

The Cryosphere Discuss., author comment AC2  
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## Reply on RC2

James A. Smith et al.

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Author comment on "Holocene history of the 79°N ice shelf reconstructed from epishelf lake and uplifted glaciomarine sediments" by James A. Smith et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2022-173-AC2>, 2023

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### Reviewer 2.

Holocene history of 79°N ice shelf reconstructed from epishelf lake and uplifted glaciomarine sediments

General comments: This manuscript reconstructs the Holocene history of 79°N Glacier and its ice shelf. This is one of the only remaining ice shelves of the Greenland Ice Sheet and it is an important glacier system that drains a large proportion of the ice sheet. I found the paper interesting and enjoyable to read. The conclusions are well supported by data and the analysis of the future behavior of the 79°N ice shelf is well reasoned. The combined lacustrine and raised marine sediment approach provides the greatest scope in time for reconstruction of the ice shelf, and the multiproxy analyses from Blasø showing marine and lacustrine sediments provides multiple lines of evidence for the presence/absence of the ice shelf. Note that I do not feel qualified to comment on the biomarker data and interpretation.

My comments are all small corrections and/or recommendations to make the manuscript clearer and easier to read.

Specific comments:

Make it clear when you are referring to 79°N ice shelf or 79° Glacier...or both. It can be confusing especially because when you use the term 'reformation' you probably mean reformation of the ice shelf. An example is L258 where I think you are referring to the ice shelf....it would be clearer if you added ice shelf after 79°N.

***We will review our text add this information throughout.***

Also Line 466 and 467 at start of discussion, do you note intervals of increased IRD during times when the 79° ice shelf is absent? During the 8.5 to 4.4 cal ka BP interval (Fig. 11b) when the 79°N ice shelf was absent, did the 79°N Glacier calve significant ice bergs and leave a record of increased IRD?

***There is no clear IRD signal in Blasø, although a minor increase in coarse-silt is observed during ice shelf absence (LF1, LC12). Lack of coarse-material, probably relates to the bathymetry of Blasø – and specifically ridges at both sides of the***

**central basin which act to block large bergs reaching the core sites. We will add a sentence stating this when reporting the grain-size data.**

L126 or thereabouts - Include description of coring platform...it was a raft according to line 220.

**We will add 'Coring was undertaken from an UWITEC raft, fitted with a 15 horse power Yamaha outboard' to line 126.**

In the study area and approach section include some background on bedrock geology so that the reader knows what was the goal and rationale of XRD. What did you expect to discover with XRD. You include a lot of this information in the sections on interpretation of Blasø lithofacies in cores, but it would be useful to have it given in the study area section.

**We will add the following to 'Study area and approach':**

**Blasø is located within the East Greenland Caledonides, a series of W-directed thrust sheets displaced against the rocks of the Palaeo- to Mesoproterozoic foreland (Higgins and Kalsbeek, 2004). The crystalline basement, consisting of strongly deformed Archaean and Palaeoproterozoic granitoid rocks, is overlain by Mesoproterozoic-Neoproterozoic and lower Palaeozoic strata. To the east of Blasø, outcrops of quartzite/sandstones (Hovgaard Ø Formation), dolerites and flood basalts (Midsommersøte Dolerite Formation) are exposed. Moving westwards these are overlain by the Neoproterozoic Rivieradal Group consisting of conglomerate, sandstone turbidite and mudstone units (Smith et al., 2004). In turn, these are overlain by the limestones, mudstones and dolomites of the Odins Fjord, Turesø and Børglum River formations further west (Smith et al., 2004).**

**We will also add to section 3.2, line 165:**

**Illite/chlorite are detrital clay minerals which are typically derived from physical weathering of crystalline/basement rocks i.e., granitoids and low-grade, chlorite-bearing metamorphic and basic rocks i.e., dolerites, respectively. Smectite normally reflects volcanic sources i.e., basalts and volcanic glass, whilst kaolinite is a product of chemical weathering, characteristic of moist, temperate to tropical regions. Kaolinite generally indicates the presence of older sedimentary strata i.e., mudstones/shales.**

3.3 Foraminiferal analysis (~L175). Did you use unbuffered distilled water?

**Yes, we will add this information to the methods.**

I noticed that you looked for foraminifera in other intervals than the 8 and 6 samples that you present in Figures 4 and 5. In fact in Section 3.3 you say you analysed 16 samples in LC12. You mention finding a few specimens in some samples. If you found samples to be barren or having too few forams to calculate percentages, it is still very useful to put the number per gram on the concentration column of those figures. It looks like you only looked at the samples within LF1, but I gather that you did more intervals than that, which makes sense as it would aid in determining the marine/lacustrine boundary. Please show all of your data (samples with #/g) and if you did not quantify just say that you saw a trace or very few...so we can see that on figures 4 and 5.

**That's correct – we did look at samples in LF2 and LF3 but with the exception of a few (<10) forams in the surface sediments, they were barren. As recommended, we will capture this information in figures 4 and 5. In addition, the raw data is available here:**

<https://doi.org/10.5285/3d37a409-c1e2-4c25-bdbc-fe495ccff653>

**Also note that the concentration data in figure 5 was incomplete (I mistakenly used an older spreadsheet when plotting this data). For clarification, we analysed 14 (LC12) and 6 (LC7) samples so will amend the text.**

Also on Figure 5 (LC12) there is a barren zone that coincides with the silt peak (that also has the out of stratigraphic order 14C age) but the text, line 232 says the whole interval contains forams. Maybe you should describe the silt layer and its low faunal content within this section to support your later determination of reworking.

**That was an error on our part – we will amend the text to read, 'Benthic foraminifera are present throughout LF1 (370.5-282 cm) with the exception of one horizon at 314 cm, which was entirely barren. The assemblage is dominated by...'**

Figures: overall the figures are quite well drafted. However, the labels on the maps are sometimes hard to read as even in the online versions the labels fade into the background colors. This is true on Figures 1, 2, 4 and 5. Make the labels as large as possible and consider using white labels or a white background.

**OK, we will ensure that the labels are easier to read.**

Figure 12 has a problem in the top panel. The aspects were squeezed so that this part cannot be read.

**Yes, we can make these changes.**

Suggested technical corrections:

L56 change exit to exist. **OK**

L153. Presumably not austral summer? Maybe just use the dates of fieldwork in 2017. **We will add the dates.**

L119. Configuration not configurations. **Thanks**

L123. Suggest you add the glacially fed rivers that enter Blasø to the map (Fig. 1 or 2). **We will add location of glacially fed rivers to Fig. 2.**

L147. Has to had. suggest...had been digested samples were centrifuged...**OK, we will amend this sentence.**

L148. Provide the concentration of sodium hexametaphosphate...and change deflocculate to disaggregate. **OK (conc. was 35%).**

L151. Provide. **OK**

L152. Change is to are. **OK**

L155. Delete 'an'. **OK**

L195. Do you really mean bacteria, phytoplankton and grasses? I was not sure about grasses.

**This was an error on our part, we will delete 'grasses'!**

L233. *Elphidium clavatum* is the accepted name now for *E. excavatum clavata*...see Darling et al., 2016. *Marine Micropalaeontology* 129:1–23. doi:10.1016/j.marmicro.2016.09.001. The name is misspelled on Figures 4 and 5. Suggest you do a search and replace throughout the text.

**Thank you, we will do this.**

L234. Suggest you add in the parentheses about *S. horvathi* (variable but up to 15% below 300 cm). **We will do this.**

L242. Suggest you say 'Most of LF1 (377-248 cm) is dominated by....**OK.**

L245. You might want to add to this statement that the top sample has the greatest # forams per gram...is that because the *S. horvathi* increased?

**Yes that is correct, we will add this information.**

L251. Define TAR. **OK (this is the "terrestrial to aquatic ratio").**

L254, L311, 369. Suggest you add descriptors to your heading. *L1 Paleoenvironmental Interpretation*, or something like that. **We will do this.**

L273. Peaks in the. **Thanks**

L274. Suggest delete 'an'. **OK**

L343. Very rare >2 mm clasts? **Yes, we will amend.**

L431. Silty sand and fine gravels or silty sand and fine gravel.

**The latter – we will change the text!**

L439. Suggest start new sentence after (Hendy et al., 2000). **OK.**

L448. Anomalously? **Yes, thanks.**

L449. Do you think limestone in the catchment will affect bulk organic matter dates?

**Yes – we will add a sentence along these lines in section 4.3, line ~447-448.**

L480. Figure 11b indicates 33 and 22 m asl rather than 33 and 15 m asl. **Thanks! We will revise.**

L492. The foraminiferal fauna. **OK.**

L504. On figure 12 this looks like 10,800 to 8000 years. I spent a while looking at Figure 12 to check the timing. The age intervals are every 400 years which is fairly awkward. If it is not too difficult I suggest making the age intervals work easily for a 2000 year interval...every 500 years?

**Yes, we will do this.**

L505. Core also (OK!); Atlantic Water advection to where? Into the fjord, toward the ice shelf cavity? Grounding line?

**Actually, we should reword to 'AW persisted in Fram Strait between 10.6 and 8.5**

**cal. ka BP'.**

L546. Refer to Figure 12. **OK**

L572. Suggest change switch back to 'return'. **OK**

L576. Span. **OK**

L577. Indicate. **OK**

L527. The glacier is still there but the ice shelf disintegrated? Clarify.

***Yes, that's correct, although the glacier must have retreated inboard of its present position to allow marine water incursions at the western mouth of the lake.***

***We will clarify this in the text.***

L628. The Spalte Glacier is confusing. It looks more like a continuation of 79°N ice shelf. I cannot see well enough on the map Figure 1, but in Figure 12 drawings it looks like the ice shelf enters that area. Can you clarify this?

***The Spalte Glacier was a large floating glacier, and a northern offshoot of the 79N ice shelf. The distinction between the floating part of the 79N and Spalte Glacier is arbitrary, and related to different catchments. However, your point highlights a potential ambiguity, which will clarify in the text. Figure 12f depicts 'recent changes' i.e., the past ~100 years. We will explicitly state this in the revised MS.***

Figures:

4 and 5. foram concentration column. Add all values and title needs to say number per cc. **OK.**

- make a notation of which age is reversed in core LC12. Asterisk? **OK.**

Figure 9. include the key for the fossils. Use larger fonts where possible. **OK.**

Figure 11. add dashed line is grounding line of 79°N Glacier. The yellow star is very very small. **OK, we will make this bigger.**

Are the hatched white polygons sea ice? **Yes, we will add this to the caption**

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