

Response to Reviewer #1

The authors present a time-varying inventory of ice-marginal lakes across Greenland that extends a past static 2017 inventory. The authors rely on this earlier work heavily for the present methods, but the methods are generally well described. However, the authors treatment of icebergs in the lake was unclear in the current version, which could have significant implications for the interpretation of lake surface temperature and area results described here. While I described several “major” issues below and numerous minor points, I consider my comments to reflect a suggestion of “minor revisions”, as everything can be addressed by text better describing methods, clearly acknowledging potential issues/data artifacts, and a few new analyses of the existing inventory (rather than anything requiring revision of the inventory itself).

Thank you for your feedback and comments on the revised manuscript. We have addressed these minor revisions below, of which we highlight the main updates here:

1. The average lake surface temperature is now presented with box plot analysis in order to provide a better evaluation on data trends and data variability
2. The rate of lake area change is updated with linear regression slope calculations, which provides valuable insights into the relationship between the rate of change and lake size
3. Clarification on iceberg removal from the average lake surface temperature estimates has been provided, which is performed implicitly through strict scene acquisition selection and the removal of temperature estimates that do not represent open-water conditions (i.e. values below 0°C)
4. Median and total (summed) lake area statistics have been incorporated into the manuscript to improve the overview of the inventory series, and provide more insight into the regional- and annual- comparisons
5. Additional technical details have been provided to clarify how lake delineations from multiple classification methods are merged. In addition, an example tutorial of this merging (in the form of a Jupyter Notebook tutorial) is now provided with the source code used to produce the inventory series

Please find more information regarding these changes below, along with individual responses to the line-by-line feedback.

Major comments

Sec 3.2: from this section and inspection of Figure 5, it doesn't seem like you are masking out icebergs from your water temperature estimates, is that right? If I'm wrong, please try to more clearly state this. If you aren't masking icebergs, how much of an effect could this have on your temperature estimates?

The dataset represents an annually averaged inventory series designed to ensure high confidence and full spatial coverage across Greenland. Water temperature estimates are derived from the

detected lake extents for each inventory year. These extents are based on averaged scene acquisitions from July and August to minimize the likelihood of iceberg and ice cover presence.

The classification of icebergs and ice cover across lakes in the Arctic remains challenging (e.g. Carrea et al., 2025; Dye et al., 2025), and no robust, transferable classification currently exists for the entire region. To address this, we adopt an alternative approach by removing temperature estimates below 0 °C, as these do not represent open-water conditions. This effectively limits the influence of icebergs and ice cover on the derived water temperature estimates.

We acknowledge that explicit masking of icebergs and ice cover would further improve temperature accuracy. We therefore identify this as an area for future work, starting with detailed analyses of lake surface temperature evolution at selected sites or regions. However, implementing such masking at a Greenland-wide scale is currently beyond the scope of this dataset.

To clarify this, we have elaborated on the approach to reducing the influence of icebergs and ice cover in the corresponding methodology section (Section 3.2 Summer water surface temperature estimation):

“A summer average water surface temperature estimate was derived using this approach, calculating an average, maximum and minimum water surface temperature value for each lake extent over each inventory year, along with the standard deviation. Scenes were filtered by a maximum cloud cover of 20%, with acquisitions limited to the month of August to reduce the probability of ice-covered lake conditions. Lake extents were cropped by a border pixel (i.e. 100 metres) to reduce the impact of edge effects. All unrealistic estimates below freezing (i.e. < 0 °C) were removed, therefore reducing the influence of icebergs and ice cover on the water temperature estimates.” (Line 193-198)

In addition, we have added information to the corresponding error estimate section (Section 5.4 Lake surface temperature error estimation) to outline the scope of the methodology and discuss the handling of icebergs and ice cover:

“In addition, the influence of ice presence is limited based on the selection of strictly summer scene acquisitions and removing temperatures below 0 °C. In future work, icebergs and ice cover could be explicitly removed before a temperature estimate is derived to reduce the influence of their presence. This is currently beyond the scope of the dataset given the challenges with classifying the presence of ice on lakes across large regions in the Arctic (e.g., Carrea et al., 2025; Dye et al., 2025).” (Line 339-346)

L243: Do you have any idea of the prevalence of false positives vs false negatives? If I understand this sentence correctly, you are taking data from a false positive rate (i.e., automated method says there's a lake, but there's

not) and are then using this value as a uniform $\pm$ error. But do you know if the method misses lakes just as often as it makes them up? It seems like this could lead to substantially different errors on the positive vs. negative sides.

In our analysis, all lakes were manually identified and mapped as point locations, with these manually verified data points forming the foundation for the error estimate. The automated classification method is designed to be robust, with no false positives (lakes incorrectly identified by the automated method). This is ensured by a thorough manual verification and intervention process that removes any misclassified lakes from the dataset. Therefore, the automated method may only exclude lakes from the inventory (i.e., false negatives), but it does not introduce any false positives.

The error estimate of ± 809 lakes (36%) in the manuscript represents a conservative lower bound. This underestimation primarily reflects false negatives, where lakes are missed by the automated method. It is also important to note that the undercounting is partly due to the size threshold (lakes smaller than 0.05 km^2) used in the automated classification, which excludes smaller lakes from the dataset.

Given this, we agree that the error estimate should be described as a conservative lower bound rather than a uniform error estimate. We have updated the text to reflect this:

“Across all inventory years, 4543 ice-marginal lakes were manually identified in total, of which 2915 (64%) are captured by the automated classification approach. This forms an abundance error estimation of ± 809 (36%), which reflects the undercounting of lakes by the automated classification. However, manually classified lakes include those under the size threshold (i.e. $< 0.05 \text{ km}^2$) adopted in the automated classification approach. The under-estimation of ice-marginal lakes within the inventory series therefore, in part, reflects smaller lakes that are removed from the dataset automatically due to the minimum area filtering. Therefore, the error estimate reported is a conservative lower bound, which reflects the underestimation of ice-marginal lakes due to false negatives (i.e. where lakes are missed by the automated classification method).” (Line 322-328)

Also, it would be good to have an estimate of error in lake area and its change. I imagine the error in lake area is much smaller (in % terms) than the error in number that you discuss here. Presenting both of these errors could allow you to say, “while absolute number is somewhat uncertain, uncertainty in lake area change is small (if true), suggesting that the lake number error is primarily attributable to varying detection of small lakes”. That would help bolster the utility of this dataset, which I imagine could be undermined by only reporting the $\pm 36\%$ error in lake number.

An estimate of lake area is included in the manuscript that addresses this comment. Specifically, extents classified with the SAR and multi-spectral methods provide a proxy for estimating error by comparing extent variability. On average, there was a difference of 1.54 km^2 (median: 0.17 km^2)

between SAR and multi-spectral delineations. When all lake areas were summed and compared, there was a total lake area error of 774.94 km². This error propagates according to lake size, with lakes over 5.00 km² having a total error of 405.98 km² while lakes under 0.10 km² had a total error of 1.89 km². The reported abundance error estimate (± 809 , 36%) is substantially larger. Therefore, as you say, "while absolute number is somewhat uncertain, uncertainty in lake area change is small, suggesting that the lake number error is primarily attributable to varying detection of small lakes". This was added to the manuscript based on feedback from a previous reviewer, which is presented in Section 5.3 (Lake size error estimation). The reported error estimate for lake extent/area includes a table summarising the error propagation with lake size (Table 4).

Figure 3: For bottom plots > the average lake area is far noisier than I'd expect given the many lakes being used to compute these averages. What do you attribute these large changes to? To me, the first thing that comes to mind is data processing artifacts like large lakes being split into multiple pieces in some years. Without a commentary on what underlies the high variability, it is hard to know how much to trust it as a physically meaningful value vs. data noise.

In connection with previous reviewer feedback, we attribute the “noise” in Figure 3 to using mean (average) statistics, which are largely influenced by outliers (e.g. large lakes such as Romer Sjø). We now present median statistics to address this concern, and provide a more robust diagnostic for our results and analysis. Total (summed) lake area and median lake area now included in Figure 3, where the total ice sheet lake area and total PGIC lake area are provided alongside lake abundance and median lake area. In addition, the associated text has been updated in Section 4.2 (Lake surface extent) describing changes in total lake area and median lake area across regions and through time (Line 222-228).

With regards to processing artefacts, we demonstrate that such artefacts are largely removed from the dataset in response to concerns on variations in lake abundance (L168-178). Specifically, an intersection routine is performed to remove processing artefacts, where lakes are grouped consistently across all inventory years. This is to combat cases where a lake separates into two water bodies – in our production pipeline, such instances will still be classified as one lake across the inventory series.

Figure 5: From looking at this image, it doesn't seem like you're doing any hole filling to remove icebergs floating in the lake? This seems like it could impose substantial variability in a lake's area following large calving events > can you comment on this somewhere?

This is correct. We do not perform hole filling, as these areas may represent both consistent features (e.g. islands) and transient features (e.g. icebergs). Applying an automated hole-filling routine could therefore introduce additional errors by artificially modifying lake extents. Instead,

we have chosen to retain the natural variability observed in the classified lake boundaries, acknowledging that iceberg presence may contribute to short-term variability in lake area, particularly following major calving events. We now clarify this in the corresponding results section (Section 4.2: Lake surface extent):

“The lack of a strong trend could reflect the high climatic variability across Greenland given its large latitudinal range. It could also be related to variability in lake contact with the ice margin over time, and/or varying iceberg presence which is not considered in the SAR and multi-spectral classification approaches.” (Line 237-239)

The caption in Figure 5 has also been updated to described what holes in the polygons shown can represent:

“Figure 5. Examples of lake morphology change, and the corresponding evolution of ice termini morphology, from the ice-marginal lake inventory series. These examples highlight basin margin retreat (a), peripheral margin retreat (b), bilateral margin retreat (c), and focused margin retreat (d). It is noted that the example from (a) is a lake with persistent ice cover throughout the summer season. Holes in the lake delineations are attributed to consistent features, such as islands, and transient features, such as icebergs. The background satellite imagery presented is from a Sentinel-2 10 m 2022 mosaic (Styrelsen for Dataforsyning og Infrastruktur, 2024). The base layers for the insert map plotting are from QGreenland v3.0 (Moon et al., 2023)”

Figure 6: Given the high noise level here, some measure of uncertainty/variation (perhaps interquartile range) would be helpful for ascertaining whether the plotted changed in the mean are due to real variation vs. noise. To me, this data seems like it would be better shown in box plot (or violin plot) form, so we could get some sense of the distribution of data, which is not easily grasped at present (aside from seeing that there is a lot of variation from lake to lake).

We have updated Figure 6 to include box plots that show the median and interquartile ranges (25th–75th percentiles) of lake surface temperatures for each inventory year. This revision helps better represent the distribution of the data and the variability across the different lakes. The addition of these box plots provides a clearer picture of the data variation and allows for more precise evaluation of the trends.

Upon examining the box plots, we observe that the interquartile ranges and the overall distribution of lake temperatures remain relatively stable across the inventory years. This suggests that there have been no major shifts in data collection methods or sample size that could have introduced substantial variability. While the figure shows some fluctuation in lake surface temperatures, no clear long-term trend in the average temperature is evident. However, there is a notable anomaly in 2018, where the average lake surface temperature drops to its lowest value (3.8°C). This anomaly could reflect a real environmental influence or climatic event; however, we

acknowledge that it is also possible that this could be a data processing artefact. Further in-depth analysis would be required to determine whether the anomaly is genuine or an artefact. However, as this manuscript focuses on dataset description, this kind of detailed analysis is beyond the scope of the current study.

We have highlighted this when discussing the Figure in Section 4.3 (Lake surface temperature):

“The median lake surface temperature follows a similar trend, fluctuating between 3.0 °C (2018) and 4.4 °C (2023). Fluctuations year on year vary, with instances of lake temperature being lower between annual time steps (e.g. from 4.5 °C to 3.8 °C from 2017 to 2018), higher (e.g. from 4.8 °C to 5.3 °C from 2022 to 2023), and remaining consistent (e.g. 4.8 °C for 2021 to 2022). Overall, there is no evident trend in average lake surface temperature across the period. However, there is a notable anomaly in 2018 which could reflect a true climatic event but needs to be investigated further.”

Additionally, the caption to Figure 6 has been updated to describe the box plots:

“Figure 6. Average lake surface temperature estimates from the month of August at each inventory lake for each inventory year (2016-2023) (grey). The average of all lakes (black) is the sum of all lake averages divided by the number of lakes, corresponding to the values reported on the plot. Boxplots (blue) indicate the median and the interquartile range (25-75%), with the shaded band representing the variation across the annual interquartile ranges...”

Minor comments

L39: The Shugar paper doing global ice-marginal lake mapping made an estimate for meltwater retention in lakes > it should probably be mentioned even if there are reasons why the estimate is imperfect (that can also be mentioned)

Done. We have highlighted the potential impact on terrestrial meltwater retention, in reference to Shugar et al. (2020):

“With continued retreat of the Greenland Ice Sheet under a warming climate, ice-marginal lakes are expected to become more abundant, larger and warmer; and will likely amplify lacustrine-driven proglacial melt rates, GLOF events, and terrestrial meltwater retention (Carrivick and Tweed, 2016; Grinsted et al., 2017; Shugar et al., 2020; Carrivick et al., 2022; Dye et al., 2021; Dømggaard et al., 2023; Lützow et al., 2023; Rick et al., 2023; Veh et al., 2023; Holt et al., 2024; Zhang et al., 2024).” (Line 38-42)

L73: Is this the GLO90 DEM, or what static DEM are you referring to?

The static DEM is in reference to the ArcticDEM 2-metre mosaic, which is used in this study to perform the topographic sink classification of ice-marginal lakes. As suggested in the next comment, Section 2.2 has now been moved and integrated with the relevant methodology sections. As a result, the DEM dataset is first referred to in Section 3.1.3 (Sink classification) now, removing this ambiguous reference.

Sec 2.2: I am not sure if this section is required by ESSD, but I personally didn't get much out of it (think most will be repeated later in more detail?) and think the whole thing could be deleted. Otherwise, the utility/value of this section should be made clearer.

Section 2.2 (Data sources and acquisition) is not specified in ESSD's requirements, but data sources/acquisition have to be clearly outlined, hence why we chose to include the section. We understand that there is repetition here with the subsequent methodology sections though (Sections 3.1-3.1.5); specifically regarding data sources and products used in the classifications. Therefore, we have chosen to merge Section 2.2 with Section 3.1 (Methodology), and subsequently editing to remove deprecated information. Table 1 has been kept as a simple summary of all data sources and acquisitions (and now referred to as Table 2).

Table 1: I suspect you mean 20 and 30% cloud cover limit across the whole image, not on some kind of pixel-wise basis > is that correct? It could be worth spelling this out

In the case of both Landsat 8/9 and Sentinel-2 data sources, cloud cover across a whole image is used in this filtering routine. In the Sentinel-2 imagery metadata, it is specifically referred to as a granule-specific cloudy pixel percentage for a scene footprint. This information has been added as a footnote, with reference to both cloud cover filters outlined in the table:

"^a Cloud cover percentage refers to the granule-specific cloudy pixel percentage for the individual scene footprint."

L129: It is not clear to me what you mean by "where positive classifications adhere to all thresholds" > please reword or clarify

This means that a pixel is retained as water (i.e. a positive classification) only if it satisfies the threshold criteria for all five spectral indices simultaneously. This was adopted as a conservative classification approach to minimise the risk of false positives. This has been clarified in the text, updating the ambiguous statement:

“Thresholds for the indices were chosen based on previous studies of ice-marginal lakes (How et al., 2021; Shugar et al., 2020), where a pixel was classified as water only if it met the threshold criteria for all five indices.” (Line 136-137)

Table 3: It would be nice to include the names of each band (e.g., “B2 = blue”) in the caption for people less used to working with Sentinel data. I think maybe you are saying that it is considered water if it’s less than that threshold value?

That’s a good idea, so a reader does not have to go to other resources to find the band information for Sentinel-2. Band names and spatial resolutions have been added as a footnote for the table:

“aB2 = Blue (10 m); B3 = Green (10 m); B4 = Red (10 m); B8 = Near-Infrared (NIR) (10 m); B11 = Shortwave Infrared 1610 nm (SWIR1) (20 m); B12 = Shortwave Infrared 2190 nm (SWIR2) (20 m).”

L168-178: Do you have a sense how much of this variation in lake number is due to processing artifacts (e.g., one lake classified as two in some years due to data issues) as opposed to physically meaningful variations? It seems like you could do some kind of intersection/spatial join to test this.

An intersection routine is performed in post-processing on the entire inventory series to eliminate processing artefacts, such as the example you describe. Lakes are grouped consistently across all inventory years. In cases where a lake separates into two water bodies, it will still be classified as one lake across the inventory series. This is summarised in the bulletpoints in Section 3.1.4 (Inventory compilation), which summarises the post-processing curation steps. We have added the following passage to clarify that this curation includes an intersection routine to remove processing artefacts:

“- Assigning common lake identifications in instances where a lake is composed of several bodies/polygons. This is supported by automated intersection analysis, where identifications are initially defined as overlapping water bodies across all inventory years” (Line 168)

L195: It is interesting that many more lakes shrunk in size > this seems at odds with what is seen in many areas. Are you doing this analysis on a last year-first year basis? This would make your results really sensitive to noise in those years. Have you tried doing a linear fit to all lake area data at a site and making this threshold based off a rate of change rather than an absolute change? That seems like it would be more resistant to noise. Regardless, do you have any physical interpretation of why shrinking lakes are more common? Maybe this comes later.

Lake area change trends for individual lakes (presented in Figure 4) are determined on a last year-first year basis. However, we understand that this is not a robust measure of the rate of change in

lake area across the inventory series. We have therefore adopted a linear regression slope calculation in the revised manuscript to provide an improved analysis of the rate of change in lake area. This shows that 83 lakes exhibited growth between 2016 and 2023, 240 lakes experienced a decline, and 1373 lakes exhibited no significant change (i.e. ± 0.05 km). This is an interesting finding, as analysis of these lake groupings show that the largest rate of area change is observed in the largest lakes in the inventory series. The majority of the “stable” lakes are the smallest lakes in the inventory series. Because of this, small and unchanging lakes account for a much smaller proportion of the total ice-marginal lake volume compared to the larger, more dynamic lakes. It is therefore likely that the regional statistics on lake area change are more influenced by shifts in the largest lakes than by trends across all regions and lake sizes. Figure 4 has been updated to include statistics from the linear regression analysis, and the associated text has been updated also:

“Overall, the rate of change in lake area could be analysed across 1696 lakes in the inventory series, representing 31% of all mapped lakes. Of these, 83 lakes showed growth between 2016 and 2023, with an increase in area of greater than 0.05 km^2 per year, while within 240 lakes experienced a decline, with a decrease in area of greater than 0.05 km^2 per year. The remaining 1,373 lakes exhibited no significant change, with area variations limited to $\pm 0.05 \text{ km}^2$ per year (Figure 4). The largest rate of area change was observed in the larger lakes. The average area of lakes that expanded or contracted was 6.18 km^2 and 7.77 km^2 , respectively, with a total combined area of 2378.75 km^2 . In contrast, the average area of lakes that remained stable was much smaller, at 0.41 km^2 , contributing a total combined area of 560.39 km^2 . Therefore, while the majority of lakes experienced minimal changes in area, suggesting stability in size, they account for a much smaller proportion of the total ice-marginal lake volume compared to the larger, more dynamic lakes. It is likely that the regional statistics on lake area change are more influenced by shifts in the largest lakes than by trends across all regions and lake sizes.” (Line 261-270)

In addition, a similar concern was raised in the previous round of reviews, and as a result, total (summed) lake area and median lake area are now included in Figure 3, where the total ice sheet lake area and total PGIC lake area are provided alongside lake abundance and median lake area. In addition, the associated text has been updated in Section 4.2 (Lake surface extent) describing changes in total lake area and median lake area across regions and through time (Line 235-239).

Sec 4.3 (related to Figure 6 comment): please discuss if icebergs are masked during temperature estimates. If not, it is unclear what these data mean. Also, have you analyzed lake temperature trends (or year-to-year temperature variability) on a lake-by-lake basis? This seems like it would add a lot to this section. As is, it is a little unclear what the lake surface temperature adds to the story here.

Water temperature estimates are derived from averaged scene acquisitions between July and August to minimize the likelihood of iceberg and ice cover presence. In addition, temperature estimates below 0°C are removed to limit the influence of icebergs and ice cover. Please see the

major comments for more details, and an outline of how we have addressed this in the manuscript.

Based on previous reviewer feedback, we have now included an additional figure (Figure 7) to demonstrate lake temperature trends. Specifically, Figure 7a shows spatial trends across Greenland and highlights a latitudinal trend in lake temperatures where the northern regions (NO, NW and NE) hold lakes with cooler surface temperatures (between 0 and 4 °C) on average compared to the southern regions (SW and SE). Figure 7b shows temporal trends in lake temperature, grouped by lake size. The trend signifies a possible link between lake size and the rate of temperature change, where the smallest lakes ($\leq 0.5 \text{ km}^2$) exhibited consistent surface temperatures across the inventory years whilst the largest lakes ($5.0\text{-}150.0 \text{ km}^2$) experienced the largest temperature change, cooling by an average of 0.5 °C. Lake temperature trends and Figure 7 are included in Section 4.3, following the description and discussion around Figure 6.

L229: I imagine this is described in more detail in How 2021, but it is unclear in the current manuscript how the different delineation methods are incorporated. How do you blend the datasets when they have inevitably somewhat differing shapes? In general, how do you choose whether just one or multiple methods are used to delineate a given lake?

The ice-marginal lake inventory series dataset includes all successful delineations to ensure full transparency and provide users with flexibility in how they apply the data. For the analysis of lake area presented in this study, common water bodies (i.e., those classified by more than one method) are merged based on their lake identification number to form the maximum possible extent. This merging is performed automatically and consistently using the “dissolve” function from the *geopandas* package, which unions all geometries sharing the same lake identification number and aggregates their associated attributes (Kelsey et al., 2020). This information has now been added to Section 3.1.4 (Inventory compilation), so that it is clear how the dissolve is performed:

“For the purpose of the lake abundance and area analysis presented subsequently, common water bodies (i.e. classified with more than one method) are dissolved based on lake identification number to form the maximum possible extent. Geometries with the same lake identification number are firstly merged into a single geometry using a union join, and then all geometry attributes are aggregated and combined (Kelsey et al., 2020). This is performed in an automated and consistent manner, where all successful classifications with the same identification number are dissolved in all instances.” (Line 174-178)

Alongside the dataset, we provide the production pipeline which includes this routine (<https://github.com/GEUS-Glaciology-and-Climate/GrIML>). We have now included an example tutorial of how the dissolve routine is used in the ice-marginal lake inventory series and the

expected output: https://github.com/GEUS-Glaciology-and-Climate/GrIML/blob/main/tutorials/dataset_tutorial.ipynb. We have updated the Code and Data Availability section (Section 8) to highlight these tutorials to the reader:

“The production code for making the inventory series is openly available at <https://github.com/GEUS-Glaciology-and-Climate/GrIML> (How, 2025a; b). It is distributed as a deployable and version-controlled Python package, including Jupyter Notebook tutorials on how to run the pipeline and basic handling of the dataset. If the production code is used or adapted, then we ask for a reference to be included in publications.” (Line 442-445)

Sec 6.1: I think this is all true, but much applies to a time static lake inventory, so it might be useful to better articulate what having the time variation adds here.

There are many potential applications of the dataset as a static inventory; however, we have now clarified in Section 6.1 how the time-varying nature of the dataset provides additional analytical opportunities beyond those available from a single time step. Specifically, we highlight that the inventory series provides a temporal dimension that is critical for furthering the understanding of dynamic systems, such as glacial hydrology. These clarifications have been added to the beginning of Section 6.1 to better distinguish between static and time-varying uses of the dataset:

“The inventory series presented here is the first step to quantifying the terrestrial storage of meltwater, and how it changes over time, which would be highly valuable for refining estimations of the future sea level contribution of the Greenland Ice Sheet and surrounding PGICs. The dataset extends the value of a single, time-static inventory by providing a consistent, multi-year record of lake evolution. This temporal dimension enables analyses that capture lake variability and persistence through time. Tentative findings have been outlined...” (Line 354-358)

Response to Reviewer #2

The manuscript has been substantially improved and previous reviewer comments have been thoroughly dealt with (thanks for the detailed responses). Whilst there are some uncertainties that are not ideal, these have been minimised to a suitable level given the complexities of identifying dynamic variable targets at an almost continental scale. The multi-annual ice marginal lake inventories will be very valuable to glaciology, limnology, ecology and wider resource/hazard management across Greenland. Given the climatic variability and increased warm events these datasets will continue to gain importance and can hopefully be extended back to 2002 to give a longer time assessment. It is imperative to publish these multi-annual inventories now given the pronounced changes around Greenland and I fully support publication. I look forward to future modifications of the methodology and extensions of the time series, which will continue to push the science forward.

Thanks you for your feedback and comments on the revised manuscript. We appreciate the time and effort taken to provide this second round of comments, which we have answered. These changes largely consist of additional clarification and editing to better convey insights into the dataset.

Minor comments

Line 231 – 233 Slightly confusing at the moment with the term ‘in general’– maybe put ‘in the whole inventory’ and you could add a sentence starter;

‘When lake size is subcategorised by contact with the main ice sheet or PGIC then...’

Maybe also worth adding a sentence explaining why this is important.

The sentence has now been changed, removing “in general” and adding a variation on the suggested opening:

“When lake surface extent is subcategorised by region then the NE region holds the largest lakes with a median lake area of 0.34 km² (mean: 1.63 km²).” (Line 223-224)

Line 244 – Do you mean subcategorised by ice margin type? The current sentence is a bit confusing. Also add ‘with subsequent time steps revealing absolute area change’?

Yes, the total summed lake area is categorised by ice margin type. This has been clarified in the text, and the suggested

“The total (summed) lake area is categorised by ice margin type (ice sheet and PGIC) in Figure 3, with subsequent time steps revealing absolute area change across each region.” (Line 234-235)

Line 245 – ‘through time’ – I think you need to be more specific here – between 2016 and 2023. Also this is an important result in itself – I think expand on this a bit more to finish the sentence (currently feels like it’s skipped over); were you expecting a uniform trend of lake area response to climate across Greenland? I think many people won’t appreciate the variability in climate zones. Also possibly worth reminding the reader here that lakes losing contact with the ice margin will affect these stats – how many lakes detached in this time?

Previous studies have suggested increasing lake area through time, linked to a retreating ice margin and enhanced runoff over time (e.g. Carrivick and Quincey, 2014); however, such studies typically infer trends from discrete regions in Greenland. It is likely a uniform trend is not evident here because of the large latitudinal range and resulting climatic variability that ice-marginal lakes in Greenland are subjected to. In addition, as suggested, this could also be related to lake detachment. Currently, we cannot quantify the number of detached lakes, with lake presence in the inventory series indicating either lake detachment or methodology performance. We have added this information to the paragraph to elaborate on the possible reason for a lack of uniform trend:

“The total (summed) lake area is categorised by ice margin type (ice sheet and PGIC) in Figure 3, with subsequent time steps revealing absolute area change across each region. No inherent trends in total lake area between 2016 and 2023 are evident across all regions, such as uniform change through time. The lack of a strong trend could be related to variability in lake contact with the ice margin over time; but could also reflect the high climatic variability across Greenland given its large latitudinal range.”

In addition, the two instances where the phrase “through time” are used have been changed:

“No inherent trends in total lake area between 2016 and 2023 are evident across all regions...”
(Line 235-236)

“When assessing lake temperature change from 2016 to 2023, lake size appears to influence...”
(Line 276)

Line 246 – add ‘provides valuable’

Done.

Line 360 – Worth a comment on how the surface temperature estimates could be used? Useful for observing average conditions between years and also regional variability – importance for downstream ecology (Fellman et al., 2014).

A comment has been added to the sentence regarding the use of the inventory series in assessing surface temperature variability and its importance for downstream ecology. The citation suggested has also been used, as it is a valuable example of such a study in an Arctic region:

“Lake conditions could also provide insights into glacier dynamics in lacustrine settings around Greenland; for example, to investigate submarine melting in lacustrine settings and its impact on glacier retreat (e.g., Mallalieu et al., 2021), and to explore regional variability and evolution of lake surface temperatures and their influence on downstream ecology (e.g. Fellman et al., 2014).” (Line 359-362)

Line 380 – I think ice-marginal lake detection is far more complex than supraglacial – as this article proves! I would change ‘is likely to be feasible’ to ‘worth further investigation’.

Done.

Line 386 – Change ‘would’ to ‘could’. I think 500m resolution would be too coarse.

Done.

Line 393 – Yes SPOT 5,6 and 7 satellites would give you this and are pretty similar spectral bands to Sentinel series from what I remember. Can't you get access through ESA? I think there would be substantial changes since 2002 and would be interesting to see what impact 2012 melt season had.

The key difference with SPOT 5, 6, and 7 is that they do not include shortwave infrared (SWIR) bands. While using SPOT imagery would be beneficial because of its broader temporal coverage and higher spatial resolution, it would require us to adjust our multi-spectral indices classification method. In practice, this means we would need to simplify the approach to rely exclusively on NDWI classifications. It is likely that compromises would need to be made on the methodology to extend the inventory series back to 2002.

Figure 7 – Nice. Shows the overall regional pattern pretty well. Panel b. needs regions adding to each subplot – currently look like they're Southern regions at top and Northern regions towards the lower part of the plot – which is counterintuitive but fine if labelled.

Panel b in Figure 7 presents lake surface temperatures categorised by lake size and not regions. This has been made clearer in the figure caption:

“The temporal variability in lake surface temperature estimate is shown in (b), categorised by lake size across six size groups (up to 0.1 km², 0.1-0.2 km², 0.2-0.5 km², 0.5-1.0 km², 1.0-1.5 km², 1.5-5.0 km², and above 5.0 km²).”