

Anonymous referee #1. Report #2

Technical Revisions:

Lines 6-9. Sentences can be combined or reworded shorter

Done, now the sentence reads as: ‘In this work, we evaluate the freshwater content in the Beaufort Gyre using surface salinity measurements from the satellite radiometric mission Soil Moisture and Ocean Salinity (SMOS) and TOPAZ4b reanalysis salinity at depth, estimating the freshwater content from 2011 to 2019 and validating the results with in-situ measurements.’

Line 13 “...this key process that is creating subtle density differences that have the potential”. What key process? The revision does not clearly answer the previous comment made. Possible change to “...understanding key processes related to salinity variations that cause density differences with potential to influence the...”

Applied, thank you.

Line 24: Add period to end of sentence.

Done.

Line 25: ‘Freshwater’ in the ocean is NOT zero-salinity, this is confusing for the reader. Reword to emphasize that it is salinity less than the reference salinity.

We don’t understand what you mean. For us the definition is correct, the quantity of freshwater that is needed to add to an area to reach the reference salinity.

Line 27: State the reference salinity here to be direct.

Done.

Line 61: “Sea Surface Salinity” remove capitalization.

Done.

Lines 126-127: Remove period after “psu” in equation (1) and start the sentence “Where” with uncapitalized ‘w’.

Done.

General Comments:

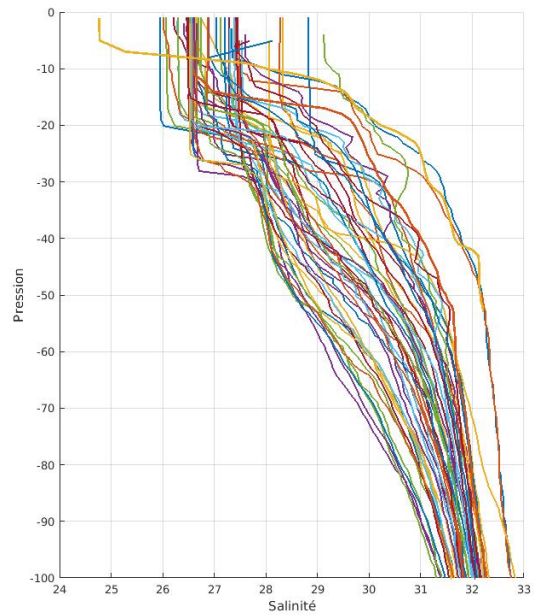
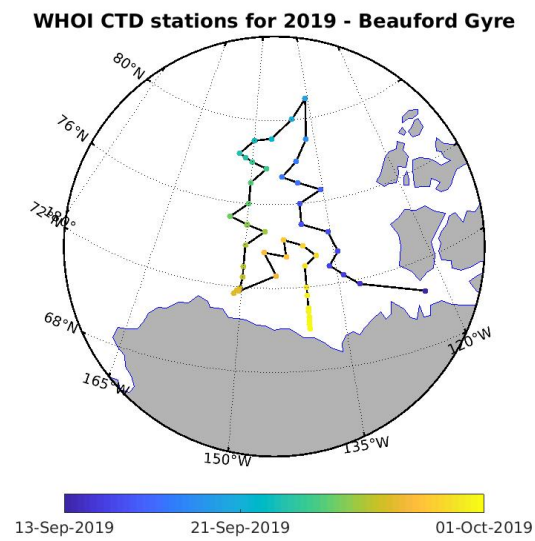
The main concern still lies on the fixed mixed layer depth being used in the analyses. The fixed mixed layer depths cited (Toole et al. 2010) is estimated by bulk profiles from 7 m and below. The manuscript aims to improve the FWC estimation using the satellite measured surface (~1 cm or less) values as the salinity above the fixed mixed layer depths. The upper ocean structure near the ice edge, river runoff... could be quite different from swapping all salinity above a fixed depth to SMOS SSS. Even though the results suggest that integrating the SMOS SSS in the upper ocean improves the freshwater depth in the Beaufort Gyre, the uncertainties from using the fixed mixed layer depths for the entire region could be problematic. Below are some possible suggestions that may help support your estimation not being blurred by large uncertainties in overly simplified methodology.

(1) Estimate mixed layer depths. The mixed layer depths can be estimated using the reanalysis data. Compare the distribution of the varying mixed layer depths with the fixed mixed layer depths. If the distribution is highly centered and close to one of your fixed mixed layer depths, it supports your results. And this may inform how much uncertainty comes from using fixed mixed layer depths alone. If the distribution is broad, then it would be beneficial to use “calculated” mixed layer depths instead. For example, the mixed layer depths could be deeper in parts of the Beaufort Gyre (as you mentioned in Line 235-236) while some closer to ice edges/ river runoff/ freshly melt waters could be very shallow (though this may or may not be well represented in the reanalysis data).

Even though the FWC results from estimating the mixed layer depths may or may not change your conclusions substantially, the value of the results would be much improved by using a more reliable method.

To ensure the coherence of the MLD estimations utilized (Toole et al., 2010), we conducted an analysis of in-situ vertical salinity profiles in the Beaufort area for the summer of 2019.

As depicted in the figures below:



Several in-situ salinity casts were obtained in September, indicating that assuming an MLD between 15 and 30 meters aligns coherently with structure revealed by the in-situ data.

Specific comments:

Line 105-106: from in-situ source? Please specify.

Done.

OSISAF sea ice concentrations are plotted in Figure 1 and Figure 2 but not mentioned in the data section. Please include it in the data section.

OSISAF data is described in lines 89-91.