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Comment on os-2021-7

Anonymous Referee #2

Referee comment on "Observational Study on the Variability of Mixed Layer Depth in the Bering Sea and the Chukchi Sea in the Summer of 2019" by Xiaohui Jiao et al., Ocean Sci. Discuss., <https://doi.org/10.5194/os-2021-7-RC2>, 2021

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 convincingly (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 litterature.

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.

Detailed comments by line number
(mostly on sections 1-3, I grew tired afterwards)

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

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).

l72: "In this region": which region?

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?

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

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

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.

l89: "100m" isobath.

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

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.

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.

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

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.

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.

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

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

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.

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), or EN4? In which way do your measurements complement these existing databases? Are there ADCP data already available in these regions? In which way is your dataset new and different?

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

l187, table 3: it is not usual to list longitude and time of each hydrographic station in 20th 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.

I199, 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.

I197: please spell out what CCMP means.

I200: please spell out what CFSv2 means.

I 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.

I214-216: why do you quote examples from two old papers (Smyth et al, 1996 and Wijesekere et al, 1996) rather than give more details on the methods used in more recent papers such as de Boyer Montegut, Holte, etc?

I218-219 "many researchers used a gradient threshold of 0.1 kg/δσ_θ (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).

I219-221 :What is the "least-squares regression and integration method" and who invented it or used it? Is this relevant for your manuscript?

I221-224 : "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 preceding sentences do not demonstrate in any way why the difference threshold and gradient are better.

I224-227: provide a reference where it is demonstrated that dissolved oxygen is not an accurate method.

I235-237: "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.

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.

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

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.

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?

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

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?

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.

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

I290-322: 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?

I327 " the BL section was representative" representative of what?

I370, Figure 5: the labels on the graphs could be more readable.

I374: Figure 6 : You don't need to show the sea surface temperature and salinity, unless there is something new. Does your measure SST compare 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?

I388: what are the units for the rate?

I427-428, "The MLD in the Bering Seashelf fluctuated with the topography": Where is this demonstrated? Is there a figure to show the relationship between MLD and bathymetry?

I429: How can bottom friction constrain MLD? What is the physical process, what is the evidence?

I430-433: 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).

I434-441: This may be interesting, but it needs to be discussed in relation with the literature. What have you found that is new?

I442-444: Is this consistent with Peralta-Ferriz & Woodgate, 2015? Or do you find something different?

I453-455: same question as above. Is this consistent with Peralta-Ferriz & Woodgate, 2015? Or do you find something different?

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

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

l471: "temperature interpreted": awkward style.

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?

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?

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

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 influence there.

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?

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?

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".

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?

I536: 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?

I542 "was shown": why use the past tense here?

I538-547: 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.

References

Clément, L., McDonagh, E. L., Marzocchi, A., & Nurser, A. J. G. (2020). Signature of ocean warming at the mixed layer base. *Geophysical Research Letters*, 47, e2019GL086269. <https://doi.org/10.1029/2019GL086269>

Gillian M. Damerell, Karen J. Heywood, Daley Calvert, Alan L.M. Grant, Michael J. Bell, Stephen E. Belcher, A comparison of five surface mixed layer models with a year of observations in the North Atlantic, *Progress in Oceanography*, Volume 187, 2020, 102316, <https://doi.org/10.1016/j.pocean.2020.102316>.

Kara, A. B., Rochford P. A., and Hurlburt H. E., 2000: An optimal definition for ocean mixed layer depth. *J. Geophys. Res.*, 105, 16803–16821.

Kara, A. B., Rochford P. A., and Hurlburt H. E., 2003: Mixed layer depth variability over the global ocean. *J. Geophys. Res.*, 108, 3079. doi:10.1029/2000JC000736.

Holte, J., & Talley, L. (2009). A New Algorithm for Finding Mixed Layer Depths with Applications to Argo Data and Subantarctic Mode Water Formation, *Journal of Atmospheric and Oceanic Technology*, 26(9), 1920-1939.

https://journals.ametsoc.org/view/journals/atot/26/9/2009jtecho543_1.xml

Johnson, G. C., & Stabeno, P. J. (2017). Deep Bering Sea circulation and variability, 2001–2016, from Argo data. *Journal of Geophysical Research: Oceans*, 122, 9765– 9779. <https://doi.org/10.1002/2017JC013425>