

## Subglacial lake activity beneath the ablation zone of the Greenland Ice Sheet

Reviewer #1

The authors have cleared up a lot of the material in the study that confused subglacial and supraglacial lakes, and it seems that what remains is a much more accurate depiction of the record of possible subglacial lake activity in Greenland. I would note that most of the plots shown in the supplemental material depict basins on the surface of the ice that are getting shallower over time, which is what we would expect to see in an empty depression on the ice surface gradually being refilled by ice flow in response to the stress anomaly associated with the basin. It would be good to note that there is some uncertainty in the interpretation of lake filling rates because of this. It also would be worth pointing out that a closed depression in the ice surface in the ablation zone can be expected to fill with water during the summer, so if these depressions remain empty, it is likely that they contain moulins or crevasses that allow the water to escape, potentially to the base of the ice sheet.

[Response: We thank the reviewer for the helpful feedback, we are appreciative of his or her help and time. We have added the explanation of the uncertainty source as suggested in Section 4.3.](#)

Beyond this, my comments are mostly editorial.

Line 38: Should say that that some lakes produce a radar signature (not all)

[Response: We specified that some stable lakes will produce a radar signature here.](#)

Line 44: Gray et al, 2005 did not generate DEMs. It would be better to say that the study used radar interferometry.

[Response: We corrected it to 'radar interferometry' here.](#)

Line 75: Are these 511 RGTs the ones that intersect Greenland? Should specify what set this is.

[Response: These 511 RGTs are the ones that intersect Greenland. We have specified it here.](#)

Also line 75: I'm not sure what track segments are here—the number seems to be about double the number of RPTs. It can probably be removed.

[Response: We have removed it.](#)

Line 78: The point density does not seem like a useful metric here, because the points are not evenly distributed. I'd recommend omitting this.

[Response: We have removed it.](#)

Paragraph around line 75: I recommend splitting this into two paragraphs, one about ATL11 and another about ATL03. I think the point counts, etc relate to ATL11, and the transition to ATL03 would be cleaner with a new paragraph.

Response: We have divided it into two paragraphs.

Line 88: “was variable” should be “is variable”

Response: Revised.

Line 109: The reference to Willis et al does not explain how the visual interpretation was done. A sentence or two for how the authors did this would be helpful.

Response: We added the explanation here. We retained the profiles that exhibited gradual elevation change with time.

Line 133: Explain what a Hampel filter is, and provide a citation

Response: We added the explanation and the citation here, and the revised sentence is ‘A Hampel filter is a type of outlier detection filter commonly used in data analysis, and it works by identifying data points that are significantly different from their neighboring data points and replacing them with a more representative value based on the surrounding data (Hampel, 1974). Therefore, it was used to remove the outliers in the time-series of the combined ArcticDEM and ICESat-2 periods (2009-2020).’.

Line 136: I don’t think “internal accuracy” is the right term here. Better to say that you assumed that the relative errors between points in each dataset were the values provided in the cited studies.

Response: We have changed ‘internal accuracy’ to ‘relative error’ here.

Line 148: “a double reflection of both the water surface and the ice surface”: this implies that there is a double reflection from each surface (four reflections in total)

Response: We have corrected it to ‘a double reflection of the water surface and ice surface beneath’.

Line 149-150: “ICESat2 can therefore be used...more than 10m deep (Fair et al, 2020).” This statement does not make sense as written, and is not supported by the citation. Should rewrite or delete.

Response: We have removed it.

Line 156-157: Where is the result for the validation of the Watta-derived depths? It’s not in the current study. This sentence needs to be rewritten or deleted.

Response: The validation was done by Fricker et al. (2020), the Watta-derived depths are close to the LandSat-8/ Sentinel-2 -based depths and manual-picked depths from the ATL03 photons.

Line 208: “the corresponding periods”: should be “the ICESat-2 period”

Response: Revised.

214: “ICESat-2 footprints” should be “ATL11 reference points”

Response: Revised.

247: Please explain or delete the reference to Livingstone et al (it's not clear why this is cited here. Does the current result agree with their result? Disagree?)

Response: We have removed the reference here.

259: Please elaborate on “filling activities of 60” and explain how the significance test was carried out. The null hypothesis needs to be clearly defined when significance tests are provided.

Response: We have rephrased it to ‘A total of 60 lake filling events (positive volume change) that occurred from 2009 to 2020, and the volume-change rates have a positive correlation (correlation coefficient of 0.40,  $p < 0.01$ ) with the cumulative runoff estimates.’. The significance test was provided during the calculation in the Person correlation coefficient.

Figure 4b: Does the color bar need to extend as far as 20km<sup>2</sup>? None of the lakes are that large.

Response: We have set the upper limit of the color bar to 10 km<sup>2</sup>.

Figure 4d: Need to explain the pie charts

Response: We explained it as follows ‘The pie chart in panel (d) represents the overall volume-change rate of lakes in each basin (blue for positive, red for negative), with the pie size is proportional to the magnitude of the absolute rate.’

4d: need to be clear about the units on the colorbar: are these dV/dt?

Response: We have changed the legend to ‘dV/dt’ for clarity.