Author response to reviewer comment: Reviewer 2

In this study, Mejia and others present field observations of supraglacial streams in the Paakitsoq region of the Greenland ice sheet that show how the drainage paths of supraglacial lakes can change considerably between different melt seasons. The study provides valuable insights into the processes by which supraglacial streams form and transport melt water from lakes to moulins, which is very relevant information for understanding and modeling the impact of surface melt on ice dynamics. The manuscript is well written but would benefit from a few clarifications especially in the methods section.

We would like to thank the reviewer for their constructive feedback our work. We believe the implementation of the reviewer's suggestions will result in the improved clarity of our manuscript, particularly in the methods sections and by incorporating all minor comments described. Below we respond to each point raised by the review with our text written in **blue** and each response will detail how the manuscript will be revised to address each concern.

Sincerely,
Jessica Mejia on behalf of all coauthors

General comments

1) Section 2.1 describes the stream mapping associated to Mars and ArcSav lakes in 2017 and 2018, but it does not mention Radical lake, the results of which are presented in Figs. 7 and 12. Was this data acquired in the same in-situ way or from e.g. WorlView imagery? The same is true for all the streams in the 2019 melt season. Although not delineated in any map (why not?), the 2019 stream paths are described in the last paragraph of the results section. At this point, the reader has to guess that this information is based on the WorldView image e.g. in the background of Figure 12. It would be good to state this explicitly. If that is how the stream paths were determined for 2019, would it be possible to use such a remote sensing approach to map streams on a larger scale or over more melt seasons?

We will revise section 2.1 to improve the clarity of our mapping methods which, as the reviewer acknowledges, did differ between years. This section will explicitly differentiate between techniques to distinguish (1) roving differential gps surveys conducted for Mars and ArcSav catchments in 2017 (2) the stream delineation from WorldView imagery with extracted ArcticDEM elevations for Radical Catchment in 2017. This methodology was also utilized for all streams in 2019 because we did not return to the field to make any ground-based measurements. And finally, (3) mapping supraglacial streams with a hand-held Garmin In-Reach. These positions were then used to extract ArcticDEM elevations along the stream paths for all catchments (Mars, ArcSav, and Radical) in 2018.

2) Section 2.2 is slightly short for the reader to fully understand what was done. In particular, I am wondering about two points:

a) Does the `steepest descent algorithm` (L98) refer to the Wang and Liu (2006) method? If so, I suggest citing them again, otherwise it is not clear that their method was not only used for filling the depressions. Furthermore, `the steepest descent algorithm` commonly refers to a search algorithm in optimization that has little to do with how it is used here, so I also suggest avoiding this specific term.

b) How were the DEM-predicted catchments `divided according to the moulins identified in the field` and `corrected for supraglacial streams` (L101-102)? There must be a set of rules that were followed, for instance that streams were not allowed to cross catchment boundaries, etc.? How was this done and how much ambiguity was there in this correction?

Potentially, it could also be helpful and interesting to show the difference between the DEM-predicted catchments and the corrected one. If the corrections were substantial, it would mean that topography alone was not a good predictor of flow paths in this case, which could strengthen the message of this study.

We will expand our discussion of catchment delineation in Section 2.2 to cover these points raised by the reviewer. Specifically, we will add a citation to L98, revise our phrasing for the steepest ascent algorithm, and expand upon how we refined the predicted catchment by including the rules we used to make adjustments. We will also elaborate on the phrase in L101-102 which states that the predicted catchments were "divided" according to moulins identified (explanation below). Finally, we will add a description of how much each catchment varied from the predicted boundary following manual adjustment (in the form of text and either statistics or a figure if possible).

To quickly address the reviewers point, this is referring to the fact that our methodology to calculate the catchment requires a single outlet point which was set to the ice sheet margin, rather than the location of each individual moulin. Therefore the resulting algorithm produced one very large catchment spanning beyond our study area. We used these predicted flow paths in conjunction with observed moulin locations "divide" this large catchment into the moulin-drained supraglacial catchments discussed in the manuscript.

3) The manuscript has many figures with partially redundant information, perhaps this could be condensed. For example, the Mars and ArcSav stream paths are depicted in Figures 1, 2, 3, 8, 9 and 12. It takes some effort from the reader to figure out the differences between those. Furthermore, it is not clear why Figure 7 has a different design than Figures 3 and 9. Does it not show the same information, just for Radical stream instead of Mars/ArcSav? Why is there no 2018 profile for Radical stream?
We will adjust figure formatting to maintain consistency between catchments. We will also explore ways to more clearly indicate the differences between figures (and rationale), potentially combining figures that show the map view of supraglacial lakes along with their stream flow data (e.g., combining Figs. 8-9) similar to what we did for Radical Catchment.

Specific comments
L35: 'through' instead of 'though'?
L117: Technically, topography does not have a direction, perhaps use slope, downward gradient or similar. (Same in L126 and maybe elsewhere.)
L127-128: `... the river flowed downslope...` could be `down the surface slope` because technically the river always flows downslope.

L148: 'stream flowed upslope' sounds like water actually flowed uphill, see L127-128; there might be other such examples that I did not point out. I understand what is meant, and it is a very minor comment, but I still think it could be more precise. Or it could be clarified once in the beginning.
L159-160: `Mars Lake drained into Phobos Moulin...` is a slightly confusing sentence. Should it be Radical Moulin instead of Radical River? And it must have drained the Radical catchment, it could be more clear to add that name again.
L162-163: Do these numbers about all tributary streams come from the DEM-predicted flow path calculations?
L186-188: The whole sentence 'Larger July lake extents before drainage coincided with... ' is unclear. How can a larger lake extent coincide with a location of `upslope streamflow`? Maybe what is meant is that it coincides with `upslope streamflow` in time? The `together indicate` does not have a proper subject in the sentence, unless e.g. `coincided` is changed to `coinciding`, if that is what is meant.
L220-222: Why is snow deposition favored on top of snowplugs? It is not just the albedo that is responsible for snowplugs becoming high points?
L222: Shallow or flat? Shallow topography usually means that the ice thickness is small. This formulation was used in other places, too.
L250: `strong` slopes seems like an unusual formulation; high slopes is more common.
L275: Hoffman and Price (2014) may not be the appropriate reference here. Without knowing the article I would think it is a study that observed the timing of daily peak sliding speeds, which is not at all the case.
L306-307: `We find that ... is magnified at higher elevations ... where surface slopes are shallow and moulin density is low.` seems too strong of a statement here since this study analyzed three catchments in one particular location. I would expect such a formulation from a study that compared the flow of many more streams on a range of elevations and surface slopes. It is something that was discussed here and is expected given the presented data, but it is not a direct finding.
We will adjust our phrasing per this suggestion