Response to reviews - os-2021-90 - "Inherent optical properties and optical characteristics of dissolved organic and particulate matter in an Arctic fjord (Storfjorden, Svalbard) in early summer" by Tristan Petit et al., Ocean Sci. Discuss., https://doi.org/10.5194/os-2021-90-RC1, 2021

The comments from the Referee are in black text, while our responses are in blue text. Note that the page, figure or line numbers here denote those in the original submission, unless otherwise stated.

Anonymous Referee #1

The article, Inherent optical properties and optical characteristics of dissolved organic and particulate matter in an Arctic fjord (Storfjorden, Svalbard) in early summer, by Tristan Petit et al., presents a dataset acquired in summer 2020, consisting of inherent optical properties (IOPs) such as absorption, attenuation, and fluorescence of optically active constituents, both dissolved and particulate. As the authors suggest the IOPs are crucial in developing bio-optical models. The dataset does include state-of-the-art bio-optical data, which could be very useful to the scientific community involved in ocean color studies in the Arctic. However, the manuscript needs to be improved and so authors are requested to consider the following comments and suggestions.

We like to thank Referee #1 for the thorough reading of the manuscript, and the multiple comments and suggestions that have helped to improve the presentation of the manuscript. Specifically we have attempted to improve the figures by editing and reorganising them as well as by adding some new content (eg. all FDOM channels are now presented as section plots). We have also modified the title of the manuscript, and added some more discussion on the relationship to salinity, and added the suggested additional references provided by Referee 1. Detailed responses to these suggestions are given below.

Out of the total 127 comments in the annotated manuscript (attached to this response with our responses to every comment), we have followed nearly all suggestions. Regarding the few cases for which we have not fully followed Referee 1 suggestions, we have detailed the rationale behind our choices either in the annotated manuscript and/or below with our responses in this letter.

Specific comments from Referee #1

Any particular reason why water samples were not collected to quantify phytoplankton pigments like chla, it being a widely studied optically active constituent?
Unfortunately this expedition was part of an educational cruise, with focus on physical oceanography, and there was limited laboratory space to support such work in an efficient manner since this was a coast guard vessel and not a research vessel. Thus this was more of a ship-of-opportunity for our work, to study an area with little to no optical data. Thus we unfortunately had to opt to collect particulate abs samples at the expense of Chla samples, although in hindsight this was an omission we should have not done. However the in situ absorption measurements (absorption line height at 676 nm) are known to be a good proxy for phytoplankton biomass, also seen from the relation to the measured Chla fluorescence.

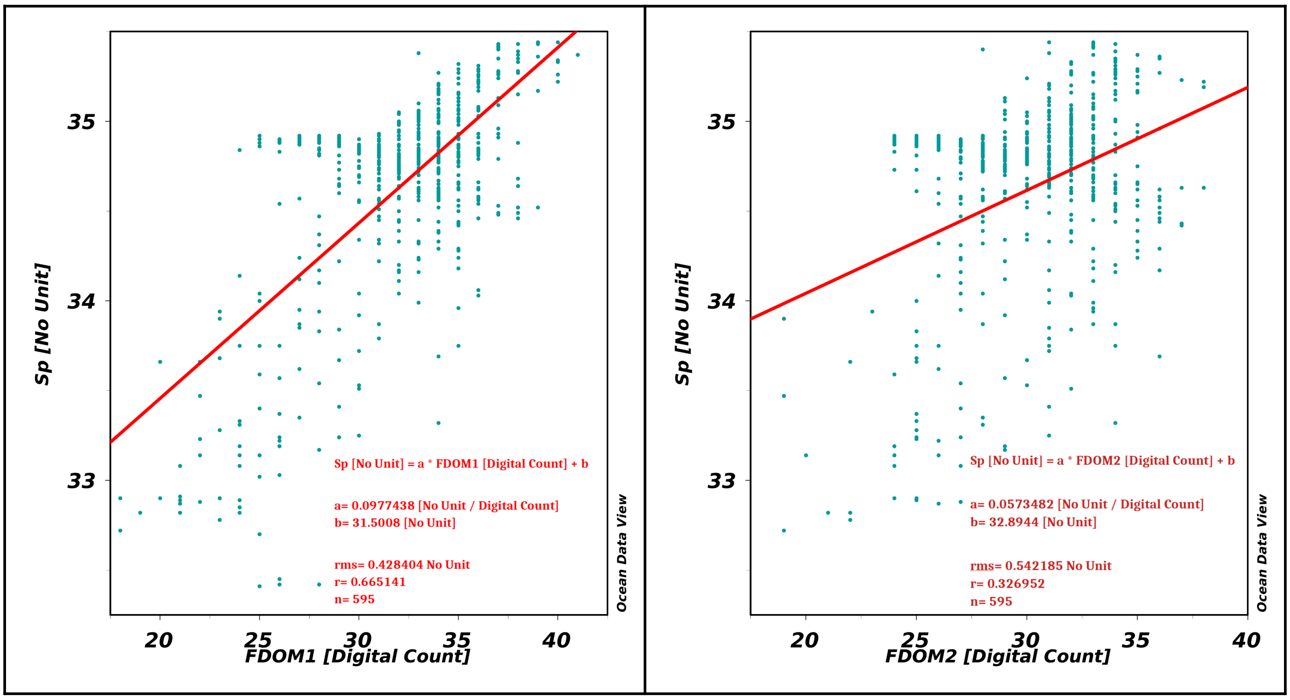
The methods section lacks references, please cite appropriate references throughout the section.

We have added a number of references where appropriate. In places we have simply written out the detailed protocol from the external labs that were used for analysis, and there is not necessarily a suitable published reference to use, since they are established laboratory practises used over long periods of time without a proper scientific reference, nevertheless proven reliable.

Can oxygen isotope values be used to quantify Dissolved Oxygen? What more can we interprete from the Oxygen isotope values?
Oxygen isotope measurements quantify the relative amount of oxygen isotopes in the water molecule, not the concentration of dissolved oxygen gas. These are two very different things. DeltaO18 is widely used in oceanography to interpret the origin of freshwater (from sea ice melt or river/glacial runoff and precipitation in the Arctic (e.g. Östlund & Hut, 1984, https://doi.org/10.1029/JC089iC04p06373), since the two freshwaters concerned (runoff or sea ice melt) have nearly the same salinity, but very different DeltaO18 signals. Thus DeltaO18 can be used to estimate the contribution from each. Here we use it to interpret the likely contribution from runoff or sea ice melting to the surface layer. We do this qualitatively, since this is the only oxygen isotope data from the fjord, to our knowledge, and it does not allow us to make quantitative estimates since we lack proper information on the end-members (sea ice and runoff) to do that properly (because more samples from Svalbard runoff and sea ice are required for that, but does not exist).

The purpose of using satellite image in the results and discussion section is unclear as there is no validation of data using field observations. I suggest to include figure 5 in section 2.4.
Our purpose was not to validate satellite products, but to show the broad aspect of the 'ocean color' situation from space at the time of sampling to place our observations in geographical context. We have now moved section 3.2 with former Figure 5 to section 3.1, right after the satellite data processing is introduced (section 2.4). This improves the flow of the text, and provides useful background information to place the in-situ observations in context. We have also slightly modified the text in former section 3.2 (now section 3.1) to better reflect the attempted use of the satellite data in the paper. Satellite validation is out of scope for this paper and given we do not have direct Chla measurements at the surface it is neither plausible to go ahead with such work, the novelty lies in the gathered in situ data in the fjord.

Investigate the relationship between surface acdom440 and salinity
Thank you for this suggestion. Indeed this should be one of the most basic approaches when dealing with oceanographic data. We have only few data of acdom440 from direct measurements (CDOM absorption samples), thus given the sensitivity of fluorescence we have here examined the relationship between salinity and FDOM data that was acquired simultaneously with the same frequency from in situ profiles. Note that we have chosen the FDOM1 and FDOM2 channels as their section plots (added in Figure 7 in the revised manuscript) do show similar patterns as the acdom440 section plot and are those channels of the FDOM instrument that are therefore most "representative" of acdom440.



This indeed shows a relationship with salinity, but appears inverse to that found in many typical estuaries (as now noted in the ms.). With decreasing fluorescent DOM with decreasing salinity, indicative of the role of low-CDOM sea ice melt diluting CDOM concentration at the surface, with little sign of impact of land runoff that typically is the high-CDOM source. One has to note the fairly low values of humic-like fluorescence leading to resolution-based gridding-like artefacts visible on the plots. We would prefer not to add these scatter plots within the manuscript for sake of brevity. Instead we have added this discussion in a concise way in the first paragraph of Section 3.4.

Further references:

Mascarenhas VJ and Zielinski O (2019) Hydrography-Driven Optical Domains in the Vaigat-Disko Bay and Godthabsfjord: Effects of Glacial Meltwater Discharge.Front. Mar. Sci. 6:335. doi: 10.3389/fmars.2019.00335, figure 4, panels C, G)

Thank you, we have added this reference in the section 3.4 where we show and discuss CDOM results

Bowers, D., and Brett, H. (2008). The relationship between CDOM and salinity in estuaries: an analytical and graphical solution. J. Mar. Syst. 73, 1–7. doi:10.1016/j.jmarsys.2007.07.001,

Thank you, we have added this reference in the section 3.4 where we show and discuss CDOM results, in relation to salinity.

Linkages between the circulation and distribution of dissolved organic matter in the White Sea, Arctic Ocean. Cont. Shelf Res. 119,1–13. doi: 10.1016/j.csr.2016.03.004, Figure 7b

Thank you, we have added this reference in the section 3.4 where we show and discuss CDOM results.

Add a table with list of acronyms and abbreviations (table 1) in section 2, rename the other tables accordingly.

Thank you, we have added a table (now Table 1) with the main acronyms used in this manuscript. Whether it should be in the main text, or supplementary material can be decided by the Editor(?).

Figures need to be revised and rearranged. Detailed comments are added in the attached manuscript.
Thank you for the suggestions regarding improvements to our figures. We have extracted below some of the detailed comments on the figures from the annotated manuscript, and responded to the suggested changes in more detail below.

Note - the Figure numbers here refer to the figure numbers in the original manuscript unless otherwise stated.

Figure 1 -
-show the water masses and direction of currents in the map.
-use a different color to mark the stations sampled across the fjord.
-mark the sill.
We have added arrows to indicate the major nearsurface currents in the area, based on the Fossile et al paper (which is based on earlier work in the area).
We have edited the colors of the station markers as suggested, with one color for the main South-North transect, and another for the other stations near the sill area.
We have added an arrow to indicate the sill.
We do not quite understand how we can show water masses on a map, these are on multiple depths and vary a lot geographically, which is why we do not want to indicate this due to the certain uncertainty in defining water masses.

Figure 2 -
- add a panel b, with a second station, may be stn. 509
We have added a second panel with stn. 509

Figure 3
-reduce ODV figures to half the size
-combine figures 3 and 4
-add potential density anomaly as a separate figure, so create 4 sub figures, and arrange 2x2
-label the figures as a,b,c,d
-y axis is pressure or depth?
-follow same color for contour lines (either black or white)
-mark stations nos. over vertical lines
-edit text for figure nos. accordingly

A big reduction in the figure size would make it too small to see the needed details. We opt to slightly reduce the size of the figures.
Combining Fig 3 and 4 is a good idea. Thank you.
Potential density (or other oceanographic variables) are commonly shown in same panels in oceanographic papers, and we opt to keep this as is, due to i) easier direct comparison of the data in the same panel, ii) we are not adding more panels to the figures, which simply takes more space.
We have labeled panels with a, b, c, .. as suggested.
As the y-axis says, this is Pressure (decibar), which is widely used with oceanographic data.
We opt to use black contours when given for the same variable as in the colored contour, and in white if an additional parameter is shown as overlay (in this case it is potential density).

We have marked station numbers.

Figure 4
Merged with Figure 3 - as suggested (see above).

Figure 5
- color code the two transects as suggested in figure 1
We have now moved this figure to section 3.1 (in response to the suggestions of reviewer), and also edited the figure to be consistent with the map in Figure 1 (marker color).

Figure 6
-reduce ODV figures to half the size
-y axis is pressure or depth?
-mark stations nos. over vertical lines
A big resizing does not make sense in our opinion and we have decided to keep the same width as the (slightly reduced) Figure 3 for all the section plots of the revised manuscript.
The y-axis corresponds to pressure as is indicated on the axis label.

Figure 7
-reduce ODV figures to half the size
-y axis is pressure or depth?
- Mark stations nos. over vertical lines
- Add FDOM1 and FDOM2 section plots as supplementary material
-investigate the relationship between surface acdom440 and salinity, and add a 4th figure panel
-label figure panels as a, b, c, d
A big resizing does not make sense in our opinion and we have decided to keep the same width as the (slightly reduced) Figure 3 for all the section plots of the revised manuscript.
The y-axis corresponds to pressure as indicated with axis label..
We have marked station numbers.
We have decided to show all the FDOM channels within the result section as FDOM1 and FDOM2 do provide some information (similar patterns between FDOM1 and acdom440) even if they show low values. Thus, we have split Figure 7 into two figures: a first one with CDOM products and a second one with FDOM products.
We have now labelled each panel with a dedicated letter.

Figure 8
Size slightly reduced

Figure 9
Added a and b to the panels.

Figure 10
-label figures as a, b, c, d, d, e. be consistent with other figures
-add a sixth figure (f) with SCM depth, use the same in discussion
We have not added a sixth panel with SCM, since we did not target our sampling to the exact depth of the maximum SCM, but used fixed depths, thus the subsurface samples here represent the SCM layer with higher biomass (which is not always exactly at the maximum SCM depth), but due to fixed depth sampling, and its misleading to call it SCM in our opinion.
Labelling done as suggested, caption edited accordingly.

Figure 11 -
-label figures as a, b, c, d, d, e. be consistent with other figures
-add a sixth figure (f) with SCM depth, use the same in discussion
Same as for Figure 10
Panels labeled