Review of 'Active subglacial lakes in the Canadian Arctic identified by multi-annual ice elevation changes'. Whyjay et al.

This paper contributes new and valuable information on the existence, location, and multi-annual dynamic activity of subglacial lakes across Arctic Canada. To achieve this, the authors have optimized the use of available satellite imagery digital elevation models (DEMS) and lidar data to produce important metrics (area, timing of fill/drain events, magnitude of vertical displacements, and cyclical changes in subglacial lake water volumes) characteristic of the subglacial lakes identified. Results from this work have potential to guide future research towards understanding the response of subglacial lakes to future climate scenarios.

Scientific rigor of throughout this paper however is lacking. This paper exhibits poor writing style, inconsistent formatting, and very poor sentence structure; all of which obfuscate the intended meaning throughout. Many statements are left unsupported by proper referencing, inconsistencies amongst the figures exist in terms of style and background graphics exist, and figure captions are poorly written – see comments below.

This paper cannot be accepted in its current form.

INTRODUCTION

L4 & 5: provide uncertainties on the measurements of lake area and water volumes

L 6: need reference after "… yearly."

L7: " **to** the Canadian Arctic".

L7: The characterization 'nearly exclusive' is an oxymoron needs to be changed.

L7: Given the numerous subglacial lakes globally identified in Livingstone et al.,(2022), ie. 755, and the fact that a recent study by Gray et al. (2022) examined subglacial lakes that would meet the definitions of 'Type 1 and 2' as defined in this study, confirms that these type of subglacial lakes are not 'exclusive' to the Canadian Arctic.

L8: indicate coefficient of correlation here.

L8: is glacier loss 'accelerating' or just entered a step-wise shift to enhanced mass loss? If accelerating, this should be explained and referenced in the text.

L13: subglacial hydrological networks can be on the order of hundreds of kilometres long (Ehenfucht et al., 2024)

L 15-16: subglacial lake drainage events have been reported to increase glacier flow by hundredfold in Alaska (Kamb, et al., 1988), and higher for glaciers on Iceland.

L 19-20: Stearns, et al., (2008) is one of dozens of papers reporting on the influence of subglacial lake drainage events on glacier dynamics. This alone is not adequate evidence for suggesting subglacial lake drainage as a key mechanism for controlling glacier mass balance.

L 29: the word 'however' is not necessary here.

L33. The word 'partially' is not adequate. This region is heavily glacierized, particularly across the high Arctic (Arctic Canada North) where glaciers and ice caps cover ~50% of Ellesmere Island, the 10th largest island globally.

L 34: Please use the adopted terminology for identifying glaciers and ice caps in the Canadian Arctic, which is 'Arctic Canada North' and 'Arctic Canada South' (eg. RGI V7.0, Rounce et al., 2023).

L 34-36: when referring to the Canadian Arctic as whole, total mass change for this region is to be reported as a whole, ie. ACN + ACS, as it is displayed in Fig 7.

L 34-36: For which period (s) of time do these reported numbers of mass change apply? This value changes annually.

L 37: WRT the sentence 'The first discovery was a hypersaline lake..'. This sentence needs to be removed as there never was a hypersaline lake discovered on Devon, so it is incorrect to refer to it as such.

L 40: The fact that there are 2 subglacial lakes in close proximity of each other is not on its own a justification to suggest that more subglacial lakes across the Canadian arctic **must** exist.

L 45-46. Change '*...helped identify numerous...*" to '...has *been used to identify...*'

L 47: ...*limiting the potential discovery*... ' It would be worth noting here that the density of satellite coverage increases with latitude for polar orbiting satellites such as cryosat and icesat.

L46L: '... identify numerous subglacial lakes....'. Where were these lakes 'discovered?

MATERIALS AND METHODS

L61: Add the remote sensing and RGI data to this intro.

L71: spell out DBSCAN acronym

L81: is visible crevassing not evident over active subglacial lakes? And is crevassing not an 'obvious change'?

L84: '*… conditions of land cover…'*, do you mean glacier ice surfaces?

L 87 : do these features not exhibit crevassing around the grounded margin of the subglacial lake?

L 88: 'Satellite images..' should be written as 'Optical satellite image data'

L89: are these zones always close together? Or can they also be separated, if so by how far?

L94: why is the criteria for new bedrock exposure specifically state to be from '2020 onward'?

L 159: state basic specs for ALOS-2, PALSAR-2, ie. wavelength, perpendicular baseline.

- L183: Why is it necessary to 'argue' that the sub-glacial lakes in the Canadian high Arctic are located in the ablation zone? Shouldn't this be clear by comparing published elevations of the ELA with elevation of the subglacial lake?

- What is the relevance of the subglacial lakes residing in the ablation zone? Would it be possible for the subglacial lakes to exist above the ELA. Please expand on this.

- Are you referring to the elevation of the ice surface over the subglacial lake, or the elevation of the subglacial lake below the ice?

- It is recommended that the authors also explore the freely available NASA Operation IceBridge swath thickness data for these analyses. Where overlap exists the OIB data may provide important information on the ice geometry, basal conditions may help explain subglacial lake dynamics and surrounding hydrology.

L184:

- Using the post-2000 decadal ELA averages from insitu monitoring (Burgess and Danielson, 2022) to identify which glaciological zone the lakes reside in is more realistic than using the 1958-2015 ELA by Noel et al., 2018.

Reference: Burgess DO and Danielson BD (2022) Meighen ice cap: changes in geometry, mass, and climatic response since 1959. *Canadian Journal of Earth Sciences*, **59**, 884–896, ISSN 14803313 (doi: 10.1139/cjes-2021-0126)

L209: change '*barely show…' to 'show minimal surface change..'*

L219: the subglacial pathway for Lake 14 was clearly revealed by Gray et al., 2024 and should be acknowledged as such.

CONCLUSIONS AND OUTLOOK

L 287: ‘ account for complete subglacial lakes…’ change to ‘account for complete subglacial lake ***alone*** ‘.

L: 289:

L: 290: Improper reference. Goeller et al., 2016 deals with Antarctic lakes not Greenland, upon which your comparison with the Canadian Arctic subglacial lakes is based.

L:291: in order to provide any substance to this claim, this statement must be backed up with evidence that the ice cap / ice sheet under discussion has morphological and glaciological characteristics that conform to conditions where subglacial lakes are known to exist.

L 294: What roles could subglacial lakes play towards ‘ … *influence the glacier mass balance’* ? Neither this study or Gray et al., 2024 noted any significant change in ice velocity during subglacial lake outflow events. Please be specific as to how the subglacial lake activity has affected mass balance, and support with references.

L294: ‘…, lake melting…’ , do you mean ablation of glacier ice due to contact with subglacial lake water? Please clarify

L295: the statement ‘…more hidden ice loss.’ is highly speculative. We don’t know anything about the level of contact between the water and ice, water temperature, water turbulence, ice accretion…

L297-298: Wording of the statement ‘…***allowing*** the retreat and mass loss of the calving front.’ needs to be changed. Calving of lake terminating ice fronts may however be **facilitated** by the presence of water at the margin.

L293-391: this paragraph reads like and introduction. Generalizations are being made without specific reference to what was observed. Please replace with a concise summary of what was observed, implications and how this work can be improved, including future monitoring strategies.

FIGURES

Figure 2.

- This lake (18) should be identified and matched to the mosaic in Fig 3.

- Hatch lines should be more narrowly spaced – they do not clearly define the non-glacierized areas.

- Why are non-glacierized areas depicted differently between figs 2 and 3?

- This sentence ‘A map of the elevation change **can** be derived…’ does not seem very effective or meaningful…

- ‘ using a selected (?) regression model …’ which model was used?

Figure 3.

- Usage of ‘ – ‘ is inconsistent between legends.

Figure 4: Many of the yellow (suboptimal) points appear to align with the valid points used in the analysis. Please explain how these suboptimal points differ from the ‘good’ points.

Fig. 4

-Polygons outlining Lakes 2 and 3a-c to are at such small scale that it is difficult see any differences between the 2015 and 2016 LandSat images

- Why do many of the yellow (suboptimal) points that align with the ‘good’ points?

-perhaps a different scale should be used for the point quality as the error bars are meaningless for most points.

- supplementary material for all figs?

- Please state

Fig. 7

- Spell out 7- axis titles in full.

- X axis titles are unclear due to location of ‘year’ labels. The labeling should definitely start at the first column. For fig 7 it should start at 2011, as it does in fig5

- Why do the x-axes for graphs in fig 7 show 2011-2021 but 2011-2022 for fig 5. Should these not match?