Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2019-60-AC3, 2020

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.

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Received and published: 15 May 2020

General comments on language:

Use definite (the) or indefinite (a/an) articles where suitable. Remember to use capital 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 capital letter R (Lena River etc.) Same with named archipelagos, use capital letter A (Severnaya Zemlya Archipelago etc.) Write the Arctic Ocean with capital letter O. Use capital letter W in named water masses: Atlantic Water, Arctic Water, etc. Be consistent with use of present (is) or past (was). Use the past and not present when referring to others' work. 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.

Answer:

Thank you very much. We have thoroughly edited the paper to follow your recommendations.

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?

Answer:

We will follow this recommendation and change the title of the paper.

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?

Answer:

We have rewritten the introduction with more focus of the undersampling of this region and on the most important river discharges in this area. We have also added the following figure for the Lena river discharge in the Data and Methods section (Fig. 1).

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

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

Corrected

Page 2, Line 9: “ via the energy vertical distribution . . .” What energy? Answer: We meant the thermal 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 . . .” Answer: Corrected

Line 15: What is meant with “the water horizon lying between the sea surface and the Arctic main halocline”? Use another word than horizon? Answer: Corrected for “layer”

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

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

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. Answer: Corrected

Page 2, Line 31: Remember unit on density (kg m-3) Answer: Corrected

Page 3, Line 8: Define L-band satellites. Answer: Corrected, 1.43 GHz

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. Answer: Thank you for your recommendation. We reorganized some sections and added information and one figure on CTD and in situ measurements on Page 3, Line 27 (see below).

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.

Answer:

Corrected where possible. We tried to unify the products names used in the paper and clarified the representation and processing.

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

Answer:

Corrected, please see a new version of the figure (Fig. 2 here). The full version of caption of Fig.1: Legs and stations of the ARKTIKA-2018 expedi- tion overlayed on the bathymetry from ETOPO1 "1 Arc-Minute Global Relief Model" " (Amante and Eakins (2009)). CTD stations are shown with white dots. The color indi- cates the number of days since August 1, 2018. The sea ice edge position is indicated with a red dashed line for the beginning (August 21) and with the purple dashed line for the end of the expedition (September 21). The ice edge is based on the sea ice mask provided in the SST DMI product. Numbers indicate positions of 10 oceanographic transects discussed below. The black triangle in the north of the Komsomolets Island shows the Arkticheskiy Cape. The Severnaya Zemlya Archipelago consists mainly of the Komsomolets, the October Revolution, and the Bolshevik Islands (with smaller islands not shown here). The black box indicates the Shokalskiy Strait between the October Revolution and the Bolshevik Islands. The Yana River estuary is situated southward the Yanskiy Bay (out of the map).

Page 3, Line 27: Did you find a typical error estimate from the comparison with CTD measurements? Answer: Yes, we did it. We added it as well as further information on the vertical profiles in this section to clarify the applicability of the CTD data for satellite validation studies : When calculating a linear regression between the CTD measurements at 6.5 meters depth and the TSG measurements, we obtained a good correlation for both temperature and salinity (correlation coefficients equal to 0.9789 and 0.9656, respectively). The standard error was 0.0231 for temperature and 0.0251 for salinity, and the standard deviation for the difference of measurements (CTD-TSG) was STD_temp = 0.4134, and STD_sal = 0.4296. We applied the obtained linear regression equation to TSG data to obtain adjusted temperature and salinity data.

Finally, to investigate if the TSG measurements can be used to study the surface layer in a highly stratified Laptev sea, we estimlated a summer mixed layer depth following de Boyer Montégut et al. (2004) method based on density and temperature gradient thresholds (Fig.2). The MLD base is found at a depth of the first maximum temperature gradient exceeding (or equal to) a defined (by a threshold) gradient (see de Boyer Montégut et al. (2004)). Using a similar approach, we also computed MLD independently with density, temperature and salinity vertical profiles. The thresholds chosen for the gradients were the following: 0.3 kg/m3 per 1 m for density, 0.2 degrees per 1 m for conservative temperature and 0.2 psu per 1 m for practical salinity gradient. For the MLD calculated from salinity (MLDsal), most (75.17%) vertical profiles had a MLDsal larger than 7 m , with a median value of MLDsal of 11.99 m. As for the temperature-based MLD (MLDtemp), 81.37% of profiles had the MLD larger than 7 m, with a median value of MLDtemp = 13.50 m. Thus, we conclude that in most cases the upper 12 m of the surface layer was homogeneous, and our CTD and TSG measurements can be used for the validation of satellite data.

The full caption for Figure 3: Vertical profiles of conservative temperature (a, b) and practical salinity (c, d) from CTD measurements in the upper ocean layer. Figures (a)

and (c) show all vertical profiles in the upper 50 m, where red stars indicate the mixed layer depth, calculated using de Boyer Montégut et al. (2004) method (see details in the text), colored profiles show the cases, when the MLD is below 7 m depth and gray profiles indicate when the MLD is above 7 m depth. Figures (b) and (c) show the median vertical profiles of temperature and salinity in the5-100 m layer, respectively, where the shaded area shows the associated STD.

Page 4, Line 2: What interpolation methods were used? Answer: Linear interpolation, added to the text.

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

Page 4, Line 8: Define AMSR2 Answer: Corrected

Page 4, Line 11: Your 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). Answer: Corrected

Page 4, Line 11: Define Level 4. Answer: "Level 4 product" means that several swath measurements were interpolated to achieve a regular resolution in time and space

Page 5, Line 7: You write "100-km averaged ship SSS . . ." Is this TSG? Answer: Yes, corrected to clarify to "100-km averaged TSG surface salinity measurements"

Page 5, Lines 12-13: Define SMAP CAP/JLP and SMOS BEC L3, REMSS Answer: Corrected. "However, existing L3 ("Level 3" means a product resampled at a uniform time-spatial grid, different from swath) SSS products: SMAP CAP/JPL (Soil Moisture Active Passive satellite, a product created using the Combined Active Passive algorithm by Jet Propulsion Laboratory) or SMOS BEC (Barcelona Expert Center), are spatially averaged from 60 km to more than 100 km." REMSS (Remote Sensing Systems)

Page 5, Line 16: Define ESA. Answer: ESA (European Space Agency)

Page 5, Line 17: Be consistent with naming of products. Here you use L2 SSS and not SMOS SSS L2. Answer: Corrected. The paragraph describing postprocessing of SMOS SSS L2 data from ESA to the used SMOS SSS L3 product was re-written to clarify the naming (see a new part 2.2.2)

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?

Individual SMOS SSS" was mentioned to refer to the radiometric resolution of L1 (Level-1 product, thus brightness temperatures at swath grid) and is an initial resolution for all L2 products, Your text hereindependent from their producer. The SMOS SSS L2 product mentioned in the text is interpolated at ISEA grid by ESA and distributed on this grid. We changed the text as following: "The mean spatial (radiometric) resolution of SMOS product is close to 50 km, but SSS SMOS ESA L2 products are distributed resampled over an Icosahedral Snyder Equal Area (ISEA) grid at 15 km resolution."

Page 5, Line 23: Define ECMWF. Answer: (European Centre for Medium-Range Weather Forecasts)

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? Answer: We add the formula of the correction in the paper. The criterion on the ACARD parameter is : we consider only SSS measurements with an ACARD value over 45. Typically, theoretical error of weekly SSS measurements may reach values under 0.5 pss in the center of the Laptev Sea and reach values higher than 2 pss close from sea ice and in coastal areas. For the individual SMOS SSS the theoretical error is very variable and may reach value higher than 10 pss.

Page 5, Lines 32-34: Where is the river plume? Define and introduce it. How does this affect the weekly SSS error? Answer: The definition of river plume will be introduced later. We changed the sentence to: Concerning the way on how a river plume may

influence the SMOS SSS "A" error : here, a river plume is associated with an increase of SST that induces a theoretical decrease of SMOS SSS "A" error. Nevertheless, river plumes are closer to the coast and SST (used as prior during SMOS SSS retrieval) has a higher error in these areas : these will increase the SMOS SSS "A" error.

Page 6, Line 4: Define all the ice masks provided. Answer: The AMSR2 ice masks were used in addition to the masks provided with every satellite product discussed (SST DMI, SMOS SSS "A", ASCAT (Advanced SCATterometer) winds L3).

Page 6, Line 10: Define ASCAT. Answer: ASCAT (Advanced SCATterometer)

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, Lines 24-25: Move to Data and Method. Page 7, Lines 1-7: This paragraph belongs in data and methods. Page 7, Lines 33-34: This belongs in the method description. Answer: Thank-you very much. We have taken these recommendations into account. The whole part 3.1 was moved to section 2: the validation of SST and SSS satellite productsis now presented after the description of the product.

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). Answer: Corrected for the singular form. The definition of river water cannot be givenat this point, as we are only later defining the water masses.

Page 7, Line 2: What are "basic statistics"? Answer: Linear regression equation, correlation coefficients, STD. . . Excluded this part from the text as unnecessary.

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? Answer: The vertical profiles of in situ temperature and salinity were added in the "data" section (new Figure 2). A "mean" vertical profile of temperature or salinity is not representative for the areas where surface temperature varies from +6 to -1.8°C and salinity, from 24 to 34.5.

Page 7, Line 15: In-situ surface layer temperature is then the upper 6.5 m (but not including the uppermost 2? meters typically)? Answer: In-situ surface layer temperatureincludes all measurements from 0 to 6.5 m depth, thus "upper 6.5 m layer". Indeed, the "uppermost 2 meters" are typically not measured, due to how a CTD cast is done and data processing. The postprocessing of the CTD data usually eliminates the top 1-3 meters, because the Rosette with CTD is by itself 1.5 m tall itself and also because surface waves and the close-by ship hull affect the near-top ends of the profiles.

Page 7, Lines 17-19: This is a complicated sentence, so please rewrite. Can this be shown? Answer: Please, see the Figure 3, where the surface CTD measurements are shown. "This value seems to be realistic, and the in situ data justifies it. According to CTD measurements, in average, the 0-3 m water layer is 0.3 degree warmer than the 3-6.5 m layer..."

Page 7, Line 21: What grid? Please describe in data and method, and refer to it. Answer: All products were interpolated on a regular polar stereographic grid (15 km)

Page 7, Lines 28-29: I guess the 15 km SMOS resolution is the interpolated resolution? 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. Answer: Yes, we meant the spatial resolution of interpolated at 15 km ISEA grid, SMOS SSS "A" product. Corrected.

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.

Answer: Corrected to "in situ measurements" here, using ARKTIKA-2018 expedition further

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? Answer: Yes, corrected to "in situ measurements"

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

Page 8, Line 1: "SMOS post-processed SSS", what is this product compared to the other named products? Answer: In the revised draft we write (and weearlier meant it) about SMOS SSS "A" - it is always the same product.

Page 9, Lines 2-3: Is the precision so high that you can use three decimals in SST? Answer: The indicated accuracy is arbitrary. It can be reduced to two decimals as in typical SST-validation reports, e.g. http://www.osi-saf.org/sites/default/files/dynamic/page_with_files/file/validation_report_sentinel3_slstr_sst_

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

Page 9, Lines 9-10: Please define river water somewhere (in data and method?). What is the definition of the river water plume? Answer: We implicitly did it in section 5 and Table 1 when discussing the surface water masses in the Laptev Sea. There was no particular definition of the river plume in this study, as collected in situ data was not covering the freshest waters sufficiently close to river discharge deltas. In general, we meant the furthest (from river deltas) salinity gradient position as a front of "river plume" . It roughly corresponds to the 29 isohaline position (Fig.4). We added the definition of "river plume" in the last paragraph of the Introduction section.

Page 9, Line 10: Standard deviation of what? Answer: "Standard deviation of SST", corrected

Page 10, Line 1: What about the Katanga River Estuary? Answer: Indeed, changed to: "Standard deviation of SST in Fig.\ref{fig: sst-sss-mean-and-std} is the largest in the

Olenekskiy Bay (over 2.5°C), along the coastline close to the Khatanga estuary (2.5-3°C), the Lena River delta (about 4°C) and in marginal ice zone (mostly over 1.5°C)."

Page 10, Line 2: Define the thermal fronts. Answer: Thermal fronts are the areas with largest gradients of temperature.

Page 10, Line 15: "at 125 E, . . ." what latitude? Answer: "At 78-80° N 125°E, free-floating patches of broken ice detached from compact sea ice edge were observed during several weeks in August-September 2018"

Page 10, Line 20: Distribution of freshwater input, is that water with S = 0? Please define the characteristics of this freshwater. Answer: Freshwater is defined in comparison to the "marine water", eg. less than 34.92 as in the studies of (Bauch and Chernyavskaya, 2018) or 34.80, as defined by Aagard et al., 1989. As the 0-salinity river water quickly mixes with saltier marine water, in reality the "freshwater" we consider is more "brackish" than "fresh". Nevertheless, for the simplicity assuming a river plume front at 29 isohaline, the "freshwater" corresponds to all water masses with a salinity lower than 29.

Page 10, Line 21: Please refer to Figure 1. What Section number or longitude/latitude limits? Answer: Virtual meridional section corresponds to section 5, and the virtual zonal section does not correspond to any real oceanographic sections. The maps of the virtual sections positions were added to both Hovmöller diagrams.

Page 10, Line 21: Temporal evolution of what? Introduce Figure 6 before Figure 7. Answer: Corrected to : "To evaluate the distribution of freshwater input in the Laptev Sea in August-September 2018, we considered virtual zonal and meridional transects along 78° N and 126° E, respectively, and plotted the temporal evolution of SST DMI, SSS SMOS "A", wind speed and SLP in Hovmöller diagrams"

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

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

sages? Answer: Below, there is an initial version of Fig. 5 with the wind speed and wind directions instead of SLP. We found it too complex to present in paper, so have chosen the pressure for clarity. The wind directions had 0-90° azimuth (north-east in "oceanographic convention").

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

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

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? Answer: It is possible that a small peak observed in the Lena River discharge in the very beginning of September (Fig. 1) contributed to an additional portion of fresh water that arrived at 78 N latitude in several weeks.

Section 4.1.1 Change to something like "Water from the Kara Sea". You have not defined Kara Sea waters anywhere in the text. Answer: Corrected the title. The Kara Sea receives the two other large Siberian Rivers, the Ob' and the Yenisey, and thus presents a low salinity compared to the central Arctic Basin. In the absence of significant river sources on the Severnaya Zemlya Archipelago, we considered that the freshwater input close to the Vilkitskiy and the Shokalskiy Straits, arrives from the Kara Sea.

Page 11, Lines 6-7: The temperature is decreasing? Answer: We suppose so, but the SST of the Kara Sea should be additionally studied.

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? Answer: The comparison of the Kara and the Laptev seas summer conditions should be additionally studied and can become a subject of another paper. Nevertheless, we can suppose that a passage through the Vilkitskiy Strait diminish the temperature of arriving waters. The

Severnaya Zemlya Archipelago is known for its icebergs (thus, the Kara Water heat might be lost in their vicinity). There is also a system of countercurrents in the Vilkitskiy Stait. Together with tidal currents and steep topography it creates turbulent instability, and a loss of energy.

Page 13, Line 1: You write ". . . significantly greater than . . ." How can you see the relative amount of freshwater from one snapshot and with different timing on each section occupation? Answer: There is no other possibility to have simultaneous measurements of freshwater amount than moorings or a dedicated campaign with several ships. The only mooring installed in the studies in this section area, is situated northward of the Bolshevik Island. Another solution is numerical modeling, but it is out of scope of this study, and in any case, without good initial and boundary conditions (meaning good measurements of all river discharges, estimated of glaciers melts, etc), the model will have some difficulties to reproduce the freshwater budget very accurately. Indeed, in this paragraph we compare the quantities measured in situ with a time difference of 4 weeks between section 1 (northward of the Arkticheskiy Cape) and section 10 in the Shokalskiy Strait. Nevertheless, the satellite images as the only source of continuous information on the surface layer, do not show any significant inflow of freshwater northward of the Severnaya Zemlya Archipelago.

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. Answer: The names of hydrographic sections were indicated both in Fig.1 and Fig.6 of the previous version of the manuscript. In the paragraph that you mention, we mention their geographical distribution. As for the conditions during every section, it can be found in the cruise report on the NABOS web-site https://uaf-iarc.org/wp-content/uploads/2019/09/NABOS-2018_report.pdf The wind speed and the air temperature during the cruise are shown in Fig. 6.

Page 13, Line 7: 1024-1027 kg m-3? Answer: Yes, corrected

Page 13, Line 14: What happens during cyclone passages? Clouds? Have you discussed this effect in Data and Methods? If yes, refer to it. Answer: Yes, as it was mentioned in the DMI SST-product description, clouds are opaque for the IR measurements, and the DMI SST dataset is blended from the IR measurements.

Page 13, Line 15: Can you provide any T and S limits? Answer: Yes, corrected Page 13, Line 17: By depression passage you mean low-pressure or cyclone passage? Answer: We call a low-pressure system a cyclone, and a high-pressure system an anticyclone

Page 14, Lines 5-7: This belongs in Data and Methods. Answer: "Oceanographic sections are used to estimate a thickness of the freshwater layer and how far the river water propagates under the ice. Section 5 provides complementary information to the meridional Hovmöller diagram (Fig.8, upper row) as it was done along the same 126E parallel from 76 to 81.4 N on September 1-4 2018." We do not provide the figures for all 10 oceanographic sections but do it to illustrate some particular processes or phenomena, so we introduce the largest meridional section in the discussion of meridional Hovmöller section.

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. Answer: Corrected to practical salinity

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. Answer: Corrected the figure: added the latitude axis.

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 δ180 data (or other tracers) to be able to identify the source of this water? Answer: Yes, there is. We added a section on the isotopes of the oxygen 18 to the Discussion part. The salinity/delta-18O scatter plot for the surface water samples is presented in Fig. 7. Using a three-component model (marine water / river water (meteoric water) / sea ice melt water) described in Bauch and Chernyavskaya, 2018 and the results of isotopes analysis from surface water samples, we calculated the fractions of each water. The isotopes analysis revealed that the most important fraction of river waters was transported to the shelf and continental edge of the East-Siberian Sea. At the same time, the water samples at the northern part of the 126°E section consist of 10-15 % of river water and only 0-5% by the sea ice melt. (Fig.7)

The full caption of Fig.7: Fractions of river water (a), sea ice melt water (b) and marine water (c), calculated using d-O18 measurements and Bauch andCherniavskaia (2018) 3-components model of freshwater balance. A thin black line shows the position of sea ice edge on August 31, 2018,when the northern stations of the meridional (5) section along 126E were done in the MIZ, and the blue line shows the sea ice edge onSeptember 16, 2020, when the ARKTIKA-2018 expedition was working in the MIZ of the East-Siberian Sea. Please, note that the colorbar scale is different for each water fraction

Page 14, Line 15: You write: "The heat exchange with the sea ice might be more effective than with the atmosphere, . . ." Why? Answer: "The heat exchange with the sea ice might be more effective than with the atmosphere," because it is a transfer of energy from a liquid to a solid body, which is more effective than to the gas. At the same time, it depends on thermal conductivity in the ice, and its initial temperature profile, so this question needs a special attention.

Page 14, Line 19: "Below the pycnoclines, . . ." to what depth? Answer: To the depth of 25 meters, which comes from p.14, lines 18-19

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

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 there instability in the AW layer? Answer: AW's main characteristics in this region is its positive temperature (Pnyushkov et al.2018, Section 2.1). In oceanographic section 5, the 0°C isotherm is situated at the depth 100-150 m, so we conclude that AW is situated below. An apparent weak "instability" is due to the colored representation.

Page 15, Line 5: Define all hydrographic sections in Data and Method (see earlier comment on this). Answer: The names of the different hydrographic sections were indicated in Fig.1 of the previous version of the manuscript.

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? The temperature is above the freezing point in most of cases. To obtain a more detailed information on the sea ice formation/melting during the ARKTIKA-2018 expedition, please see the Fig. 7.

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

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)?

For the Ekman transport we assume that there is a layer with no vertical momentum flux, and that it is not the sea bottom (no friction at the ocean floor). Of course, coastlines are discontinuities, where the approach will not work, and close to them (and in the very shallow areas), the assumption of no bottom friction does not hold either.

Page 16, Line 8: Give the reference to TEOS-2010 and show the formula for the drag coefficient CD. For the wind speed below 10 m/s : u* = 0.051*Uw - 0.14 for stronger winds, u* = 0.051*(Uw-8) + 0.27, where Uw is a wind speed (from FOREMAN AND EMEIS, 2014 http://www.atmo.arizona.edu/students/courselinks/fall10/atmo551a/DragCoef_2010jpo4420%

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

Page 17, Line 12: You write ". . . mixing of different water masses, . . ." What are these water masses? You should introduce the water masses in the region in the introduction section. The common names of the surface water masses do not exist, as there was no previous study at this temporal scale to define them. The most well-known water masses are defined in the new version of the Introduction.

Section 5 Perhaps start the results with this section? Answer: We aggree, so this section was moved to the beginning of Results part

Page 17, Line 17: And below 200 m? Answer: We discuss only the upper 200 m in this Figure.

Page 17, Line 23: Specify which of the Arctic Ocean waters that quickly change. Answer: Corrected to "surface water"

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

Page 17, Line 32: The "classical" water masses, do they have a name? Answer: Corrected to the "main surface water masses"

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

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

Corrected to "river plume front"

Page 18; Line 8: 145 E? How do you define the sea edge? Is it a specific sea ice concentration limit? Answer: It is a typo. Corrected to "sea ice edge", which is defined with 1% sea ice concentration from AMRS2 SIC product.

Page 18, Line 11: You write ". . . captured under the ice and exposed back." How or when? What about melting sea ice from below? Answer: We added a section on oxygen isotopes that clarifies this point.

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

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

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. Answer: Corrected, please see an improved version of this section.

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. Answer: Corrected. Please see a new paragraph on "wind forcing".

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? Answer: We added a section on oxygen isotopes that clarifies this point.

Page 19, Lines 18-20: What about river water melting sea ice from below? Are there any δ18O data (or other tracers) to evaluate this? Answer: Please, see a new section on oxygen isotopes that clarifies this point.

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

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 the 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. Answer: Corrected. Here the ice edge is based on the sea ice mask provided in the SST DMI product

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

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 in the 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? Answer: Corrected to "Hovmöller diagram of SST (a), SSS (b), wind speed (c), and sea level pressure (d) for the zonal transect at 78N. Small circles at SST and SSS diagrams show in situ measurements of temperature and salinity (first CTD of TSG at 6.5 m). Sea ice concentration (AMSR2) is indicated with a blue color, see Fig.5 for the color scale. The depth profile along the transect (e) is extracted from "1 Arc-Minute Global Relief Model" (Amante and Eakins (2009). The position of a virtual transect is shown at SST SMI and SSS SMOS "A" maps for August 26, 2018 (f, g)."

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. Answer: Corrected to practical salinity. These two figures explain transformation of different water masses. Fig.6 illustrated the processes of Kara and Laptev waters mixing in the western part of the Laptev Sea, and Fig. 8 shows the propagation of river

waters above the shelf and the shelf break.

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? Answer: The boxes show the cores of 6 water masses described in text. Red line show the freezing point.

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.

Answer: Corrected in most of cases.

Tables. Table 1: Add more information to the table caption. Answer: Corrected

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

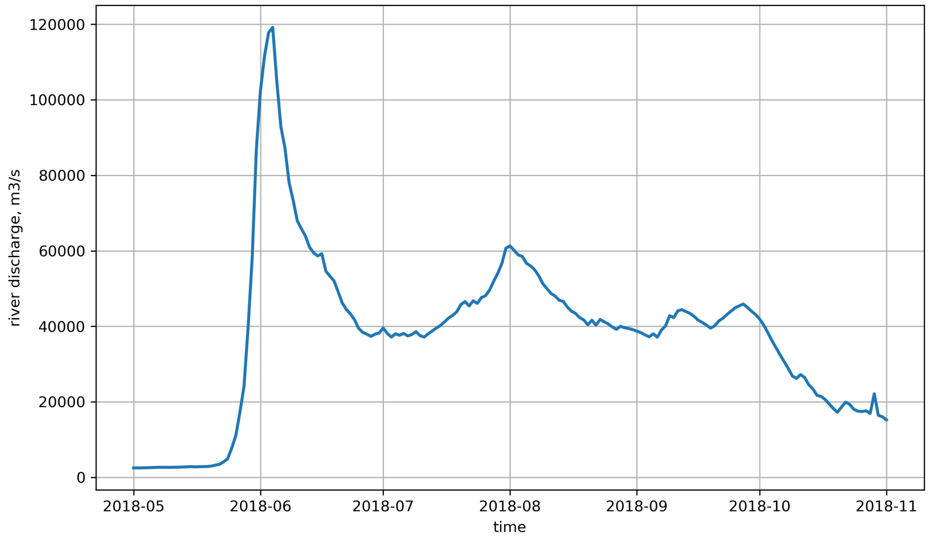

Fig. 1. The Lena River discharge in 2018, data from Arctic GRO dataset (https://www.arcticrivers.org/data)

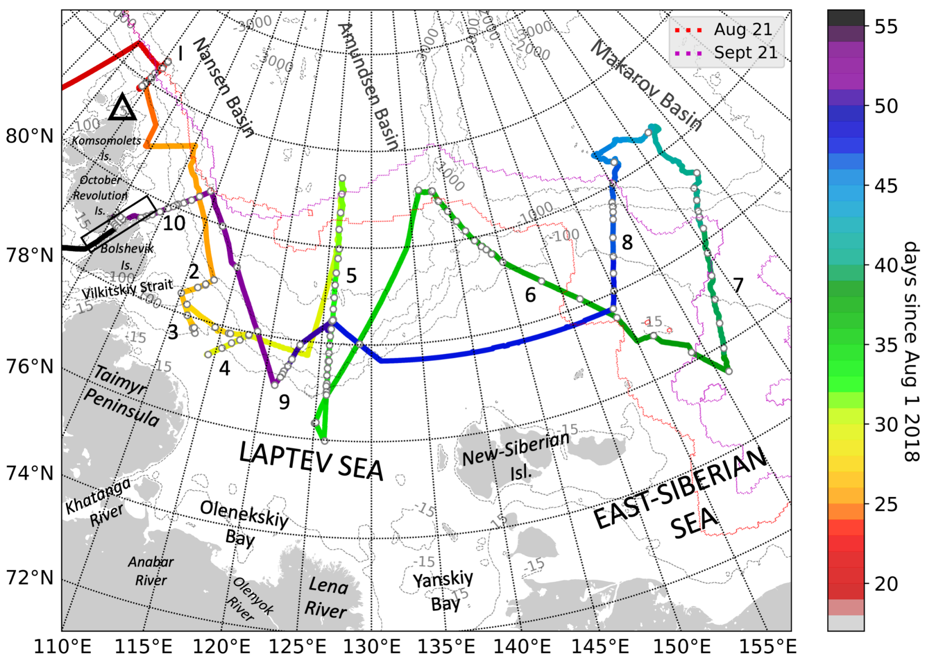

Fig. 2. Legs and stations of the ARKTIKA-2018 expedition overlayed on the bathymetry

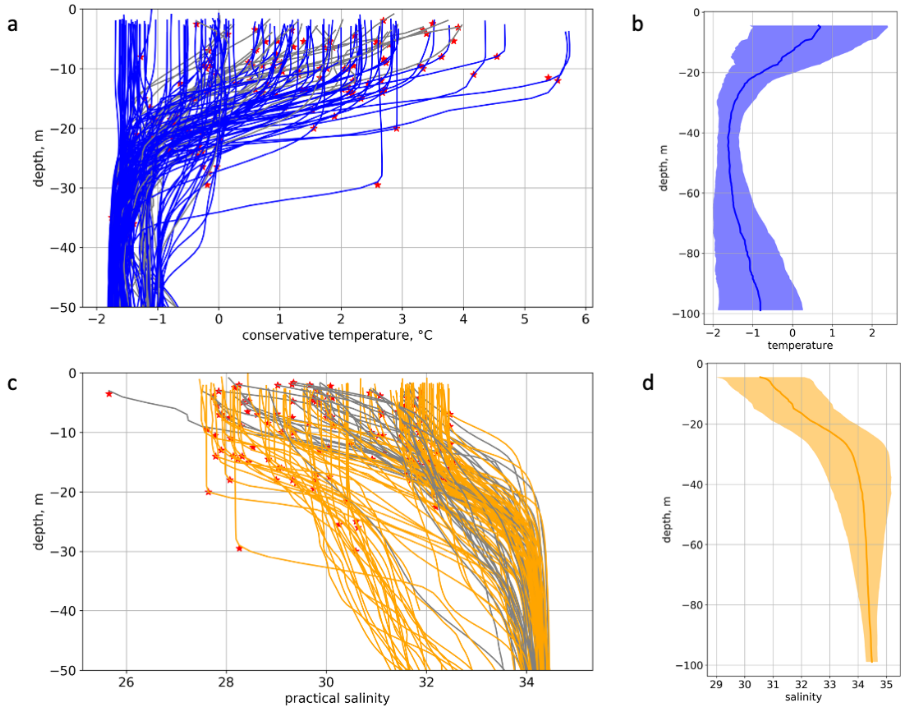

Fig. 3. Vertical profiles of temperature (a) and salinity (b) from CTD measurements in the upper 50 meters. The red stars indicate MLD, colored profiles have MLD larger than 7 m, gray - smaller than 7 m.

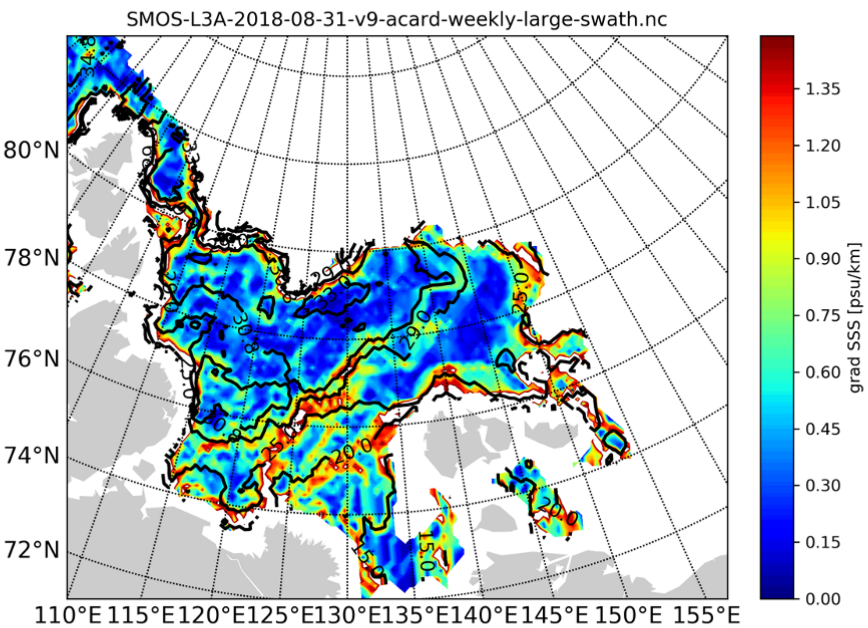

Fig. 4. Gradient of salinity for August 31, 2018 calculated from SSS SMOS “A” (see the description of product in a new version of manuscript), [psu/km]

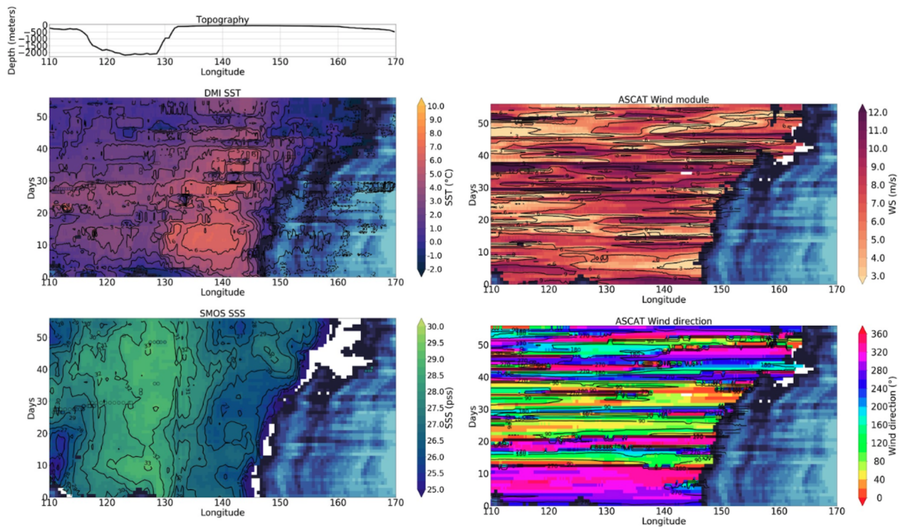

Fig. 5. Hovmoller diagram for zonal virtual section along 78 N: SST DMI (upper left), SSS SMOS "A" (lower left), ASCAT wind speed (upper right) and direction (lower right).

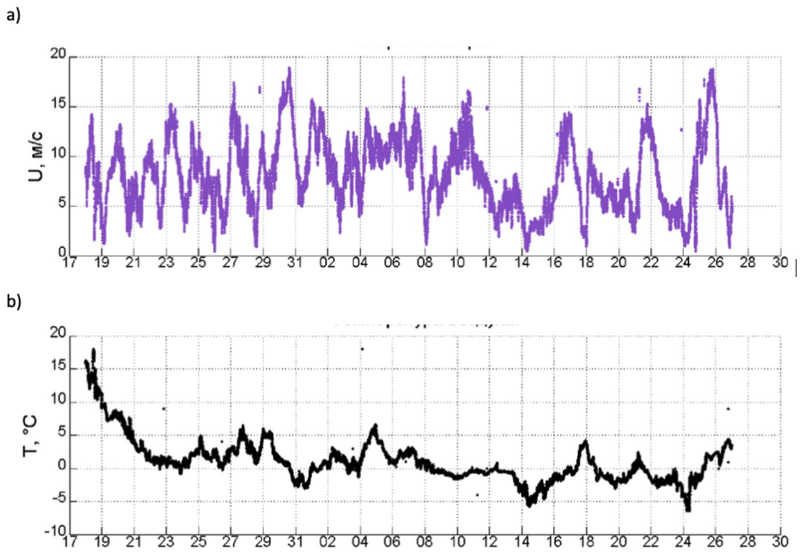

Fig. 6. Wind speed and air temperature measured in the ARKTIKA-2018 expedition (from August 17 to 26 of September).

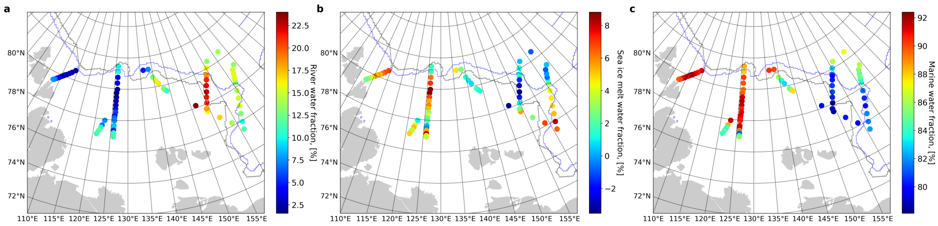

Fig. 7. Fractions of river water (a), sea ice melt water (b) and marine water (c), calculated using d-O18 measurements and Bauch andCherniavskaia (2018) 3-components model of freshwater balance