



EGUsphere, referee comment RC1
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Comment on egusphere-2022-970

Anonymous Referee #1

Referee comment on "A High Arctic inner shelf–fjord system from the Last Glacial Maximum to the present: Bessel Fjord and southwest Dove Bugt, northeastern Greenland" by Kevin Zoller et al., EGU sphere, <https://doi.org/10.5194/egusphere-2022-970-RC1>, 2022

The paper presents new and interesting multibeam and sediment core data from Bessel Fjord and Dove Bugt in NE Greenland. It is based on a Msc thesis from 2020 by the first author and the main results have been synthesized in the manuscript. This process has clearly not been easy and there are many things that could be improved. The structure is not clear, and there are many typos and redundant sentences, and it also needs to be updated with the newest scientific literature from the area. However, with some substantial editing it has the potential to become a valuable scientific contribution. My comments below should therefore not be seen as an excuse to reject the paper – rather the opposite – it should be seen as help to improve it.

Major concerns:

1) Both the title and the abstract make a great deal out of this being a study of the southern part of NEGIS. It is not. The main part of the study concerns Bessel Fjord where most of the multibeam data and 2 out of the 3 marine cores are from. Only a minor part of the multibeam data and 1 sediment core is from outside the mouth of Bessel Fjord and could potentially inform about the NEGIS. Accordingly, I suggest that the authors refocus the study to account for the glaciation history in Bessel Fjord where most of data is from their data is from.

2) Several relevant papers are missing and would be very relevant to include that in the discussion:

Pados-Dibattista, T., Pearce, C., Detlef, H., Bendtsen, J., Seidenkrantz, M.-S., 2022. Holocene palaeoceanography of the Northeast Greenland shelf. *Climate of the Past* 18,

103-127.

Katrine Elnegaard, H., Lorenzen, J., Davies, J., Wacker, L., Pearce, C., Seidenkrantz, M.-S., 2022. Deglacial to Mid Holocene environmental conditions on the northeastern Greenland shelf, western Fram Strait. *Quaternary Science Reviews* 293, 107704.

Rasmussen, T.L., Pearce, C., Andresen, K.J., Nielsen, T., Seidenkrantz, M.S., 2022. Northeast Greenland: ice-free shelf edge at 79.4°N around the Last Glacial Maximum 25.5–17.5 ka. *Boreas*, bor.12593.

Jackson, R., Andreasen, N., Oksman, M., Andersen, T.J., Pearce, C., Seidenkrantz, M.-S., Ribeiro, S., 2022. Marine conditions and development of the Sirius Water polynya on the North-East Greenland shelf during the Younger Dryas-Holocene. *Quaternary Science Reviews* 291, 107647.

Davies, J., Mathiasen, A.M., Kristiansen, K., Hansen, K.E., Wacker, L., Alstrup, A.K.O., Munk, O.L., Pearce, C., Seidenkrantz, M.-S., 2022. Linkages between ocean circulation and the Northeast Greenland Ice Stream in the Early Holocene. *Quaternary Science Reviews* 286, 107530.

Larsen, N.K., Søndergaard, A.S., Levy, L.B., Strunk, A., Skov, D.S., Bjørk, A., Khan, S.A., Olsen, J., 2022. Late glacial and Holocene glaciation history of North and Northeast Greenland. *Arctic, Antarctic, and Alpine Research* 54, 294-313.

Smith, J.A., Callard, L., Bentley, M.J., Jamieson, S.S.R., Sánchez-Montes, M.L., Lane, T.P., Lloyd, J.M., McClymont, E.L., Darvill, C.M., Rea, B.R., O'CoFaigh, C., Gulliver, P., Ehrmann, W., Jones, R.S., Roberts, D.H., 2022. Holocene history of 79° N ice shelf reconstructed from epishelf lake and uplifted glacial marine sediments. *Ice sheets/Paleo-Glaciology (including Former Ice Reconstructions). The Cryosphere*

Håkansson, L., Graf, A., Strasky, S., Ivy-Ochs, S., Kubik, P.W., Hjort, C., Schluchter, 2007. Cosmogenic Be-10-ages from the Store Koldewey island, NE Greenland. *Geografiska Annaler Series a-Physical Geography* 89A, 195-202.

3) Description and interpretation of sediment cores

The description and interpretation of the sediment cores could be simplified. Overall, it seems that 2 units would be sufficient to describe the changes in palenvironmental

conditions recorded in the cores i.e., proximal, and distal marine mud. Maybe a third unit comprising the sandy interval in 1289 reflecting Neoglacial re-advance could be considered. Now 6 different facies are presented, and these don't really give an understanding how the cores are subdivided into units and what it means in terms of paleoenvironmental changes. Figure 7 summarize the lithological data, but it is too small to see the details and in includes too much text. The interpretations should be omitted – they are already described in the main text.

The chronology is poorly constrained and based on 5 ¹⁴C ages in 3 cores. It is therefore not appropriate to calculate an accumulation rate and particularly not in the two cores where the chronology is based on a single ¹⁴C age.

There are some inconsistencies in the way ¹⁴C and cosmo ages are reported. Some ¹⁴C ages are reported as ka others as cal ka BP or cal BP. Sometimes the unit is not even given (see minor comments).

4) The discussion is very unfocused. The paper would benefit from a clear structure where A) the first part of the discussion summarizes the main findings in the new study. B) the second part of the discussion should elaborate how the new data ties into the existing knowledge about the glaciation history of the area. Here the comparison with paleoclimate data would be relevant.

Minor issues:

Line 1-3: I would suggest making a title that reflects the study i.e. glaciation history of Bessel Fjord.

Line 12: what does "this" and "its" refer to?

Line 13-17: It is unclear how marine cores from the shelf can be used to determine how the GrIS responded to the HTM. In most places the GrIS was smaller than present during HTM i.e. not located on the shelf. I suggest this is reformulated.

Line 19: It is generally accepted that the Northeast Greenland Ice Sheet is abbreviated NEGIS – not NGIS.

Line 43: change "making it the current largest" too and it is currently the largest

Line 47: Larsen et al2018 is not the correct citation. It is better to cite Joughin et al2001 or Khan et al 2014.

Line 51: Omit Larsen et al2018

Line 60: see major concerns on relevant papers that have relevant information about NEGIS and NE Greenland in general.

Line 67-72: There are more relevant papers dealing with the terrestrial deglaciation chronology that could be used and cited.

Line 85: Move the text concerning the data source to the figure caption.

Line 86: change "black" box to "white" box

Line 87: change "northern East" to Northeast

Line 110: The gravity cores have been mixed up. I (1290) is placed in the inner part of Bessel Fjord – it should be outer coast. The others are also labelled wrongly. Move the text concerning the data source to the figure caption.

Line 137-139: There is more up-to-date literature on the Milne Land moraines. See:

Levy, L.B., Kelly, M.A., Lowell, T.V., Hall, B.L., Howley, J.A., Smith, C.A., 2016. Coeval fluctuations of the Greenland ice sheet and a local glacier, central East Greenland, during late glacial and early Holocene time. *Geophysical Research Letters* 43, 1623-1631.

Larsen, N.K., Søndergaard, A.S., Levy, L.B., Strunk, A., Skov, D.S., Bjørk, A., Khan, S.A., Olsen, J., 2022. Late glacial and Holocene glaciation history of North and Northeast Greenland. *Arctic, Antarctic, and Alpine Research* 54, 294-313.

Line 142: Are the ages cal ka BP, ka BP or ka?

Line 157: The first cosmogenic isotope dating on Store Koldewey was presented by Lena Håkansson. Later more data was presented by Skov and Larsen. See major concerns.

Line 164, 166: cal ka BP

Line 169: no units after age?

Line 211-213: You could consider calibrating the dates with Marine20 and the suggested δR values of Pienkowski et al 2022 Boreas.

Line 241: The yellow color (hill-hole pair) on Fig 4b is difficult to see.

Line 268: Cold-based ice is not very likely under an ice stream where MSGL are formed. It is also suggested that frozen sediments have been dislocated. However, it seems unlikely that the seabed is frozen at 400m water depth. This needs to be elaborated more.

Line 299: The mapped landforms are very difficult to see. Consider making the figure bigger or cut the section into two.

Line 311: Again the yellow colors are very difficult to see and fig. 6b

Line 356-367: Rewrite and simplify.

Line 393-394: It is not clear how subglacial or proglacial processes could have made the microfractures observed in the core. Or did the ice override the sediments after deposition. This should be elaborated.

Line 468-495: The section concerning the ^{14}C dating could be simplified. And the section concerning the sediment accumulation rate should be omitted – it is not scientific sound to make this estimation with so few ^{14}C ages.

Line 483: Remove Calib from table and remove accumulation rates from table (see above).

Line 496-507: this section is not well-incorporated into the description and interpretation of the data. It could potentially be incorporated in the sediment description or omitted.

Line 514-516: This sentence seems misplaced and can be omitted.

Line 526: The last sentence seems misplaced?

Line 530-531: Remove "acted asStokes and Clark) and"

Line 543: This paleogeographic reconstruction should be updated with the newest studies from the area. See list of papers under major concerns. Much of the text is very small (font size) and could be moved to the figure caption.

Line 549-550: Nanok II is not mentioned in Vasskog et al, 2015 – they only discussed the Milne Land moraines. Probably the Nanok moraines correlated to the Milne Land moraines and they date to early Allerød – early Younger Dryas (See Larsen et al.,2022 for discussion).

Line 610-611: "east of Dove Bugt in Store Koldewey.." Rewrite sentence

Line 615: I don't understand why the radiocarbon age from 1309 is a maximum age for the onset of deglaciation. Both the 1309 site and Bessel Fjord could have been deglaciated earlier. There is more than 50 cm of undated sediments below the dated interval in 1309 i.e. the site was deglaciated for some unknown time.

Line 645-649: This is very speculative and not supported by any data from the study. Should be omitted.

Line 653-658: It is not scientific sound to base your interpretation on a linear age-depth model constrained by one date.

Line 657: change believed with demonstrated.

Line 665-666: There are no exposure ages that show that the HTM ended by 5.6-4 ka

from NE Greenland. And Briner does not provide any ^{10}Be ages in the review paper from 2016.

Line 673-688: This section is very speculative and the data to support presence or absence of sea ice in Bessel Fjord needs much more documentation. It is not clear from the result section that the Ca/Fe content is interpreted as a sea ice proxy.