

Interactive comment on “Surface waters properties in the Laptev and the East-Siberian Seas in summer 2018 from in situ and satellite data” by Anastasiia Tarasenko et al.

Anonymous Referee #2

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The submitted manuscript “Surface waters properties in the Laptev and the East-Siberian Seas in summer 2018 from in situ and satellite data” by Tarasenko et al., presents and validates DMI SST L4 and SMOS SSS products (including errors) in a novel way against in situ temperature and salinity data (CTD profiles from the upper 6.5 m and TSG data at 6.5 m depth) obtained during the ARKTIKA-2018 expedition in the Laptev Sea and the East-Siberian Sea in August and September 2018. Since this region is highly under sampled, this study is of high relevance for the scientific community focusing on air-ice-ocean interaction processes in the Arctic Ocean. In the study, they follow the north-eastward spreading of warm and fresh river water from the Lena River Delta towards the central Laptev Sea and further towards and under the sea ice

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in the East-Siberian Sea. Also, river water inflow from the Kara Sea to the Laptev Sea is followed. By combining SST and SSS data products with satellite-derived products of sea ice concentration, wind speed (and direction), and ERA5 reanalysis fields of sea level pressure, they investigate wind-induced horizontal displacements of the river water plume due to Ekman transport and change in the strength of the stratification across different shelf-slope transects due to Ekman pumping (downwelling/upwelling). Based on the satellite-derived SST and SSS data, they also suggest different types of surface water masses for the area, and further present their distribution and presence during the studied period.

Even though this study is of high relevance, the submitted manuscript needs a major revision before suited for publication in Ocean Science. First of all, the English language needs to be improved and corrected. There are simply too many grammatical and syntax mistakes and typos for me to point out, so I will only mention some of the most general mistakes below. Secondly, I spent too many hours reading the manuscript due to an unfinished appearance with in some places lack of background information or a logical flow. Hence, I found it a bit hard to get the main objectives, the main results, and the main conclusions from the study. More specific comments follow below.

General on language:

Use definite (the) or indefinite (a/an) articles where suitable.

Remember to use capitol letter S in named seas: Laptev Sea, Kara Sea, East-Siberian Sea etc. This is not used consistently in the text. Same with named rivers, use capitol letter R (Lena River etc.) Same with named archipelagos, use capitol letter A (Severnaya Zemlya Archipelago etc.) Write the Arctic Ocean with capitol letter O. Use capitol letter W in named water masses: Atlantic Water, Arctic Water, etc.

Be consistent with use of present (is) or past (was). Use past and not present when referring to others work.

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Avoid plural in surface water, river water, etc. if you don't have several named surface or river waters.

"Ice free areas" instead of "free of ice areas"?

In the north/south/east/west, not on the north/south/east/west.

Practical salinity scale (PSS) or practical salinity unit (PSU) is termed salinity with no unit, while absolute salinity is termed absolute salinity with unit g/kg.

Title

Perhaps change the title to "Properties of surface water masses . . ." To use surface water in plural seems a bit strange to me. You are suggesting six different water masses in the surface, not several surface waters, or?

Introduction

Generally, the introduction lacks objectives and proper background information of the study area. What is known in this region already, what studies have been done in this under-sampled area of the Arctic Ocean, what about river discharges into the study area (the river water plume is the main research focus of the study), and why is this area important?

Page 1, Line 19: "In the Arctic region, a strong seasonal warming and cooling with sea ice melting and freezing modify . . ."

Page 2, Line 5: ". . . the upper ocean water displacement . . ." Not plural.

Page 2, Line 9: " via the energy vertical distribution . . ." What energy?

Page 2, Lines 14-19: Rewrite this paragraph and improve language, for instance:

Line 14: Rewrite to i.e. ". . . proposes to use the term "surface layer" instead of "mixed layer" for the Arctic Ocean, because the water . . ."

Line 15: What is meant with "the water horizon lying between the sea surface and the

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Arctic main halocline"? Use another word than horizon?

Line 17: "m depth in the Eastern Arctic Ocean (Dmitrenko et al., 2012) and at 100-200 m depth in the Western Arctic Ocean . . ."

Page 2, Line 23: Rewrite to i.e. ". . . the saline waters, which was considered the mean Arctic Ocean salinity at that time."

Page 2, Line 25: Reorder sentence to "Cherniavskaia et al. (2018) reported an overall salinity in the upper 5-50 m layer to lie within the range from 30.8 to 33 based on in situ data in the Laptev Sea during 1950-1993 and 2007-2012.

Page 2, Line 31: Remember unit on density (kg m⁻³)

Page 3, Line 8: Define L-band satellites.

Data and Methods

All information regarding the data and methods (presentation of the in situ hydrographic sections, processing and analysis methods) that are described and included in the results section should be moved to the data and method section. More details are given later. It would also be useful to include a link or doi to the downloaded data products (DMI SST L4, SMOS SSS L2 (you are making weekly averages of these, are you using any other SSS products?), AMSR2 SIC (and specify all SIC products used), ASCAT C-2015 L3 for wind speed and direction, ERA5 reanalysis for SLP and air temperature). Several data products are mentioned and utilised in this study, and to better clarify which ones that are actually used, it would be good to start the description of the used data products, why these ones are chosen, and what has been done with the data products in this study (post-processing). Then, other alternative products used in other studies can be mentioned afterwards for comparison? This goes especially for Section 2.2.2, which now appears a bit messy with a lot of mixed information about others products and work and the products used in this study.

Page 3, Lines 19-21: Put all place names on the map in Figure 1.

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Page 3, Line 27: Did you find a typical error estimate from the comparison with CTD measurements?

Page 4, Line 2: What interpolation methods were used?

Page 4, Line 6: Define AVHRR, MODIS and VIIRS

Page 4, Line 8: Define AMSR2

Page 4, Line 11: You write "(hereafter referred to as "SST DMI")", then make sure you do. Several names are used on this product later in the manuscript (DMI SST L4, the SST field from DMI L4 product, blended DMI product?, temperature estimates provided by DMI, and others).

Page 4, Line 11: Define Level 4.

Page 5, Line 7: You write "100-km averaged ship SSS ..." Is this TSG?

Page 5, Lines 12-13: Define SMAP CAP/JLP and SMOS BEC L3, REMSS

Page 5, Line 16: Define ESA.

Page 5, Line 17: Be consistent with naming of products. Here you use L2 SSS and not SMOS SSS L2.

Page 5, Line 18: What do you mean with individual SMOS SSS? Explain how the SMOS SSS are sampled over an Icosahedral Snyder Equal Area grid at 15 km resolution. Is this the interpolation?

Page 5, Line 23: Define ECMWF.

Page 5, Lines 26-29: Specify the correction with numbers. Also, give the criterion on the ACARD parameter. And what are the typical errors in the weekly SMOS SSS and the individual SMOS SSS?

Page 5, Lines 32-34: Where is the river plume? Define and introduce it. How does this affect the weekly SSS error?

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Page 6, Line 4: Define all the ice masks provided.

Page 6, Line 10: Define ASCAT.

Results

Move all method and technical descriptions to Data and Methods. Only results should be presented here. The results section should have more focus on the SST and SSS distribution, the hydrographic sections, and highlight results to be discussed, not so much on technical details, error analysis and discussion, which I recommend you to move to the data and method section. In general when presenting and discussing the results, please be consistent and distinguishing between the parameters SST/SSS and in situ temperature/salinity. Don't use temperature or salinity on both.

Page 6, Line 22: Please define the river waters. Use plural form if there are several types of river water, if not, use singular form (river water).

Page 6, Lines 24-25: Move to Data and Method.

Page 7, Lines 1-7: This paragraph belongs in data and methods.

Page 7, Line 2: What are "basic statistics"?

Page 7, Lines 4-5 & 8-9: How much does the temperature and salinity change in the upper meters? Perhaps show a mean +/- std profile of the upper 10 meters?

Page 7, Lines 10-11: And how is it in ice free conditions?

Page 7, Line 15: In-situ surface layer temperature is then the upper 6.5 m (but not including the uppermost 2? meters typically)?

Page 7, Lines 17-19: This is a complicated sentence, so please rewrite. Can this be shown?

Page 7, Line 21: What grid? Please describe in data and method, and refer to it.

Page 7, Lines 28-29: I guess the 15 km SMOS resolution is the interpolated resolution?

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Please be more precise when naming the different SMOS SSS products, which should all be clearly defined and stated in the data and method section.

Page 7, Line 31: Use either ARKTIKA-2018 expedition or Akademik Tryoshnikov measurements. Be consistent with the naming of data both in the text and in the figures.

Page 7, Line 33: Again, be consistent with naming of data products, I guess the vessel SSS is the CTD and TSG data from the upper 6.5 m from the ARKTIKA-2018 expedition?

Page 7, Lines 33-34: This belongs in the method description.

Page 8, Line 1: "SMOS post-processed SSS", what is this product compared to the other named products?

Page 9, Lines 2-3: Is the precision so high that you can use three decimals in SST?

Page 9, Lines 2-4: Put place names on the map in Figure 1.

Page 9, Lines 9-10: Please define river water somewhere (in data and method?). What is the definition of the river water plume?

Page 9, Line 10: Standard deviation of what?

Page 10, Line 1: What about the Katanga River Estuary?

Page 10, Line 2: Define the thermal fronts.

Page 10, Line 15: "at 125 E, ..." what latitude?

Page 10, Line 20: Distribution of freshwater input, is that water with $S = 0$? Please define the characteristics of this freshwater.

Page 10, Line 21: Please refer to Figure 1. What Section number or longitude/latitude limits?

Page 10, Line 21: Temporal evolution of what? Introduce Figure 6 before Figure 7.

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Page 10, Line 25: "shelf break" instead of "edge of the shelf"?

Page 10, Line 29: What was the wind direction during these series of cyclone passages?

Page 10, Line 30: Change to "... salinity increased by 1 ..."

Page 10, Line 34: Change to "... mixing event induced by the wind."

Page 10, Lines 30-34: How does this relate to any river discharge data from the same period? Are there any model data to compare with?

Section 4.1.1

Change to something like "Water from the Kara Sea". You have not defined Kara Sea waters anywhere in the text.

Page 11, Lines 6-7: The temperature is decreasing?

Page 11, Line 7: Where and when has the exchange with the atmosphere taken place? Is the atmosphere colder here than in the central Laptev Sea?

Page 13, Line 1: You write "... significantly greater than ..." How can you see relative amount of freshwater from one snap-shot and with different timing on each section occupation?

Page 13, Lines 2-5: Show place names on map in Figure 1. Also, define the hydrographic sections in data and methods with time, wind condition, and air temperature during their occupations. Then stick to the named Sections (Section numbers) later in the text.

Page 13, Line 7: 1024-1027 kg m⁻³?

Page 13, Line 14: What happens during cyclone passages? Clouds? Have you discussed this effect in Data and Methods? If yes, refer to it.

Page 13, Line 15: Can you provide any T and S limits?

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Page 13, Line 17: By depression passage you mean low-pressure or cyclone passage?

Page 13, Lines 18-19 & Page 14 Lines 1-4: What about wind direction? Wind speed alone will not give the complete forcing pattern. Perhaps make some cross-correlation maps between wind speed/direction and SLP with SST and SSS? SLP and wind direction should be highly correlated.

Page 14, Lines 5-7: This belongs in Data and Methods.

Page 14, Line 9: Absolute salinity and conservative temperature are shown in Figure 8. Either change the text to absolute salinity and unit g/kg or change to practical salinity in figure.

Page 14, Line 11: You refer to different observations at specific latitudes in the figure, but the figure is presented with distance in km, so please refer to km as well. This applies for the other sections as well.

Page 14, Lines 12-16: What about melting under the sea ice due to the presence of warmer (above freezing point temperature) river water? This will cool the river water and still keep the water under the ice relatively fresh. Are there any $\delta^{18}O$ data (or other tracers) to be able to identify the source of this water?

Page 14, Line 15: You write: "The heat exchange with the sea ice might be more effective than with the atmosphere, ..." Why?

Page 14, Line 19: "Below the pycnoclines, ..." to what depth?

Page 15, Line 1: The 34.5 isohaline is not shown in the figure.

Page 15, Lines 2-3: What are the T and S characteristics of AW in this region? I don't agree that AW is seen at 100-120 m depth in Figure 8? Why is it instability in the AW layer?

Page 15, Line 5: Define all hydrographic sections in Data and Method (see earlier comment on this).

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Page 15: Please remember to refer to figures.

Page 15, Line 11: You write: "... which is clearly seen in temperature signal that is negative even close to the surface." Is the temperature still above the freezing point, i.e. any melting under the ice?

Page 15, Lines 13-14: What kind of mixing?

Page 15, Line 19: How can you see an efficient mixing from these data?

Page 15, Line 20: Are the temperatures still above freezing?

Page 15, Lines 25-26: The river discharge information should be introduced in the introduction.

Page 15, Lines 27-28: Was the atmosphere colder or warmer than the river water or the mixed upper layer water? What about melting of sea ice from below? Is the river water warmer than the freezing point temperature?

Section 4.1.2

Some more background information is needed in the beginning of this section. It is also an analysis method and should be moved to the data and method section. The surface fronts in question should be defined. To get the Ekman transport, you need to integrate over the Ekman depth, what is the Ekman depth in this region? Assumptions made by Ekman were no boundaries, infinitely deep water, and no geostrophic flow. How are these assumptions met in this region? What happens when you have boundaries (coastlines)?

Page 16, Line 8: Give the reference to TEOS-2010 and show the formula for the drag coefficient C_D .

Page 16, Line 10: Use Ekman pumping instead of vertical Ekman speed?

Page 17, Line 12: You write "... mixing of different water masses, ..." What are these

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water masses? You should introduce the water masses in the region in the introduction section.

Section 5

Perhaps start the results with this section?

Page 17, Line 17: And below 200 m?

Page 17, Line 23: Specify which of the Arctic Ocean waters that quickly change.

Page 17 Line 24: Add "... , and the synoptic satellite data provide ..."

Page 17, Line 32: The "classical" water masses, do they have a name?

Page 18: Refer to figures.

Page 18, Line 1: Add "... larger range than the near-surface (upper 6.5 m) in situ measurements ..."

Page 18, Line 7: A recognisable river front or a river plume front? Define.

Page 18; Line 8: 145 E? How do you define the sea edge? Is it a specific sea ice concentration limit?

Page 18, Line 11: You write "... captured under the ice and exposed back." How or when? What about melting sea ice from below?

Page 18, Lines 21-22: Show place names on map in Figure 1.

Page 18, Lines 24-25: There is also a high density within the range 22.5-30 and 3-4 °C.

Discussion and conclusion

This section provides little discussion or conclusions, mostly summary. There is more discussion in between the presentation of the results in the Results section.

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Page 19, Lines 11-12: You write "The fresh waters displacement was associated with the Ekman transport." How? This is not well presented or described in the results.

Page 19, Lines 15-16: You write "... and there is no evidence that the sea ice melting itself can create such a considerable layer of freshwater." How or where have you presented this lack of evidence?

Page 19, Lines 18-20: What about river water melting sea ice from below? Are there any $\delta^{18}\text{O}$ data (or other tracers) to evaluate this?

Page 19, Line 24: Add "Calculated monthly Ekman pumping indicates the area of most intense mixing processes induced by wind.?"

Page 19, Lines 25-26: Why is this included? This is not used in the discussion. Are there any conclusions from this?

Appendix

Page 20, Lines 7-10: What about Ekman transport to the south in September piling up water on the shelf and toward the coast in the south? This might induce downwelling (see Figure 9).

Figures

Figures with more than one panel should be labelled with a), b), c) etc. and then properly referred to in the figure captions and the text when the figures are described. Also use same font size in the figures with several panels. Remove titles on figures and add this text in the figure caption instead.

Figure 1: What is the definition of the sea ice edges? Add all place names mentioned in the text on the map.

Figure 2 and 3: Last sentences in the figure captions: this information should be provided in the data and method section.

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Figure 4: Missing numbers on y-axis in lower left panel. Use white isolines below 0 degree Celsius/28 PSS? It is hard to see black lines on dark background. This is also the case for Figures 6 and 8.

Figures 5 and 7: Where is the data from? What bathymetry data is used?

Figure 8: Why do you show conservative temperature and absolute salinity in this figure and not in

Figure 6? At least use proper units when referring to Figure 8 in the text.

Figure 9: Increase the fonts. The two upper rows are not described in the text. What are the arrows in the lowest row, and why is the resolution higher than in the row above? Write units in the figure caption. Where is the data from?

Figure 10: Add the freezing point temperature line. Remove the figure title.

Figure 11: What are the boxes? Are the lines the freezing point temperature line?

Figure 12: Put the dates inside the plots instead.

Figure A1: Remove the titles from the figures. Write units in the figure caption. Increase the fonts.

Tables

Table 1: Add more information to the table caption.

Interactive comment on Ocean Sci. Discuss., <https://doi.org/10.5194/os-2019-60>, 2019.