Dear Editor, dear Liz,
many thanks for all the helpful input! Before we present below the point 2 point answers, we'd like to comment on the topic of triangular moulins.

We do agree, most moulin features are not round, but the triangular shape we find in this instance is from our point of view distinct from other drainage fractures. Over the past decade we conducted numerous airborne campaigns over 79NG and Zacharias Isbrae in which we accidentally recorded surface fractures with the airborne camera. All those instances are from their shape different from what we have found at this particular lake. We find very frequent linear fractures with pitted cracks and we also found wide oval shaped drainage locations in areas where the glacier surface is already heavily crevassed (Store Glacier and Zacharias Isbrae). Of course the statistics is still pretty low, as all what we surveyed so far is only a small portion of all lakes, but this particular lake is from out perspective very distinct from others. We do not yet have a very clear explanation what exactly causes the triangular shape, although we found comparable examples in 'surface initiated contact fatigue cracks' (Fig. 11 in https://doi.org/10.1016/j.ijfatigue.2016.12.004). We abstained from discussing such a link before we are more confident, that this is the origin for the triangular shape. We also want to spark the interest in the community to look into their own surveys and data if they find more triangular formed fractures and drainage pathways. This is the reason why we originally suggested this new term gully and why we now want to keep the term triangular in the text. However, we have carefully checked where triangular is absolutely needed and reduced the occurrence by 30%.

Best wishes,
Angelika and co-authors

Revision of ‘Supraglacial lake drainage through gullies and fractures’
Thank you for the revised text and the responses to reviewers’ comments. One reviewer has provided additional comments on the manuscript that I request that you review and incorporate, along with some minor amendments suggested below.
The reviewer raises the new nomenclature of ‘triangular moulins’ . This is a tricky one since it was a compromise term. I think we could revert to simply ‘moulin’ and include a sentence describing the unusual shape, noting the Reviewer’s comments on this. Interestingly, some data I am working on seems to suggest our impression of a moulin as a largely ‘circular’ hole rarely applies, so the triangular shape here may not be that unusual. But if you believe that ‘triangular’ is important to the explanation, I am happy for it to be retained. A compromise may be referring to either ‘triangular feature’, ‘moulin fracture’ or ‘moulin’ – the shape is how you differentiate it on the imagery, and the moulin/fracture describes the functionality. These terms are used in the text already. The discussion is still a little long, especially after the very detailed results, and even with the attempt to signpost in the first sentence it can be tricky to follow. I wonder if you could either condense it, or add two-three subheadings (Surface fractures, englacial fractures, longer-term changes?) in place of the first sentence? I did find the final paragraph very effective.
I look forward to seeing the final revision.
Liz Bagshaw, Editor

Minor amendments (grammar, sentence structure, readability) to be considered in conjunction with the reviewer’s suggestions:
(attention, the line numbers used by the editor are the ones in the diff version)

L16: be consistent with capitalization of southern, northwestern, vs. Northeast. I understand why (NEGIS requires capitalization), but in this sentence I think lower case

We have checked this and "Northeast" should be capitalized as it refers to a specific geographic region.

L16: is the most notable? I would say ‘a notable recent example is’
. Could be further simplified: ‘While the mass loss was most prominent in the southern and north-western parts in the first decade, it has now reached the northeast of Greenland, where floating tongue of Zacharias Isbræ (ZI) disintegrated in 2013 (REFS)’
Done

L302: remove ‘itself’ – ‘drained’ is sufficient
Done.

L305: simplify. ‘The 2021 survey (UWB, ALS and Canon camera, 29-07) showed that the moulin had the same horizontal geometry as in 2019, although the triangular feature has snow cover. Laser scanner data…’
Done.

L315: ‘are piling up’ should be ‘piled up’
Done.

L327: replace the new text ‘triangular moulins appeared’ with ‘no new fractures were visible, but the two from 2022 can be…’ – since you mention the triangular shape in this sentence, no need to have it in the previous sentence.
Done.

L329 – 332: you have an intro sentence at the end of the previous section (‘We will discuss the details of the fracture formation and reactivation further below. ’) and then begin the next section with another intro sentence (‘Next, we present evidence of crack formation in accordance with lake drainage’). Whilst the signposting is very helpful for the reader, I think just one is sufficient.
We removed the one at the end of the previous section.

L343: delete ‘its position is shown as coloured dashed lines’ – this information should be in the caption
Done.

L350: Long-winded, rather than telling us what you are going to do, just do it. For example ‘A comparison of the drainage in 2005 and 2015 (Figure 4b) shows that the triangular feature can be tracked over the years. In 2015, the crack is 2725 m long and the triangular feature has a side length of 250–300 m. Both features are still well visible in ALOS-2 imagery from 2016-12-18 as surface reflectors , 17 months after their formation. The high-resolution WV imagery from 2020 also shows a triangular-shaped feature of similar size (170–230 m side length), although strongly eroded, and it is still identifiable in 2022, seven year after its formation (Fig. 4). By 2021,
the crack-line visible in 2015 has disappeared, and the triangular feature is slightly off the trajectory between regions A–B, 200–500 m further south. Most importantly, it now sits at higher elevation, at the margin of the lake’s middle branch, and is thus unlikely the main drainage channel. ’
We tried to followed the previous advice not to jump straigth into, but to introduce the next step with an intro. We are happy to follow the new advice and have changed this paragraph accordingly.

L364-365: a stranded sentence, suggest joining to the previous paragraph.
Done.

L366: ‘The crosses in Fig. 8 denote principal stress directions’
– this information is in the caption so can be removed from the main text. Instead ‘The cracks predominantly match the principal stress directions (calculated by inverse modelling, as in REF, Fig. 8), indicating the dominant fracture mode is tensile (mode I). Close inspection of the surface of the lake ground shows narrow and potentially shallow cracks to exist in the area inside and outside the lake, and also
the presence of cracks that are not aligned with the principle direction (Fig. 8d).
We have changed this paragraph accordingly.

L370-375 is a little confusing. Suggest: ‘This is explained by the formation of tiny cracks at a 45° angle, which are formed in the main shear direction (similar to Humbert et al. 2023). Once these cracks propagate at 45°, they form a connection from one row of narrow cracks to the next, where the crack propagation follows the main principle direction for a while until it again jumps onto the 45° and so on’
Many thanks for the suggestion! We have changed this paragraph accordingly.

L403: Agree with reviewer that ‘Englacial features’ or ‘Englacial signals’ would be a better title for this section
We have changed it to 'Englacial features'

L410: lake base rather than ‘lake ground’?
Yes, lake base is also fine. In the literature also lake bottom is used.

L426-428: could be removed without detriment, or refer to ‘T1’ in the text to relate directly to figure
We have removed this text.

L441: tenses not quite correct in this new sentence: ‘These radargrams give some insight into englacial drainage pathways, so now we must consider where water masses might be stored beneath the glacier, and how this varies in time’ . It should also be joined to the next paragraph, rather than left stranded here.
We have corrected the tense in the sentence and moved it to the next paragraph.

L480: ‘The discussion is structured by’ rather than ‘we are structuring the discussion’ . Suggest ‘We begin our discussion with an evaluation of the evolution of the lake, followed by an analysis of the surface and englacial fractures, before attempting to understand their long-term change and the climate context. ’ , or including subheadings as suggested above.
We have considered the subheadings, but the subsections would be so imbalanced in length, so we decided against this.

L483: ‘areal extent remained lower’ – unclear whether this means that the lake area is lower in elevation, or whether the surface area extent is reduced.
Has been changed to 'the size of the lake remained lower'

L484: unclear what is meant by ‘lower load’
We have rephrased this to 'lower mechanical load'

L485: sentence is very confusing: ‘the fractures are for longer (does this mean longer in time or space?) in the topographic low and with that in the area of highest water pressure at the lake ground’ – can you rephrase this?
Indeed 'for a long time' is the correct statement. We have changed this accordingly.

Reviewer comments

General Comments

17 years after Das, the title ‘Supraglacial lake drainage through fractures’ is perhaps overly general and not good at communicating what is unique about this study and its contribution to the literature. Is there a better title that can communicate the multi-modal and multi-annual/long-term nature of the observations?
This is a good point. We have found a new title.

In the response to reviewers and in the text, there is now a focus on ‘triangular moulins’. I am slightly confused as to why the triangular component is significant here. It seems to imply that there is something distinct and important about the triangular shape that is not found in alternatively-shaped drainage moulins (Das, Doyle, Chudley, etc). These other moulins are not triangular but are still distinctly angular when fresh. Is it not just a coincidence as to how the final shape appears? It is interesting that multiple generations of moulins from this lake appear to be triangular, but this manuscript doesn’t appear to address (i) what might enforce this; and (ii) why it is important or distinct cf. other shapes. My guesses are that either the triangle forms due to the intersection of a second fracture, orthogonal to the first (Fig 4a, 8a, 9) or that ongoing water input into the moulin thermomechanically erodes a gorge-like feature orthogonal to the initial crack (Fig 5a, 7a, 8c/d, etc). But I’m not sure whether this is particularly important to necessitate any distinct terminology.
There has always been a focus on the triangular shape of the moulins, but they were denoted by us gullies. This was not well received by the reviewers and we had to change this to standard terminology and this is why triangular moulins, triangular moulin fractures appear in this version. Indeed, the shape is distinct – very distinct. Which is why we wanted to introduce a new term. No, it is not just a coincidence. We have surveyed numerous other lakes and in none of those cases a similar shape is found. Just last summer, we surveyed the lake in Chudley’s paper and the fracture pattern is very different.

Minor Comments (attention, the line numbers used by the reviewer are the ones in the new manuscript not the diff version)

L17 - “Zacharias Isbræ” - why not Zachariae Isstrøm, as is more common in the literature? Interestingly, some light googling appears to suggest that most references to Zacharias Isbræ come from literature originating from this group. I am genuinely open and interested to know if there is something this group knows with regards to the proper naming of ZI that others do not - certainly, this has happened in the past!
We have no background in linguistics and happy to change this to Zachariæ Isstrøm (done). It definitely obeys more characteristics of an outlet glacier (bræ) then an ice stream (isstrøm), but if the community likes to call an outlet glacier an ice stream, we won't object this. In this case, it would be worth to consider the actual correct form for Zachariae written as Zachariæ.

L40 - ‘tenths of metres’ - perhaps ‘tens of metres’?
Done.

L76 - ‘mumulti-chromatic0.3’
Done.

L78 - ‘screened’ - perhaps ‘manually quality-assessed, with poor-quality/cloudy images

removed' for clarity?
We have rephrased screened.

L79 - Was the SNAP toolbox actually used by the authors, or was for processing an existing data source (Copernicus Browser, Google Earth Engine, etc.)? If the latter, perhaps it's preferable to simply state where the data was sourced.
Yes, the SNAP toolbox was used by the lead author.

L132 - Under section 2.3 (and before section 2.3.1), it might be nice to have a top-level summary stating general information about the aircraft mission, flight paths, flight dates, etc.
We inserted some top-level summary, although this is counter productive in terms of shortening the manuscript and the request to make this easier to read. The dates of the relevant survey flight were anyway given in the respective figures. We don't agree to insert another figure as in the overview figure 1 the profile sections of the relevant radar data is shown. We refer to the online AWI radar data viewer, were all profile lines are shown.

L134, 148, 149, and perhaps elsewhere - repeated instances of 'gegeoref' as an error. A find-and-replace issue, perhaps?
Apologies - corrected.

L216 - 'Ice-Sheet' > 'Ice-sheet', and perhaps also include 'ISSM' in brackets, as an acronym many might be more casually familiar with.
Done.

L235-236 - 'One can constrain the initiation of this lake' - perhaps reword as 'No lake was observed to form in the observational data until…', which more explicitly states the evidence (if this is indeed the case)
We have rephrased this to 'Although the data coverage in the 1980's and 1990's is sparse, no lake was observed to form in the observational data until 1995.'

L239-240. Was there no observed filling between 2007-2011? This might also be worth stating explicitly..
We even have a table (Tab. 2) that states this explicitly.

Fig 4 - I had assumed each of the sequential colours in panel b is indicative of one year passing, but this isn't the case (there are only enough lines in the viridis colorscheme to get us to 2020). Perhaps these need individually labelling?
The lines are now labelled with a date.

Fig 8 - RE: my previous comment about coloring the crosses. As someone color-deficient myself, I appreciate that the author's concern for color-blind interpretability, but my critique was primarily about struggling to differentiate the contrast of the two directions. If the authors do not wish to switch to colors, would is be possible to make the darker cross slightly darker and the lighter cross slightly lighter?
We have changed the crosses into a coloured version.

L357 - and elsewhere. This is a long paper - currently on page 23! - that incorporates many methods, and by this point I was beginning to lose track of the purpose of some of the approaches. The purpose of the modelling is not introduced in the intro, methods, nor here, so I was at a loss as to why it would be important to 'evaluate the shape and size stability of englacial channels'. Although it might be strictly considered discussion, I wonder whether it would be possible to have a small introductory remark (e.g. "In response to [...] it is necessary to establish [...]. Hence, we…"). I would recommend this for all sections, not just this one - the next section (3.4 Moulin refilling) was another moment where I found myself

wondering why this analysis was being done. Although the discussion should make all this clear, in this longer paper some additional ‘signposting’ would be beneficial to keep the reader on track! (L430/Section 3.7 actually does this well).
We do not agree here. The purpose of modelling is clearly stated in the introduction: ‘We incorporate viscoelastic modelling as a case study to understand if and how drainage pathways close over time.‘ and moreover the type of modelling is introduced in an entire paragraph, that was even considered to be not necessary by reviewers before.

Section 3.5 - This section is called ‘Englacial channels’, but nowhere in the text are the englacial features identified as channels. Is there anything that could be made explicit that it is correct to interpret these as channels and not as e.g. (water-filled) fractures, or static perched englacial water bodies?
We have renamed the section to Englacial features.