Response to comments by Reviewers #2

We deeply thank you for your constructive suggestions on the early version of the manuscript numbered "os-2021-7" (hereinafter named old manuscript). We have addressed all the comments formulated by the replying (in red) to your remarks (in black) and the changes in manuscript (*in red italic*). Each picture has two numbers: the first (in red) was the order in this reply letter; the second (*in red italic*) was the order in the revised manuscript.

Review of the manuscript:

Observational Study on the Variability of Mixed Layer Depth in the Bering
Sea and the Chukchi Sea in the Summer of 2019
by X Jiao, J Zhang, C Li.
I am sympathetic to oceanographers who go at sea in interesting regions of the world where climate change is amplified, such as the Bering and Chukchi Seas, and make new measurements there. There is the potential to write an interesting paper about these new measurements taken in the summer of 2019. Unfortunately, in its present state the manuscript is very far from the standards of an Ocean Science publication. Additional, more rigorous analysis and an extensive rewriting are necessary to reach the required level of quality.

Overall comments by section

Section 1, introduction.
The introduction is not well written. It feels like a mix and match of general considerations on mixed layer dynamics, previously published results and descriptive oceanography of the region, with no clear ordering of the ideas nor focus. The "state of the art" is not presented correctly: previous studies of the mixed layer based on hydrography in your region should be mentioned in the introduction (for example, Ladd and Stabeno 2012, which you quote later in your manuscript). This section does not introduce the manuscript properly. The introduction should pose clearly each scientific question that your manuscript will attempt to answer, and explain convicingly (with recent references) why your analysis is new.

Section 2
The first parts, 2.1 and 2.2, are too long and wordy, and the text does not bring useful information but rather merely repeats the tables and figures. Subsection 2.3 (MLD criterion) is badly written and does

not justify clearly the choice of criterion made in the manuscript.

Section 3, results analysis. There is very little analysis in this section, the text merely describes the figures (which is unnecessary) rather than focussing on what is new, original, important. In subsection 3.1 on salinity and temperature, no reference is cited, and no attempt is made to place the hydrographic data into the context of previous work and in the context of climate change. The same for sections 3.2 and 3.3, which are too descriptive and cite no reference to previous work. The control of mixed layer depth by salinity vs. temperature is discussed in these sections, but when MLD is controlled by, say, salinity, I suppose that the stratification index is also controlled by salinity. Could you have a on temperature vs salinity control of both the MLD and the underlying stratification, to avoid repetitions? In section 3.4, the relation between temperature, salinity and MLD is discussed, but the relation with density is discussed in 4.1, this is not logical.

Section 4, factors influencing the MLD : This section is weak. It is often unclear in the text whether space variability or time variability is considered. The significance of correlations need to be computed, and the different physical mechanisms must be discussed more rigorously, based on the literature.

Section 5, Conclusion: this section is just a summary, not a conclusion. It is necessary to demonstrate what is new in your results, why they are important for the progress of Ocean Sciences, and to discuss perspectives.

Reply:
Thanks a lot for your assessment and constructive comments. They are valuable for improving our paper and research. I embraced your comments to present better results of our research.

Introduction was rewrote and rearranged as the following outlines: The northward heat and freshwater transport is strongly influenced by the temperature, salinity and depth of the mixed layer (Woodgate, 2018); Few works focusing on the MLD in both the Bering Sea and the Chukchi Sea were found. Most of these previous works mainly focused on the MLD at low and middle latitudes (Holte et al., 2017; Carton et al., 2008; de Boyer Montégut et al., 2004; Holte & Talley, 2009; Hosoda et al., 2010; Monterey, 1997; Schmidtko et al., 2013); Some focus on the MLD in the Arctic and found the shoaling of the MLD (Peralta-Ferriz & Woodgate (2015)); It's worth to study whether the MLD on both sides of the Bering Strait interact with each other and MLD inter-annual changes through site observation; The processes modulated the changes and distribution of the MLD in this region need to be clarified.

The Section 2.1 and 2.2 has been simplified. The lengthy description about the ADCP and CTD was deleted. The Section 2.3 was rephrased: the introduction to the different methods defining the MLD was removed the Section 1.

The result was rewrote to place the hydrographic data into the context of previous work. The discussion was expanded and rewrote by citing more references to a make it more robust. The discussion was improved to demonstrate what is new in this research.

The 4.5 Section was supplemented in the revised manuscript to compare the temperature, salinity and MLD along the BL (Bering Sea) and R (Chukchi) sections in 2019 with previous years. The shoaling and warming of the mixed layer were found in 2019 than previous years and the climatology. And this was accompanied by the warming of the Cold Intermediate Water in the Bering Sea.

Detailled comments by line number

(mostly on sections 1-3, I grew tired afterwards)

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l59: "related subjects", not "relative".

Reply:

Thank you for your careful inspection. I corrected the inappropriate vocabulary in the revised manuscript as *"... related subjects."*

l64 to l71: these sentences could be clarified. How does the "air-sea kinetic energy exchange" affect the stratification? "Under the effect of wind, waves, and Langmuir circulation": wind is an atmospheric forcing, but waves and Langmuir circulations are processes taking place in the ocean, these should not be mixed up in the same sentence. Wind causes waves and Langmuir circulations but wind also causes other processes, such as vertical shear due to inertial oscillations and internal waves, that play an important part in setting the MLD. Other ocean processes such as mixed layer instabilities should be mentioned. The papers describing the results of the OSMOSIS experiment in the north earth Atlantic as especially interesting in this regard (Damerell et al 2020, and references therein).

Reply:

Thank you for your logical suggestion. I rephrased these sentences and corresponding references are added as well. The revised sentences were as following:

The strengthening or weakening of stratification caused by the air-sea kinetic energy exchange or buoyancy flux in the surface of the ocean will also change the MLD (Deardorff et al., 1969; Kato & Phillips, 1969; Kraus & Turner, 1967; Large et al., 1994; McWilliams et al., 1997; McWilliams et al., 2009; Price et al., 1986). Under the effect of waves, Langmuir circulation, mixed layer instabilities, and the vertical shear due to inertial oscillations and internal waves, the MLD become deeper, which has been proved by many researches based on theory, observations, and numerical models (Bruneau & Toumi, 2016; Li et al., 2013; Wu et al., 2015).

l72: "In this region": which region?

Reply:

Thank you for pointing out my ambiguity in expression. I cleared it as following:

"... in the Bering Sea and Chukchi Sea ..."

l78-79: "The hydrological characteristics in the Bering Sea are influenced by the Pacific Ocean due to the water exchange between the Bering Sea and the Pacific Ocean": this sentence is a bit repetitive, could the style be improved?

Reply:
Of course. I changed it as following:
The hydrological characteristics in the Bering Sea are influenced by the Pacific Ocean due to the water exchange, such as the major inflow through the Near Strait and outflow through Kamchatka Strait (Stabeno & Reed, 1994).

l84: "Northwest wind": you mean wind from the Northwest or towards the NorthWest? Same for South wind (line 85).

Reply:
Northwest wind means wind from the Northwest. The same for South wind.

l85: "will be frozen": the use of the future tense in this sentence is surprising.

Reply:
Thank you for your advice. I changed it into past tense as following:
Northwest wind prevails and part of the sea surface was frozen (Zhang et al., 2010).

l86-92: Explain how the subregions listed here are important for the results to be discussed in this manuscript, or else, these details are not necessary.

Reply:
Thank you. As these details are not necessary, I deleted these details in my revised manuscript.

l89: "100m" isobath.

Reply:
Thank you. I corrected it and checked the mistake throughout the manuscript.

l94: "The sea ice showed a trend": why the use of the past tense here? over which period is this trend observed?

Reply:
Markus et al. (2009) explored changes and trends in the timing of Arctic sea ice melt onset and freeze up over the period from 1979 to 2007. That's why I used the past tense here. And the manuscript was changed as following:
The sea ice in the Arctic showed a trend of later freeze up and a trend toward earlier melt onset over the period from 1979 to 2007 (Markus et al., 2009)…

l96-97: The Monterey reference is too old and not specific to the region considered here. It is necessary to consider more recent references. For example, Johnson and Stabeno (2017) document the seasonal cycle of the MLD in the deep part of the Bering Sea.

Reply:

Thank you. I replaced the Monterey reference with the Johnson and Stabeno (2017). And the related revision in the manuscript was:

The mean MLD were around 15-20 dbar in summer and around 80-160 dbar in winter (Johnson and Stabeno, 2017).

l100, figure 1: the readability of the figure could be improved. Black text and red text are too close to each other and the red text is barely readable. In this figure as well as in the other maps of the region, readability would be much improved by using a color for continents that is outside the colorbar, such as white, grey or black.

Reply:

Thank you. I modified the figure 1 as you suggested: Changed the red text to make them more readable; Change the color of the continents into grey to improve the readability of the maps. The revised figure 1 was as following:

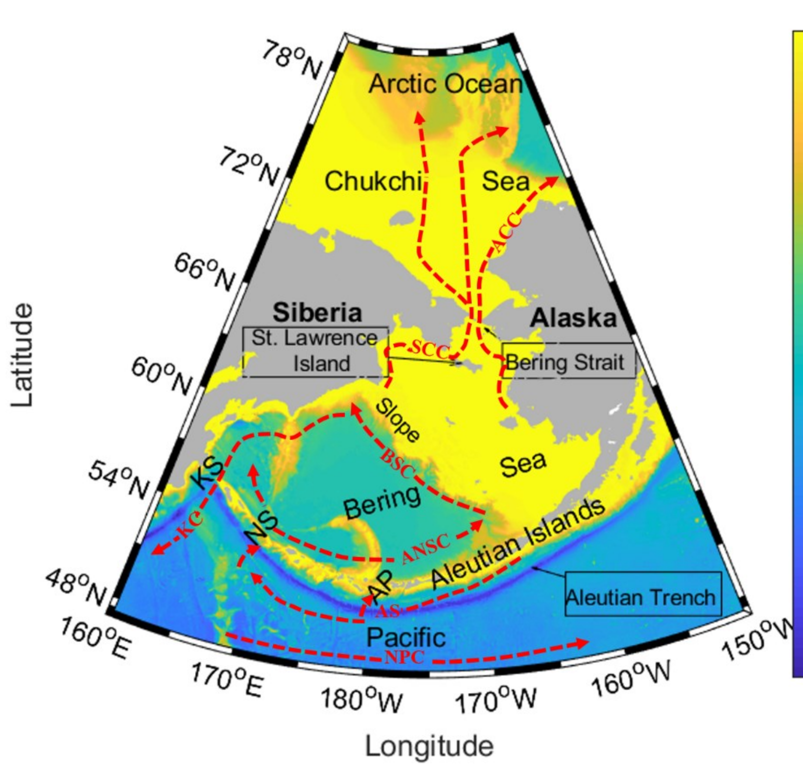

Figure 15 *Figure 1. Topography, bathymetry, and circulation in the Bering Sea, Chukchi Sea, and adjacent region. Abbreviations include: ACC = Alaskan Coastal Current; SCC = Siberian Coastal Current; KC = Kamchatka Current; BSC = Bering Slope Current; ANSC = Aleutian North Slope Current; AS = Alaskan Stream; NPC = North Pacific Current; KS=Kamchatka Strait; NS=Near Strait; AP=Amchitka Pass. (Danielson et al., 2014; Kawaguchi & Nishioka, 2020; Johnson and Stabeno, 2017)*

The color of the continents in other maps of the figure 2 in the manuscript was changed into grey as well.

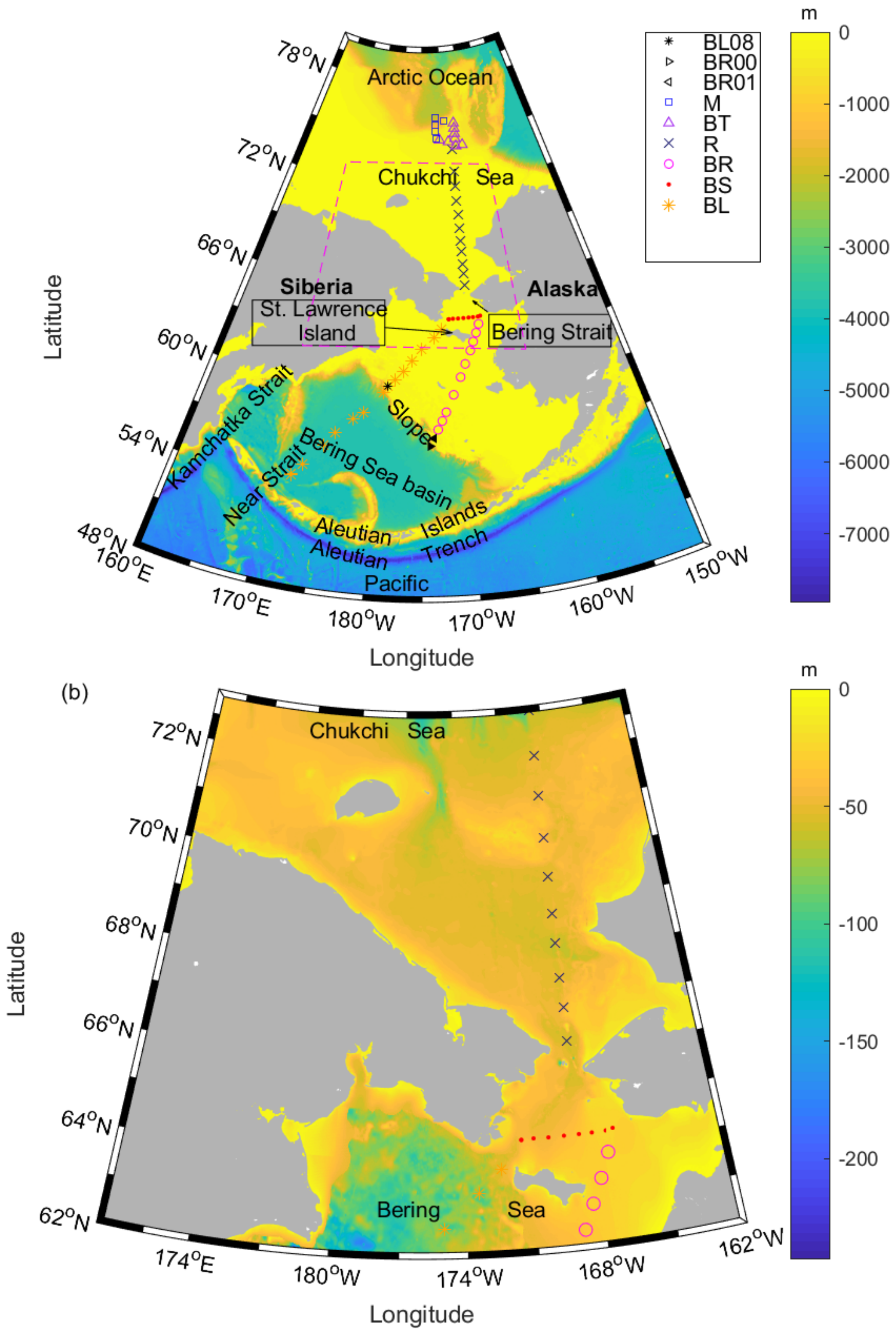

Figure 16 *Figure 2. (a) showed the distribution of the 58 observation stations. The asterisks, dots, circles, crosses, triangle, and squares represented the BL, BS, BR, R, BT, and M*

transection, respectively. (b) showed the bathymetry and topography in the dashed line rectangle in (a). ACW was the abbreviation of Alaska Coastal Water.

l107-108: the Monterey dataset is older than ARGO. Please also mention the Holte dataset in this list.

Reply:
Thank you for your recommendation. I mentioned the Holte dataset in the revised manuscript as following:
*Thanks to the rapid growth of Argo observations in the past decade, the MLD in most of the global ocean has been better studied (**Holte et al., 2017**). There are several global MLD datasets available (Carton et al., 2008; de Boyer Montégut et al., 2004; **Holte & Talley, 2009**; Hosoda et al., 2010; Monterey, 1997; Schmidtko et al., 2013).*

l120-123: please avoid casual style. The enumeration "will benefit the model calibration and evaluation, air-sea interaction, and climate change, etc." is not fit for a scientific paper, unless you establish precisely how your paper will impact each of these different scientific domains.

Reply:
Thank you for your criticism. I deleted that enumeration in the revised manuscript and I will pay attention to this point in my future research paper as well. The corrected line 120-123 was as following:
In this paper, the field observational data sampled during the summer of 2019 will be analyzed to study the spatial variations of MLD in the Bering Sea and the Chukchi Sea.

l128-140: "2.1 study area" presents only the bathymetry. Why is it important to list the depths of all the subregions in the text? A look at the maps of figure 2 is enough (although figure 2 could be improved). This subsection 2.1 seems unnecessary.

Thank you for pointing out my unnecessary subsection. In consideration of the introduction to the circulation, wind, sea-ice, etc. in this region, I agree with your suggestion. I deleted the subsection 2.1 in my revised manuscript.

l144: what is the meaning of the section designations (BL, BR, BS, R, BT, and M)? Do the letters refere to something?

Reply:
The letters are meaningless and refer to nothing. And a supplementary note was made in the revised manuscript:
As shown in Figure 2, 58 stations were distributed in BL, BR, BS, R, BT, and M section (The section designations are meaningless and refer to nothing.).

l145-150: it is not necessary to repeat the location of the sections in the text. The figure is enough.

Reply:
Thank you. The repetitive part of the location of the sections in the text was deleted in the revised manuscript.

l149-150 "These sections are representatives of this region": what do you mean by "representative"? representative of different bathymetries? different hydrography? current regimes? Certainly they are not representative of the seasonal cycle, being taken in summer only.

Reply:
Thank you for pointing it out. I changed it into a more rigorous style as following:
These sections are representatives of different bathymetries, hydrography, and current regimes during the expedition period in this region.

l151-183: This subsection 2.2 is redundant with the tables. If you keep the tables, you can shorten this text and avoid listing technical details such as the reference of the equipment, sampling details, etc which the reader can find in the tables. You can replace this text by a short paragraph pointing to what is new and original. For example, have hydrographic measurements been carried out in this region before? Are such measurements available in distributed databases such as World Ocean Atlas (WOA), of EN4? In which way do your measurements complement these existing databases? Are there ADCP data already available in this regions? In which way is your dataset new and different?

Reply:
Thank you. I kept the tables and deleted the repetitive text about technical details which can be found in the tables. And the following was supplemented to the revised manuscript to explain in which way this dataset was new and different:
The dataset was valuable as there were no such measurements for the summer of 2019 available in distributed databases such as Word Ocean Atlas (WOA) when this manuscript was submitted. As similar ADCP and CTD measurements were performed along the BL, BS, and R during the previous Chinese National Arctic Research Expedition, the inter-annual variation of the hydrography and MLD could be explored.

l184-196: the two tables 1 and 2 about the details of the equipment could be merged into one table.

Reply:
Thank you. The CTD and ADCP were listed for different technical details, so the table were different and difficult to merged into one table. If they were burdensome in the manuscript, I will move them into the supplemental information.

l187, table 3: it is not usual to list longitude and time of each hydrographic station in XXIst century oceanographic papers. This information is usually shown on a map (which you do in figure 2) and the actual numbers are found in the databases or in the supporting datasets made available with the manuscript. Table 3 is not necessary.

Reply:

Thank you. I moved them into the supporting datasets available with the manuscript.

l199, figure 2: the figure could be more readable (see remark about figure 1). If you want to point out some isobaths, please superimpose the corresponding contours, or use a discrete colorbar.

Reply:
Thank you. The color of the continents in other maps of the figure 2 in the manuscript was changed into grey as well.

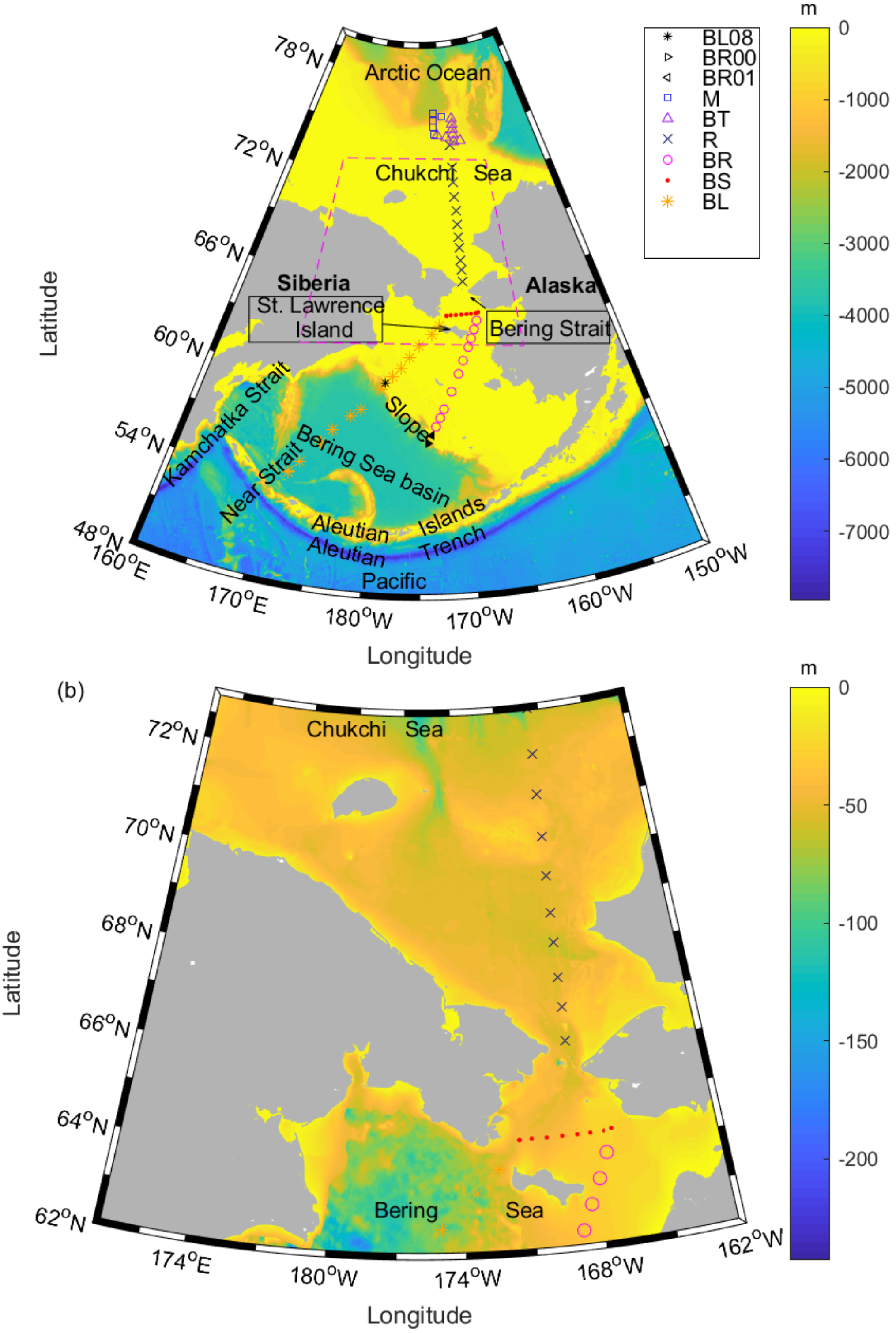

Figure 17 *Figure 2. (a) showed the distribution of the 58 observation stations. The asterisks, dots, circles, crosses, triangle, and squares represented the BL, BS, BR, R, BT, and M transection, respectively. (b) showed the bathymetry and topography in the dashed line rectangle in (a). ACW was the abbreviation of Alaska Coastal Water.*

l197: please spell out what CCMP means.

Reply:

Thank you. I spelt out CCMP, CFSv2, etc. The corresponding revised sentence was as following:

The wind observed by the shipborne automatic meteorological station were used to evaluate the Version 2 Cross-Calibrated Multi-Platform (CCMP) Wind Vector Analysis Product.

l200: please spell out what CFSv2 means.

Reply:

Thank you. I spelt out CFSv2. The first sentence in which CFSv2 appeared was supplemented as following:

The sea surface heat flux and water flux were obtained from the National Centers for Environmental Prediction (NCEP) Climate Forecast System Version 2 (CFSv2) (Saha et al., 2011, available online at https://rda.ucar.edu/datasets/ds094.0/).

l 203-207: please quote the publications describing these copernicus datasets. The links to the web sites should appear in the "data availability" section, not in the text.

Reply:

Thank you. I noticed that issue while writing the manuscript. So I checked the terms (as shown in Figure 18) in the “How to cite or reference Copernicus Marine Products and Services?”:

Figure 18 The example of indicating where to find the references in the terms.

The truth was that some of the dataset products have no reference in the dataset information catalogue entry and so does the dataset I used (as shown in Figure 19):

Figure 19 The information tab of the dataset I used in the paper.

l214-216: why do you quote examples from two old papers (Smyth et al, 1996 and Wijesekear et al, 1996) rather than give more details on the methods used in more recent papers such as de Boyer Montegut, Holte, etc?

Reply:

Thank you.

For the comments on l214-216, l218-219, l219-221, l221-l224, l224-227, I deleted this part while replacing the old papers with the more recent papers.

For the comments on l214-216 and l218-219, I replaced the old papers with the more recent papers in the revised manuscript, and moved this paragraph to the Section 1 Introduction:

Methods to estimate MLD include difference threshold (de Boyer Montégut et al., 2004; Kara et al., 2000; Kara et al., 2003), gradient threshold (Lukas & Lindstrom, 1991), curvature method (Lorbacher et al., 2006), split and merge method (Thomson & Fine, 2003), hybrid method (Holte et al., 2009), etc. For example, Kara et al. (2000, 2003) defined the Isothermal Layer Depths (ILD) as being the depth at the base of an isothermal layer, where the temperature has changed by a fixed amount of ΔT *from the temperature at a reference depth of 10 m, and the mixed layer depth (MLD) was the depth at the base of an isopycnal layer where the density has changed by a fixed amount of* $\Delta\sigma_t = \sigma_t(T+\Delta T, S, P) - \sigma_t(T, S, P)$ *from the density at a reference depth of 10 m. Note that their*

$\Delta\sigma$ criterion varied based on a fixed ΔT. de Boyer Montégut et al. (2004) defined the MLD as the depth within which the temperature (density) varied within a threshold value of $\Delta T = 0.2$℃ ($\Delta\sigma = 0.03 \mathrm{kg}/m^3$) relative to the value at 10 m depth. Some researchers proposed a split-and-merge method, which could be used not only to calculate the MLD but also to describe other marine vertical structural features (Thomson & Fine, 2003). Holte et al (2009) came up with a hybrid method, which derived five possible MLD values for density profiles: the density threshold MLD estimate, the density gradient MLD estimate, and the intersection of the density mixed layer and thermocline fits, as well as the temperature threshold MLD estimate, collocated temperature and temperature gradient maxima, the temperature maximum, and the final MLDs from the temperature and salinity algorithms, and then analyzed the patterns in the suite to select a final MLD estimate.

l218-219 "many researchers used a gradient threshold of 0.1 kg/ð'š4 (Lukas & Lindstrom, 1991)". Why this old reference? Please discuss the most recent methods, starting with Kara (2000, 2003), Clement de Boyer Montegut (2004) or Holte et al (2009).

Reply:
Thank you. As this comment on l218-219 focused on the old papers as the comment above (on l214-l216), and were replied after the comments on l214-216.

l219-221 :What is the "least-squares regression and integration method" and who invented it or used it? Is this relevant for your manuscript?

Reply:
Thank you. I deleted these methods from old reference, and discussed the most recent methods as mentioned in the reply to the comment on l214-216.

l221-l224 : "Some researchers proposed a split-and-merge method, which could be used not only to calculate the MLD but also to describe other marine vertical structural features (Thomson & Fine, 2003). Therefore, the difference threshold and gradient threshold are better choices.". When you use "Therefore" to start a sentence, it means that your statement is a consequence of the previous sentences. Here, the preceeding sentences do not demonstrate in any way why the difference treshold and gradient are better.

Reply:
Thank you. I deleted these methods from old reference, and discussed the most recent methods as mentioned in the reply to the comment on l214-216.

l224-227: provide a reference where it is demonstrated that dissolved oxygen is not an accurate method.

Reply:
Thank you. I deleted these methods from old reference, and discussed the most recent methods as mentioned in the reply to the comment on l214-216.

l235-237: "the temperature of the mixed layer had local extremum. As a result, if a small threshold was used, the calculated MLD would be shallower than the real MLD." What is the "real" MLD? By definition, the MLD is the depth over which everything can be considered "well-mixed" (temperature, density, salinity). If temperature is not mixed, then you have not defined a "true" or "real" MLD. Please show the corresponding profiles of salinity and density to demonstrate that they are indeed mixed.

Reply:

Thank you. The local extremum means that due to the high accuracy of the instruments, the temperature, salinity, and density profiles are not pretty smooth and may have very small fluctuation within the MLD. I have added the profiles of salinity and density in the revised manuscripts as following:

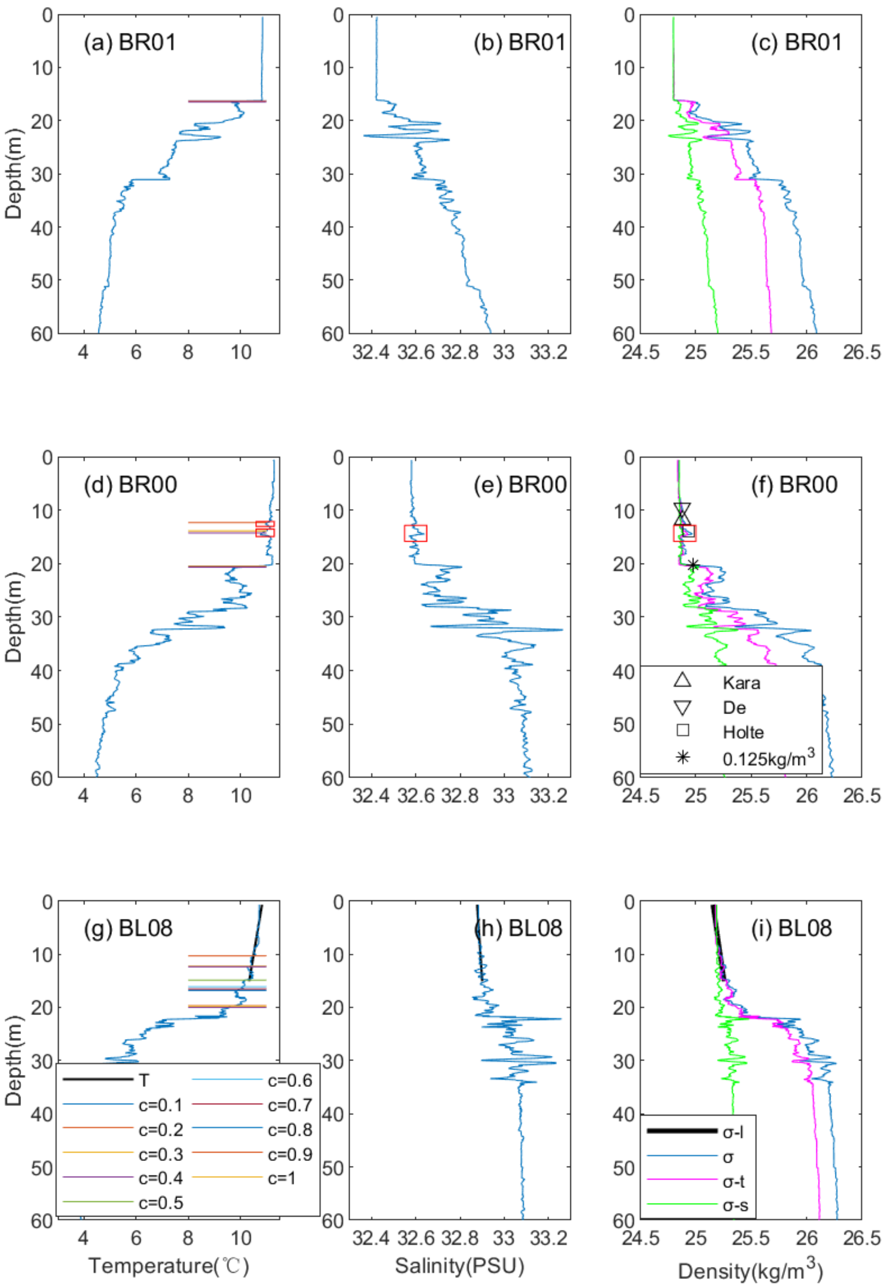

Figure 20 ***Figure 3.*** *Three types of temperature, salinity, and density profiles. (a), (b), and (c) showed the type A temperature, salinity, and density profiles, which had almost the same MLDt using different criteria. (d), (e), and (f) showed the type B temperature, salinity, and density profiles, and the MLDt calculated from this temperature profile using different temperature criteria was distributed around the local extremum. The local extremum in the red boxes might lead to smaller MLDt than the real MLDt. (g), (h), and (i) showed the type C temperature, salinity, and density profile; the MLDt calculated from type C temperature profile using different temperature criteria had*

more difference, and the distributions were more dispersed. Horizontal lines in different colors showed different MLDt responding to a group of temperature criteria in (a), (d), and (g). The variable c in the legend represented the temperature criteria which ranged from 0.1 to 1 ℃. The black solid lines in (g), (h), and (i) showed the linear regression of the temperature, salinity, and density profiles within the mixed layer. The magenta (green) solid line in (i) showed density profile calculated from the depth-related temperature (salinity) and the fixed salinity (temperature) at the depth of 5 m. The upward-pointing triangle, downward-pointing triangle, square, and asterisk in (f) showed the MLDd got based on the criteria of Kara et al. (2000), de Boyer Montégut et al. (2004), Holte et al (2009), and $\Delta\sigma$=0.125kg / m^3.

l230-255: It is unclear what your types A, B, C are. Please explain at the beginning of this section how you classify the profiles, providing equations if necessary. The way the text is written, at the beginning your classification of profiles into categories seems to be based only on temperature (Figure 3) while in fact you end up choosing a density-based threshold and you show that salinity is important. All this discussion has to be rethought carefully and rewritten completely. Please classify the profiles as a function of their control by salinity or temperature, and show the profiles of density, salinity and temperature in figure 3.

Reply:

I rewrote this paragraph to clarify what types A, B, C are as following. The figure was modified (as shown in Figure 20) to include the temperature, salinity, and density profiles in the revised manuscript.

According to the shapes of the temperature, salinity, and density profiles, they were identified into three classes: type A profiles within the mixed layer were almost completely homogenous, and showed no gradient and fluctuation; type B profiles showed obvious fluctuation, as shown in the red box in (d), (e), and (f) of Figure 3; type C profiles showed both obvious gradient (black line in (g), (h), and (i) of Figure 3) and fluctuations within the mixed layer. BR 01, BR00, and BL08 showed the profiles of the temperature, salinity, and density of type A, B, C, respectively (Figure 3). Due to the existence of the fluctuations (in the red box in (d), (e), and (f) of Figure3) in the temperature, salinity, and density profiles, suitable criteria were required to get MLD.

l258-259: you mention a criterion (0.5) for temperature but not for density, the sentence is illogical.

Reply:

Thank you. I mentioned a criterion ($\Delta\sigma$=0.125kg / m^3) for density later in the initial manuscript:

*The MLDd was defined as the depth at which **density** differed from that of the depth of 5 m by 0.125* kg / m^3.

To make it clear, I rewrote these relevant sentences in the revised manuscript:

*The criterion for the **MLDd** was* $\Delta\sigma$=0.125kg / m^3 *, and the reference depth was 5m. The criterion* *was the same as some previous studies, such as Suga et al. (2004) for the North Pacific. But inconsistent with the reference depth of 10 m in their study (Suga et al., 2004; de Boyer Montégut et al., 2004), a reference depth of 5 m was adopted because the MLDd in some area was shallower than 10 m. The suitable criterion for the* ***temperature difference method*** *was 0.5 $°C$, and the reference depth was also 5m.*

l263-265: Here for the first time you explain what "threshold" means and you say that you look at the difference between density at a given depth and density at 5m. Do you also consider temperature at 5m? Why 5m, while others such as De Boyer Montegut use 10m? This information should come earlier.

Reply:

Thank you for your suggestion. The Section 2.2 was modified significantly. The threshold method was explained at the beginning of Section 2.2:

In this paper, the most widely adopted ***difference threshold method*** *(de Boyer Montégut et al., 2004) was used to estimate the MLD. The MLDd was defined as the depth at which density differed from that of the reference depth by a criterion.*

I did also consider temperature at 5 m, because the MLDd and MLDt in some area was shallower than 10 m. And this was explained as well in the revised manuscript:

The criterion for the MLDd was $\Delta\sigma = 0.125 \text{kg}/m^3$, and the reference depth was 5m. The criterion was the same as some previous studies, such as Suga et al. (2004) for the North Pacific. But inconsistent with the reference depth of 10 m in their study (Suga et al., 2004; de Boyer Montégut et al., 2004), ***a reference depth of 5 m was adopted because the MLDd in some area was shallower than 10 m****. The suitable criterion for the* ***temperature difference method was 0.5 $°C$, and the reference depth was also 5 m****.*

l264: "This is consistent with previous research": which research? Certainly not Clement de Boyer or Holte who use lower density jumps. Can you justify your choice by comparing the different methods using your data, rather than relying arbitrarily on one publication, Kara 2000?

Thank you for your suggestion. I supplemented the reference in the revised manuscript:

The criterion for the MLDd was $\Delta\sigma = 0.125 \text{kg}/m^3$, and the reference depth was 5m. The criterion was the same as some previous studies, such as ***Suga et al. (2004)*** *for the North Pacific.*

And the MLDd got based on the criteria of Kara et al. (2000), de Boyer Montégut et al. (2004), Holte et al (2009), and $\Delta\sigma = 0.125 \text{kg}/m^3$. were marked and compared in (f) of Figure 20 (which was Figure 3 in the revised manuscript).

l242: figure 3. Please show temperature, density and salinity profiles. Please indicate the location of the profiles you have chosen.

Reply:

Thank you for your suggestion. I supplemented temperature, salinity, and density profiles in Figure 3 in the revised manuscript (Also shown in Figure 20 of this reply letter). The location of the profiles I have chosen were indicated in Figure 16 of this reply letter (Figure 2 in the revised manuscript).

l268, figure 4: Please have a horizontal axis in kilometers besides the stations labels, or else, because your sections are mainly oriented south/north, use the latitude. What are the different criteria listed?

Reply:

Thank you for your suggestions. I modified the figure in the revised manuscript to have an axis in latitude (on the vertical axis). The left panels showed the MLD from temperature and the right panels showed the MLD from density. The new figure 4 was shown as following:

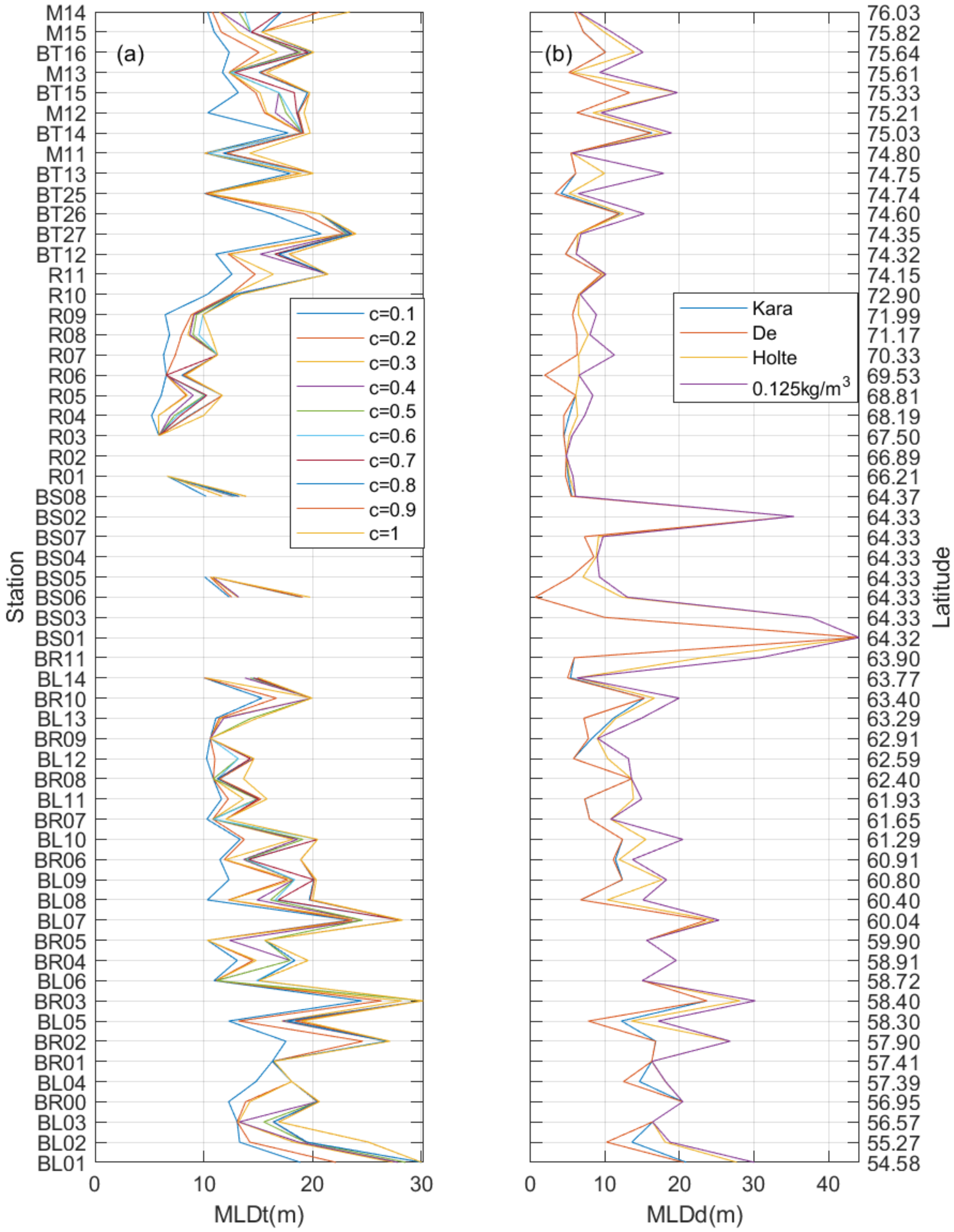

Figure 21 ***Figure 4.*** *(a) The MLDt corresponding to a group of temperature criteria. The variable c in the legend represented the temperature criteria which ranged from 0.1 to 1 ℃. (b) The MLDd corresponding to the criteria from the Kara et al. (2000), de Boyer Montégut et al. (2004), Holte et al (2009), and* $\Delta\sigma = 0.125 \mathrm{kg}/m^3$*, respectively. Both the left and right panels were in ascending order of the latitude.*

l 274-288: The stratification criterion is not relevant for the mixed layer if you compute it over the entire depth of the water column where the ocean is deep. Ladd and Stabeno compute it down to 60m. Please explain here what you do exactly, and why you choose 60m. You may also write an equation to show how you compute the relative contributions of temperature and salinity. You won't have to repeat the method in section 4.

Reply:

Thank you for your suggestion. I modified the manuscript and the stratification index was calculated within the MLD. The figure 10 was revised and Section 4.1 was rewrote as well, as shown in the following. The contribution to SI due to temperature (SIt) and Salinity (SIs) was SIs/(SIt+SIs), SIt/(SIt+SIs), respectively.

4.1. Stratification

The salinity and the temperature contribution to the MLD was explored by studying the stratification index (SI). The SI covered the whole depth of the mixed layer. The stratification index was O($1000 J/m^2$*) in the Bering Sea basin and the southern Bering Sea shelf including BL01-BL13, as shown in* ***Figure 10*** *(a) and (b). In the northeastern Bering Sea shelf, due to the high-salinity of the Anadyr Water, the SI was significantly larger (**Figure 10** (c)). In the northwestern Bering Sea shelf and the Chukchi Sea, the SI was significantly smaller (**Figure 10** (c), (d), (e), and (f)). The SI showed a trend of decrease northward and was dominated by the salinity. The contribution of the temperature to stratification was too weak to be ignored. This was consistent with the research of Johnson et al. (2012), which showed that the seasonal variation of the mixed layer in the Arctic was dominated by salinity. Therefore, it was reasonable to assume that the characteristics of the mixed layer are related to the low-salinity water generated from the melting of sea ice in the Chukchi Sea and the northern Bering Sea shelf in the summer of 2019.*

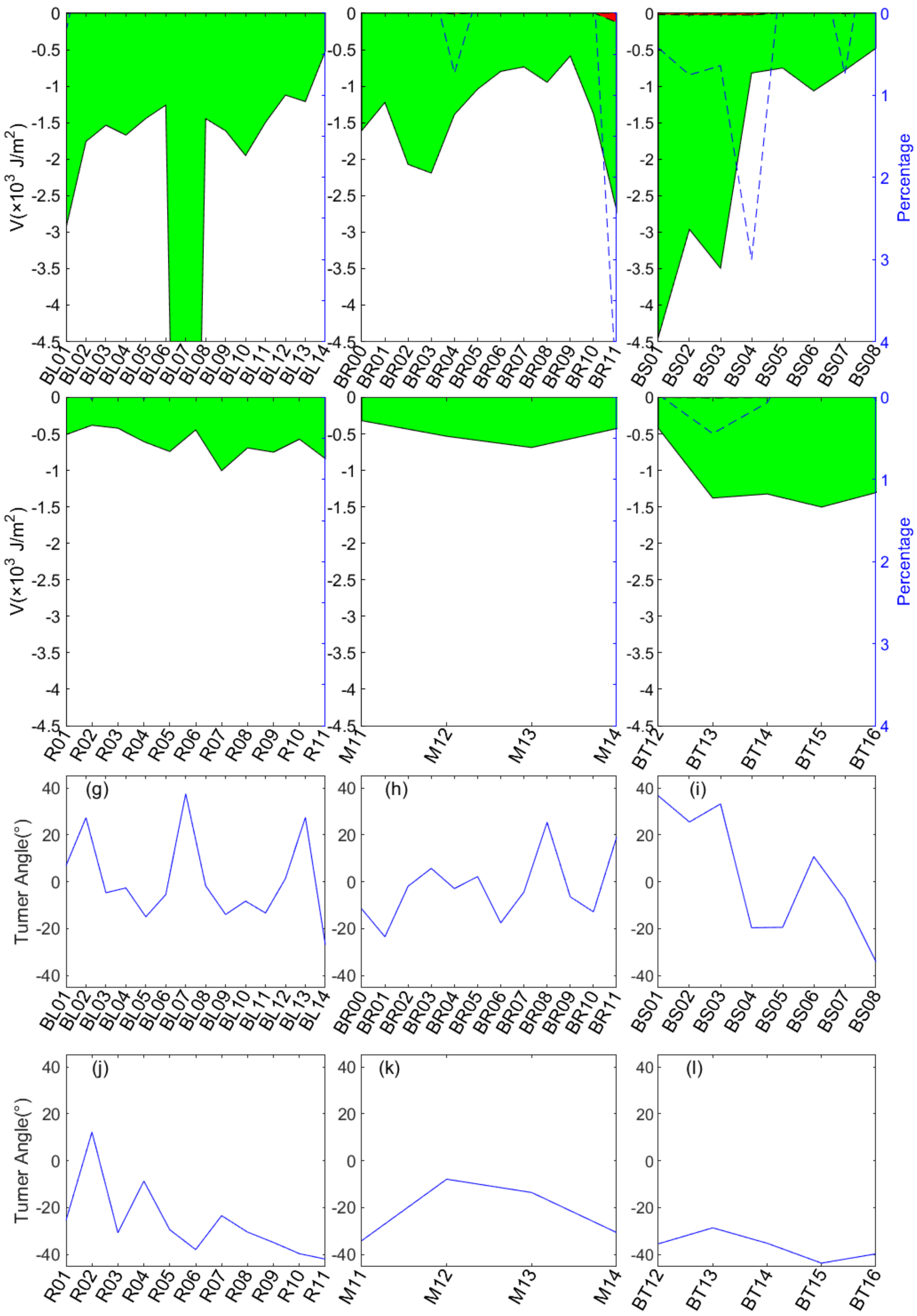

Figure 22 ***Figure 10.*** *(a)~(f) The left axis represented the stratification index. Red was the proportion of stratification due to temperature. Green was the proportion due to salinity. The right axis represented the percentage of the contribution of the temperature. The blue dashed line represented the proportion of the contribution of the temperature to the stratification at different stations. (g)~(l) The mean Turner Angle within the mixed layer.*

l 274-278: Besides a stratification index you may also consider the Turner angle (e.g, Clement et al, 2020, or references therein).

Reply:

Thank you for your suggestion. The Turner angle was showed in Figure 23 and analyzed in the revised manuscript, showed in the following:

The mean Turner angle within the mixed layer was $-45° < Tu < 45°$*, which meant that the mixed layer was stable on the whole. Half of the stations in the Bering Sea was larger than* $0°$*, and that meant that temperature played important role in the stable layer. The contrast along the BS section showed that temperature dominant the stable state in the Anadyr Water while salinity dominant the stable state in the Alaska Coastal Water. All the station except the R02 showed Turner angles smaller than* $0°$*, which meant that the salinity dominant the stable state in the Chukchi Sea.*

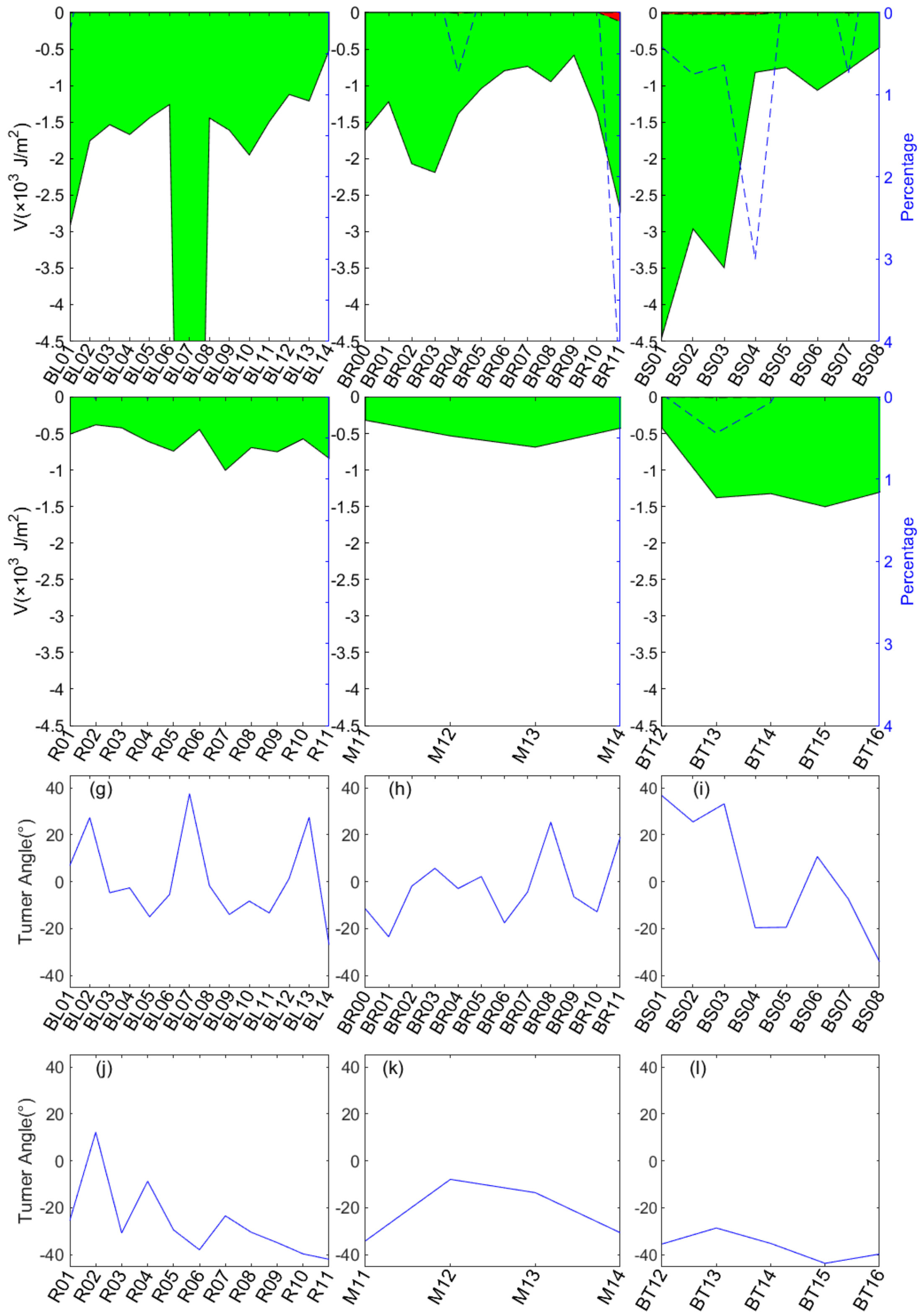

Figure 23 *Figure 10 (a)~(f) The left axis represented the stratification index. Red was the proportion of stratification due to temperature. Green was the proportion due to salinity. The right axis represented the percentage of the contribution of the temperature. The blue dashed line represented the proportion of the contribution of the temperature to the stratification at different stations. (g)~(l) The mean Turner Angle within the mixed layer.*

l290-322: This is a mere description of your figures. Please present new, original, scientific results: is there something unexpected in the temperature and salinity in 2019 compared with the databases and the previously published literature?

Reply:

Reply you for your comments. I analyzed the observational dataset from previous Chinese National Arctic Research Expeditions and WOA as you suggested in the overall comments. The mixed layer was shallower in the summer of 2019 in the Bering Sea and Chukchi Sea than those in previous years and climatological fields from WOA. And this was accompanied by the warming of the mixed layer. And this results were added in the Section 4 Discussion in the revised manuscript. The results were showed in the following as well for your convenience:

4.5 The inter-annual variation

To explore the inter-annual variation of the MLD in the Bering Sea and Chukchi Sea, the observations along the BL section and R section from the World Ocean Atlas 2018 (WOA2018) and previous Chinese National Arctic Research Expeditions were compared.

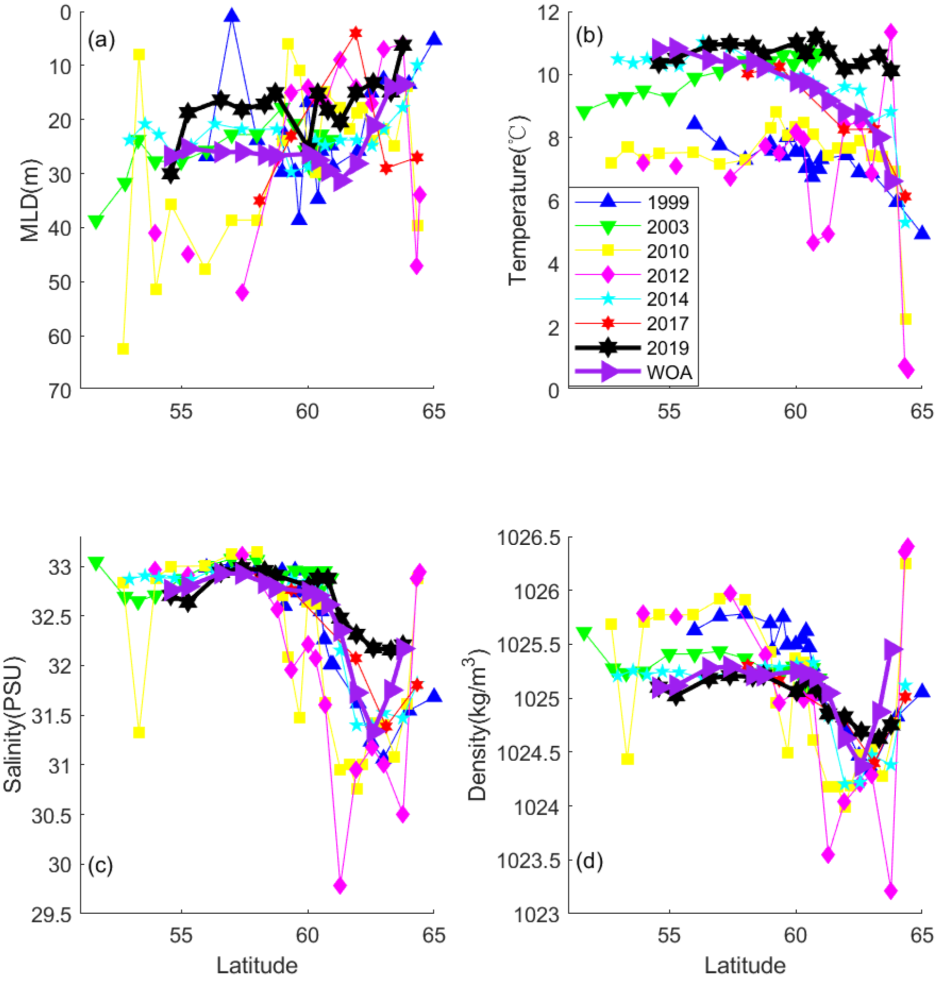

Figure 24 *Figure 15 The inter-annual variation of the MLD, temperature, salinity, and density of the mixed layer from the Chinese National Arctic Research Expeditions and the climatological MLD from WOA along the BL section in the Bering Sea.*

*The MLD in 2019 was obviously shallower and the temperature of the mixed layer was higher than those in the other five years along the BL section in the Bering Sea (**Figure 15** (a) and (b)). This shallower MLD was accompanied by the warming of the surface layer (**Figure 6** (c) and (d)) and cold intermediate layer (CIL) (**Figure 16** (a) ~ (f)). The minimum temperature of the CIL water mass in the BSb showed a trend of increase: it was* 0.54℃, 0.94℃, 0.82℃, 0.69℃, 1.99℃, *and* 2.50℃ *for the year of 1999, 2003, 2010, 2012, 2014, and 2019, respectively (**Figure 16** (a)~(f)). The warming of the CIL may be related to the air temperature warming in the previous winter and the processes in the north pacific (Overland et al., 2012).*

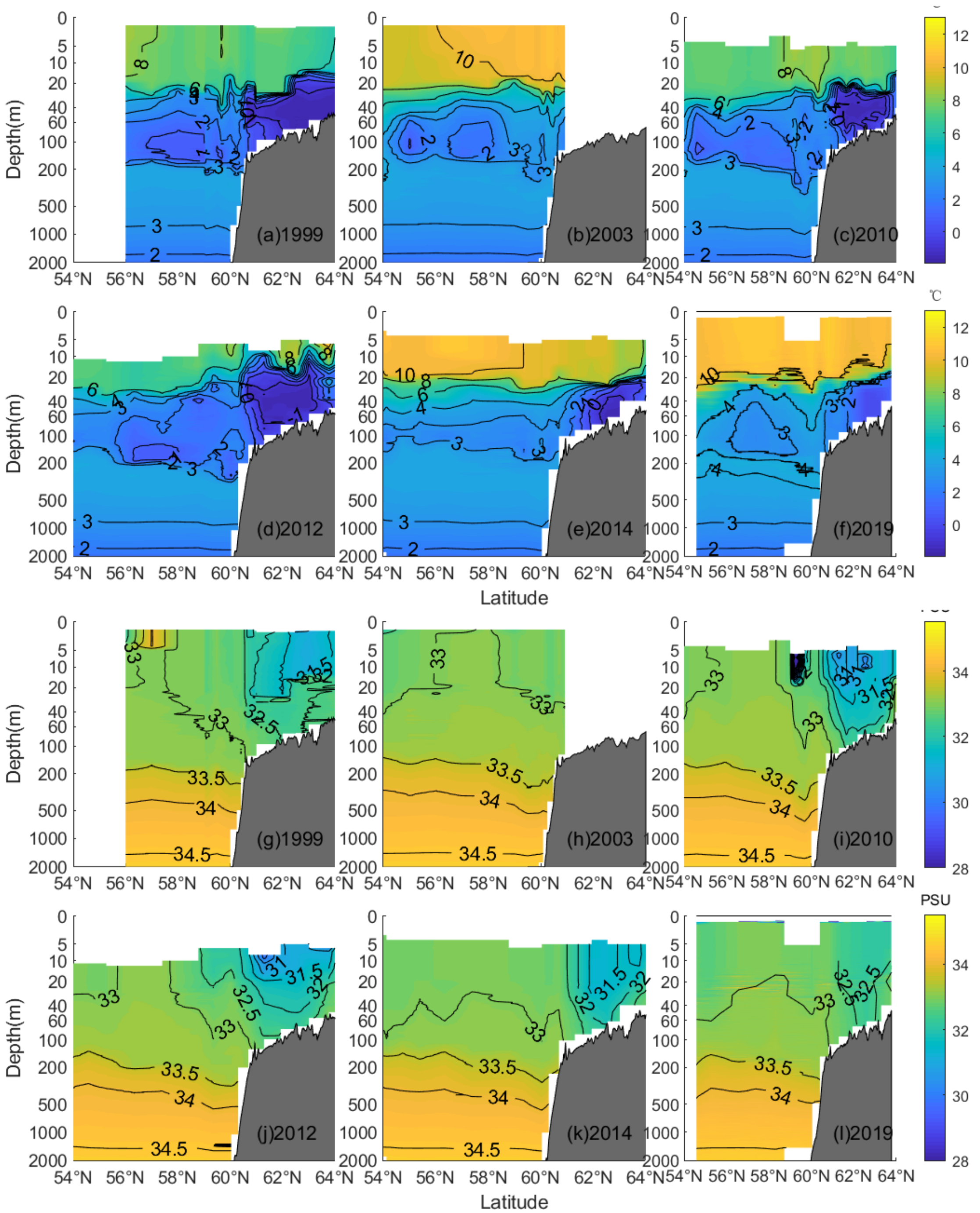

Figure 25 *Figure 16 The temperature ((a)~(f)) and salinity ((g)~(l)) profiles along the BL section in the Bering Sea from the Chinese National Arctic Research Expeditions and WOA. These expeditions were all carried out in summer.*

*The MLD in 2019 was shallower than those in 1999, 2003, 2010, 2012, 2014, and 2017 along the R section in the Chukchi Sea (**Figure 17** (a)). And this was accompanied by the warming of the mixed layer (**Figure 17** (b), **Figure 8** (a) and **Figure 18**). This surface warming was related with to the regional air-sea heat flux and the Arctic amplification (Danielson et al., 2020). Chronologically, the salinity and density was* *consistent with the WOA climatological fields (**Figure 17** (c) and (d)), while the MLD was shallower and the temperature was higher than the WOA climatological fields in the summer of 2019 (**Figure 17** (a) and (b)). But salinity dominated the spatial fluctuation of the density for most of the year (**Figure 17** (c) and (d)). It should be noticed that the salinity of the water in the BSs was larger than the climatology (**Figure 6** (d) and (f), **Figure 15** (c)) while it was not so in the CSs (**Figure 17** (c)). This may be linked to the increasing net glacial ablation in the Gulf of Alaska watershed (Danielson et al., 2020).*

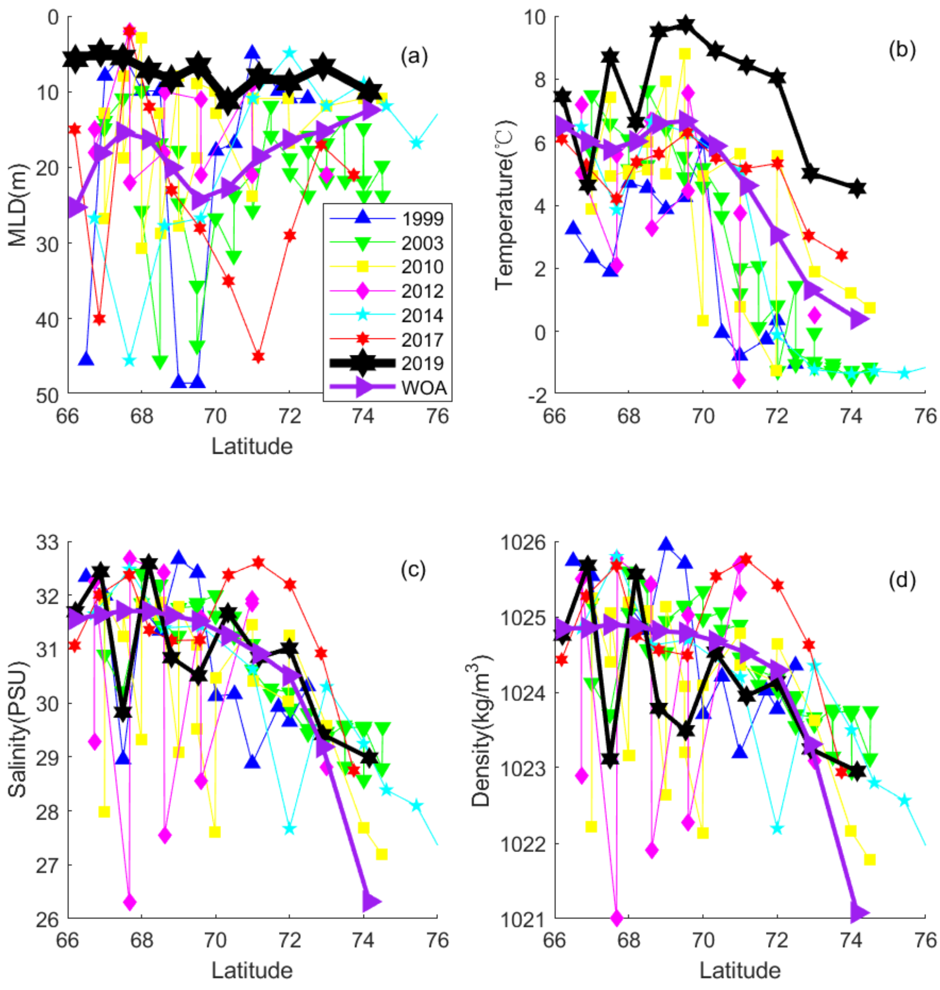

Figure 26 *Figure 17 The inter-annual variation of the MLD, temperature, salinity, and density of the mixed layer from the Chinese National Arctic Research Expeditions and the climatological MLD from WOA along the R section in the Chukchi Sea.*

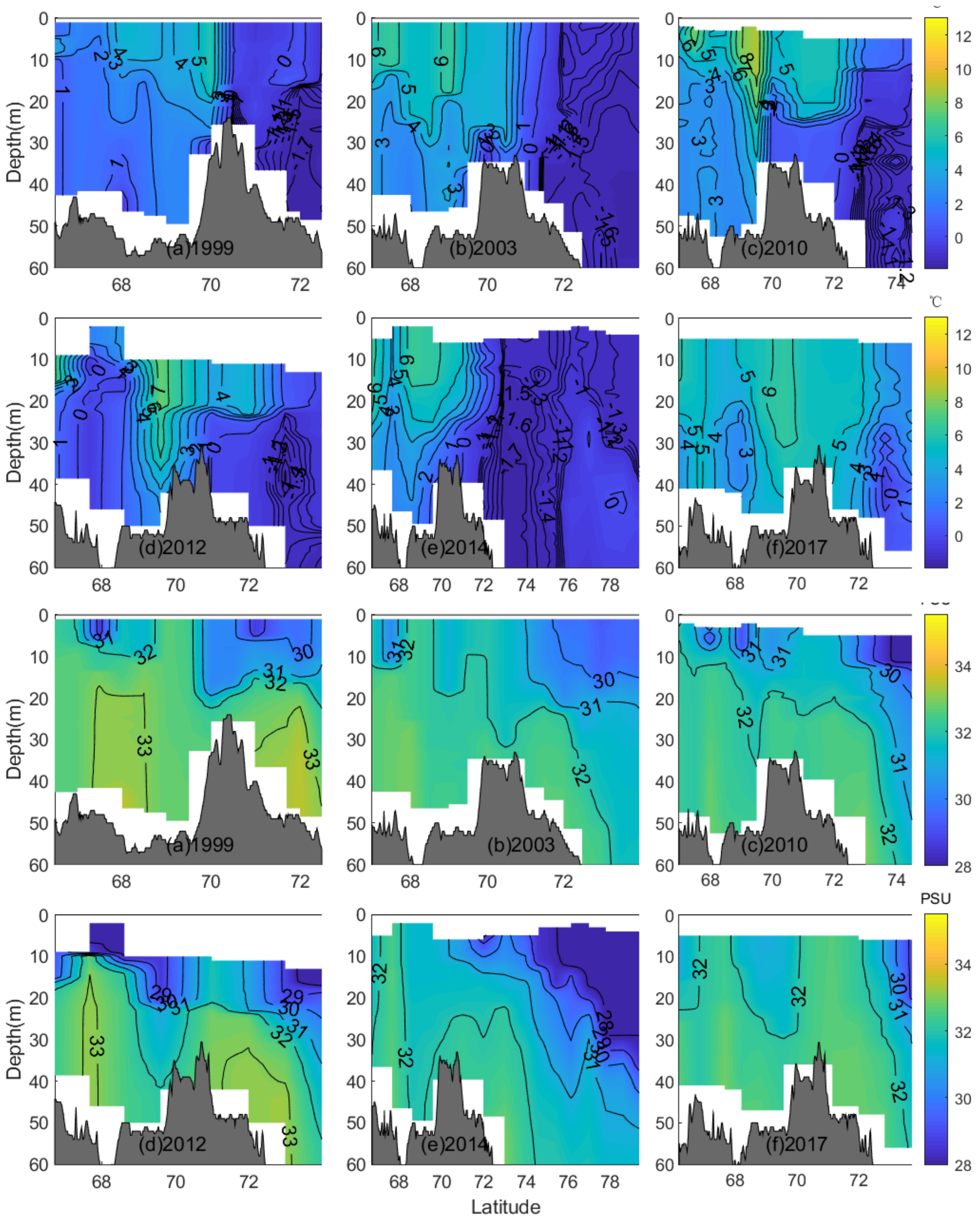

Figure 27 *Figure 18 The temperature ((a)~(f)) and salinity ((g)~(l)) profiles along the R section in the Chukchi Sea from the Chinese National Arctic Research Expeditions and WOA. These expeditions were all carried out in summer.*

l327 " the BL section was representative" representative of what?

Reply:

Thank you. I cleared my expression as following:

The BL section was representative main circulation and water masses during the expedition period in both the Bering Sea basin and shelf.

l370, Figure 5: the labels on the graphs could be more readable.

Reply:

Thank you. I modified the labels Figure 5 and supplemented the lines representing the MLD as well. The new Figure 5 in the revised manuscript was as following:

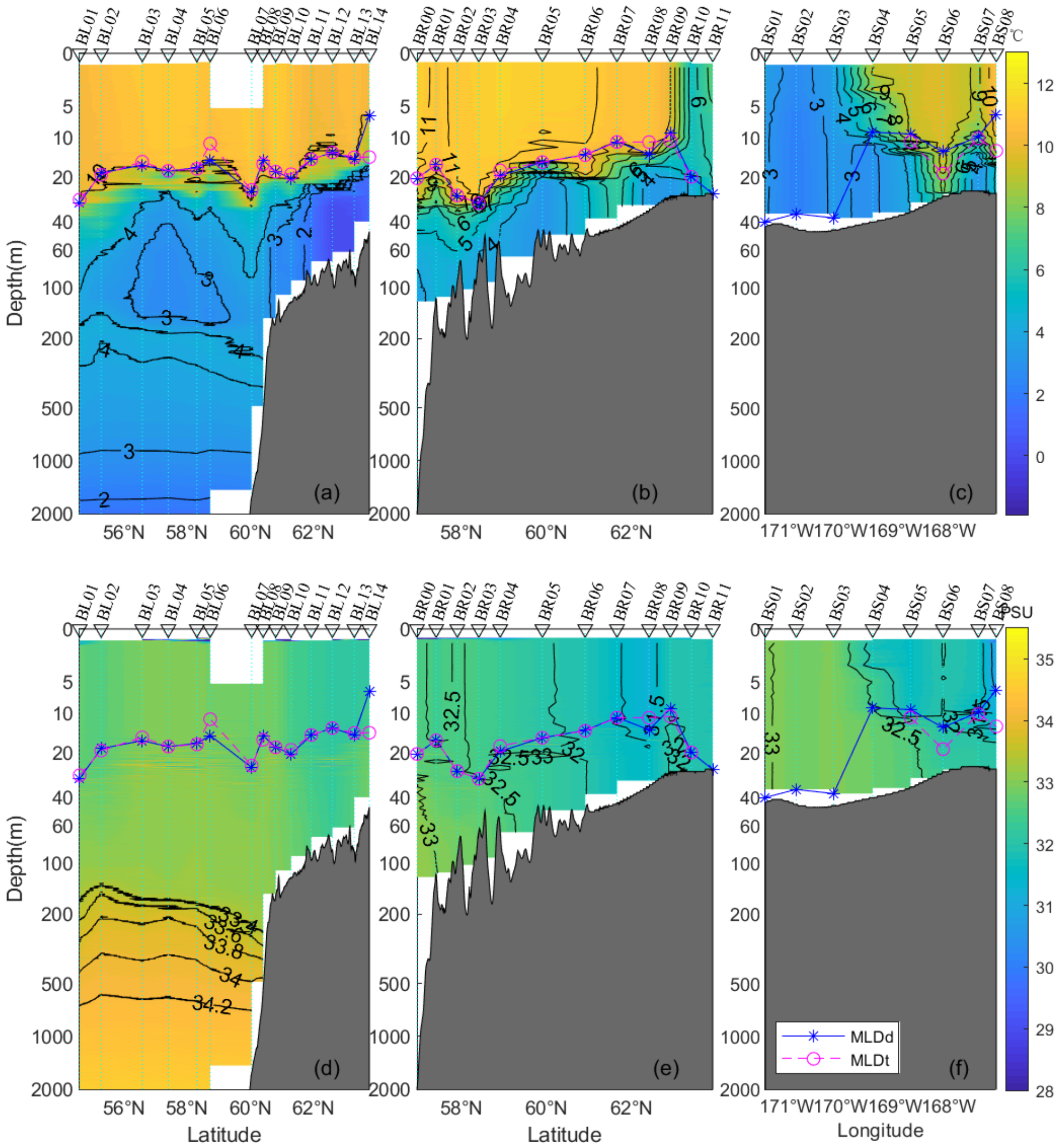

Figure 28 *Figure 5 The upper panels and the lower panels represented the temperature and salinity profiles, respectively. The left (a, d), middle (b, e), and right (c, f) column represented the section of BL, BR, and BS, respectively. The blue solid line represented the MLDd. The magenta dashed line represented the MLDt.*

l374: Figure 6 : You don't need to show the sea surface temperature and salinity, unless there is something new. Does your measure SST compare will with satellite SST? Does your SSS compare with the climatology (say, World Ocean Atlas) for the month of the cruise? If the year 2019 is special, how and why?

Reply:

Thank you for your suggestions. I compared the in situ measure SST with the satellite SST, and it was consistent with the satellite SST (the difference within 1 ℃, Figure 29 (c) and (e)). The measure SST was warmer (reached 2.7 ℃) than the climatology (WOA, Figure 29 (c) and (e))). The measure SSS was consistent with the climatology (WOA) in the Bering Sea basin but larger than the climatology in the Bering Sea shelf (Figure 29 (d) and (f)). The detailed discussion was showed in the revised manuscript:

The MLD in 2019 was obviously shallower and the temperature of the mixed layer was higher than those in the other five years along the BL section in the Bering Sea (Figure 16 (a) and (b)). This shallower MLD was accompanied by the warming of the surface layer (Figure 6 (c) and (d)) and cold intermediate layer (CIL) (Figure 17 (a) ~ (f)).

It should be noticed that the salinity of the water in the Bering Sea shelf was larger than the climatology (Figure 6 (d) and (f), Figure 16 (c)) while it was not so in the Chukchi Sea shelf (Figure 18 (c)). This may be linked to the increasing net glacial ablation in the Gulf of Alaska watershed (Danielson et al., 2020).

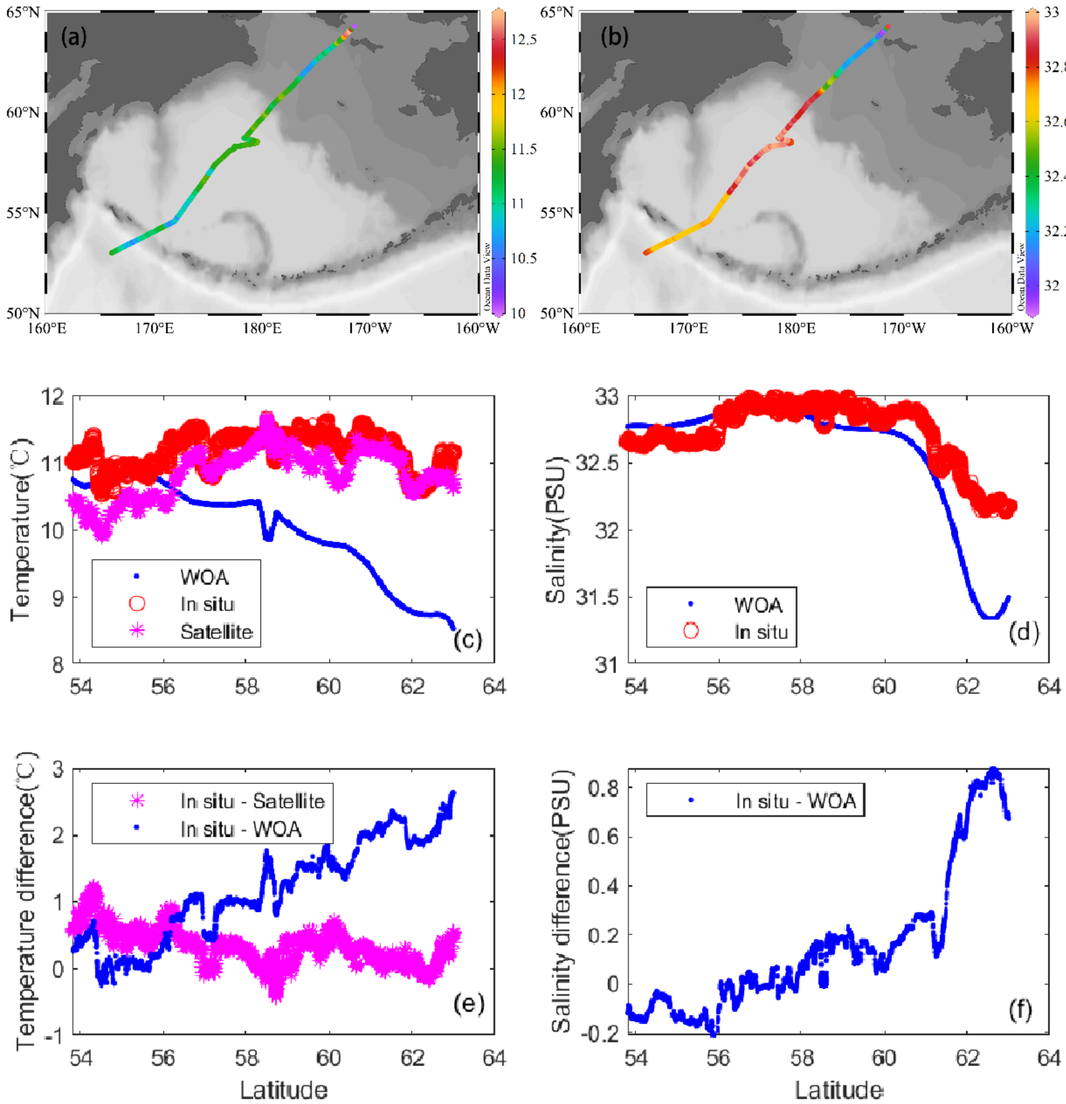

Figure 29 *Figure 6 The sea surface temperature (a) and salinity (b) in the Bering Sea.*

l388: what are the units for the rate?

Reply:

The rate equals $\Delta MLD(m)$ divided by distance (m). So, the rate was dimensionless because both the units of the MLD and distance was meter. I supplemented this explanation in the revised manuscript as well.

l427-428, "The MLD in the Bering Sea shelf fluctuated with the topography": Where is this demonstrated? Is there a figure to show the relationship between MLD and bathymetry?

Reply:

Thank you. I supplemented the MLD in Figure 28 (Figure 5 in the revised manuscript), and bathymetry was showed as well. The related stations and figures were listed in the revised manuscript:

*The MLD at the stations BL07~BL14 and BR01~BR09 in the Bering Sea shelf fluctuated with the topography (**Figure 5** (a) and (b)).*

l429: How can bottom friction constrain MLD? What is the physical process, what is the evidence?

Reply:

Thank you for your insightful comment. I deleted my assumption in the revised manuscript. I need to do sensitivity experiment by numerical modeling to explore the evidence and the physical process in my following research.

l430-433: This is irrelevant. Here you link the ML depth to the position of isotherms, but if there is a dynamic link, it has to be between the MLD and the seasonal pycnocline (the underlying stratification).

Reply:

Thank you for your comment. I deleted this irrelevant part in the revised manuscript. I will do sensitivity experiment by numerical modeling to explore the dynamic link in my following research.

l434-441: This may be interesting, but it needs to be discussed in relation with the litterature. What have you found that is new?

Reply:

Thank you. Previous researches on the Anadyr Water and the Alaska Coastal Water focus on the temperature and salinity and its' distribution: In the northwestern Bering Sea shelf, there was a cold and salt water mass called the Anadyr Water (AW hereafter) (Wang et al., 2020; Liu et al., 2016). The Alaska Coastal Water (ACW hereafter) was located on the northeastern Bering Sea shelf with the feature of high temperature and low salinity (Wang et al., 2020; Liu et al., 2016). In this study, their impact on mixed layer was discussed:

Due to the significant difference in density between the AW and the ACW, advection occurred and the seawater was stratified in the transition zone. As a result, the MLD in the transition zone was shallower *than that in the northeastern and northwestern BSs (Figure 7 (c)).*

l442-444: Is this a consistent with Peralta-Ferriz & Woodgate, 2015? Or do you find something different?

l453-455: same question as above. Is this a consistent with Peralta-Ferriz & Woodgate, 2015? Or do you find something different?

Reply: to both l442-444 and l453-455

Thank you for your comments. The research by Peralta-Ferriz &Woodgate, 2015 was vast and numerous, and it was very great. It inspired me. The research by Peralta-Ferriz &Woodgate, 2015 focus the spatial distribution the MLD in Chukchi Sea in summer **in a wider space range**: *Summer MLDs, everywhere shallower than winter MLDs, show a smaller but spatially similar east to west decrease (Eurasian Basin ~22 m, Makarov Basin ~16 m, Canada Basin and Southern Beaufort Sea ~9 m), with the Chukchi (~12 m) being regionally perhaps slightly deeper. The Barents Sea, although giving by far the deepest winter MLDs (~168 m), has summer MLDs that are in general a little shallower (~18 m) than the adjacent Eurasian Basin (~22 m).*

It neither mentioned "*northward increase of the MLD in the Chukchi Sea*", nor discussed "*the larger MLD at R05 and R07 stations might be related to the ACW appearing within the range of 68.5 - 70.5°N on the bottom.*"

Overall, this study was more regional and specific to the Chukchi Sea. The mean MLD in the Chukchi Sea was 10 m, smaller than that of Peralta-Ferriz &Woodgate, 2015. This MLD shoaling was discussed in the section 4.5 The inter-annual variation, which was already listed above responding to comments on l290-322.

l447-451: parallel to, perpendicular to: wrong grammar.

Reply:

I corrected them as following in my revised manuscript:

Although the MLD increased in the Chukchi Sea slope as that in the Bering Sea slope, there was a difference between them. It was remarkable that, from the ocean basin towards the continental shelf, the isotherm and isohaline tended to ***be in parallel with*** *the continental slope in the Chukchi Sea, while they tended to* ***be perpendicular to*** *the continental slope in the Bering Sea.*

l467-l490, Stratification: can you focus on what it new?

Reply:

Thank you. The Stratification Index was recalculated within the mixed layer in the revised manuscript other than the 60 m water column. And the role of the temperature and salinity in the MLD was discussed by Stratification Index and Turner angle:

The SI covered the whole depth of the mixed layer. The stratification index was O( ) in the Bering Sea basin and the southern Bering Sea shelf including BL01-BL13, as shown in Figure 10 (a) and (b). In the northeastern Bering Sea shelf, due to the high-salinity of the Anadyr Water, the SI was significantly larger (Figure 10 (c)). In the northwestern Bering Sea shelf and the Chukchi Sea, the SI was significantly smaller (Figure 10 (c), (d), (e), and (f)). The SI showed a trend of decrease northward and was dominated *by the salinity. The contribution of the temperature to stratification was too weak to be ignored. This was consistent with the research of Johnson et al. (2012), which showed that the seasonal variation of the mixed layer in the Arctic was dominated by salinity. Therefore, it was reasonable to assume that the characteristics of the mixed layer are related to the low-salinity water generated from the melting of sea ice in the Chukchi Sea and the northern Bering Sea shelf in the summer of 2019.*

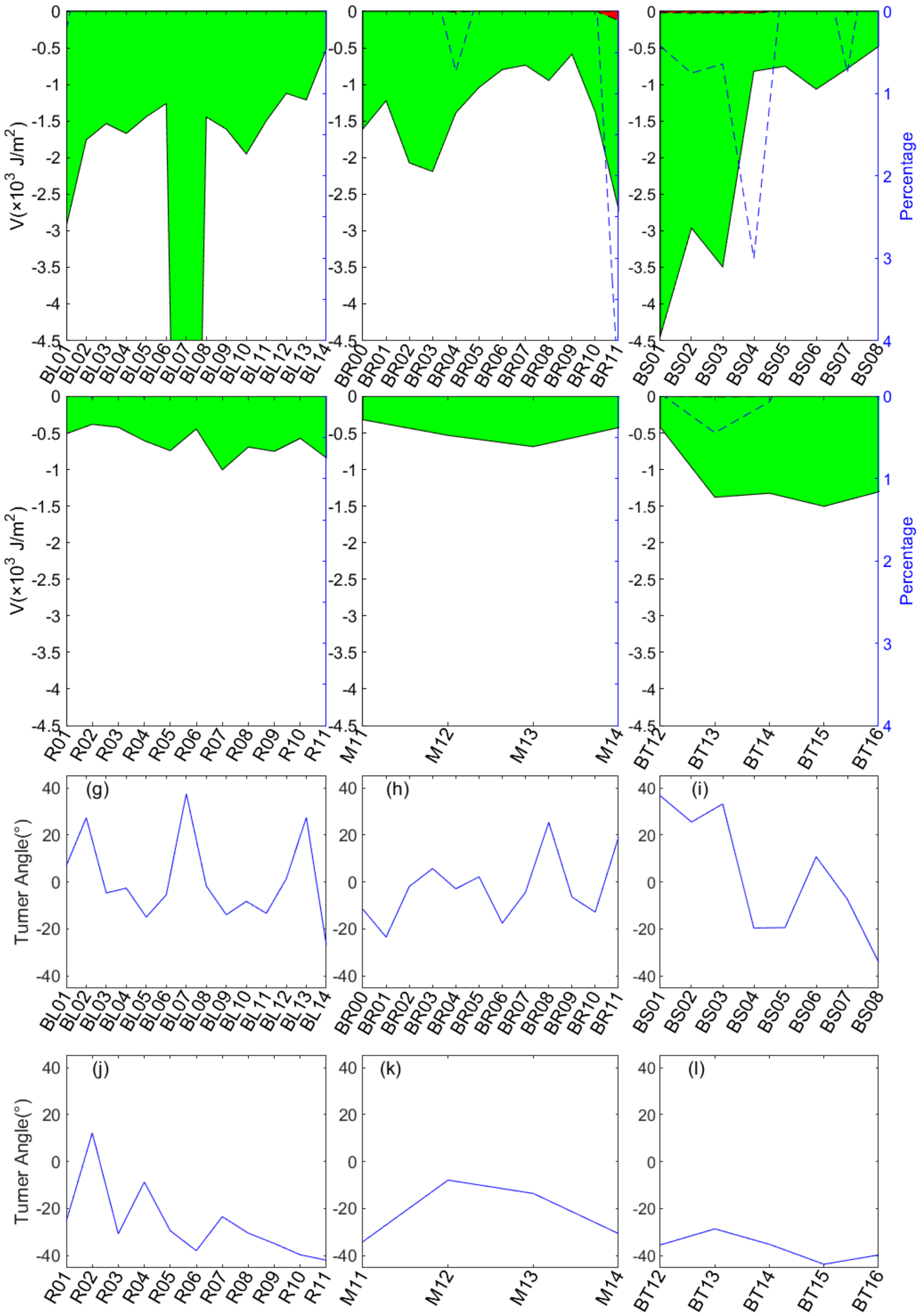

Figure 30 *Figure 10 (a)~(f) The left axis represented the stratification index. Red was the proportion of*

stratification due to temperature. Green was the proportion due to salinity. The right axis represented the percentage of the contribution of the temperature. The blue dashed line represented the proportion of the contribution of the temperature to the stratification at different stations. (g)~(l) The mean Turner Angle within the mixed layer.

The mean Turner angle within the mixed layer was $-45° < Tu < 45°$*, which meant that the mixed layer was stable on the whole. Half of the stations in the Bering Sea was larger than* $0°$*, and that meant that temperature played important role in the stable layer. The contrast along the BS section showed that temperature dominant the stable state in the Anadyr Water while salinity dominant the stable state in the Alaska Coastal Water. All the station except the R02 showed Turner angles smaller than* $0°$*, which meant that the salinity dominant the stable state in the Chukchi Sea.*

l471: "temperature interpreted": awkward style.

Reply:
Thank you. As the paragraph was rewrite as replied to above comment, this awkward style was deleted and the whole revised manuscript was corrected as well. And I corrected this awkward style throughout the manuscript.

486, figure 10: I don't understand the figure, I don't understand the axes. I suppose that if temperature explains x%, then salinity explains (100-x)% of the stratification, isn't it? In that case, information about one of the two is sufficient to deduce the other. What other useful information is there in the figure?

Reply:
Thank you for your comments. The revised figure 10 was showed as Figure 30 in this reply letter. It should be noticed that there were two y-axes for one x-axis. And the left y-axis represented the stratification index (red for temperature and blue for salinity) and the right y-axis represented the percentage of temperature. The useful information in the figure was that the salinity dominated the stratification, so the spatial distribution of the MLD was related to the processes influencing the salinity.

l507, figure 11: the arrows are unreadable. What are the red contours? What is the 16-days period over which you have averaged the data?

Reply:
Thank you. The figure 11 was revised to make the arrows readable. And these explanations were supplemented in the revised manuscript as following (**But it was deleted in the revised manuscript as you suggested in the next comment**):

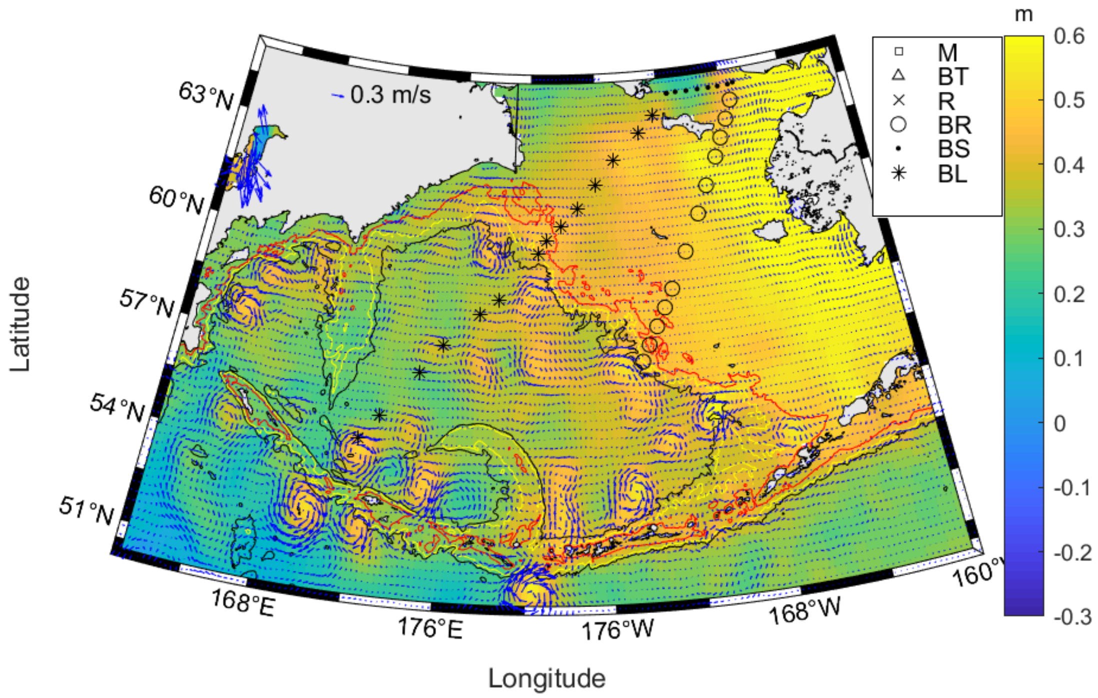

Figure 31 *Figure 11. The 16-day (the period during which the Expedition was carried out) averaged absolute dynamic topography and the surface geostrophic flow in the Bering Sea and the Chukchi Sea from satellite altimeter. The red, yellow, and black solid line represented the 200 m, 2000 m, and 3000 m isobaths, respectively.*

l511, figure 12: the arrows are much easier to read in this figure compared with figure 11. Figure 11 seems redundant.

Reply:
Thank you. I checked the manuscript and modified figures to make them easier to read.

l492-493: Regarding the deepening of the MLD in the Bering Sea slope, is there an influence of tidal mixing? Are internal tides generated along the slope? Tidal influences may be larger than eddy infliuence there.

Reply:
Thank you for your insightful comment. I need more measure data and sensitivity experiment by numerical modeling to explore the influence of tidal mixing on the deepening of the MLD in the Bering Sea slope in my following research.

l497-499: "probably related to the eddies"... Is it related or not? You can reach a stronger conclusion, based on the data available. It is important do discuss the expected behavior of MLD in cyclones. vs. anticyclones (Gaube et al, 2019 and references therein). Do your measurements confirm or contradict the litterature?

Reply:
Thank you for your comments. I reached a stronger conclusion in the revised manuscript, and this

confirm the conclusion that anticyclones deepen the MLD in the research of Gaube et al., 2019:
The large MLD at BL01 in the northern continental slope of the Aleutian Islands was related to the anticyclonic eddies along the Aleutian Islands (Figure 11). And this coincides with the conclusion that anticyclones deepen the MLD in the research of Gaube et al., 2019. The MLD at BL01 was 30 m, significantly larger than that at BL02, which was 19 m (Figure 7 (a)). The upper ocean current velocity at BL01was about 0.2m/s, while it was measured less than 0.1m/s in the BSb according to the ADCP observations. The spiral of the current became irregular at the base of the mixed layer at BL01 (Figure 11 (c)).

l520 "In summer, the Aleutian low moved northward": why the use of the past tense? Do you mean the summer of 2019 in particular, or do you mean that 2019 was like every summer?

Reply:
Thank you. I mean that 2019 was like every summer. I should not use the past tense, and I corrected it in the revised manuscript:
In summer, the Aleutian Low moves northward and the south wind prevails.

l522-525: I don't understand why you are trying to correlate zonal and meridional winds, what are the time or space scales you compute your correlations over, and what you mean by "behaved well".

Reply:
Thank you. Sorry for my ambiguous expression. I correlated the measured zonal winds and the Cross-Calibrated Multi-Platform (CCMP) zonal winds. Meanwhile, I correlated the measured meridional winds and the Cross-Calibrated Multi-Platform (CCMP) meridional winds. I computed the correlations over the period from 24 Aug. to 6 Sep., during which the measurement of temperature and salinity was carried out. I mean that CCMP wind coincide with the measured wind: The correlation coefficients of the zonal wind between the CCMP wind and the measured wind by the ship were 0.92. The correlation coefficients of the meridional wind between the CCMP wind and the measured wind by the ship were 0.91. And these corrected expression was supplemented in the revised manuscript:
The speed of the ship estimated by GPS was used to calculate wind speed. The sampling interval was 1 minute. The wind observed by the shipborne automatic meteorological station were used to evaluate the Version 2 Cross-Calibrated Multi-Platform (CCMP) Wind Vector Analysis Product over the period from 24 Aug. to 6 Sep.. The wind speed bias, wind speed root-mean-square error (RMSE hereafter), wind direction RMSE of the CCMP wind product was 1.29m, 2.37m, and 27.46° *, respectively. The correlation coefficients of the zonal wind between the CCMP wind and the measured wind by the ship were 0.92. The correlation coefficients of the meridional wind between the CCMP wind and the measured wind by the ship were 0.91. The mean difference of the zonal wind between the CCMP wind and the wind measured by the ship was 0.51 m/s. And the mean difference of the meridional wind between the CCMP wind and the wind measured by the ship was 0.29 m/s. That meant the CCMP wind product behaved well in the target region.*

l526-534: The correlation between wind and MLD is not convincing. The mixed layer deepening due to strong wind is a process that takes time (at least one inertial period), and it is very sensitive to wind bursts at high frequency. What is the frequency of your wind product? Maybe you should try to correlate each point observation with the wind rms amplitude integrated over the previous half day or day. What is the spatial variability of the wind? Does the amplitude of the wind speed vary significantly from one hydrographic section to the next?

Reply:

Thank you for your comments. The vessel measured the wind along the way per minute, and the CCMP wind is a 6-hourly ocean vector wind analysis product. As you suggested, I correlated each point observation with the CCMP wind Root Mean Square (RMS) amplitude integrated over the previous day. On this occasion, the wind and MLD showed better correlation, and the correlation coefficient was changed from 0.6 to 0.63. The amplitude of the wind speed varied significantly from one hydrographic section to the next, and this could be seen from the scatter plot of MLD and wind speed (Figure 32).

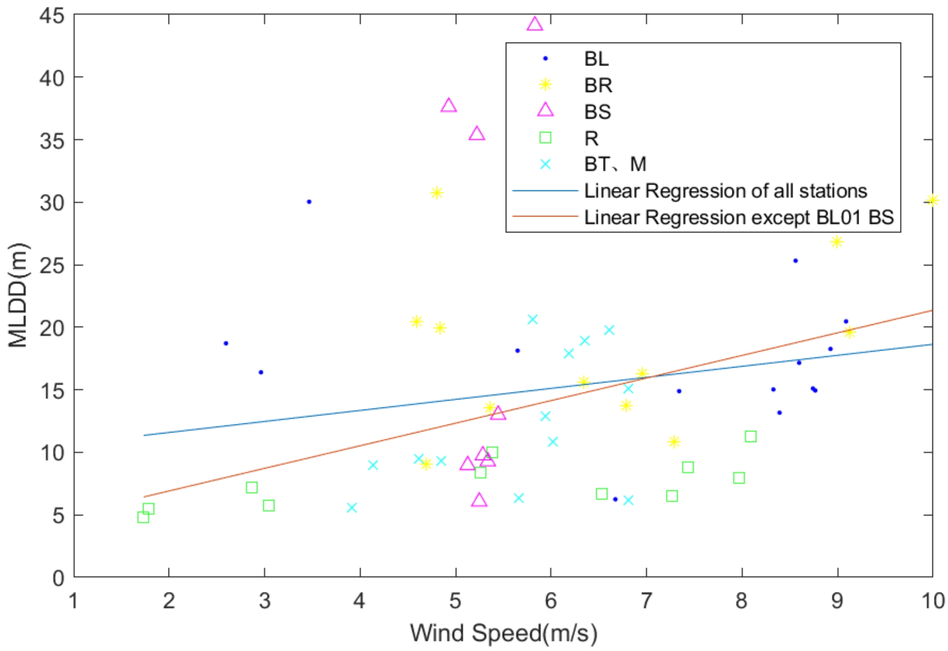

Figure 32 *Figure 13. Scatter plot of wind speed and MLD of all the stations. The red solid line was the regression line between the wind speed and the MLDD in the BL (except BL01), BR, BT, and M stations. The blue solid line was the regression line between the wind speed and the MLDD of all the stations.*

l536: Figure 13. Explain in the legend what the two regression lines are. Why are there data points along the blue line? Why are there points with zero MLD?

Reply:

Thank you. I supplemented what the two regression lines are in the legend in Figure 13 (Figure 32 in this reply letter): The red solid line was the regression line between the wind speed and the MLD in the BL (except BL01), BR, BT, and M stations. The blue solid line was the regression line between the wind speed and the MLD of all the stations. The BL01 was excluded because the deepening of MLD was attributed to the eddies, while the MLD at R was characterized by the front formed by the high-density Anadyr Water and the low-density Alaska Coastal Water.

As for the data points along the blue line, I plotted this figure using the dash-dot line style in MATLAB. I changed this misleading line style to solid line in the revised manuscript (Figure 32 in this reply letter).

I correlated the MLD from temperature instead of MLD from density in the previous manuscript, which resulted in the existence of points with zero MLD. I corrected this and correlated the MLD from density and wind speed in the revised manuscript (Figure 32 in this reply letter) .

l542 "was shown": why use the past tense here?

Reply:

Thank you. I corrected it into present tense now:

The average buoyancy flux caused by sea surface net heat flux and freshwater flux from July 1 to Sept. 8 is showed in Figure 13.

l538-547: I am not sure any of the correlations you compute are significant. Please compute the significance of each correlation and eliminate all correlations that are not significant from the discussion and from the figures.

Reply:

Thank you for your comments. The significance of the correlation between the MLD and the combined effect of the buoyancy flux and the momentum was 0.046 (P value), smaller than 5% and indicating that the correlation was convincing. All correlations that are not significant were eliminated from the discussion:

The significance of the correlation between the MLD and the combined effect of the buoyancy flux and the momentum was 0.046 (P value), smaller than 5% and indicating that the correlation was convincing. Under the combined effect of buoyancy flux and momentum flux, the MLD could reach a regional extremum, such as BL14, BR00, BR11, BT12, BT25, BT26, M11, R01, R05, R08, R11 in Figure 13. This result of multiple linear regression had a correlation coefficient of 0.41 with the measured MLD.