We thank Reviewer 1 for their comments on our paper. Their suggestions have been on point and have improved the paper substantially. In particular, we have expanded our methods section, which has now been moved to an Appendix, changed the title to better reflect the main findings and expanded on the previous research into subglacial lakes. Our responses can be found below. Reviewer comments are in black with replies in blue.

On behalf of all co-authors,

Kind Regards,

Stephen Livingstone

Reviewer 1

This paper presents three new observations of subglacial lakes identified from satellite surface elevation data near the margin of a land-terminating section of the western Greenland Ice Sheet. The lakes are small in size, but their location near the ice margin makes them easy study objects for future investigations, compared to subglacial lakes in the interior of the ice sheet. Subglacial lakes have only recently been identified in Greenland, compared to in Antarctica, and therefore there is a potential to study these features in more detail to understand how they interact spatially and temporarily with the subglacial and proglacial hydrological systems. The paper is well structured and the language is fluent. I recommend publication after minor revision taking into account my general and detailed comments below. I apologize for any misunderstandings and look forward to seeing a revised version of the paper. My main comments and suggestions for improvements are:

1. I find the title does not reflect the paper content in a proper way; it refers to "outbursts floods". There is only one such event documented in Fig. 3. Are similar outburst floods observed for the other two lake drainage events? How common are these kind of flooding observations in satellite data from Isunnguata Sermia? Could the observed event coincide with supraglacial lake drainage events upglacier? Also, there are no drainage data presented to verify the qualitative observations from the satellite image. I would like to see some description of these caveats in the discussion section.

We agree this is misleading and have modified the title to "*Brief Communication: Subglacial lake drainage beneath Isunguata Sermia, West Greenland: geomorphic and ice-dynamic effects",* which we think better reflects the key findings of the paper, and takes into account the new data included in the revised paper. We tried to identify outburst floods associated with the other two subglacial lake drainage events, but could not find any conclusive evidence. The satellite and DEM archive is patchier for these two earlier events (particularly in-front of Isunguata Sermia), making it more difficult to discern any outburst events (either from NDWI or elevation change). The 2015 event also seems to have been the largest of the three, which may be one reason why we were able to clearly identify its downstream response.

2. Since subglacial lakes are relatively new findings in Greenland, it would be nice with some more review of previous studies in the introduction linked to the discussion. Are the lakes in this study a new type of subglacial lake in Greenland or have they been observed elsewhere?

Good points, thanks. We have expanded the introduction section to include more detail on how subglacial lakes in Greenland have been identified to date (see also comment below). We have also

expanded the discussion section, adding in a new paragraph where we link back to the introduction, including the three main subglacial lake types from the Bowling et al. (2019) paper and the potential for water storage to delay transfer to the margin and influence downstream ice dynamics.

3. The methods are described shortly at the end of the introduction. I believe not all readers are familiar with these data and methods. Therefore, a methods description could be added in supplements. In this description, a short review on how subglacial lakes have been found in previous studies could be included.

We have expanded the methods, which we have now moved to an Appendix as also suggested, to include more details of the NDWI method (as also recommended in the specific comments). We have also added information on how subglacial lakes in previous studies were identified in the introduction where we review previous subglacial lake research.

SPECIFIC COMMENTS
Title:
The usage of plural of "outbursts floods" needs to be reflected in the paper. Only one observation of an outburst flood is presented for Lake 2 in Fig. 3. Are there additional satellite images showing outbursts floods for lake 1 and 3? If there is not room for additional figures in the paper, they could be included in supplements. Or the title could be changed to reflect the content of the paper.

Done. See reply to major comment above re. title.

Introduction:
L28: "Shallow hydraulic gradients" sounds confusing to me when referring to water, maybe write "low hydraulic gradients"?

Done.

L37: I suggest replacing the word "significant" since it is a statistical term.

Changed to "important".

L37-39: This sentence holds a lot of information and is a bit unclear to me, e.g. please clarify what you mean with "surface imprints". Do they not often coincide with subglacial depressions and potential subglacial lakes?

By 'surface inputs', we refer to the input of surface meltwater to the bed, which is a key component of the subglacial drainage system in Greenland, relative to Antarctica. We have clarified this to "surface meltwater inputs".

L40-44: Could you add some more review on these findings? Also, you mentioned three types of lakes here. Are the ones described in this paper a new type of lake (marginal lakes that fill over several years)? Please mention in the discussion.

Please see reply to major comment above.

L46: Do you have a reference for the statement "..is thought unlikely*: : :*" or is it from the references above? If so, please move the references to the end of the sentence.

We have added a reference (Bowling et al. 2019) to support this finding.

L47: Add a reference for the Landsat data.

We have added the following in brackets “(distributed by the U.S. Geological Survey - https://earthexplorer.usgs.gov/)”

L51: Vertical accuracy?

This is the horizontal accuracy of the ArcticDEM DSMs, and we have corrected to make this clear.

L52: How were the DSMs corrected against filtered IceSAT data? Did you do this? This sentence is a bit unclear.

The mean offset between ArcticDEM swaths and coincident IceSAT elevations is provided in the ArcticDEM metadata, and so this correction when available could just be applied directly to the ArcticDEM tile. This is specified in our new Appendix A. Datasets and Methods.

L53: Please describe in more detail how NDWI is used. Is there a reference to this method?

We have expanded the section on NDWI to explain its use and pre-processing steps, and also now include a reference – Zhao et al. (2018) – although to stay within the limit of a brief communication we have had to delete a reference elsewhere to accommodate this.

Zhao, H., Chen, F., and Zhang, M. A systematic extraction approach for mapping glacial lakes in high mountain regions of Asia. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 11(8), 2788-2799. doi: 10.1109/JSTARS.2018.2846551, 2018.

L50-55: These sentences describe methods and do not fit very well in the introduction. I suggest to move them to the next section and rename it to “Methods and Observations” or similar. Also, it would be clarifying with a last sentence in the introduction describing the objective and aim of the study.

To also account for the ice velocity methods and additional information on NDWI and uncertainties we have we have moved the last few sentences to a new, expanded - Appendix A. Datasets and Methods.

Discussion:

L91-93: Leverett and Russell Glacier have another subglacial drainage catchment than Isunnguata Sermia, so these two are not necessarily connected. Have you checked with other potential sources of subglacial water upglacier, such as supraglacial lake drainage events?

Certainly, during the period of late August and early September, when these subglacial lakes drained, there will also have been a number of supraglacial lake drainage events, and this is evident from checking the available satellite imagery. However, we do not think a supraglacial lake drainage event a likely cause of our proglacial observations given that the outburst flood coincides with the timing of ice-surface elevation anomaly 2. In addition, supraglacial lake drainages are relatively common along this western margin of Greenland, but major outburst floods characterised by rapid aggradation of up to 8 m of sediment are not.

L95: Wrong reference, please correct. The subglacial hydrological analysis was made in the Lindbäck et al. (2015) GRL paper (doi:10.1002/2015GL065393).

Good point. However, we are at the limit of the number of references allowed and so we have chosen to delete the wrong reference and just use Chu et al. (2016) as an example, given this is also used elsewhere in the manuscript.

L98: "*: : :*one drainage event _each_ over*: : :*"

Done

L100: How were the uncertainties (±) of each lake volume change determined?

The uncertainties of each lake volume change were determined by multiplying the internal error of the ArcticDEM by the surface area both before and after drainage and adding the errors together in quadrature. We have added a sentence to this effect in the Appendix.

L106: "largest and best-constrained _lake_*: : :*"?

Done

L112-114: I don't follow this statement "recharge were similar over winter and summer". February is a winter month, please rephrase the comparison periods. Also, the plot in Fig. 2 for Lake 2 looks steeper in summer 2016 than in winter, suggesting a faster refill in summer. The other two plots do not have high enough temporal resolution in summer to support the statement.

We agree that we have little data supporting this statement and discussion and so have deleted this section on lake recharge between summer and winter.

L118: What do you mean with "in close proximity"? Are you referring to other lakes than these three? Please clarify the sentence.

We have clarified our meaning here by adding "…the three subglacial lakes are…"

L120: Do you have a reference for this modelling work?

This is poorly phrased – we are actually referring to the hydrological routing analysis (Shreve equation, assuming ice overburden = water pressure) here, which is shown in Fig. 3a, and have rephrased accordingly.

L121: As mentioned earlier. How about supraglacial drainage events upglacier? Can these be ruled out?

See comment above, we believe a supraglacial lake drainage event causing our proglacial observations is unlikely.

L133: One difficulty with future studies of these lakes, is that it is hard to predict when the lakes will drain in the data (almost no observed filling/elevation change before the drainage events in Fig, 2). Any recommendations regarding this?

This is currently a challenge as we only have one drainage event per lake and so we cannot calculate the recurrence interval. In addition, the lakes seem to fill and then remain stable for some time before then draining again and so we cannot estimate based on how full the lake is (i.e. they do not seem to reach a drainage threshold). Hopefully, as the 2018 and then 2019 ArcticDEM timestamped data are released we will capture repeat drainage events that will help us to begin to answer that question.

Conclusions:
L154: As mentioned earlier, I would avoid using the term "significant" for qualitative data.

We have deleted the word "significant" here.

Figure 1:
North arrow and spatial reference are missing. I find it difficult to see the color differences, eg. 1 m compared to 10 m change. Also, is it possible to provide exact date for the images used in the subtraction? Makes it easier to reproduce the results.

We have added both a north arrow and spatial reference. The images do not have exact dates, as they are actually down-sampled (to 50 m) composites produced by merging (using median values where there is overlap) all the DSMs available in that particular year. This was done to produce a more consistent DSM of larger spatial extent to better identify large-scale changes, and was needed as the timestamped DSMs are rather patchy. We have now added some brief details to the caption detailing how the DSMs were produced and making this clear.

Figure 2:
Nice figure.

Thanks

Figure 3:
North arrow and spatial reference are missing. Fig. A: Define IS in the caption. Fig C: Why is the ice green? Fig. D: Why are the lakes blue? Are they masked out or have they lowered 10 m in elevation? Seems unlikely.

We have added a north arrow and graticule. IS is defined in the caption in the fourth sentence. There are two possible reasons why the ice is green (-ve) in the NDWI plot of Figure 3C. The ice might be drier in the second image, thus reducing the NDWI value and therefore on the change in NDWI figure, indicate a reduction in water content; and/or a change in sun angle can influence the brightness of the ice and therefore have a slight impact on the NDWI values. The lakes are blue because in one of the DSMs there are NoData values (-9999). This has now been rectified, with these values turned to Null.