The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC1
https://doi.org/10.5194/tc-2022-122-RC1, 2022

Comment on tc-2022-122

Zachary Fair (Referee)

Referee comment on "Subglacial lake activity beneath the ablation zone of the Greenland Ice Sheet" by Yubin Fan et al., The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2022-122-RC1, 2022

Subglacial lakes are an important component of ice sheet hydrology, particularly in their influence on meltwater transfer between the ice sheet surface and bed. Although previous efforts have documented subglacial lakes over Antarctica, lakes over the Greenland Ice Sheet have received less attention. This manuscript aims to improve our understanding of Greenland subglacial lakes using ICESat-2 altimetry data. A combination of the ICESat-2 ATL11 product and the ArcticDEM is used to infer and validate the location of subglacial lakes. Interannual changes in ice sheet height from ATL11 are used to measure changes in lake area, height, and volume. The authors were able to identify 61 subglacial lakes over Greenland, many of which were not reported in previous literature.

Overall, this paper discusses an interesting and underreported topic in the cryosphere community, and its contents fall within the scope of The Cryosphere. The paper is generally well-written, and it is interesting that to see ATL11 applied to a novel application. Before publication, I do have a few concerns:

Main Comments

Previous methods for lake detection have used lower level ICESat-2 products, such as ATL03 or ATL06. Although it is interesting to see ATL11 used for this analysis, and ATL03 is used to identify supraglacial lakes, I would like to see some justification on why ATL11 was selected as the primary dataset over other ICESat-2 products. A reader less familiar with ICESat-2 may wish to know why ATL11 is preferable for this application, or why other ATLAS products may be less effective.

Generally, the results are presented as a range of values across all 51 confirmed lakes. For an ice sheet as large as Greenland, I do not think this is very useful, particularly when the range is across three orders of magnitude (e.g. volume change rates and uncertainties). The lakes are grouped into regions in Figures S5 and S6, so I suggest aggregating the statistics (mean, uncertainties, etc.) by region and discussing how the elevation and volume change rates vary (or do not vary) between regions.

I appreciate that the data in the supplementary tables is provided, but I think the spreadsheets would be better placed in an open-sourced repository. The tables in the manuscript could then be used to show aggregate statistics for each region of Greenland assessed.

Other Comments

Abstract: Lake area, height, and volume are an important part of the analysis, so I suggest adding a few lines that mention these parameters.

Line 32: "Subglacial lakes can be identified from various remote sensing *techniques*"

Lines 32-33: What kind of instrument (or instruments) is used to make these inversions?

Line 48: Minor nitpick, but the documented footprint size is ~13 m.

Line 68: Are all these reference points co-registered with subglacial lakes? If not, I would mention how many reference points are (if that is not too difficult).

Line 68: Replace "entire of Greenland" with "Greenland Ice Sheet"

Line 88: "a more conservative threshold *of*…"

Lines 103-105: Is this a significant problem? Please provide justification on why or why not.

Line 106: For clarity, this is referring to ICESat-2 tracks, correct?

Line 112: Consider revising to something like: "Supraglacial lakes seasonally form over much of the GrIS ablation zone. These surface lakes may either refreeze on the surface or drain to the ice bed (Selmes et al., 2011)."

Line 114: Elaborate on what ATL06 is (i.e. land ice height).

Equations 3+4: "confirmred" à "confirmed"

Line 168: 2009 à 2019

Line 168: Use "ICESat-2" to prevent confusion.

Lines 170-171: Nitpick, but a more up-to-date number is from Brunt et al., (2021), which shows an accuracy of ~0.04 m over ice sheets (reference below).

Lines 177-179: "An additional 10 active lakes were detected by ICESat-2 but not the ArcticDEM" can be removed – the first sentence of the paragraph establishes this already. The rest of the sentence could be rephrased as: "Five of the reported active lakes were missed by ICESat-2, indicating that…"

Line 179: "bright" and "strong" are redundant in this context.

Lines 184-185: I am not sure if I understand the connection here. If the lakes with the most sampling are at upper latitudes, then why would it not be associated with the increased density of ICESat-2 tracks?

Line 207: Where were these lakes located? A depth of >50 m is awfully large…

Lines 211-212: "Lakes with both positive and negative elevation change rates during the study period were found in each basin with few exceptions." Redundant sentence –

consider revising or removing.

Line 238: Terms such as “quiescence” and “high stand” are infrequently used jargon. I suggest using other terminology (or define what “high stand” means) to make it more understandable to a general audience.

Line 241: “The temporal resolution of the ArcticDEM varies[,]…” (add comma)

Conclusions: This needs a paragraph on how this paper would benefit future research studies, or how future studies could build upon the limitations or difficulties discussed in this study.

Figure 1: A colorbar label (with units) is needed.

Lines 381-382: “The red-blue lines represent the differences between ICESat-2 tracks…”

Line 382: “…while *the* grayscale colorbar is the ArcticDEM.”

Lines 382-383: “Elevation anomaly profiles across the subglacial lake are given for RGT 321 (b) and RGT 162 (c).”

Line 384: “Their spatial locations are also indicated in (a).” Redundant sentence.

Figure 2: I suggest adding a label for the colored circle legend in (b), otherwise I am not sure what the colors represent (or what the units are).

Figure 3: Please provide a legend for the differently colored dots.

Reference

Brunt, K., Smith, B., Sutterly, T., Kurtz, N., & Neumann, T. (2021). Comparisons of Satellite and Airborne Altimetry With Ground-Based Data From the Interior of the Antarctic Ice Sheet. Geophysical Research Letters, 48 . https://doi.org/10.1029/2020GL090572