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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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General comments: "The manuscript introduction <...> does not really say why the region is important, why it matters <. . .>: freshwater fluxes, specifically the role of the Siberian shelves in modulating the inflow to the Arctic Ocean of the great Siberian rivers, either those that discharge directly into the Laptev and East Siberian Seas, or those west of Severnaya Zemlya, some of whose freshwater runoff enters the region through the Vilkitskiy Strait. The most recent (and very good) review of such issues is the Eddy Carmack paper (JGR 2016). Item 4 below gives three references led by Tom Armitage. They are pan-Arctic remote sensing papers that have quite a bit to say

about the Siberian Shelves, and they are not mentioned. Plus I could add Johnson & Polyakov (GRL 2001), Semiletov et al. (GRL 2005), Lenn et al. (GRL 2009 and JPO 2011), and the Lenn papers remind me that the manuscript talks about currents but does not mention tides, which are important in the shelf seas." (+ commentary 2) "In the same first paragraph, it is correctly stated that the region is little-studied, but I think there should be a sentence stating why the authors think the region is important. At the end of para. 1 on the top of p 2, add a sentence "The region is important because ...". " (+commentary 4) " Recent papers led by Armitage using Envisat, Cryosat and GRACE between 2003- 2014 seem not to have been looked at: JGR 2016 is about sea surface height variability, with discussion of Siberian shelf seas; Cryosphere 2017 is about surface geostrophic circulation; GRL 2018 is about sea level & surface circulation response to the Arctic Oscillation. Some the material in these papers is directly relevant, and this omission should be corrected.

Answer: Thank-you, we have rewritten introduction, conclusion and annex A to take into account these general and specific comments, and correct these omissions.

Specific comments: 1. The first paragraph on pp 1-2 describes the region. Reference should be added to the map of Figure 1; all locations in the text should be labelled, so please add text "Severnaya Zemlya" to the map. Later you refer to Arkticheskiy Cape, add this as well.

Answer: Corrected, please see a new version of Fig.1

The full version of caption of Fig.1: Legs and stations of the ARKTIKA-2018 expedition 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 indicates 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).

2. In the same first paragraph, it is correctly stated that the region is little-studied, but I think there should be a sentence stating why the authors think the region is important. At the end of para. 1 on the top of p 2, add a sentence "The region is important because ...".

Answer:

Please, see a new version of the introduction.

3. When talking about salinity, it is not appropriate to use "PSS". If using the new Absolute Salinity, then you can say parts per thousand, ppt, or use the "per mille" symbol. If not, then just "salinity of nn.n" or "nn.n in salinity" is correct.

Answer:

Agree that the use of PSS is not appropriate. Nevertheless, the community of satellite-derived salinity widely uses the psu, practical salinity unit, to quantitatively describe the salinity; “in situ” practical salinity is computed from CTD measurements of conductivity, and also uses the “psu” scale. For the validation of SSS we use practical salinity. Absolute salinity was used only to calculate water density. We would prefer to change the units from pss to psu, but agree to make it unitless.

4. Recent papers led by Armitage using Envisat, Cryosat and GRACE between 2003-2014 seem not to have been looked at: JGR 2016 is about sea surface height variability, with discussion of Siberian shelf seas; Cryosphere 2017 is about surface geostrophic circulation; GRL 2018 is about sea level & surface circulation response to the Arctic

Oscillation. Some of the material in these papers is directly relevant, and this omission should be corrected.

Answer:

Corrected, please, see a new version of Appendix A.

5. All figures with multiple panels, please label them a, b, c, etc. and refer to the panels as such in the manuscript text. All captions must state all plotted quantities and their units.

Answer:

Corrected.

6. Section 3.1.2 on salinity, and cf SMOS text in 2.2.2. I doubt that the spatial resolution is as high as it appears in Figure 3. I understood SMOS to resolve at about 100 km, in 2.2.2 the authors mention sampling at 15 km resolution, but adjacent points are surely not independent. How does this affect their statistics?

Answer:

The “initial” SMOS instrument (radiometric) resolution is 50 km (which we meant to explain in 2.2.2, line 17-18), but the SMOS SSS product distributed by ESA is already sampled in the ISEA grid with a resolution of 15 km. In other words, the spatial resolution of SMOS SSS Level 2 v662 product is 15 km, we just resampled all satellite products at the same grid for convenience. This “oversampling” of SMOS SSS at 15 km is practical for two reasons. First, to retain the real salinity gradients observed with in situ measurements and not to smooth them to 50 km when comparing with SMOS SSS. The spatial resolution of ship measurements depends on the ship speed (8 knots $\sim$ 3 m/s), pumping speed (16 l/s) and the CTD measurement frequency (24 Hz), and is of order (o) 1 m. After processing the raw data, its resolution is (o)250 m. A 7.5-km in situ measurement average corresponds to 30 minutes of TSG measurements, as line 6, p.3.1.1 (and a 15-km pixel represents one hour of measurements). Second, this retains SSS on the same grid as the rather high resolution SST for further calculations, e.g., density.

7. Section 4 first & second lines, your temperature accuracy cannot be 1 degree C, so why are you quoting temperature values to three decimal places?

Answer:

Corrected, and temperature reported to 2 decimals

8. Figures 5 and 7, Hovmoller plots: you are inconsistent. Figure 5, longitude (x-axis), days (y-axis); figure 7, vice-versa. Pick one orientation and stick to it.

Answer:

The orientation of the Hovmoller plots was chosen to have a better geographical representation: meridional section has longitude in y-axis, and thus, days in x-axis, and zonal section have latitude in x-axis, and days in y-axis. We added the maps with the positions of these virtual sections to illustrate it (Fig.2, 3).

The full caption to figures 2-3 are the following: Fig. 2. "Hovmoller diagram of DMI SST (a), SMOS SSS "A" (b), ASCAT wind speed (c) and ERA5 SLP (d) for the virtual meridional transect at 126 degree E. Sea ice concentration (AMSR2) is indicated with a blue color, see Fig. [SSS validation] for the color scale. The bathymetry 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 on SST SMI and SMOS SSS "A" maps for August 26, 2018 (f, g)."

Fig. 3 "Hovmöller diagram of DMI SST (a), SMOS SSS "A" (b), ASCAT wind speed (c), and ERA5 sea level pressure (d) for the zonaltransect at 78 degree N. Small circles at SST and SSS diagrams show in situ measurements of temperature and salinity (first CTD or TSG at 6.5m). Sea ice concentration (AMSR2) is indicated with a blue color, see Fig.5 for the color scale. The bathymetry along the virtual 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 SMIand SMOS SSS "A" maps for August 26, 2018 (f, g)"

Figure 8, temperature sections. Improve your presentation, please. Viewing the PDF, about half of the figure is just black and any temperature structure is obscured. The simplest solution would be to plot contours in white – not black!

Answer:

Corrected, please see Fig. 4 here. The full title of this figure is: "Temperature, degree C, (a, e, i, first column), salinity, (b, f, j, second column), water density, kg/m3 (c, g, k, third column) and buoyancy frequency, 1/s, (d, h, l, fourth column) obtained from CTD measurements in the upper 50 m for section 1 northward of Arkticheskiy Cape (upper row), section 10 across the Shokalskiy Strait (second row), and section 4 across the Vilkitskiy Strait (lower row). See Fig.1 for the section's positions. The zero km is always placed at the southern point of each section "

10. Section 4.1.2. Please improve your terminology. "Transport" is typically a volume transport, units mËĘ3/s. In your eq. 1, stress (N/m2) divided by [density (kg/m3) * Coriolis (sËĘ-1)] has units m2/s. These units appear in tiny (almost unreadable) notation in figure 9. This is neither a velocity nor a transport. Importantly, though: are your Ekman calculations valid in shallow water? Ekman's assumptions included (1) no boundaries (remote from coasts), and (2) deep water (typically >200 m). What is the Ekman layer depth? Is it not more likely that upwelling / downwelling are dominated by sea surface height changes in shallow water? For instance, a wind from the west will cause surface water movement to the right (the south) in the northern hemisphere. Water "piles up" against the coast, and that induces downwelling (at the coast): see papers by Steven Lentz, for example. Is this in accord with your calculated vertical velocities in figure 9? I would say not.

Answer:

The assumption with Ekman transport is exploited as the region of study has a very strong vertical stratification during the survey, which isolates the surface Ekman layer from the bottom. It was used as an illustration of possible mixing mechanisms, although we agree that over the most shallow areas this concept is not realistic. Please, see a new version of calculated horizontal Ekman transport et pumping (Fig. 5, 6)

The conclusions cannot then tell the reader why the new results matter.

Answer:

For the first time, we followed how the river water input was distributed and where it was stored in the Laptev and the East-Siberian Sea at synoptic scale. It became possible, first of all, due to a new satellite-derived salinity field in this region, a vast range of in situ measurements and also results of geochemical analysis. The shelf area of the Laptev and the East-Siberian Seas was described as a substantial region of sea ice production for the central Arctic by, e.g. Ricker et al., 2016, so the fresh water pathways in the Arctic should be understood better. The transformation of fresh river water input occurs and diminish very quickly during the Arctic summer, on the order of 1-2 weeks. Part of the fresh water was clearly mixed over the shelf of the Laptev Sea by wind-driven mixing, but a very important part was transported northward and to the East-Siberian Sea, under the ice. This result is different from a concept that fresh river water propagates mainly eastward, following the coastline under the Coriolis force. It is also different from the suggestion of Morisson et al.2012, where the displacement from the Eastern shelf Seas is northward (to the Central Arctic) with a low Arctic Oscillation Index (AO) and eastward with a high AO. In 2018 the mean AO index was high , but we showed that an important part of the river water was transported to the central basin. To better evaluate the freshwater budget, we suggest that future models assimilate the estimates of river discharge, a new satellite-derived sea surface salinity, and winds.

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

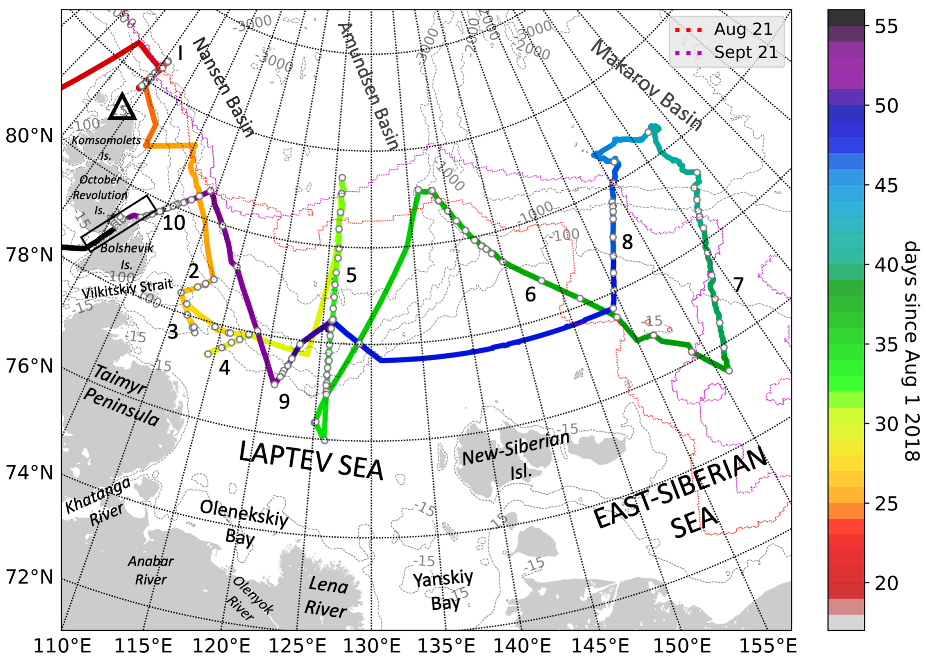

Fig. 1. Legs and stations of the ARKTIKA-2018 expedition overlayed on the bathymetry

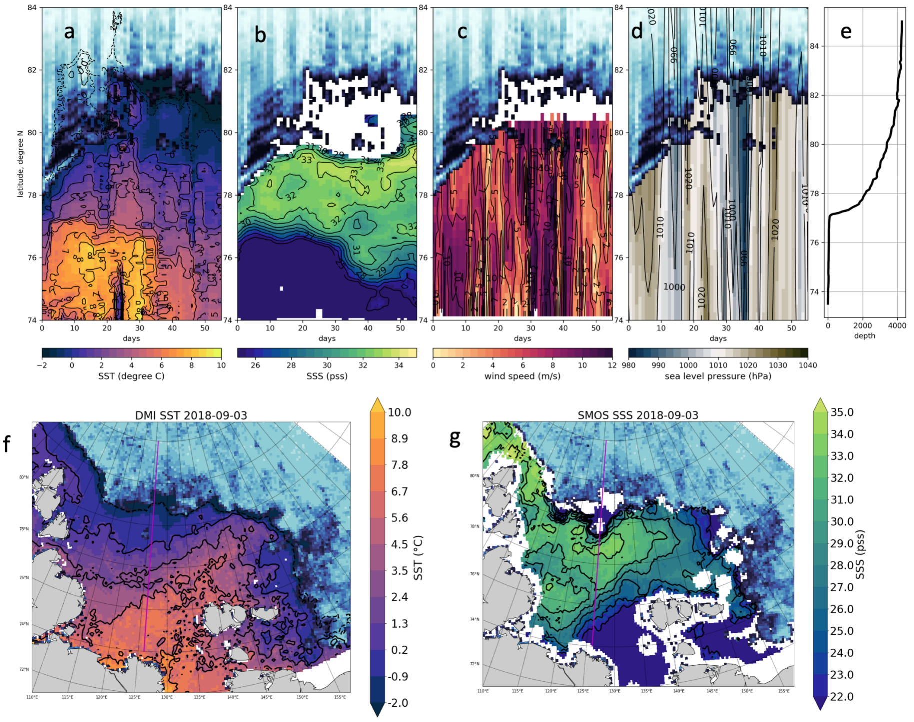

Fig. 2. Hovmoller diagram of DMI SST (a), SMOS SSS "A" (b), ASCAT wind speed (c), and ERA5 sea level pressure (d) for the meridional transect at 126 E

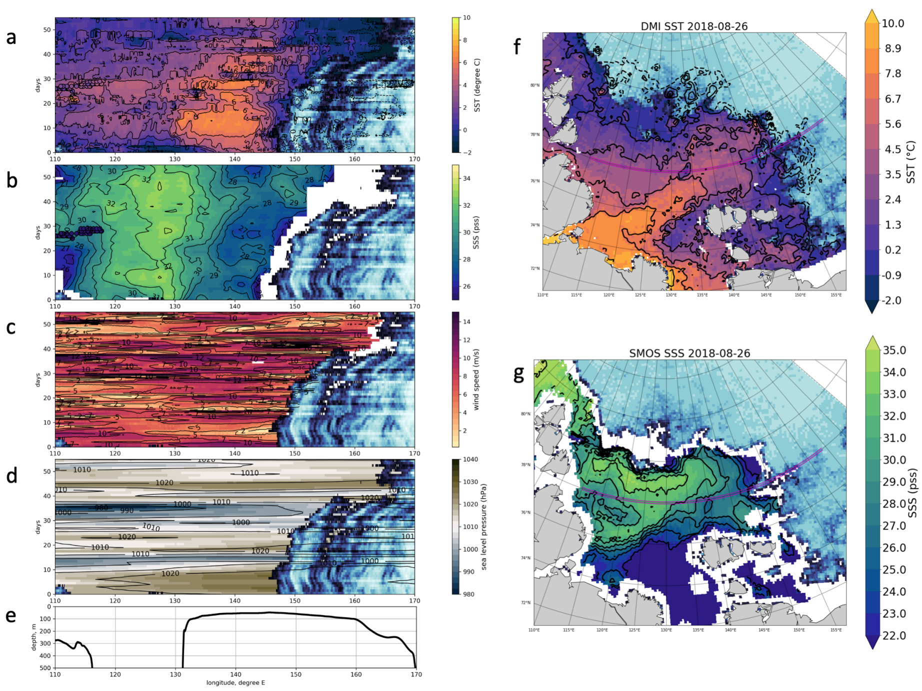

Fig. 3. Hovmoller diagram of DMI SST (a), SMOS SSS "A" (b), ASCAT wind speed (c), and ERA5 sea level pressure (d) for the zonaltransect at 78 N. Small circles at SST and SSS diagrams show in situ measurements

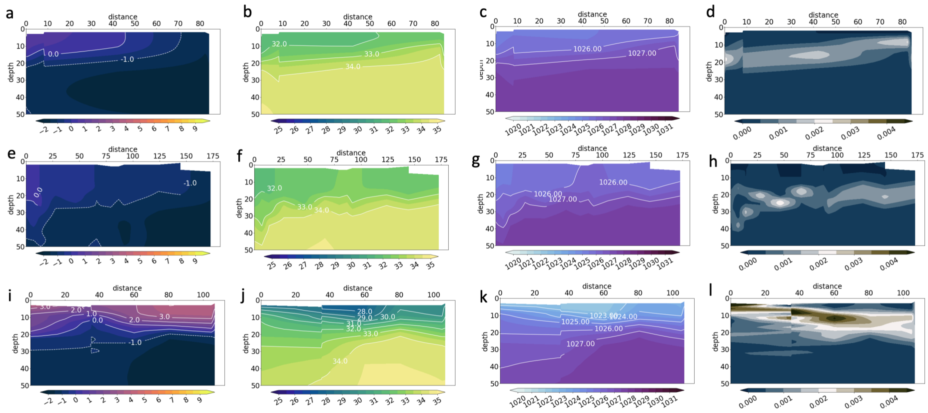

Fig. 4. Temperature, salinity, density obtained from CTD measurements in the upper 50 m for sections 1, 10, and 4

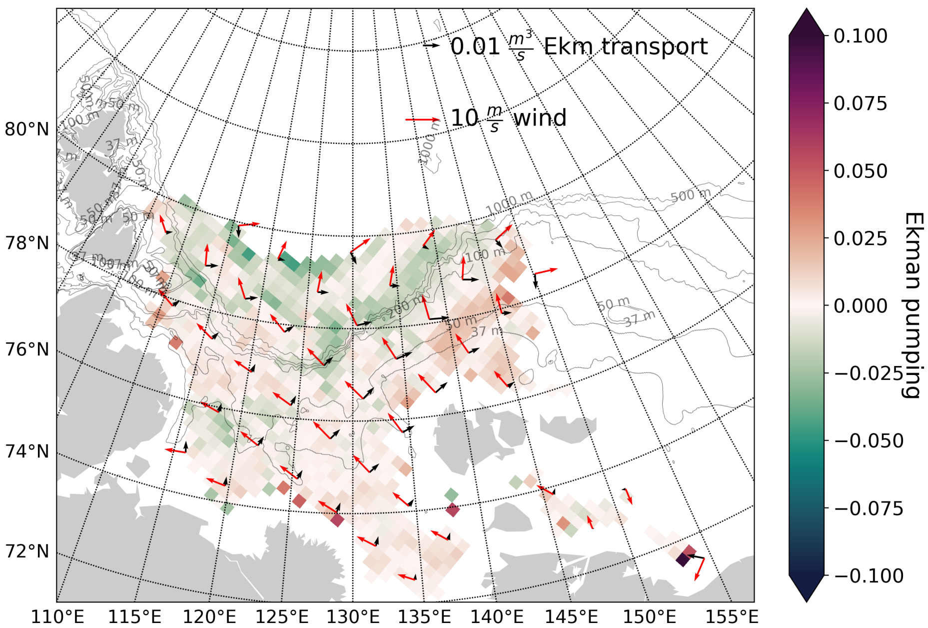

Fig. 5. Mean monthly Ekman transport and pumping together with wind speed in August 2018

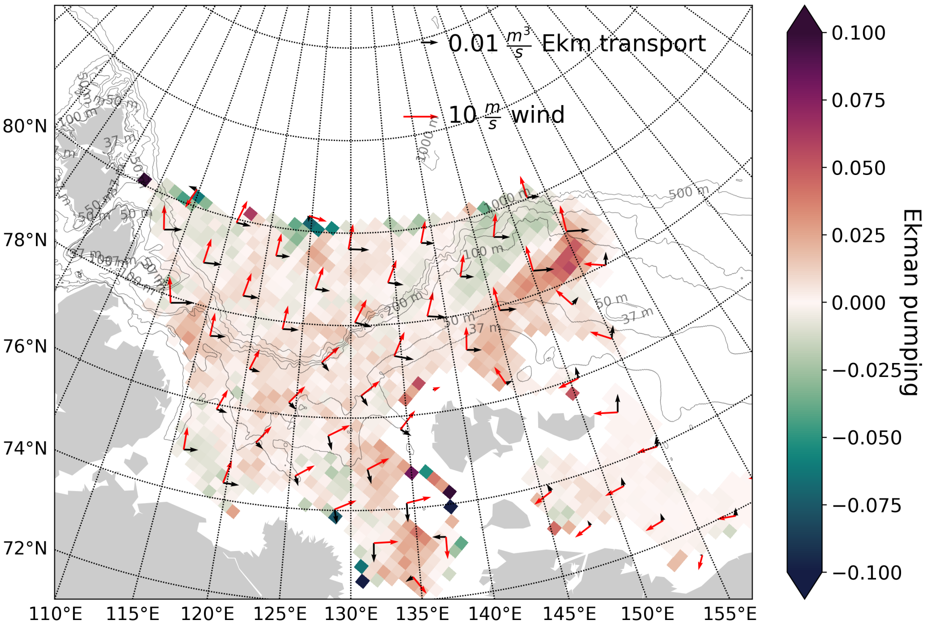

Fig. 6. Mean monthly Ekman transport and pumping together with wind speed in September 2018