

Response to Reviewer 3

This is a novel paper involving the generation of a unique and valuable data set on surface stream characteristics for 85 glaciers in Valais, Switzerland from open access 0.15 m resolution SwissTopo orthophotos and DEM. The lead author is to be congratulated for manually digitising the 1890 streams, although it is a shame this couldn't have been automated. Automation was attempted, based on previous methods applied to the Greenland Ice Sheet, but these were found not to work here. Having created the data set, the paper investigates statistical relationships (correlation, PCA) between channel variables (segment length, channel slope, sinuosity, minimum elevation, maximum elevation and elevation range) and several glacier variables (drainage density, glacier area, mean slope of the snow-free area, aspect, glacier minimum elevation, glacier mean elevation and glacier maximum elevation). Differences in certain channel characteristics between clean and debris covered glaciers are investigated, as are differences between the way the channels terminate (moulins, crevasses, running out the terminus or edge of the glacier, etc). The results are shown in a set of nicely produced figures and tables, and examples of different types of streams are shown in Fig 4 (although I'd like to have seen an example of a stream which terminates in a lake, although this type of termination only makes up 1% of the total). [We thank the reviewer for their positive assessment of our paper and respond to each comment in turn below in blue text. Firstly, in response to the final sentence above, we have expanded the spatial coverage of Fig. 4e so a small supraglacial lake is visible on Gornergletscher.](#)

I think the justification for the work is adequately provided in the Intro, although I'd add the importance of the supraglacial stream network, and particularly for whether the water enters moulins or crevasses or not, for understanding subglacial drainage evolution, water pressures, and basal motion to this. [Amended – we have now added additional information and references.](#)

The data sets and methods are described well, although I'd like to hear more about precisely what automated methods were attempted and why they failed.

[The first paragraph of the methods has been reworded because it suggested that we attempted more than one method of automation. We did not attempt other methods such as flow routing because the DEM was > 3 times coarser than the orthophoto and would reduce the number of channels we could detect. The methods text now clearly conveys that we tested the NDWI_{ice} method \(following Yang and Smith, 2013\) and describes the imagery we tested it on, prior to opting to map channels manually. The NDWI_{ice} method is likely best suited to coarser imagery where the output is not complicated by water filled crevasses, ponded surface melt and surface debris.](#)

I also note that the orthophotos were collected in mid-July 2020. Can this melt season be put into some perspective? Was it a high accumulation winter previously? What was the weather doing in the spring and early summer? So what were the snow / ice conditions in mid-July this year compared to other years? What are the implications of using orthophotos from this time? I imagine results would be very different if they'd been collected later in the summer during very high melt conditions? Does the timing of the orthophotos explain why you only found 85 (out of 285) glaciers with streams on them? This seems quite a low number to me.

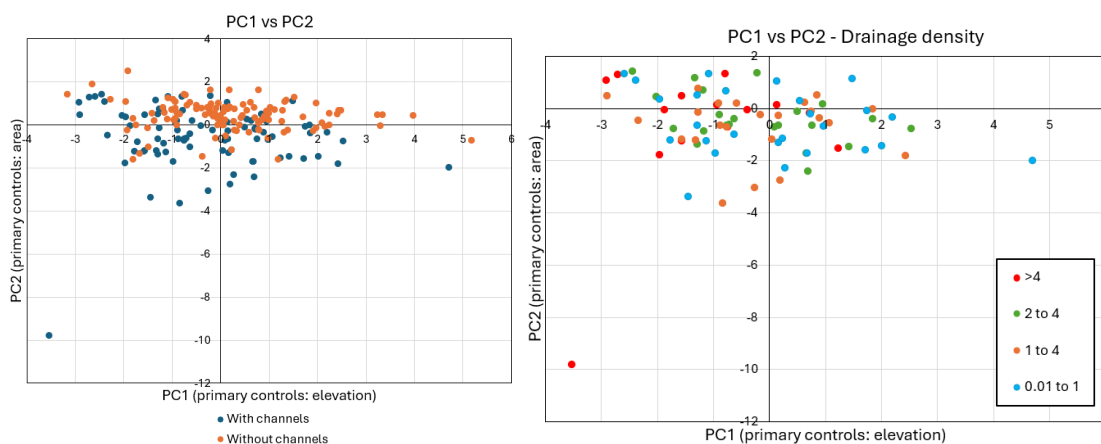
[We have now added into the methods that the conditions that preceded the acquisition of the orthophotos in mid-July 2020 were not highly abnormal. The previous winter \(DJF\) precipitation total was 570 mm which is lower than the 2009/10 to 2019/20 average of 704 mm, meaning there was less winter accumulation than normal. Temperatures began to rise above freezing in May time, and May in](#)

2020 was warmer (3.4°C) than the 2010-2020 mean temperature of 1.7°C. However, July was colder than average (4.8°C) compared to the 2010-2020 mean of 6.3°C. Hence, it is possible that the snow-cover at the time of imagery acquisition was slightly below average (2010-20).

In response to our detection of channels >0.5 m on 85 out of 285 glaciers, this more than likely represents the size distribution of glaciers in the study area, as 200 out of our 285 glaciers are smaller than 1 km² meaning that channels (if present) are likely to be harder to detect from our imagery resolution (15 cm). It may seem logical to simply omit these smaller glaciers from our dataset, but we do still find clearly mappable channels on some (33) of the glaciers <1 km². We now acknowledge in the methods that these glaciers likely have some smaller channels that are not sufficiently clear enough to map, but likely still form a key hydrological component of these glaciers.

The results are clearly presented overall, and the statistical analysis seems generally robust, and the results sensibly interpreted. The PCA doesn't add very much, and I wonder whether the authors had considered collapsing potential independent glacier variables (glacier area, mean slope of the snow-free area, aspect, glacier minimum elevation, glacier mean elevation and glacier maximum elevation) using PCA and then investigating the correlations between the PCAs and potentially dependent channel variables (segment length, sinuosity, drainage density)? This would appear justified given the significant correlations between all the variables (Fig 6), and the desire to try to explain the variability in channel characteristics.

We have explored how to reduce the dimensionality of the independent variable space following the reviewer's suggestions. We collapsed the glacier independent variables into a new PCA and explored correlations between the PCAs. This reinforced the importance of glacier area and elevation as a control on where channels exist, particularly when looking at the difference in clustering between glaciers that do and do not have channels (clustering differences are only apparent for glacier area) (see below). We also grouped points by drainage density to see if there is any clustering with the PCA that would provide insight into where the highest drainage densities occur. However, this has not provided any new insight and the original PCA already highlights the importance of area and elevation, as their presence in PC1 and PC2 explains 50% of the total variability. Instead, we strengthen the language around our PCA to state that it is evident that glacier area and elevation are the primary controls on variability within the dataset.



Left plot: PC1 compared against PC2. Glaciers with channels (>0.5 m) are in blue and glaciers without large channels are in orange. PC1 is primarily controlled by minimum, and mean glacier elevation but closely followed by max elevation. PC2 is primarily controlled by glacier

area. Right plot: PC1 vs PC2 with the points colored based on their drainage density.

I think the weakest part of the paper is the Discussion, which is not sufficiently focussed on the results presented, occasionally confuses results vs previous work, and appears a little long-winded and speculative in places. I think there are some interesting points to come out of the results and some legitimate comparisons that could be made with previous similar work on the Greenland Ice Sheet and other glaciers in the Arctic or which are debris covered. It's just that these need to be more streamlined and succinctly articulated. The Conclusions would then be stronger, and the paper would have more impact.

Following the suggestions in the detailed comments, we have rewritten the paragraphs highlighted by the reviewer as being weak in structure and focused on outlining our results first, before bringing in previous research. During this process we have also condensed parts of the discussion, specifically the sections on comparing our study area to ice sheets and debris cover, which has helped to streamline the discussion. We have tried to reduce speculation in places, and we have done this by toning down sections on our hypothesized hydrographs and where we discuss predicting glacier meltwater pathways based on hypsometry.

I provide more comments on all these points in the details below, together with recommendations for where grammar could be improved, clarity could be enhanced, or where I have queries.

I have one more general query which is why did the authors decide to use the English names for all the glaciers? Would it not be more appropriate to use the local Swiss names (which are in German or French)? [Amended - We have modified the manuscript to use the local language for each glacier.](#)

I think the work should be published if the authors are able to address my comments and suggestions.

Detailed line by line comments

13. I'd say '~ 2000' [as <2000 could be anything between 0 and 1999]. [Amended.](#)

12-14. Seems odd as worded. Would this be better: "Here we use high-resolution (0.15 m) orthophotos across a sample of 285 glaciers in Valais Canton, Switzerland, to identify 85 that contain supraglacial channels. For these 85 glaciers, we delineate ~ 2000 supraglacial channels (> 0.5 m wide) and investigate their distribution and characteristics." [Amended – We have reworded the sentence but have shortened the suggested version to keep within the 250-word limit.](#)

15-16. What are 'lower relief slopes'? Should this be 'lower angle slopes'? This phrase is used several times throughout the paper. [Amended – we have changed this to 'lower angle' throughout the manuscript.](#)

21. Should be "...where all channels terminate englacially...". [Amended.](#)

23-24. You could delete "the majority of channels reach the terminus supraglacially and" as you already said that on lines 18-19. [Amended – We have reworded this sentence to make it less repetitive but kept the mention of where channels terminate to save the reader having to revisit information earlier in the paragraph.](#)

43. Suggest “channels has implications...” [Amended](#).

44-45 Suggest ‘...through and under glaciers, with potential to impact suspended sediment...’ [Amended](#).

48-50. The distinction between channels vs channel absence is a bit artificial here as the former is typical on an ice surface in the ablation area whereas the latter will be confined to higher elevations. Can you distinguish between importance of channels vs absence in ablation areas as this controls delivery of water to bed which influences subglacial water pressures and basal motion (e.g., Banwell, A., Hewitt, I., Willis, I. and Arnold, N., 2016. Moulin density controls drainage development beneath the Greenland ice sheet. *Journal of Geophysical Research: Earth Surface*, 121(12), pp.2248-2269). Channels vs absence on firn at higher elevations reflects melt rates vs infiltration capacity, and I agree this has implications for portioning of refreezing vs runoff. [Amended – We have replaced these sentences with the implications of surface-to-bed routing of meltwater.](#)

52-53. ‘...glacier systems...’ is vague. If you elucidate importance for proglacial water quality, glacier dynamics, and mass balance above, you could refer to these things again here. But are you going to address the impacts in this paper? If not, I suggest delete this last clause. [Amended – we have removed the last clause.](#)

64-65. Suggest “...larger ice sheets also apply...” [Amended](#).

67-8. Suggest “...about supraglacial channel distribution in mountainous environments, but previous research has helped to establish some fundamentals (e.g., Knighton...” [Amended](#).

75 ‘present’ => ‘presence’ [Amended](#).

76 ‘influences’ [i.e. singular as refers to ‘presence’] [Amended](#).

76-80. These two sentences are repetitive. Suggest combine to make the point about the controls of discharge and slope just once. ‘increased slope’ should say ‘high slope’. [Amended](#).

80. ‘discharge rates’ is wrong as discharge is a rate [discharge is the volumetric flow rate of a stream]. [Amended – this has been removed.](#)

86. Suggest changing ‘systems’ => ‘glaciers’. [Amended](#).

132 ‘records an historical’ [Amended – this section has been removed.](#)

122-137. To what extent is all this info on climate and glacier area change relevant? Can you delete it all (or much of it)? [Amended – we have removed the sentences that follow on from “the mass balance of Swiss glaciers in recent decades \(Fischer et al., 2015; Davaze et al., 2020\)...”](#)

146 Need a comma here “small amounts of water, or incised channels where...” [Amended](#).

141-147. You say you applied automated methods [i.e. plural] and refer to Yang et al 2019. Does this reference detail all the different automated methods you applied? But then you only mention the first method you used and refer to Yang and Smith. This seems odd. Why did you single out just this one method to talk about if you applied others? Clarify here how many methods you applied, what they were, and what the problems with all of them were. [Amended](#)

– We acknowledge that the wording may have been confusing and have reworded this information to clarify that we only tested the NDWI_{ice} method of channel detection. Other methods such as flow routing would not have been viable with the resolution of the available DEM.

148. when you say ‘multispectral methods’ do you mean ‘automated methods’ [as referred to on line 141]? **Amended – Yes, this is now clarified that in the text.**

149. You mention your data set here “high resolution cloud-free orthophoto imagery” but was this the data you first attempted to detect channels on automatically as mentioned above? State above what data you were working with. **We have now added information about the imagery used to test the NDWI approach. This was the same orthophoto imagery (0.15 m) referenced throughout.**

150-52. Suggest “hence 6% of glaciers were still snow-covered down to their termini and were omitted from further analyses as the presence or absence of channels could not be detected.” **Amended.**

I assume by this statement that you included glaciers that were still largely snow-covered, as long as they had some exposed ice on them? **Yes, we did. However, the mean percentage of snow-free glacier area was 38.9% in mid-July when we acquired our imagery. A very small number of high-elevation glaciers only had a small area of ice exposed, with a minimum snow-free area of 5%. This snow-free glacier area increases to 45.0% when glaciers have a mean elevation between 2500 and 2800 m.a.s.l. The lowest mean for an elevation band is 36.6% between 3100 and 2400 m.a.s.l, demonstrating that there is not a large difference between the elevation bands. This information has now been added into the manuscript.**

150-7. You need to reorder this material. First state how many glaciers you start with, then how many you remove because they are too small, then how many of those you remove because they are still completely snow covered. **Amended – this paragraph has been restructured.**

167-8. How easy was it to distinguish how the streams terminated? We find that it is typically easy to identify where the streams terminate due to the imagery resolution, whereas the largest source of error is when the mapper stops mapping up-channel to avoid over interpreting. **We expand upon our mapping accuracy in new sentences that have been added to the first paragraph of section 3.1.**

Fig 2. The stream in C looks like it used to terminate in the moulin identified but that a new moulin on a crevasse has opened up above it. **Upon further inspection of the feature that is visible upstream, it is not a moulin and the channel runs directly through it, without appearing to capture any meltwater. There are many moulins in that area, but they appear much darker in the imagery, and this feature looks to be a darker depression that contains debris. Hence, the channel terminus has been correctly identified.**

256-7. You say ‘When only considering terminal segments...’ but you used the term ‘channels terminate in a range of settings’ on line 254. So what do you mean by ‘terminal segments’? You mean ignoring those that join another channel or disappear below map resolution? **Amended – We have clarified that we do indeed mean channels that do not join another channel or disappear below the mapping resolution.**

Are there segments that disappear below map resolution but then look as though they reappear again down glacier? How common is this? What are the implications for your results?

If there are channels that disappear and reappear, we cannot confidently assume that they are part of the same channel, hence they will have been mapped separately. As we have now more clearly described in the methods, we take a conservative approach to mapping to avoid over-interpreting channels. A gap in channel mapping should not significantly affect the drainage density of the glacier, but it will affect the assigned terminus of the channel (i.e., assigned “disappears below the mapping resolution”). We do not include channels that disappear below the mapping resolution in the calculations for meltwater routing. Hence, if a channel disappears below the mapping resolution, and subsequently reappears and terminates in a crevasse, we would still be capturing the final channel terminus location, without affecting our values for where meltwater is routed. However, it is likely that we underestimate the number of englacially terminating channels where the terminus cannot be clearly identified, as we don’t detect the true location where it re-emerges, but this would not be possible to identify without further information (e.g. from dye tracing).

261 ‘singular’ => ‘single’ Amended.

261-2. I don’t understand what you mean by ‘Thus, when the percentage of channels terminating in each position are extracted as an average value from each glacier...’ ‘are’ should read ‘is’ as its singular as it refers to ‘the percentage’. But even with this grammatical change I don’t think the statement makes sense, does it? Amended – we have reworded this sentence to clarify the meaning of the text. We are trying to convey that we calculate channel termini locations for each glacier (e.g., 30% of channels terminate englacially and 70% terminate supraglacially) and when you average these values for all glaciers you get X% terminating at a certain location. We display this value because it is likely more useful than using the raw data for all channels because a few large glaciers contain a disproportionately large portion of the channels.

274-5. You could cut words (and improve style) here and just say “Here, we investigate links between different supraglacial channel characteristics. Previous studies...” [You refer to Fig 5 at the end of the relevant sentence below so no need to refer to it up front]. Amended.

279-80. Is this accurate? I think I’d remove the word ‘clear’ [as the boundary looks a bit fuzzy to me] and I’d say a sinuosity of 1.3 [eyeballing the figure suggests you have 8 values > 1.2 but only 4 > 1.3 for slopes > 20 degrees]. Amended.

280-281. Do you need the word ‘segment’ here? You just said channel length on line 277. Amended - For the purpose of clarity and consistency we have kept ‘segment’ here and added ‘segment’ into line 277 and into the figure captions that use channel segment length as a metric.

281. You say ‘which often have a lower density of crevasses’ but there’s no evidence for this in Fig 5b that is referred to. Is this interpretation – in which case this could be moved to the Discussion section. Or do you have evidence for this, in which case refer to it here. Amended – we have removed this.

282-283. You don’t need to refer to the slope-sinuosity relationship in Fig 5a again here as you’ve just dealt with that. Just stick to telling us what the upper boundary for the slope-length relationship is. For example, you could say that except for one outlier, channels >500 m long are confined to slope < 20 degrees. Amended.

290 Consider “...along with...” => “...as do...” Amended.

300. What do you mean by this sentence? ‘...less evident’ than what? ‘...lower number of data points’ than what? Haven’t you just been referring to the influence of a glacier characteristic (slope) on channel characteristics (length & sinuosity)? **Amended** – we have rephased the sentence to make it clear that we are referring to the number of data points in Fig. 5a-b compared to Fig. 5e-h. The reference to slope in the paragraph above refers to slope of individual channels, hence it is grouped with the paragraph on the controls on channel characteristics. This differs to the mention of slope on line 300, which refers to the overall slope of the glacier, rather than at a specific channel. This was likely confused by the mention of ‘glacier slopes’ when Fig. 5a was mentioned, hence we have now edited this to improve the clarity.

302-305. I think these statements about drainage density vs minimum or maximum glacier elevation and ref to Fig 5f and g are spurious. What you say is based on just 4 data points, which is not an adequate sample. I’d just point out no obvious relationships between drainage densities and either min or max elevation. **Amended** – we now note that there is less evidence of a relationship in Fig. 5g ($p = -0.39$), and tone down discussion of Fig. 5f, but suggest that a larger dataset would be needed to validate whether a relationship might exist between glacier drainage density and minimum glacier elevation.

306. Do you mean ‘interception’ not ‘inception’ here? **Amended**.

316. Should say ‘Fig 5e’ here. **Amended**.

340. What do you mean by ‘variables such as drainage density’? This is not clear. What is drainage density an example of? Should you not just list all the variables that are not closely related to just one other variable? Note you’re saying that drainage density is not obviously related to a single causal variable, which was my interpretation of the bivariate plots 5f and g above. **Amended**.

341. The word ‘singular’ is used incorrectly here. You could say “... not closely related to just one other variable. Overall, our PCA analysis reveals no single main driver of variance..” **Amended**.

354. I think ‘restricting’ should be changed to ‘determining’ or ‘affecting’ or ‘controlling’ as the first part of your sentence is just establishing a general relationship not the direction of that relationship. **Amended**.

354-6. This sentence is not quite grammatically correct as it should be ‘...can either intercept...or route...’. I’m not quite sure what you’re saying here. Are you saying that shallow crevasses may simply route the surface water along them, contributing to the supraglacial drainage system and maintaining channel length? Whereas deep crevasses may intercept surface water and deliver it to the englacial drainage system, thereby reducing surface channel length? **Amended** – this has been rewritten to more clearly convey what the reviewer has suggested.

358. I think ‘surface’ is redundant here. **Amended** – this has been removed.

358. I think you should introduce Fig 7 at the start of the next paragraph and introduce it fully. Is it depicting the influence of slope more than elevation? Or at least as well as elevation? **Amended** – we now introduce figure 7 in the second paragraph and that paragraph now discusses both slope and elevation.

361-371. You refer to 'valley glaciers' and 'Upper Theodul Glacier' in this paragraph but you don't systematically take us through the increasing drainage densities going from left to right in your Fig 7. I think it'd be helpful to describe the drainage density component to Fig 7 more systematically and thoroughly, perhaps with more ref to your case study e.g.s shown in Fig 4. [Amended – we have rewritten this paragraph to go through Figure 7 in an orderly manner with reference to case studies.](#)

360. Can you say 'Alpine settings' rather than just 'the study area' to make your conceptual model more generic? [Amended.](#)

362 'higher' => high. [you say 'small' not 'smaller so should say 'high' not 'higher']. I'd not use comparative adjectives through this paragraph unless it's obvious what your comparison is with. [Amended.](#)

370. It will not just be glaciers extending to lower elevations that will require channel incision rates to increase. It'll be the likes of Upper Theodul Glacier too won't it? [Amended – this is indeed true, but what we meant to convey was that whilst warming will be universal, glaciers with larger portions of their mass at lower elevations will likely be more vulnerable to temperature increases. We have modified the text to reflect this.](#)

385 'or a slightly delayed peak. [peak;singular] [Amended.](#)

400-1 suggest 'main stem channel segments' [Amended.](#)

407 Delete 'compared to 0 % at the Aletsch glacier' as you've just said that. [Amended.](#)

409-10. "...but rather may act as part of the channel network and are mapped as individual segments as they may not be continuous." The second part seems to contradict the first part. Surely a channel network must be continuous, doesn't it? Whether you can see it all or not is another matter. Can you clarify the point you're making here? [This section has been rewritten in response to another reviewer's comment and hopefully helps to improve the clarity. What we are trying to convey is that there is uncertainty over whether crevasses capture or route meltwater, so we don't map meltwater along crevasses / crevasse traces unless meltwater can be clearly seen to reemerge.](#)

411-12. What do you mean "We attribute the difference in drainage pathways..."? Is this the difference in drainage density between Aletsch and Upper Theodul Glacier'? Things are getting a bit hard to follow here. [Amended – this section has been separated into a new paragraph and we have reworded this sentence to provide added clarity.](#)

414-428. This is all rather speculative and rather long-winded. Also, it seems odd to be talking about specific glaciers again having introduced your conceptual model (Fig 7). Can't you continue to talk in the generic way wrt Fig 7, having given examples of the 3 types of glaciers depicted in the previous paragraph? Can you summarise much more succinctly and based on evidence where possible, the impacts of the different surface stream densities, on hydrographs, basal motion, and proglacial hydrochemistry? [Amended – this section has been rewritten more concisely within a new, smaller paragraph. It now focuses on how the glaciers described above fit into the conceptual model.](#)

Fig 8. I'm not convinced Fig 8 adds to the paper as it's just one example of a particular

phenomena that's not especially groundbreakingly novel. Figure 8 is used to illustrate one of the uncertainties we have with identifying where meltwater is going, rather than being novel, hence we believe that keeping it is helpful.

435-453. This whole paragraph is very speculative. It contains 4 instances of the word 'likely' and 2 of the word 'may'. I don't think this deserves 18 lines of prose. Amended – we have rewritten this paragraph to more clearly convey our evidence first, followed by a more logical wording of the evidence to support our conclusions.

441. I find the term 'higher relief slopes' odd. Is this used widely in the fluvial geomorphology literature that I don't know about? Why not just say 'steeper slopes'? If you agree, can you check all instances of this term in the paper and change accordingly? Amended – we have changed the language throughout.

442. '...this figure'. What figure are you referring to here? The 20 degrees? I think this sentence needs writing more precisely. Does your PCA allow you to add evidence to the statement I think you're making here? We have amended the text to clarify that we are referring to Fig. 5a. The point is that flatter areas are more likely to contain larger channels, and larger channels are more likely to be sinuous. Given the argument set out we would be looking for a relationship between sinuosity and glacier slope (mean) in the PCA, which isn't particularly apparent. This is likely because mean, min or max slope are unlikely to provide a good enough measure of whether a large enough low angle slope is present.

454 -464. It's difficult to work out from this paragraph, which statements are based on the new evidence presented in this paper, and which are based on previous research. Ideally these discussion paragraphs should clearly state the former and then bring in the latter to show the extent to which previous work supports or contradicts the findings from the new work presented.

For example, where is the evidence for the first sentence? The only thing I recall wrt debris-covered vs clean glacier is Fig 5c which shows no difference in the sinuosity between debris-covered and clean glaciers in Valais.

Amended – we have merged the paragraphs from lines 454 to 464 and lines 465 to 478 to make the paragraph more concise. We now clearly state the evidence from our research at the beginning of the paragraph and contextualize it amongst previous research later in the paragraph. The axis of Fig. 5c has been amended and the differences (even if small) between the three classes are now more obvious in the figure. The data from this figure was found to be statistically different based on an ANOVA test, which provides support for there being some difference between the classes.

465-478. As above. Potentially some interesting points in here but the discussion must be related to the results you show. Amended – we have reduced this paragraph and merged it with the previous paragraph which now more clearly follows on from results we show.

481-499. Again, I do not think enough in this paragraph stems from the work presented in the results. It's too speculative. Can you just compare your results with the results of similar work (a lot by Lawrence Smith, Kang Yang and coworkers) on the GrIS? By all means offer a sensible reason for any differences, but avoid all the lengthy speculation. Amended – in response to this comment and the one below, we have merged this paragraph with the one below to provide a more concise comparison between our work and research on ice sheets.

500-512. OK This para is better and does what I suggested above. I don't think the last sentence follows on from the rest of the paragraph. Instead, I'd weave that info and the refs into a point in your introduction, justifying that the study of surface streams and where they terminate is important for subglacial water pressures, subglacial drainage evolution, and basal motion. [Amended – this sentence has been removed and further information on the implications of where channels terminate has been added to the introduction.](#)

514-529. I think this para is basically fine – it's speculative but then it must be as it's about the future.

532. Should say "...dataset on..." [Amended.](#)

536. Delete 'existing'. I'd say "low slopes". [Amended.](#)

537 suggest change 'mass' => 'area' as that is what you measure. Could delete 'We find that' [Amended.](#)

539 'low ice surface slopes' YES!

543-5. This sentence is not quite grammatically correct. "...the percentage of channels...revealing that...80% of channels" do one thing and 20% do something else doesn't make sense. It is not the percentage of channels that reveals it. I think this whole sentence needs rewriting (also of => oU). As I mentioned earlier wrt lines 261-2, I don't follow what you mean by 'averaged by glacier'. Whether you simply calculate the % of different types of channel irrespective of glacier and quote those, or whether you calculate the % of different types of channel for each glacier, and then average all the percentages for the different channel types, and quote those doesn't matter. You get the same result. Unless I've misunderstood something. [Amended – we have rewritten this paragraph and split it in two. When we refer to average by glacier, we mean that we have calculated the % of channel terminus locations per glacier and then averaged this amongst the dataset. This is to make sure that each glacier is weighted the same, because if we didn't calculate the average per glacier, the data would be over-represented by the Aletsch glacier \(582/1890 channels\) which contains entirely englacially terminating channels, which is not the case for most glaciers in Valais.](#)

546-7. What exactly do you mean by "The variation in where channels are located"? Are you talking about elevation on the glacier, whether they're on clean ice or debris, close to or far from medial moraines, steep slopes or shallow slopes, or what? [Amended – this was redundant, and we now just refer to where the channel terminates.](#)

548-9. The phrase 'with different glacier geometries likely predictive of glacier drainage density and channel pathways' is vague. You've not mentioned glacier geometry so far in the paper so what are you referring to? And 'pathways' has been mentioned 4 times but again not very clearly defined. You say glacier geometry is likely predictive of glacier drainage density and channel pathway and refer to Fig 7. But if I look at your evidence in Fig 5e-h it's not clear that anything shown really controls drainage density, is it? Your correlation matrix in Fig 6 shows highest correlations between glacier slope, glacier mean elevation and drainage density so glaciers with low slopes and low mean elevation have the biggest drainage densities. Anyway, I think the paper would be strengthened if you based your conclusions on the evidence that you present in the results section and avoid weak speculative statements. [Amended – we have rewritten this](#)

section to clarify what we mean by channel pathways. We have also provided an example of how drainage density and proglacial stream hydrographs can be predicted based on glacier characteristics.