

Response to RC1: “Comments on egusphere-2025-2906” by Renata Giulia Lucchi, 30 July 2025.

General comments

This manuscript investigates the long-term glacial history of the Northeast Greenland Ice Sheet by analyzing a large seismic dataset and sedimentary information from three boreholes on the continental margin. The manuscript reconstructs the ice sheet evolution since ~6.4 Ma corresponding with the first recorded advance of grounded ice masses across the NE Greenland shelf, and the intensification of the shelf glaciation after ~4.1 Ma, potentially linked to Northern Hemisphere glaciation onset.

The manuscript is very well written, and the discussion is nicely developed. I made only minor edit suggestions through the text and some comments to be considered (see attached pdf).

The last paragraph (5.3) of the discussion is more speculative. Nevertheless, the discussion is very well developed and linked to previous studies, providing a series of possible forcing mechanisms to consider for the establishment of the Greenland ice sheet.

[Dear Lucchi, thank you very much for your comments. You will find that all of your comments have been addressed, and most are reflected as changes in the manuscript. Thank you for your help to improve this manuscript.](#)

Highlighted comments

Paragraph 4.2 Seismic Units: When presenting the seismic mega units, please provide through the text an approximation of the thickness in meters next to the s (TWT)

[Thank you, we have made changes throughout the text accordingly.](#)

Pag 18, line 479: What is the time frame here, 7.0–6.4 Ma? Does "multiple glaciations" imply alternating warm periods between glacial events, or were the ice streams continuously present during an overall cold period with alternating periods of ice streams' still stand and reactivation?

Thank you. The text you have highlighted aims to describe the general process under which TMFs form. We have rephrased the text to make this more clear to the reader. To comment on your question: the time frame of stage 1 (MU-1) is not known, but we favour a late Miocene age, possibly coinciding with increases in IRDs in the Fram Strait during the interval 6.4 – 6.0 Ma. We have elaborated on this in the text. By “multiple glaciations” we mean to imply that the TMFs of MU-1 was probably not formed during one single glaciation, but rather multiple glaciations. However, the scope of this study is not to investigate the details of each glaciation. We have rephrased the paragraph to accommodate your comments.

Pag 24, line 662: in support to the statement here, you can consider to add the preliminary report of IODP Exp-403 that documented the presence of IRD through the Pliocene record at sites U1619 and U1620 or, alternatively, the Scientific Proceedings that will be released end of January 2026 (i.e. Lucchi, R.G., St. John, K.E.K., Ronge, T., and the Expedition 403 Scientists, in press 2026. Initial Report: Eastern Fram Strait Palaeo-Archive. Proceedings of the International Ocean Discovery Program)

Thank you for bringing this to our attention. We have added the reference as suggested.

Pag 24, line 684: within the oceanographic factors facilitating the onset of glaciation on the eastern Greenland margin, it is worthy to acknowledge also the cooling influence of the cold Eastern Greenland Current, activated by the opening of the Fram Strait which still contributes to sustaining the eastern Greenland Ice Sheet despite of the ongoing warming trend.

Thank you, we have included this in the text in sections 5.3 and 6, as suggested.

TABLE 1 write TGS and GXT in full in the captions.

We have added the full name of TGS, GXT and AWI in section 3.1 Seismic data.

Figure 2, the patterns used to indicate the presence of silty clay/clayey silt, sandy clay, and dropstones/IRD are too similar. Please follow my suggestion to improve the logs

Thank you, we have made changes accordingly.

Figure 3 and 4, please change some of the white text to black text including the letters labeling the dashed boxes, the scale, and the border of the colored arrows (or avoid the border and use a sharper color for the arrows).

Thank you, we have made changes accordingly.

Figure 6, add “NEG= Northeast Greenland unconformity (-1, 2, 3)” in the caption.

Thank you, we have made the change accordingly.

Figure 7, use red dots to indicate the boreholes. Also please add the location of the main throughs and banks described through the text (WT, NT, SKT, IT-A, etc.)

Thank you, we have made changes accordingly.

Line comments:

52 (Figure 1 caption) change to mbsl instead of Mbsl

Thank you, we have made the change accordingly in all figure captions.

Figure 2a: Please use a white background of the legend in order to use a gray line to indicate the 2D seismic coverage like in the map

Thank you, we have made changes accordingly.

Figure 2b: Too similar patterns, try to differentiate. Perhaps the silty clay only light gray color without pattern, and sandy clay gray with segments but not dots

Thank you, we have made changes accordingly.

228 comment on “Three regional unconformities were identified in this study with time surfaces created for each horizon using a 1 km grid size”: **This goes in the results.**

The meaning of this sentence was to give the reader information on the grid size of the surfaces. We’ve rephrased the sentence to “A grid size of 1 km has been used to create surfaces of the two-way travel time horizons”.

Figure 3: Please use black text instead of white. Black text also for the letters in the dashed boxes

Thank you, we have made changes accordingly.

Figure 3: The arrows are not very evident. Either use a stronger color or a black contour instead of white

Thank you, we have enlarged the white background to make them more visible.

Figure 4: Black text. in the seismic lines heads.

Thank you, we have made changes accordingly.

339 Change to early Pliocene, as in the title

Thank you, we’ve made changes in the text according to your suggestions.

341 This is a bit far from the early Pliocene

Thank you for pointing this out. The age estimated by Hull et al. (1996) are Pliocene to Pleistocene, and not Plio-Pleistocene. Thus, our early Pliocene age falls within the range this rather large age estimation. We have made corrections in the text to clarify this.

356 Please give also an approx thickness in m

Thank you, we’ve made changes in the text according to your suggestions.

366 Please provide also a thickness in m according with the seismic velocity analysis

Thank you, we've made changes in the text according to your suggestions. However, we have chosen to use an average velocity of 2 km/s for the glaciated sediments (section 3.3), which is close to velocities from similar glaciated margins.

Figure 7 Please indicate on the map the location of the main Troughs (WT, NT, SKT) and banks as reported in the discussion

Thank you, we have made changes accordingly.

480 What is the time frame here, 7.0–6.4 Ma? Does "multiple glaciations" imply alternating warm periods between glacial events, or were the ice streams continuously present during an overall cold period with alternating periods of ice streams' still stand and reactivation?

Thank you. The text you have highlighted aims to describe the general process under which TMFs form. We have rephrased the text to make this more clear to the reader. To comment on your question: the time frame of stage 1 (MU-1) is not known, but we favour a late Miocene age, possibly coinciding with increases in IRDs in the Fram Strait during the interval 6.4 – 6.0 Ma. By “multiple glaciations” we mean to imply that the TMFs of MU-1 was probably not formed during one single glaciation, but rather multiple glaciations. However, the scope of this study is not to investigate the details of each glaciation. We have rephrased the paragraph to accommodate your comments.

484 Please report the location in Figure 7a

Thank you, we have made changes accordingly.

499 Please indicate the location on Figure 7b

Thank you, we have made changes accordingly.

503 Please indicate in Figure 7b

Thank you, we have made changes accordingly.

508 Please indicate on Figure 7b

Thank you, we have made changes accordingly.

531 Please indicate in the Figure 7c as well as the other relevant bathymetric features

Thank you, we have made changes accordingly.

662 In support, you may want to add here the preliminary report of IODP Exp-403 that documented the presence of IRD through the Pliocene record at sites U1619 and U1620, or the Scientific Proceedings that will be released end of January 2026. i.e. Lucchi, R.G., St. John, K.E.K., Ronge, T.A., and the Expedition 403 Scientists, 2024. Expedition 403 Preliminary Report: Eastern Fram Strait Paleo-Archive. International Ocean Discovery Program. <https://doi.org/10.14379/iodp.pr.403.2024> or Lucchi, R.G., St. John, K.E.K., Ronge, T., and the Expedition 403 Scientists, in press 2026. Initial Report: Eastern Fram Strait Palaeo-Archive. Proceedings of the International Ocean Discovery Program

Thank you for bringing this to our attention. We have added the reference as suggested.

684 Additionally, consider the cooling influence of the cold Eastern Greenland Current, activated by the opening of the Fram Strait which still contributes to sustaining the eastern GrIS despite of the ongoing warming trend

Thank you, we have included this in the text in sections 5.3 and 6, as suggested.

720 with cold water masses descending the Arctic along the eastern Greenland margin, and...

Thank you, we have made changes according to your suggestions in section 5.3 and 6.