

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-373

Anonymous Referee #2

Referee comment on "Impact of freshwater runoff from the southwest Greenland Ice Sheet on fjord productivity since the late 19th century" by Mimmi Oksman et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-373-RC2>, 2022

General Comments

This is a good paper that attempts to interpret a complex data set that at first glance is not easy to understand. I commend the authors for their efforts in interpreting these records cohesively. The age models are reasonable, although in Site 17 it is more difficult to recognize where the unsupported Pb reaches supported Pb levels and the Cs peak is hard to see. Nonetheless, the authors interpretation of the likely age model is sound. The geochemistry is clear and interpreted appropriately. The authors should be commended for including detailed diatom ecological information and references to back up their interpretations. This should be universal in diatom papers but is often missing. I have some concerns and questions about the grain size data and diatom data, but overall, the paper is a great contribution to our understanding of freshwater discharge from Greenland and primary productivity.

Specific Comments

The figures are quite hard to read in many cases. The font is exceptionally small. In some cases, it is the equivalent of 2 or 3 points—nearly impossible to read even when zoomed way in on the pdf! In Figure 1, please increase the font size of the numbered fjords. Figures 3 and 4 are the most problematic for the reader to investigate. It's nearly impossible to read the axes because of the small font size. In addition, the authors compare productivity levels between sites, but the x-axes are different for each site. It would be helpful if the x-axes were identical between sites in Figure 3. It's possible that this will be difficult for some measurements, like BSi, but it would be helpful if possible. For Figure 4, it is inappropriate to plot diatom relative percent data with varying axes. The length of 10% on the x-axis for Sea Ice Associated species should be the same length for

10% on the x-axis for *Detonula confervacea* and for every other taxa. This is the only way to evaluate relative percent. In rare cases, it's okay to break an axis for taxa that overwhelm the assemblage, but I don't think this is an issue with this data. It needs to be clear to the reader that the assemblage is dominated by cold-water species and freshwater species are a small percentage. These axes lengths should also be the same for all three sites. In addition, the length of the axes for diatom concentration should be consistent between sites in Fig. 4. I noticed that for all of these figures, although they take up the full vertical space on the page, there is ample space for the figures to stretch horizontally to accommodate these changes in axis length. Please also increase the font size on all the axes so that they're easy to read.

It's concerning that there isn't agreement between the two different grain size methods (Malvern Mastersizer and wet sieving). Shouldn't they both show increases in the coarse fraction at the same times? The authors should address this in the result section.

Please be cautious about how you interpret "productivity." In section 4.1 you discuss productivity in terms of TOC, diatoms, and BSi, which is appropriate. However, in section 4.3, you discuss productivity only in terms of BSi. It seems important that the three productivity indicators are not correlated at all sites and in some cases are anticorrelated (site 20). There should be a discussion of these differences and potentially interpretations of why they are different. This could be in Section 4.1 or a new section between 4.2 and 4.3. Please also be specific in section 4.3 that there is an increase in BSi, but not necessarily an increase in "productivity."

There is discussion about sub-glacial sediment plumes drawing nutrients from deep water to the surface. However, all these sites are at about 500 m water depth. Are the nutrients sourced from this depth (intermediate water depths) or are they somehow drawn from the deeper ocean and in over the fjord sill to upwell at the sites? I see the references here, but I'm having trouble understanding how this mechanism works. Perhaps a sentence or two more in section 4.3 would elucidate this.

In section 4.4, I'm having a really hard time seeing the association between late summer species and freshwater discharge. I'd be more easily convinced that species like *Synedra* and benthics were responding to the freshwater increase than *T. antarctica* and *Detonula*.

Technical Corrections

Table 3: Please either include p-values or the significance level for the correlations.

Line 358: Which site are you referring to in this sentence? Site 8? This is confusing because in the first part of the sentence you refer to the Outer fjord, then say that there are frequent low-amplitude fluctuations, but I can only see one fluctuation in TOC at Site 8. Please clarify this.

Line 378: Please provide references for the $\delta^{13}\text{C}$ values.

Lines 365-371: It's striking that Site 17's BSi is similar to the other sites, but there are no diatoms at this site. It would be helpful if the authors mentioned this and perhaps addressed why this might be.

Lines 385-390: It's quite easy to check and see if there is a significant amount of land-derived inorganic nitrogen. You just need to plot TOC vs. TN and check if the y-intercept is 0. If it is, then there is no clay bound nitrogen. I suggest the authors do this so they know whether or not it is present. See Schubert and Calvert (2001) for more information.

Lines 416-421: Are you referring only to the inner fjord in this sentence? Please clarify. This statement doesn't hold true for Site 6.

Line 528: I noticed a typo, this phrase should read, "...summer blooms become larger..." not "becomes."

References

Schubert, C. J., & Calvert, S. E. (2001). Nitrogen and carbon isotopic composition of marine and terrestrial organic matter in Arctic Ocean sediments: implications for nutrient utilization and organic matter composition. *Deep Sea Research I* 48:789-810.