Review of “Snapshots of ice-free season dynamics in the near-shore water column of the northern Gulf of St. Lawrence, Canada”, by Arsenault et al.

Author’s response

General comment

The manuscript describes an oceanographic dataset collected from 35 sites along the northern Gulf of St. Lawrence coastline from May to October of 2022. The data were collected using a CTD probe equipped with PAR, turbidity and chlorophyll fluorescence sensors. This dataset is a valuable contribution to the study of the temporal and spatial variability of key oceanographic variables, such as water temperature, salinity, irradiance, turbidity, and in vivo chlorophyll fluorescence (an index of phytoplankton biomass), during the ice-free season. Crucial variables for coastal zone management and modeling, such as stratification intensity and the depths of the thermocline, halocline, pycnocline, euphotic zone, and subsurface fluorescence maxima, can be derived from these data. These variables are also useful for modeling phytoplankton blooms and declines in nearshore environments and for understanding how small and major rivers influence marine water properties. However, revisions are necessary before the manuscript can be published. Below are some comments and suggestions that I hope will help the authors revise the manuscript.

General comments

The writing of the paper could be improved.

The general and specific objectives of the study are not clearly defined and are scattered across the last two paragraphs of the introduction. In addition, the last paragraph contains redundancies.

We thank the reviewer for the suggestions, the corrections have been made.

Some details are missing from the Materials and Methods section (see Specific comments), Graphs in Figures 4-7 are not effective (see Specific comments).

The description of the temporal and spatial variability of the oceanographic variables could be improved. The authors should include a table showing the mean, standard deviation, and range of each variable measured in the surface water of the three site zones for each month of sampling. Another table can show the depth of the thermocline, halocline, pycnocline, euphotic zone, and subsurface fluorescence maxima, as well as the stratification index, for the three site zones.

Thank you for the suggestions, these two tables have been added as Tables A2 and A3 in the annex.

It would be also interesting to calculate the diffuse light attenuation coefficient (kd) and perform a regression analysis between kd and in vivo chlorophyll fluorescence and turbidity, as these factors affect PAR transmission in the water column.

We thank the reviewer for this suggestion. We have calculated Kd and performed regression analyses as suggested. We revised the methods, results and discussion sections, and added a new figure showing the seasonal and spatial variation of Kd (fig. 7)

Specific comments

Title: The title could be improved to more accurately reflect the content of the paper.

We thank the reviewer for the comment. The title was changed to "Oceanographic dataset of the near-shore water column of the northeastern Gulf of St. Lawrence, Canada, during the ice-free season"

Line 16: Change "sensor" to "probe".

Change made

Line 20: Change "parameters" to "variables". Variables are quantities that vary from individual to individual. In contrast, parameters do not relate to actual measurements or attributes but to quantities defining a theoretical model (Altman and Bland, 1999). For example, in the linear regression equation, $y = mx + b$, m (slope) and b (intercept) are parameters. x is the variable.

Change made

Line 34: Change sea-ice" to "sea ice".

Changes made

Line 38 and throughout the manuscript: List citations in alphabetical order.

Thank you for the comment, according to the journal guidelines, the in-text citations order can be chronological or alphabetical

Line 42: Change "al. 2022" to "al., 2022".

Correction made

Lines 50-54: River plumes are always stratified.

We thank the reviewer for the comment, but we are not sure to which sentence you are referring to.

Lines 67-74: This paragraph needs to be rewritten, as the objective of the work is unclear.

We thank the reviewer for the suggestion, we revised the introduction and objectives.

Line 68: Change “sensor” to “probe”

Change made

Line 68: Change “temperature, salinity and fluorescence” to “salinity, temperature and in vivo chlorophyll fluorescence”. Why is turbidity excluded here?

Changes made

Lines 67-69: This information should be moved to the Materials and Methods section.

Change made, the information was put in materials and methods

Line 69: Change “phytoplankton biomass based…instrument.” to “phytoplankton chlorophyll a biomass.”.

Change made

Line 98: Define “PSI”.

Correction made

Line 104: Change “(Shaw et al., 2019)” to “(Shaw, 2019)” or “(Shaw et al., 2022)”.

Correction made

Lines 106-108: Suggestion: “The vertical profiles were obtained with a CTD probe equipped with sensors that measure temperature and salinity (Sea-Bird ADD THE MODEL), photosynthetically active radiation (PAR; ADD THE MODEL), turbidity (Seapoint…) and in vivo chlorophyll fluorescence (Seapoint…).”

We thank the reviewer for the comment. We added to the manuscript information about the CTD and sensor models.

What was the CTD’s descent speed?

The average descent speed was of 1m/s, we added this information in the manuscript.

What type of sensor was used to measure underwater PAR? Was it a cosine-corrected sensor (2 pi) or a spherical quantum sensor (4 pi)? Please clarify. Was the in vivo fluorescence sensor calibrated using collected water samples?

The PAR sensor was a Biospherical QSP-2300L with a spherical quantum sensor, the information was added in the manuscript. The CTD and all sensors were last calibrated in 2017.

Line 110: Brunt-Väisälä frequency

Correction made

Line 113: Change “2022,)” to “2022 (“.

Correction made

Line 116: Who is providing the meteorological data?

The Government of Canada, we added it to the manuscript.

Line 116: Change “(Table 1)” to “(Table 1A)”.

Change made

Line 143: Change “(2024-5),” to (2025)”.

Thank you for your comment, however we didn’t find (2024-5) in the text.

Line 148: Change “temperature” to “the water temperature”.

Change made

Line 153: Change “Fig.” to “Figs.”.

Change made

Line 179: A stratification intensity index could have been calculated. This index would demonstrate significant temporal and spatial variability along the coast.

Thank you for your comment, we added a stratification index table in the annex.

Lines 182-184: These two sentences are difficult to understand.

Correction made

Line 184: Change to “…and had no missing values, which made visualization easier.”.

Changes made

Line 196: “Change to “…and Ste-Marguerite rivers”.

Correction made

Lines 201-202: As expected, the water temperature decreased with depth, while salinity increased. Cold, saline water has a higher density than warm, fresh water. Generally, surface water is warmer in turbid rivers or river plumes than in rivers or river plumes with low turbidity. Since suspended particles absorb and scatter light, turbid surface waters should be warmer and have reduced PAR compared to clear waters. Is this the case along the coast?

Thank you for your comment, if we look at the more turbid values (in June, sites 15 to 21), temperatures in June are a bit warmer at these same sites.

Line 211: Define “FTU”.

Correction made

Line 224: Was the in vivo fluorescence sensor calibrated using extracted chlorophyll a samples from the water column? The fluorescence value is surprisingly low in May.

We thank the reviewer for this question. We have added a statement in the methods acknowledging that the sensors were last calibrated in 2017, and that fluorescence should be interpreted with caution.

Lines 224-227 and 233-244: It is not useful to present averaged chlorophyll fluorescence and PAR values throughout the water column. Surface in vivo fluorescence and PAR values should be used to describe the seasonal variation along the transect. The presence of a subsurface in vivo fluorescence maximum in July is obvious in the vertical fluorescence profile (see data in the Excel file).

We thank the reviewer for this suggestion. We have revised the text to report surface in vivo fluorescence and PAR values instead of averaged values of the whole water column. The subsurface fluorescence maximum observed in July has been explicitly identified in the revised text.

Figures and Table

Figure 1: In the map, change “Matam ec” to “Matamec”. Delete “138” under “Matamec”. Check the spelling of Ste Marguerite (see line 196).

We changed “Matam ec” to “Matamec”, but kept the “138” as it refers to the main road in the area.

Figures 2, 4, 5, 6: Heatmaps are not the best method for presenting vertical profiles along the transect.

We appreciate this suggestion. However, given that our datasets has multiple stations over six months, we believe heatmaps are the most effective way to simultaneously visualize both the spatial and temporal patterns in the vertical profiles.

Figure 2: The vertical variations of the water temperature along the coast for each sampling period should be prepared with the Ocean-Data-View software (R. Schlitzer, http://odv.awi.de) or another appropriate software. In addition, the top and the bottom of the thermocline layer could be traced in the figure.

We appreciate this suggestion. All figures in this study were produced in R, which allowed us to maintain a consistent visual style throughout the manuscript and to use colorblind-friendly color palettes.

Figure 3: The maximum value of photosynthetically active radiation (PAR) at the Earth's surface during peak sunlight is typically around 2000-2500 µmol photons m-2 s-1 . The maximum value of PAR measured with a cosine-corrected sensor is 1800 µmole photons m-2 s-1 and about 2200- 2400 µmole photons m-2 s-1 with a spherical quantum sensor. What type of sensor was used to measure underwater PAR? If a cosine sensor was used, then PAR values > 1800 indicate that the instrument is not correctly calibrated. Some underwater PAR values in the Excel file are very high and therefore suspect.

We thank the reviewer for the comment. The PAR sensor was a Biospherical QSP-2300L with a spherical quantum sensor, last calibrated in 2017. We added an acknowledgement about the careful interpretation in the methods.

Figure 5: A title is missing from the vertical axis. The difference in colors is difficult to discern. The pink rectangles are not visible on the heatmaps.

We added the missing title, and removed the pink rectangles from the legend as it was a mistake.

Figure 7: These scatter plots are not useful in their current form. I suggest displaying the changes in the relationship between in vivo chlorophyll fluorescence and the physical variables for each sampling month. These relationships can also be displayed for each site zone and month of sampling.

We thank the reviewer for this suggestion. The scatter plots have been revised to display the relationships between in vivo chlorophyll fluorescence and each physical variable (temperature, salinity, PAR, and turbidity) separately for each sampling month. Given the number of panels (6 months × 4 variables = 24 panels), these figures have been moved to the annex (Figs. A1–A4). The main text has been updated to highlight the key patterns revealed by the monthly breakdown.

Table 1: The legend is unclear. Define the 3 zones. Define “IP” in the table legend. Instead of presenting the mean value, present the depth profile range. Indicate the water depth if available.

We thank the reviewer for this suggestion. We updated the table title to: “Table 1: Site zones, description of land use, and mean of the maximum CTD depth for each site (Zone 1 = Sites between Port-Cartier and the west of the BSI; Zone 2 = Sites inside the BSI; Zone 3 = Sites between the east of the BSI and Matamec; IP = Industrial-port zone)”. The mean value presented corresponded to the mean of the maximum CTD cast depth across sampling months, which reflects the water depth at each site.

Reference

Check the references of Shaw (2019).

Correction made

Appendices Add the reference for Government of Canada (2025).

It is now in the references