt are closely coupled. There were however some gaps in the research and some confusing wording, which I will explain below. I think this manuscript can be published in Ocean Science after moderate revisions.

Thanks for the comments, which encourage us to improve the quality of the MS. In the following, we provide point to point responses (blue text) to the suggestions and revised the MS ***(black bold italic)*** accordingly.

Major comments:

My **first major comment** is that important details were left out of section 2. Specifically, I was left wondering the following:

1.How long were the simulations run for?

We are sorry for missing those important details. All the simulations run for a year, starting on 1 May. We revised the sentence in **section 2.4.**

Lines 159-160: *… a total of six experiments were conducted at each station for a simulation period of 1 year, starting on 1 May and ending on 30 April next year.*

2.Why were only data for short periods in April or May used for initialization?

The experiments began on May 1st because April or May falls within the late stages of the freezing season or early stages of the melting season in the Arctic Ocean. As a result, the simulation covers a full melting-freezing cycle, which helps to better investigate the feedback effects of melt water on sea ice during summer, as well as its impact on subsequent freezing. This is the reason why we use ITP data from either April or May as initialization for the model. We added sentences in **section 2.4.**

Lines 162-164: *The experiment started on 1 May with the objective of conducting a full melting period followed by a complete freezing phase in the model, which helps to better investigate the feedback effects of the melt water on sea ice melting in summer, as well as its impact on subsequent freezing in winter.*

3.What time step was used for the simulations?

The timestep is 600s. We revised the sentence in **section 2.4.**

Line 165: *… the melt water flux of a timestep (600s) is determined by the …*

4.Why were no data used for initialization between 2014 and 2020?

We re-screened the ITPs from 2011 to 2020 and found several usable data from 2015 to 2020 for the experiments. We conducted the experiments again using these data. Due to the addition of some new experiments, we reorganized the station names in the Arctic basin. The stations' location and time information of the ITPs are plotted in Figure 1 and listed in Table 1 in the revised MS.

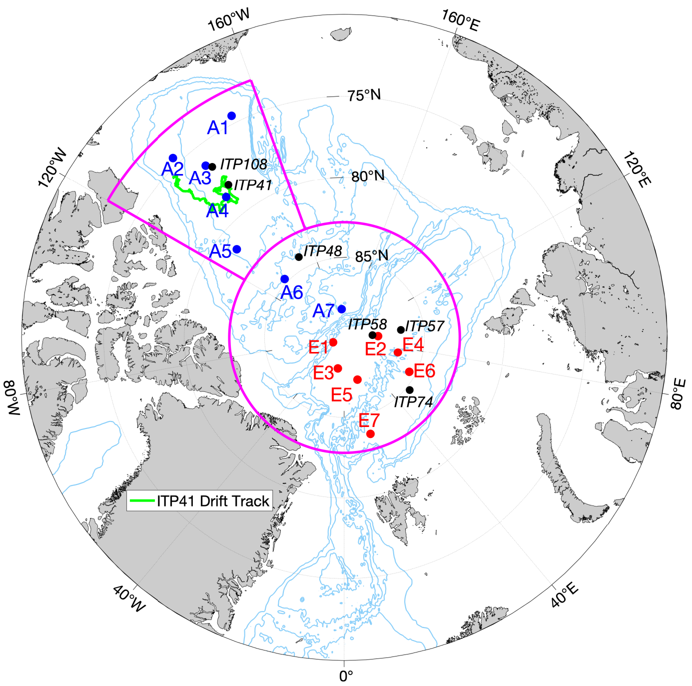

Figure 1: Locations of the ITP data used as initial profiles in the model. Stations A1-A7 are located in the Amerasian Basin (indicated by the blue dots), and E1-E7 are in the Eurasian Basin (indicated by the red dots). The black dots represent the ITPs used for comparison with the simulations. The green line represents the trajectory of ITP41. The bathymetry is from ETOPO-2. The same atmospheric forcing field, derived from the 2011-2020 average for the specific region outlined by the solid magenta line, is utilized in all experiments.

Table 1. Details of the ITP records used in the model

Station	**ITP number**	**Time**	**Comparison ITP number/Time**
A1	ITP-53	2012.5.1-5.5	
A2	ITP-18	2008.4.6-4.7	
A3	ITP-108	2018.5.7-5.13	ITP-108/2018.1.1-1.31
A4	ITP-41	2011.5.1-5.15	ITP-41/2011.8.1-8.5
A5	ITP-105	2019.5.2-5.10	
A6	ITP-48	2012.5.9-5.23	ITP-48/2012.1.18-1.31
A7	ITP-47	2011.4.12-4.30	
E1	ITP-93	2016.5.1-5.8	
E2	ITP-57	2013.5.25-5.28	ITP-58/2013.3.9-3.10
E3	ITP-83	2015.5.25-5.30	
E4	ITP-74	2014.5.1-5.2	ITP-57/2013.8.1-8.2
E5	ITP-58	2013.5.1-5.2	
E6	ITP-74	2014.5.26-5.30	ITP-74/2014.8.1-8.5
E7	ITP-111	2020.5.25-5.30	

5. Why was the MLD definition selected? See Peralta-Feriz and Woodgate (2015; Seasonal and interannual variability of pan-Arctic surface mixed layer properties from 1979 to 2012 from hydrographic data, and the dominance of stratification for multiyear mixed layer depth shoaling - ScienceDirect) for an overview of different MLD definitions in the Arctic.

Thanks for the comments. We chose the threshold criterion Δσ =0.03 kg/m³ for the definition of the MLD with reference to Peralta-Feriz and Woodgate (2015), however, we did not clarify it in the first MS. The following is the reason why we chose the criterion Δσ =0.03 kg/m³ rather than Δσ =0.1 kg/m³.

Peralta-Feriz and Woodgate (2015) chose the threshold criterion Δσ =0.1 kg/m³ because it provides a better comparison with the heuristic method in the pan-Arctic profiles. However, in small parts of the Eurasian Basin where the stratification is very weak, the threshold criterion of Δσ = 0.1 kg/m³ yields MLD estimates more than 20 m deeper than those from a heuristic assessment of the profiles. Thus, for these profiles, they chose a threshold criterion of Δσ = 0.03 kg/m³ instead, which gives a closer agreement with the heuristic assessment.

Based on above information, we compared the two threshold criterions of Δσ = 0.1 kg/m³ and 0.03 kg/m³, and found that Δσ = 0.03 kg/m³ is more consistent with our model results. In the Canadian Basin, there is no obvious difference between the two criterions (fig. 1g-i and fig. 2a-c). However, for stations in the Eurasian Basin, the criterion of Δσ =0.1 kg/m³ overestimates the MLDs. It is found from the winter vertical temperature and salinity profiles that the Atlantic water in the MWP-0% and MWP-20% runs at stations E6 and E7 mixes upwards in winter (Fig.1e and f, below), and the mixed layer reaches 300 m. The MLDs we calculated using the criterion of Δσ = 0.03 kg/m³ is consistent with the modeled temperature and salinity profile (Fig. 2e and f below).

Based on the criterion of Δσ = 0.1 kg/m³, the calculated MLDs for the MWP-40% runs could reach 300 m in March (Fig. 3e and f, below). However, the model results show that the temperature and salinity profiles of the MWP-40% runs in March only mixed to the depths of no more than 200 m (Fig. 1e-f and k-l, below).

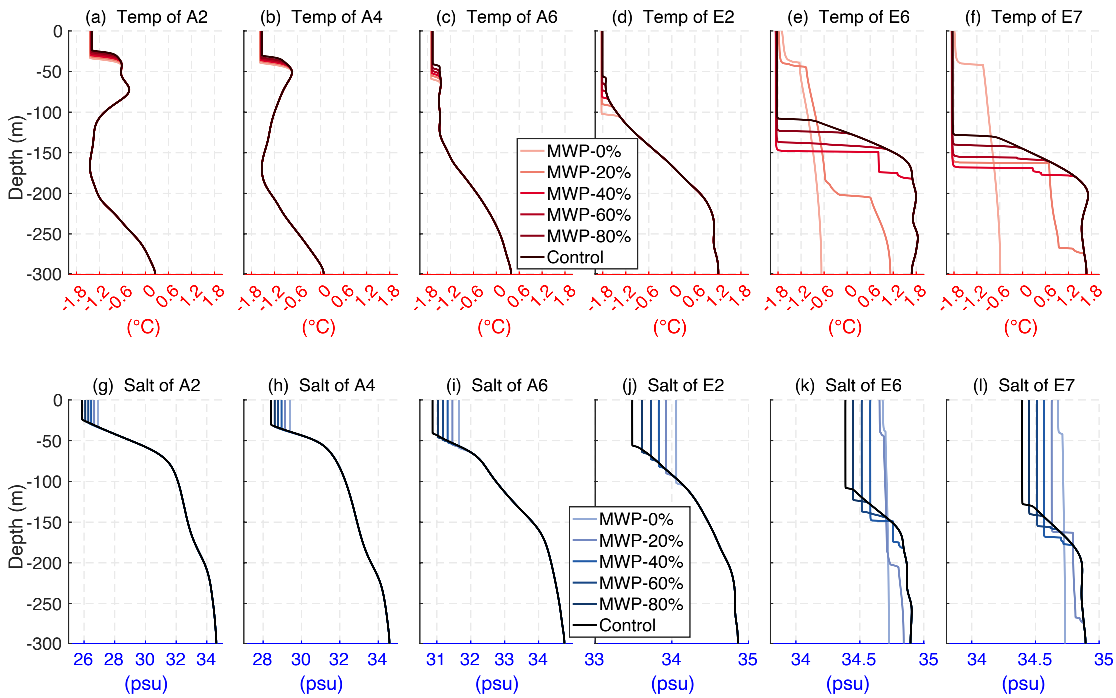

Figure 1: Simulated temperature (top row) and salinity (bottom row) profiles of MWP runs and control runs in mid-April for stations A2, A4, A6, E2, E6 and E7.

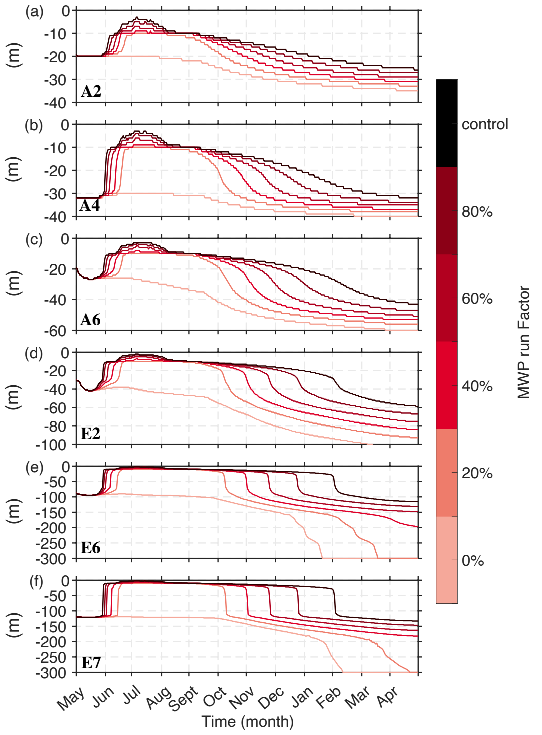

Figure 2: Time series of the MLD (criterion Δσ =0.03 kg/m³) of the control and MWP runs for stations A2, A4, A6, E2, E6 and E7. The color of each line represents the MWP run factor.

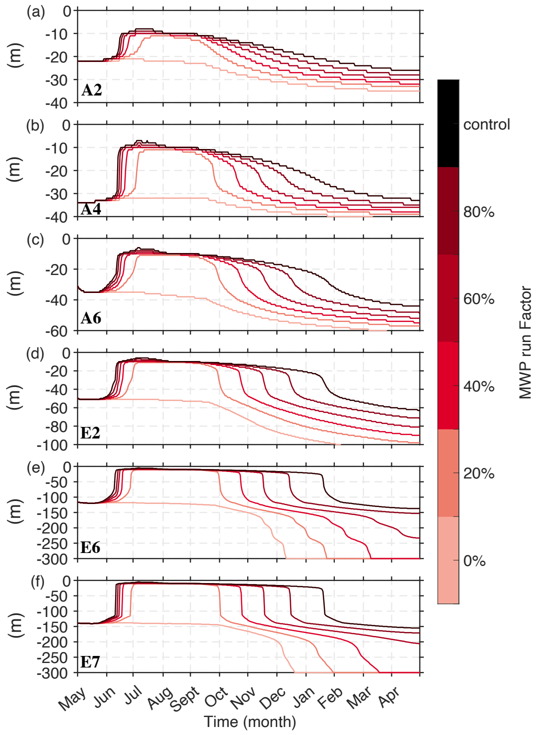

Figure 3: Same as figure 1 but for criterion Δσ =0.1 kg/m³.

In order to clarify the reasons for the choice of the threshold criterion Δσ = 0.03 kg/m³, we added some sentences in **section 2.4.**

Lines 180-188: ***In this paper, we define the base of the mixed layer (ML) as the depth at which the potential density relative to 0 dbar initially surpasses the shallowest sampled density by the threshold criterion of Δσ =0.03 kg m^{-3}. Peralta-Ferriz and Woodgate (2015) used a threshold criterion of Δσ=0.1 kg m^{-3} to define the ML and report the ML properties of the Arctic Ocean from 1979-2012. They also acknowledged that the Δσ=0.1 kg m^{-3} criterion would overestimate the ML in parts of the Eurasian basin where the upper ocean's stratification is very weak. To account for this, they used a threshold of Δσ=0.03 kg m^{-3} in areas with weak upper ocean stratification. We calculated the simulated MLDs using the two methods, respectively, and found that in the Canadian Basin, the MLDs determined by the two criteria show no significant difference. However, in the Eurasian basin, the criterion of Δσ = 0.1 kg m^{-3} would severely overestimate the MLDs. Therefore, we chose the criterion of Δσ = 0.03 kg m^{-3} to determine the MLD in this study.***

My **second major comment** is that there was no discussion about how heat released from the NSTM melts ice through winter. A number of studies (Winter sea-ice melt in the Canada Basin, Arctic Ocean - Jackson - 2012 - Geophysical Research Letters - Wiley Online Library; The impact of stored solar heat on Arctic sea ice growth - Timmermans - 2015 - Geophysical Research Letters - Wiley Online Library; Episodic Reversal of Autumn Ice Advance Caused by Release of Ocean Heat in the Beaufort Sea - Smith - 2018 - Journal of Geophysical Research: Oceans - Wiley Online Library) have shown that strong stratification can store the NSTM through winter. This heat can be gradually released throughout winter via storm-driven mixing, which breaks down the stratification. Evidence of the heat release can be seen by ocean to ice heat fluxes.

Thanks for the suggestion. We added discussions about how heat released from the NSTM melts ice in winter in the Introduction with reference to the listed previous studies. We added some sentences in **section 1 and section 3.2.2 (b).**

Section 1, lines 43-46: ***In winter, surface fresh water is recycled via ice formation, weakening ocean stratification (Peralta-Ferriz and Woodgate, 2015), meanwhile, vertical convection caused by brine rejection or storm-driven mixing, can erode the NSTM layer, entraining warm water upward, and impeding winter ice formation (Steele et al. 2011; Jackson et al. 2012; Timmermans, 2015; Smith et al., 2018).***

Section 3.2.2 (b), lines 364-367: ***In particular, the reduction in summer melt water leads to a weakening or even absent NSTM, and that there isn't enough heat stored in the subsurface layer to replenish the heat loss at the surface when autumn arrives, leading to a more rapid cooling of water temperature to the freezing point in autumn, and hence increasing ice formation in autumn. This result suggests that the presence of the NSTM effectively hinders sea ice growth in autumn, which is consistent with Toole et al. (2010)'s results.***

I wonder if including ITP data from the winter of 2007-2008 – a year where the NSTM was stored year-round – would change the results in Figure 5c?

Thanks for the suggestion. We studied the ITP data (ITP18) located in the Canadian Basin from 2007 to 2008 and found that a year-round NSTM. Figure 4 (below) shows the vertical temperature-salinity profile of ITP18 in April 2008. There were two temperature maxima in the upper 100 meters: one at around -80 meters, which is the Pacific Warm Water, and the other at around -40 meters, which is NSTM. We conducted an experiment in the Canadian basin (A2 in the new MS), initializing the model using data from April 2008 (ITP-18).

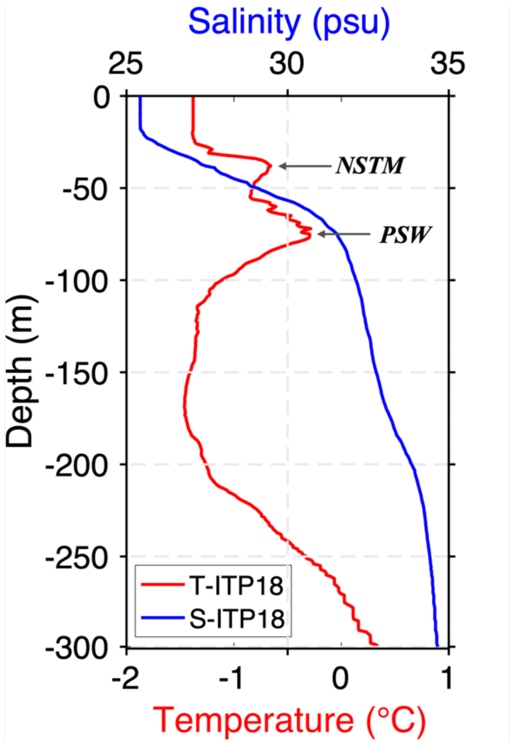

Figure 4: Initial profile of station A2 in the new MS.

The experiments using ITP18 as the initial field did not change the results of Figure 5c (Figure 6c in the new MS). We added this experiment to the new MS and added sentences to describe ITP18 (station A2 in the new MS) in **Section 2.2**.

Lines 130-133: ***The temperature profile at station A2 shows two peaks in the upper layer, one is the NSTM, and the other is the PSW. The initial profile at A2 station was obtained from ITP measurements in the southern Canadian Basin in 2007-2008, and due to a strong halocline that year, the NSTM formed in the summer of 2007 persisted until the spring of 2008 (Jackson et al., 2012).***

In fact, we originally intended to conduct the experiment using the data from April 2007, because we wanted to know if the NSTM stored until winter 2008 would change the results of Figure 5c (Figure 6c in the new MS). However, the data of ITP18 starts in August 2007. So, we conducted another experiment using the profile of ITP18 at the end of summer 2007 as the initial field. The experiment results show that the NSTM could be preserved until winter 2008, but its ocean-ice heat flux did not show episodic high values (Fig. 5 below). This is because the episodic high winter ocean-ice heat fluxes are usually associated with strong wind events (Smith et al., 2018). In this study, all experiments utilized regionally averaged wind fields to eliminate the impact of wind field variability. This may be the reason why this one-dimensional model did not simulate episodic high values of the ocean-ice heat flux in winter 2008.

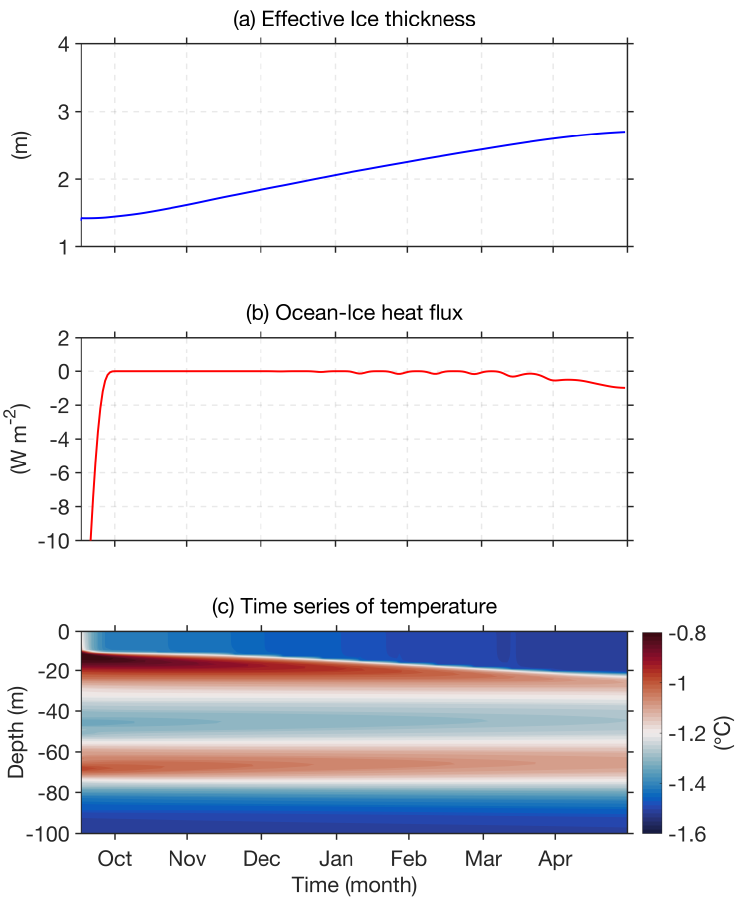

Figure 5: Experimental results using ITP18 data from mid-September 2007 as the initial field. (a) effective sea ice thickness; (b) ocean-ice heat flux; (c) temperature time series in the upper 100 m.

We added some sentences in **section 3.1.2** to explain why our model does not reproduce the episodic high values in winter.

Lines 253-261: ***As observed by Jackson et al. (2010) and Steele et al. (2011), our model also shows that the NSTM normally deepens, cools, and disappears throughout the autumn and winter (Fig. 4). However, it has been observed as a year-round feature sometimes. Jackson et al. (2012) found that when ITP18 drifted into shallow waters from early to mid-December, the ocean-ice heat flux reached up to 55 W m^{-2} (Jackson et al., 2012), reduced sea ice thickness at the end of the 2008 growth season by about 25% (Timmermans, 2015). Smith et al. (2018) also discovered occasional high values of the winter ocean-ice heat flux (about 100 W/m^2) in the Canadian Basin using ITP and CTD data from 2015. These high winter sea-ice heat fluxes are usually associated with strong wind events (Smith et al., 2018). In this study, all experiments utilized regionally averaged wind fields to eliminate the impact of wind field variability. This may be the reason why our one-dimensional model did not reproduce the episodic high values of the ocean-ice heat flux in winter successfully.***

My **third major concern** confusion with the feedback language used - in general, I got confused with how the authors were referring to a negative and positive feedback in this context. I think adding some clear definition of negative and positive feedbacks in the introduction as well as how these feedback are related to the atmosphere-ocean-ice- system would help the readers understand the importance of these results and how they fit into previous knowledge.

Thanks for this suggestion. We are sorry for missing some important references. We revised sentences in **section 1.**

Lines 47-57: ***Melt water from the sea ice has a comparatively low density and therefore accumulates in the top ocean layer, strengthens the upper ocean stratification. Due to the stabilizing of the cold halocline, the ocean heat flux available to melt sea ice decreases, which in turn hinders sea ice melting. This is a negative sea ice/ocean feedback on sea ice melting (Bintanja et al., 2013), and we call it melt water feedback in this paper. Zhang (2007) and Bintanja et al. (2013) suggest that this negative sea ice/ocean feedback can explain the anomalous increase in Antarctic sea ice extent before 2010s. Many positive feedback processes in the Arctic atmosphere-ocean-ice systems are extensively studied, such as the well-known sea ice albedo feedback (Hall, 2004; Winton, 2000; Pithan and Mauritsen, 2014), water vapor feedback (Gordon et al., 2013; Taylor et al., 2013) and the Cloud-Albedo feedbacks (Zelinka et al., 2012; Bodas-Salcedo et al., 2016). However, there are almost no quantitative studies on this negative melt water feedback on sea ice melting in the Arctic, although many previous studies have investigated the effects of increased freshwater flux by adding freshwater flux to the ocean surface in models to represent increased runoff or precipitation (Nummelin et al., 2015, 2016; Davis et al., 2016a; Pemberton and Nilsson, 2016).***

Furthermore, the effect of melt water on ice freezing in winter cannot be considered as a feedback process and we revised the relevant content in the new MS.

Abstract, lines 12-15: ***The impact of melt water released during the previous melting season on ice growth in winter depends on the strength of stratification. After removing all the melt water during the summer, ice formation in areas with strong stratification increased by 12.3% during the winter, while it decreased by more than 40% in areas with weak stratification.***

Section 3.2.2 (b), lines 374-375: ***The results indicate that the impact of melt water released during the previous melting season on winter sea ice growth depends on the strength of stratification, with gradually transitions from promoting to impeding ice growth as the halocline weakens.***

Section 3.2.2 (c), lines 385-386: ***The impact of melt water released during the previous melting season on the subsequent winter ice formation depends on the strength of stratification. It hinders (promotes) ice formation in areas with strong (weak) stratification.***

Section 5, lines 487-489: ***Our findings reveal that the effects of melt water from the previous melting season on the subsequent winter ice formation depend on the strength of stratification. Specifically, it impedes ice formation in areas with strong stratification, while it promotes it in areas with weak stratification.***

My **fourth major concern** is that knowledge from several important manuscripts were missing. In addition to the above cited manuscripts, I suggest the authors read the following:

(1) Toward Quantifying the Increasing Role of Oceanic Heat in Sea Ice Loss in the New Arctic in: Bulletin of the American Meteorological Society Volume 96 Issue 12 (2015) (ametsoc.org)

(2) Modeling the formation and fate of the near-surface temperature maximum in the Canadian Basin of the Arctic Ocean - Steele - 2011 - Journal of Geophysical Research: Oceans - Wiley Online Library

(3) Winter Convection Transports Atlantic Water Heat to the Surface Layer in the Eastern Arctic Ocean in: Journal of Physical Oceanography Volume 43 Issue 10 (2013) (ametsoc.org)

(4) Freshwater and its role in the Arctic Marine System: Sources, disposition, storage, export, and physical and biogeochemical consequences in the Arctic and global oceans - Carmack - 2016 - Journal of Geophysical Research: Biogeosciences - Wiley Online Library

(5) Arctic sea-ice melt in 2008 and the role of solar heating | Annals of Glaciology | Cambridge Core

We are sorry for missing these important references. We read and cited the references in **sections 1.**

Lines 29-30: ***Ocean-ice heat fluxes play a crucial role in modulating the Arctic Sea ice growth/melt cycle, with half of the total heat flux absorbed by the sea ice originating from the ocean (Carmack et al., 2015).***

Line 46: ***… entraining warm water upward, and impeding winter ice formation (Steele et al. 2011; Jackson et al. 2012; Timmermans, 2015; Smith et al., 2018).***

Lines 70-72: ***Previous research suggests that brine-driven surface convection could entrain the Atlantic Water heat upwards in the Eurasian Basin (Polyakov et al., 2013a, 2020), while the strong stratification impede this convection process in the Canada Basin (Toole et al., 2010).***

Line 28: ***… and seasonal ice melt are critical factors that maintain this stratification (Haine et al., 2015; Carmack et al., 2016).***

Sections 3.1.2, line 253: ***… the main heat source is the absorption of solar radiation (Perovich et al., 2011) …***

Minor comments

- Section 2.1 – I find this section confusing the way it is written. Specifically, the variables were not described in the order that they appeared so I had to jump around to understand. I suggest reorganizing so that the variables are described. Another option is to add a table that lists and defines all variables.

We are sorry for the confusion in the description of variables, and we reorganized the variable description in **section 2.1, lines 95-109:**

…. The heat fluxes at the ice top and bottom are:

$$F_{top} = F_s(\alpha) - Fs_{ice} \quad (1)$$

$$F_{bot} = Fb_{ice} - F_b \quad (2)$$

where F_s is the surface heat flux absorbed by the ice, Fs_{ice} is the conductive heat flux from the upper layer of the sea ice to the ice surface, Fb_{ice} is the conductive heat flux from the ice bottom to the lower layer of the sea ice. F_b is the ocean-ice heat flux:

$$F_b = c_{sw}\rho_{sw}\gamma(T_{sst} - T_f)u^* \quad (3)$$

where γ ***is the heat transfer coefficient and*** u^* ***is the frictional velocity between ice and water.***

The albedo parameterization of this model is dependent on ice thickness:

$$\alpha = \alpha_{i_{min}} + (\alpha_{i_{max}} - \alpha_{i_{min}})(1 - e^{-h_i/h_\alpha}) \quad (4)$$

where $\alpha_{i_{min}}$***=0.08 and*** $\alpha_{i_{max}}$***=0.64 are the maximum and minimum ice albedo values, respectively*** h_α***=0.65 is the ice thickness for albedo transition, and*** h_i ***is the ice thickness.***

The net ocean surface heat flux can be written simply as Steele et al., (2010):

$$F_{ocean} = F_{sw} + F_b + F_{ao} \quad (5)$$

where F_{sw} ***is the heat flux from solar radiation,*** F_b ***is the ocean to ice heat flux, and*** F_{ao} ***is the heat flux from the ocean to the atmosphere through the ice-free area (including longwave radiation and sensible and latent heat flux).***

- Line 74 – What are the estimates of vertical diffusivity in the Canada Basin versus the Nansen Basin? I imagine vertical diffusivity is smaller in the Canada Basin due to the strong stratification. I suggest the authors add a sentence that cites studies that have examined vertical diffusivity from different regions to justify their decision to choose this parameter value.

Thanks for the comments. We cited previous studies and revised the sentence in **section 2.1.**

Lines 85-90: ***Shaw and Stanton (2014) show that the vertical diffusivity in the deep central Canadian Basin averages near-molecular levels, ranging between 2.2×10***$^{-7}$ ***m***^{2} ***s***$^{-1}$ ***and 3.4×10***$^{-7}$ ***m***^{2} ***s***$^{-1}$***, and Fer (2009) found that vertical diffusivity between 10***$^{-6}$ ***-10***$^{-5}$***m***^{2} ***s***$^{-1}$ ***in the Eurasian Basin. The background vertical diffusivity of the model used in this study is set to 10***$^{-6}$ ***m***^{2} ***s***$^{-1}$***, which is a representative value in the central Arctic Ocean and has been applied to several one-dimensional models studying the Arctic Ocean (Linders and Björk, 2013; Nummelin et al., 2015; Davis et al., 2016)***

- Line 81 – Why were these values chosen for albedo. Pleas add some references to justify this choice.

The choice of albedo parameter in this paper was determined by artificial adjustment. Initially, we used the default value in the model ($\alpha_{i_{\min}}$=0.2, $\alpha_{i_{\max}}$=0.65, h_α=0.5) (Hansen et al., 1983), but this albedo value is relatively high, resulting in little sea ice melt in summer and less shortwave radiation being absorbed by the ocean, making it difficult to simulate the NSTM well. Therefore, after adjustment, we chose these albedo parameters. We cited the reference in **sections 2.1.**

Line 106: ***…The albedo parameterization of this model is dependent on ice thickness (Hansen et al., 1983) …***

- Figure 1 – I can't see A5 in this figure.

Due to the inappropriate color scheme, it is difficult to distinguish A5 from the others in Figure 1 of the the old MS. We redraw Figure 1 in the new MS (see Figure .1 above).

- Line 99 – Why is ITP E6 not listed here?

Sorry for missing it, we corrected it in **section 2.2.**

Lines 113-114: ***… A1-A7 located in the Amerasian Basin (the blue dots in Fig. 1) and E1-E7 in the Eurasian Basin (the red dots in Fig. 1).***

- Lines 112 to 114 – The NSTM is defined based on salinity, and it looks like the temperature maximum in A1 to A3 shown in Figure 2 include both NSTM and Pacific Summer Water. I suggest adding this to the Figure 2 description.

The NSTM was defined by Jackson et al., (2010) as the shallowest temperature maximum (Tmax)

that satisfies three criteria. These are:
Criterion 1. The Tmax's temperature above freezing must be greater than 0.2°C.
Criterion 2. The Tmax's temperature above freezing must be more than 0.1°C warmer than an immediate underlying temperature minimum.
Criterion 3. The Tmax's salinity must be less than 31.

Based on criterion 2, The temperature profiles in A1, A2 and A3 in the old MS (which are A1, A3, and A4 in the new MS) not include NSTM.

- Lines 178 to 179 – I think the authors have made an error here. They state that the MLD was deeper in the western Arctic than Eastern Arctic. I think here they define the western Arctic as the Canada Basin? Please clarify.

Thanks for pointing out the error. We revised the sentence in **section 3.1.1.**

Lines 223-224: ***Both the modelling and the observations show that the MLDs are usually deeper in the Eurasian Basin than in the Canadian Basin.***

- Section 3.1.1 – While the model does a good job of reproducing the NSTM, the modeled NSTM is colder than the observed one, which could have implications for sea ice melt and formation. Could the authors please add a few words about how the colder NSTM could impact their results?

Thanks for this suggestion. We added two sentences in **section 3.1.1.**

Lines 217-218: ***However, the simulated summer NSTM in the Canadian Basin is generally cooler than the observations (Fig. 5a). This discrepancy may lead to an overestimation of winter ice formation in the simulations.***

- Lines 196 to 203 – Previous literature (e.g., Figure 5b in Jackson et al., 2012; Figure 7 in Smith et al., 2018) show observational values of ocean to ice heat flux, including episodic high values in the Canada Basin in winter. I suggest the authors compare their results with these studies.

Thanks for this suggestion. We added some sentences in **section 3.1.2.**

Lines 253-261: ***As observed by Jackson et al. (2010) and Steele et al. (2011), our model also shows that the NSTM normally deepens, cools, and disappears throughout the autumn and winter (Fig. 4). However, it has been observed as a year-round feature sometimes. Jackson et al. (2012) found that when ITP18 drifted into shallow waters from early to mid-December, the ocean-ice heat flux reached up to 55 W m^{-2} (Jackson et al., 2012), reduced sea ice thickness at the end of the 2008 growth season by about 25% (Timmermans, 2015). Smith et al. (2018) also discovered occasional high values of the winter ocean-ice heat flux (about 100 W/m^2) in the Canadian Basin using ITP and CTD data from 2015. These high winter sea-ice heat fluxes are usually associated with strong wind events (Smith et al., 2018). In this study, all experiments utilized regionally averaged wind fields to eliminate the impact of wind field variability. This may be the reason why our one-dimensional model did not reproduce the episodic high values of the ocean-ice heat flux in winter successfully.***

- Figure 6 – Why is there only 1 station from the Canada Basin?

In the first MS, the simulation results for stations in the Canadian Basin are similar, so we only show one station. In the new MS, we added several experiments and showed the results for three stations in the Canadian Basin (A2, A4 and A6) and three stations in the Eurasian Basin (E2, E6 and E7). We added some sentences in **Section 3.2.1 (a).**

Lines 272-275: ***The experimental results for some stations in this study are very similar, so this paper shows the simulation results for six representative stations to show the general behavior of the***

model and the impact of ocean stratification. Three of them are located in the Amerasian Basin (A2, A4 and A6) and three in the Eurasian Basin (E2, E6 and E7).

- Lines 234 to 240 – How do these results compare with results from Peralta-Feriz and Woodgate, 2015?

The simulated MLDs in the control experiments are in good agreement with the observation-based statistics of Peralta-Feriz and Woodgate (2015). We revised sentences in **section 3.1.1.**

Lines 219-222: ***In all control runs, the simulated maximum winter MLD is ~33 m in the Canadian Basin, ~43 m in the Makarov Basin, ~67 m in the Amundsen Basin, and more than 100m in the Nansen Basin. These results are comparable to the observations. The observed maximum winter MLDs in Canada and the Makarov Basin are 29 ± 12 m and 52 ± 14 m, respectively, and those in the Eurasian Basin range from ~50 to over 100 m (Shimada et al., 2001; Peralta-Ferriz and Woodgate, 2015).***

- Figure 11 – It is difficult to distinguish the line colours. Also, as mentioned above, I find the wording of positive and negative feedback to be confusing.

This figure could cause some misunderstandings and does not help readers understand the article. We removed it in the new manuscript, and we revised the feedback language used in this article as mentioned above.

- Figures 12 and 13 – I found it confusing to decipher what positive and negative values mean. It would help the reader if you added this to the figure caption.

We added explanations for positive and negative values in Figure 12 and 13 in the new MS.

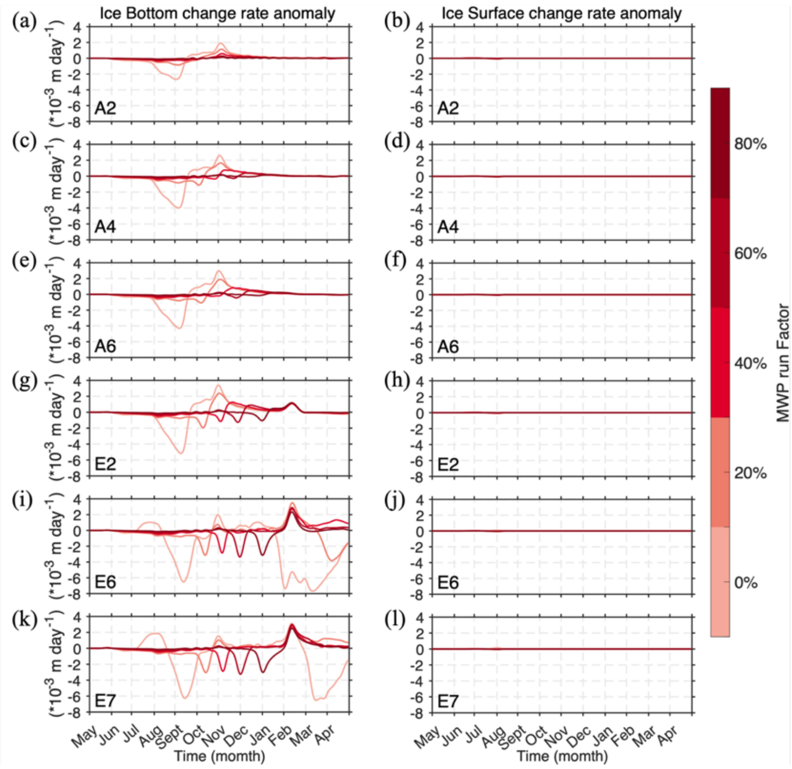

Figure 12: Time series of (left) the anomalies of ice bottom change rate and (right) the anomalies of ice surface change rate for stations A2, A4, A6, E2, E6 and E7. The anomalies are obtained from the MWP run minus the control run. The negative (positive) values indicate faster (slower) rates of ice decrease in the MWP run compared to the control run. The color of each line represents the MWP run factor.

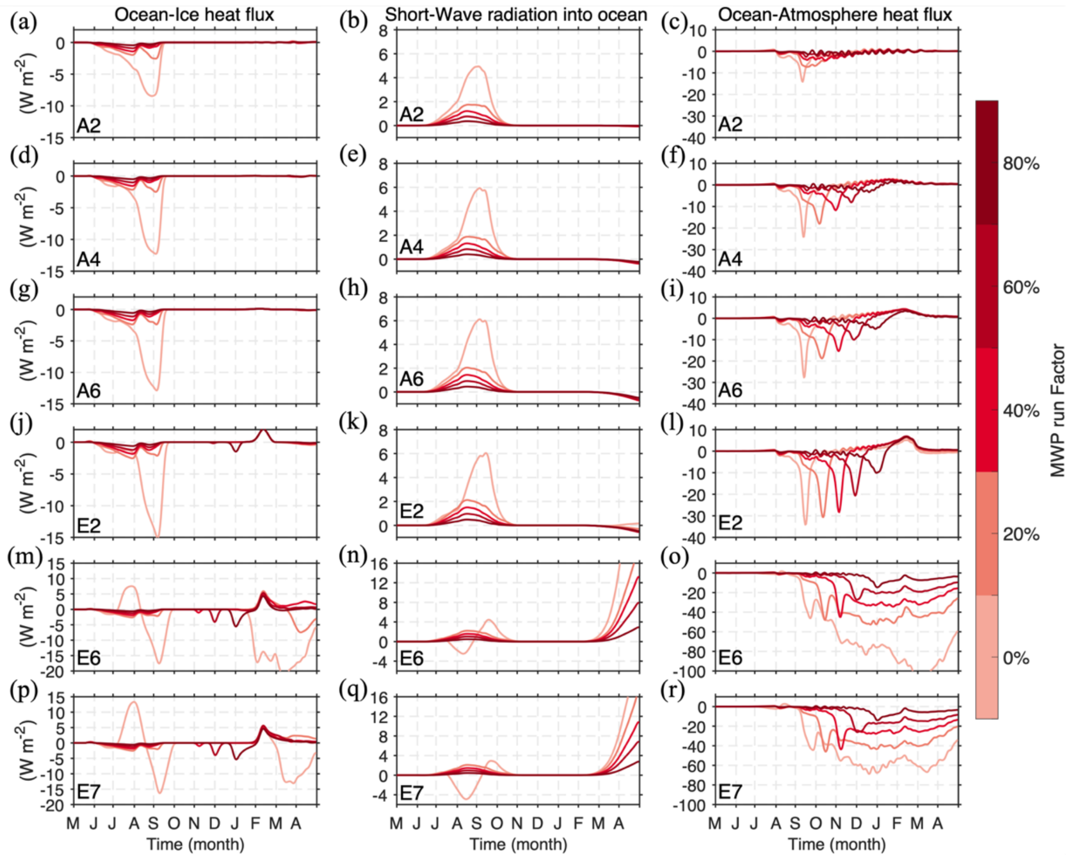

Figure 13: Time series of (left) the anomalies of ocean-ice heat flux, (middle) the anomalies of shortwave radiation, and (right) the anomalies of ocean-atmosphere heat flux for stations A2, A4, A6, E2, E6 and E7. The anomalies are obtained from the MWP run minus the control run. The negative (positive) value indicates heat gain (loss) by the ocean in the MWP run compared to the control run. The color of each line represents the MWP run factor.

- One suggestion I have for future research, which could be added as a sentence in the discussion, is to add wind sensitivity experiments to explain how wind mixing impacts the stratification and sea ice melt/formation.

  We added two sentences in **section 4.**

  Lines 453-457: ***In addition, as mentioned in section 3.1.2, changes in wind speed will affect stratification and the melt/formation of sea ice through increased vertical mixing. The ideal modelling method used in this study cannot reproduce the episodic high values of ocean-ice heat flux caused by wind mixing, as reported by Jackson et al., (2012) and Smith et al., (2018). Therefore, it is necessary to consider the wind speed on the role of melt water in the sea ice-ocean coupled system in future work.***