Distribution and characteristics of supraglacial channels on mountain glaciers in Valais, Switzerland

Holly Wytiahlowsky et al.

3rd review by Ian Willis

General Comments

I have commented positively on this work in my previous reviews and those points still stand. The paper presents a highly original data set, much of it obtained from meticulous manual digitising of tens of orthophotos. The descriptive statistics of the channel and glacier characteristics and their relationships (analysed using correlation and PCA) are all well done. It's good to see the improvements that have been made to the manuscript since my last review. For all these reasons I do think this work deserves to be published.

In my last review, I showed how the Discussion section needed the most work and it's good to see that in the latest version of the paper many changes have been made to the Discussion. I'm sorry to say, though, that I still don't think the paper is quite ready to publish because the Discussion and Conclusions still need some work. A fundamental problem is that many of the statements made in the Discussion and Conclusion do not clearly follow on from the data presented.

I think a major problem I'm having is that the Results focus on good robust quantitative analysis of glacier and channel characteristics and their relationships (4.1, most of 4.2, 4.3 and 4.4) with a short weaker section on 'qualitative observations' towards the end of section 4.2 (6 lines of text and Fig 4) but the Discussion and Conclusions focus a lot on those 'qualitative observations' and don't draw out some of the interesting things from the quantitative work.

Given the importance of these 'qualitative observations' I think they should be defined and described better and more thoroughly. Looking at lines 295-301, the 'qualitative observations' ostensibly show examples of how 'channel distribution and morphology' are controlled by 'glacier structure and topography'. These terms are poorly defined. Channel distribution is rather a vague term and not precisely defined but I take it to mean where they are located on a glacier vs where they are not]. Channel morphology is defined on line 49 as "channel shape and structure" which is slightly confusing as when I think of channel shape I think of the shape of a channel cross section. 'Planform shape' would be a better description as this is what is meant (i.e. whether channels are straight or meandering (sinuous). Channel structure is never defined. What is this? 'Glacier structure' features twice in this paragraph and nowhere else in the paper and is never defined. It seems to refer to patterns of crevasses, which is not what I'd call 'glacier structure'. 'Glacier topography' is not defined but I think this is probably clear to most readers, i.e. the pattern of surface elevation and its derivatives (e.g. slope).

Despite it being suggested that both 'channel distribution and morphology' are controlled by both 'glacier structure and topography', we're just given one example of how 'channel distribution' is controlled by 'channel topography' (Fig 4b), which is a channel occurring 'along the interface between debris-covered and bare ice'. We're also given an example (Fig 4c) of how 'glacier structure' influences 'channel morphology' which is a straight channel following a 'trace or shallow' crevasse. Finally, we're given another example of how 'glacier topography' influences 'channel morphology' (Fig 4e), which is a sinuous channel at low elevations on a flat part of the

glacier towards it's terminus. [We're also told that such channels tend to occur on 'large glaciers', which is not defined by 'glacier structure and topography' but is anecdotally thrown in here].

I'm sorry to labour the point here but this paragraph is weak and yet a lot seems to hang on it in terms of your Discussion and Conclusions. How to improve it? First, you'd need to very precisely define the terms. Second, the reader would need to have an idea of how representative these 3 examples are of all the glaciers that you've looked at. Otherwise, how do we know that you're not just 'cherry picking'? Personally, I'd recommend removing this section as it is. Given that you have done all the robust quantitative work, I'd strongly recommend you base your Discussion and Conclusions on that evidence and perhaps show these examples in Fig 4 (and more if you like) of glaciers that show the typical behaviour that you see from the analysis of your large sample. Your quantitative work cannot tell us anything about how 'channel distribution' relates to 'glacier structure or topography' but it can tell us how 'channel length', 'drainage density', 'sinuosity' are related (or not) to the glacier variables of 'area', 'slope' and 'elevation'. Note you cannot tell us anything about how 'glacier structure' [by which I assume you mean presence and orientation of shallow crevasses] influences channel characteristics as you do not have this information about crevasses in your large data set. What you can tell us about is that 'crevasse extent' influences 'drainage density' as that's shown in Fig 5h.

You'll see in the line by line comments, when you get to the Discussion and Conclusions that I'm pointing out all the instances where I do not see evidence to support the statements you make. I would recommend a fairly root and branch edit of the Discussion and Conclusions so that your statements more firmly follow on from the robust evidence you have.

I think your correlation matrix and your PCA show some very interesting findings, only some of which you draw out. For example, your first PC shows that the greatest variability in your data set concerns glacier area, glacier elevation and channel maximum elevation. The way these variables are related (+ve / -ve), which is also shown in the correlation matrix, is interesting and could be interpreted. I think I give a possible interpretation in the line-by-line comments below. Similarly, your second PCA shows the 2nd greatest variability in your data set is to do with drainage density, mean glacier slope and mean glacier elevation. Again, the way the variables are related in their contribution to PC2 (and in the correlation matrix) is really interesting and supports the main conclusion that you wish to make (and which you've depicted in your conceptual model). Fig 5h also supports this. As far as I can tell you have no evidence that 'glacier area' may affect drainage density (r = -0.1) although you do have evidence that glacier area may affect sinuosity (r = +0.29). These points based on your evidence need articulating clearly.

Another thing you'll see form the line by line comments is that you need to be careful to separate out correlation (which you have evidence for) from causation (which is your interpretation). Be careful and consistent throughout your paper on this point. I think I've given examples below on how you can change things or where you should.

I hope my comments are helpful. As I've said before, they are designed to improve the paper so that it's intelligible and people will want to read it, understand it, and hopefully reference it.

Line by line comments

Introduction

45. suggest "...why surface meltwater becomes channelised on some glaciers but not others..."

55-7. correct to "...as most channels on mountain glaciers are likely much smaller than those on the GrIS and therefore fall below the resolution of even the highest-resolution freely available satellite platforms..."

58-59. Better to say: "...comparable to those on mountain glaciers. Mountain glaciers are characterised..." [because 'the latter' strictly refers to "the channels on mountain glaciers"]

70-72. "Where channels occur, they are often reactivated annually" repeats lines 67-8. And "...deeply incised channels suggested to be a product of high discharge.." is similar to lines 64-5 as high meltwater production => high discharge.

79-81. Better to say: "However, much of what we know about supraglacial channels was established from observations of a small number of individual glaciers, especially those that are cold or polythermal (e.g., Knighton, 80 1972, 1981, 1985; Gleason et al., 2016; St Germain and Moorman, 2019).

91. I'd say "glacier surface characteristics"

92. Can you briefly summarise what the 'qualitative observations" are? Although if you follow my advice in my general comments this may be removed.

Study location

100 Swiss canton [not capitalised here as not a specific canton, e.g. Valais Canton]

101 I'd delete the 2nd 'area' so "... a maximum of 77.3 km2..."

118. delete 'right'? Isn't G Aletsch just in the centre?

Methods

154-5. I'd say "This is because they are likely too small to form channels large enough to be detected in our imagery, and because many of the small glaciers listed in the Swiss Glacier Inventory (SGI2016) do not meet the criteria for classification as glaciers (Leigh et al., 2019).

174 "...main channels were mapped..."

178-179. confusing to have 'terminus' for channels and for glacier. Suggest use 'snout' for glacier terminus throughout paper. [Or you could use terminus for glacier and terminal for channel]. Also, later you talk about a channel running off (terminus or periphery). Would it better to refer to that here. So you could alter your list here to say: The type of terminus was assigned to each channel, which was one of: running off the glacier snout, or off the glacier side, or terminating in a moulin, crevasse, or lake, or adjoining another channel, or disappearing beyond the image resolution (i.e.., the terminus was not visible and could not be inferred confidently).

Note I've changed 'periphery' to 'side' here as 'periphery' to me would include the front (i.e. snout). If you like these suggested changes, check your entire paper and make the relevant changes.

184. "Supraglacial channels on Glacier de Moiry and (c-d) on Allalingletscher..."

186. Should assessment be plural? Also, put in brackets the initials of the 'individual'. I assume (HW).

191. Tell us approx. what the time period was. E.g. "...was conducted over an approximately 6 month period."

192. "...of each channel length and glacier's drainage density..."

193. Could delete 'here'

195-6. This is unclear to me. Do you mean you mapped the up-glacier channel limit to where you were confident the channel existed? Note past tense 'were'.

199. Helpful to reiterate "..the 85 glaciers..."

204. Regarding segment length, wasn't this derived from the orthophotos not the DEM as implied here? Regarding straight line distance, is this in 2D plan (so from the orthophotos) or in 3D (so from the orthophoto and DEM)?

209 change 'which' to 'and'

201 could delete 'record'

199-219. There's confusion I think between these paragraphs about how you calculate elevation and slope. In the first para you say the DEM was used to calculate both. In the 2nd you say that slope was calculated for the snow free area so calculated from the DEM. But what about elevation variables? Did you also calculate that for the snow free part?

226-27. given what you said earlier you could reorder these and say "drainage density, glacier area, aspect, minimum elevation, mean elevation, maximum elevation, and mean slope of the snow-free area."

228-233. Could be abbreviated and improved to say: "A one-way ANOVA was performed to test the significance of the relationship between the three debris-cover classes and sinuosity. In addition, a Principal Component Analysis (PCA) was conducted to examine relationships among variables and identify the main drivers of variance in the dataset, with the data normalised to enhance pattern detection."

Results

243 I'd change 'on' to 'of'   and say 'km2, with a maximum..."

264. It would be helpful to indicate where these glaciers in Fig 4 are on Fig 1.

286. change 'terminus' to 'snout'? See earlier comment. Change throughout if you agree.

289. change 'periphery' to 'side'? See earlier comment. Change throughout if you agree.

292. What do you mean here? what is 'the average glacier'? Also, have you defined 'terminating proglacially already? Is this the same as having water running off the glacier snout or off the glacier side?

305. 'variables to test for..."

306. 'affect' implies definite causation, but of course you're doing correlation (not causation). You could say " 'may affect' or 'are related to' here.

312-13. "The 'debris' class generally contains more sinuous channels than..." is more correct

341. You can't say 'controls' here as this implies causation which you don't know from correlation analysis. From here and for the rest of our paper you'll need to be careful with this. You'll need to be clear when you're sticking to the facts (correlation) and when you're making inferences from them about cause-effect or processes. You could say "'associations between' or 'possible controls' here.

345. 'control' No

355. What does " high channel sinuosity can in part be explained by multiple weak correlations" mean? I'd just delete this.

358. 'controlled' No

361. 'relationships' [plural]

361-2. did you use all the channel and glacier variables in your PCA? If so state that here.

362-367. Capitalize 'Principal Component' when referring to a specific PC (1, 2 , 3 etc). Or just abbreviate to PC

366. Tell us what % PC1 and PC2 explained individually (not just together).

Discussion

377. I assume you want to say "Previous work has suggested that the presence of visible channels is primarily controlled by..." ? Because you do not measure 'meltwater supply' in your paper. Or is this interpretation based on your results? It'd be best to start each discussion point (so 5.1, 5.2, etc) with <u>explicit reference to your findings, then your interpretation of those findings (make it clear where results end and interpretation begins) and you could also discuss your findings / interpretation in the context of previous work.</u>

Section 5.1

This subsection is headed "Controls on the spatial distribution of channels" . This is a little unclear as a title, especially as you haven't really shown results on this topic. Your paper is not about why channels form in some places and not others on a glacier.

382. Your statement "glacier area controls much of the variability within the dataset (Table A1)" is correct as glacier area dominates PC1. You could refer to PC1 after Table A1 to clarify this.

383-4. Your statement "... albeit with large variation in drainage density." Is rather thrown away here. Drainage density dominates PC2. So why not explicitly say that.

384. When you say "This variation is in part attributed to glacier slope..." what exactly do you mean? I can see that PC2 is dominated by drainage density (+ve) and glacier slope (-ve). Is this what you're talking about? Refer to the evidence for your statements. Note glacier mean elevation (-ve) also contributes to PC2. Why not mention this? What this means is that a high source of variability in your data set comes from these three variables contributing to PC2. Glaciers with high drainage density tend to have low slopes and are situated at low elevations. Use your results to discuss them.

384-5. Your statement "...together with ice flow velocity, governs the crevassed area of a glacier" is either from previous work or it's your interpretation of your results. You do not analyse ice flow velocity. Nor do you show the relationship between glacier slope and crevassed area. You need to more clearly discuss your results and explain what your evidence shows and how you interpret it.

388-92 'Channel formation is also governed by glacier hypsometry...' is a little confusing as 'hypsometry' is not one of the variables you quantified and investigated. Similarly, you talk about "glaciers containing a larger proportion of their area at lower elevations', which I agree is to do with hypsometry, but again, you don't measure or report this. What I can see is that the 3rd most important variable contributing to PC2 is glacier mean elevation, and I can see from the Table A1 and the Fig 6 correlation matrix that drainage density is inversely correlated with glacier mean elevation, so lower elevation glaciers have higher drainage densities. Refer carefully to your data and evidence and make statements that you can support. Then interpret. The last two sentences of this para don't really contribute meaningfully to the discussion.

393. The word 'hypsometry'. Again, this is not something you explicitly focussed on in our paper so I'd remove reference to it. However, here you're focussing on explaining variation in drainage density (so we're with PC2 still) and you could also draw on evidence from the correlation matrix. It is glacier slope and glacier mean elevation that correlate with drainage density and contribute to PC2.

394. "The lowest drainage densities are predicted to occur on smaller cirque glacier..." You cannot say this based on your work. First, the word 'predict' suggests you've developed a model (e.g. regression) and are using it for prediction, which is not the case. But nor did you show that low drainage densities are correlated with small glacier size. In fact, the correlation between these two variables is only -0.1 and non-significant so you need to play down the role of glacier area. Lowest drainage densities are associated with glaciers with steep slopes and high average elevations (PC2 and correlation matrix). Perhaps they're not necessarily the cirque glaciers, just steep, high elevation glaciers – they could be valley glaciers. Base your statements on the evidence. Then you could go on to infer the processes involved in explaining the correlations, i.e. your interpretation. Make it obvious to the reader in your writing when you're moving from results to interpretation.

398-400. As above, you've not shown direct evidence for this statement. You have evidence that large drainage densities are on gently sloping glaciers at low mean elevations. Why are you talking about steep slopes and crevasses here?

400-402. Again, you must use your results as the basis of your discussion. You have evidence that large glaciers extend to lower elevations and have channels that don't extend to very high elevations (PC1 and correlation matrix). I cannot see evidence for a link between glacier area and drainage density. The opposite in fact as these have a low correlation. You have evidence that glaciers with high drainage densities have low slopes and have a low mean elevation.

404-408. The two sentences here are a contradiction to your general finding based on the statistical analysis of high drainage densities for glaciers with low mean elevation. You'd be better to discuss things based on your findings!

413. Channel inception in Fig A should read interception – I think I pointed out this mistake in an earlier review.

425. As I say above, I don't think glacier size can be discussed in relation to your conceptual model that is supposed to be based on your evidence. You could talk about steep, high elevation glaciers here but not 'small'. Categorising them as 'cirque' is an interpretation I assume?

428. 'valley glaciers are larger' Again, valley glaciers is an interpretation. Your evidence doesn't allow you to equate 7B glaciers with size. Your evidence suggests these are less steep with lower mean elevations cf. glaciers in 7A.

435-436. Again, link to your evidence. Avoid talking about 'area'. Here you're talking about very shallow gradient glaciers with very low mean elevation. These have the highest drainage densities. And they have the lowest incidence of crevassing (Fig 5h).

441. 'connectivity'? What does this refer to?

442. "...based on the locations of our mapped channel termini". Up to this phrase, this sentence sounded like a summary of your previous paragraph and conceptual model shown in Fig 7. This phrase throws a spanner in the works as you have not yet discussed possible links between locations of mapped channel termini and lag times between melt and discharge. I've read on and it appears as though you're going to talk about this wrt 2 case study glaciers. I suggest rewriting this sentence to introduce the work you'll present in this paragraph.

442-3. As I mentioned before, what exactly does this mean? How do you define 'average glacier'?

444. "... the largest glacier, Grosser Aletschgletscher (type B in Fig. 7)" OK, so your largest glacier is type B not C! This adds to my advice that you should not refer to glacier area as a control on drainage density (for which you don't have evidence).

451-2. where are the 'trace crevasses' in Fig 8? They are not labelled as such.

440-456. This paragraph is a little rambling and unfocussed. State at the outset what you're aiming to achieve here. It looks like you want to show us how different types of glacier (low drainage density to high drainage density - types A to C in Fig 7) have channel segments that

terminate in different ways. Correct? One way to have done that would have been to cluster your glaciers into the three types (based on their statistical attributes - either the raw variables or the PCs) and then looked at the number of channel termination types in each of the 3 clusters. You'd hypothesize that your steep, high elevation, low drainage density glaciers (type A) would have most channel termini ending in crevasses. Type C would have most ending by flowing off the snout or side. And type B would be somewhere in between. That would have provided you with the evidence you need to support all your statements relating to crevasses affecting channel / drainage characteristics. But you're not doing that.

Instead, you're picking a single case study example of Type B and Type C and telling us about their channel termini characteristics. For completeness why not do the same for a Type A glacier? Explain at the outset that this is what you're doing in this paragraph. In fact, would it be best to do all this BEFORE you present your conceptual model because in your description of the 3 types of glaciers you mentioned crevasses without really showing us any evidence that crevasses were relevant.

460. You refer to ' meltwater overtops the crevasse' . Does this make it a trace crevasse then?

464. You refer to Oberer Theodulgletscher and Grosser Aletschgletscher but as I said above it'd be helpful to add an example of a type A glacier wouldn't it? Note the proper nouns (names of glaciers here) do not need to be prefixed by 'the'.

473. As I said before, you don't measure 'hypsometry' but you do show the role of glacier mean elevation so I'd refer to that here.

472-3. I'd agree with the statement: "Hence, categorising glaciers based on their slope and mean elevation is beneficial because it provides insight into the anticipated drainage density of a glacier" because this is based on your evidence from your correlation matrix and PC2.
474-5. This statement about things providing insight into "channel pathways (i.e., sub-/englacially or proglacially terminating), and whether a higher amount of surface-to-bed meltwater transfer is likely" is a bit clumsy and is less well supported by your evidence but see my suggested way forward above wrt cluster analysis.

479 "...slope affects sinuosity". Clarify you're talking about channel slope. And avoid the word 'affects' as this implies causation whereas you just show correlation.

480. As well as Fig 5a you could refer to Fig 6 as this is supported by your correlation work. It's also interesting that this -ve association between channel slope and sinuosity remains apparent in PC5.

481. After stating the correlation between channel slope and sinuosity, you could interpret it and discuss processes. It's what you'd expect isn't it? Steeper slopes → lower sinuosity. On steep gradients, water has high energy and tends to take the most direct downslope path. This reduces the development of bends, keeping channels relatively straight. Gentler slopes → higher sinuosity. On low gradients, flow velocity and stream power are lower. Water has less ability to cut straight downslope and instead meanders laterally, forming more sinuous channels.

482-3. Fig 4e doesn't provide all the evidence to support the statement. It just provides examples of two sinuous channels on clean ice. Are there other channels not shown that are straight and on dirtier ice? I'd be tempted to delete this sentence.

483-5. The statement spanning these lines could also explain the sinuosity of at least one of the channels shown in Fig 4e as that channel seems to be sourced on debris. So this all seems a little weak.

486-500. I don't really see what you're trying to explain here. Channel slope controls stream power. Surely this promotes straighter channels. So your finding of more sinuous channels on gentler slopes makes perfect physical sense to me. Like you say, discharge also controls stream power so if discharge is higher through gentler slopes, then I suppose that could override the slope control, promoting straighter channels on gentler slopes and more meandering channels on steeper slopes. But you do not find this! Nor do you have any discharge data! So why try to explain it? Are you trying to explain Fergusson's and StG and M's findings, which would seem to buck what makes more physical sense? Haven't they already done that in their papers? Is it your job to do it here? I suppose you could just briefly explain that your findings are different to those from the Arctic glacier but explain briefly why the earlier work provides evidence which is contrary to what you might expect. But be brief.

503-5. Split the sentence to be clear. So say: "Previous research on supraglacial channel morphometry has focused predominantly on the GrIS (e.g., Smith et 503 al., 2015; Karlstrom and Yang, 2016; Yang and Smith, 2016; Yang et al., 2016, 2021, 2022). We find some similarities between the drainage patterns observed on Valais glaciers, and those on the GrIS."

505-6. I don't think you should resort to just picking out this one glacier in 4a. Your work has not focussed on how dendritic drainage patterns are. Can you not compare some of the quantitative channel and glacier characteristics and relationships between Valais and the GrIS, e.g. drainage density or sinuosity and their correlations with channel / glacier attributes?

507-8. "...some glaciers in Valais display parallel, weakly interconnected channel networks, likely due to insufficient distance for meltwater to converge into a single channel" Seems a bit anecdotal. Do you have strong evidence that this is prevalent on Valais glaciers? Doesn't the GrIS also display this in places?

509 "...these networks...". Which networks are you referring to here? The parallel weakly interconnected ones? So Yang et al 2016 find these follow Horton's laws on the GrIS? Why not calculate them for your drainage networks? Then you could properly compare Valais glaciers with GrIS. So far, you've not convincingly told the reader based on evidence whether and how the supraglacial hydrology differs between Valais glaciers and the GrIS.

511. You say 'trace crevasses exhibit a strong control on meltwater routing on Valais glaciers'. I do not believe you can conclude this from the evidence you've presented. The only mention of 'trace crevasses' in your results is on p18 wrt Oberer Theodulgletscher when you say "it is not known whether meltwater enters englacially or is routed on the glacier surface through trace crevasses (e.g., Fig. 8). Fig 8 makes no mention of 'trace crevasses' explicitly.

512. I'd delete ref to Antarctic ice sheet – see the subheading title!

514. should say 'Valais glaciers and the GrIS...'

516. I'm still unsure what the "average Valais glacier" is.

520 "appears to affect..."

520-1. Where did you show debris cover affects channel distribution? And what do you mean by 'distribution'? The only place I can think of is Line 295 onwards "Qualitative observations suggest that channel distribution and morphology are controlled by glacier structure and topography. For example, channels often occur along the interface between debris-covered and bare ice (e.g., Fig. 4b), particularly adjacent to medial moraines, where channels are confined to a topographic depression, commonly occurring at the confluence between two tributaries." This is only one example you've shown and I bet you could find at least one example of a channel on the GrIS flowing adjacent to a medial moraine. I don't think you have enough evidence to say anything meaningful here about the similarities or differences between Valais glaciers and the GrIS in terms of the effects of debris on channel 'distribution'. What about morphology? Any studies of sinuosity and role of debris on GrIS?

522-4. This sentence seems misplaced as it's for a glacier in Svalbard. Suggest delete.

524. What do you mean by "scale" here? And are you comparing Valais glaciers with the GrIS?

526. At the end of this para I don't have a clear sense of the similarities and / or differences between Valais glaciers and the GrIS in terms of the role of debris on supraglacial channels.

530. 'may' => 'are likely to continue to'

534 'large enough' => 'sufficient'

537-9. Seems a shame that you can't add anything to this based on your work. What would you expect from Fig 5c?

540-47. All this is not about the future evolution of channel systems. You need a separate section, or you need to reframe this section and provide a new heading. If you're talking about future work, you should discuss the possible imitations on your work of using July imagery rather than later season imagery.

Conclusion

550. I'd say 'From a sample of 285 glaciers…"

551-2. Here you talk about variability in glacier drainage density. This relates to PC2. Before this you could report the PC1 finding of high glacier area variability with large glacier area correlated with low minimum glacier elevation and low maximum channel elevation. And the possible reasons / implications of this. Of course, you'd need to have this as a discussion point earlier, as I suggested you could.

553. As well as ref to Fig 7 I'd use (or add) your correlation matrix Fig 6 here.

553-554. " The presence of channels is primarily dictated by a sufficiently supply of meltwater (i.e., large enough glacier area)" Note sufficiently => sufficient. But more importantly, this can't be a direct conclusion of your work as you do not measure melt water supply in your study. In your conclusions, explain what you actually find and then explain what your interpretation is. A large glacier area is not necessarily synonymous with a large supply of meltwater as you seem to be suggesting here. I assume this conclusion relates to your first result on lines 237-8 "Glaciers with channels (n = 85) have a larger mean area than glaciers without channels (n =

200) (mean area = 5 237 km2 vs. 0.6 km2) and all glaciers larger than 5.6 km2 contain channels > 0.5 m wide (Table 1, Fig. 3a)." If so would it be useful to remind us of this or refer to the relevant Fig?

554-555. "...and an uninterrupted distance for meltwater to coalesce (i.e., absence of crevasses)" Where did you show us that the 85 glaciers had fewer crevasses on them than the 200 glaciers that did not have channels, as you are suggesting here?

555-57. I can't see evidence for this sentence. You're suggesting that there are thresholds of glacier slope and glacier area beyond which channels don't form. Where is the evidence for this? Fig 5b does not show this. You also suggest that glacier slope and glacier size provide a limit on channel length. Again, where is the evidence for this? Fig 5b shows the relationship between channel slope and channel length of your sample. There is nothing about 'limits' here.

557. "...strong structural controls on channel distribution exist." It seems really odd to be talking about channel distribution as that is not really what your paper looks at. For the glaciers with channels on them, your paper focuses mostly on the relationships between channel and glacier characteristics, not about the presence or absence of channels in particular places.

557-8. "For example, trace crevasses have been observed to act as preferential meltwater pathways, resulting in channels forming perpendicular to ice flow." Where have they been observed? I think you give just two examples in your study (Fig 4c and Fig 8) and this point is mentioned almost in passing. It is hardly a major conclusion of your work. On line 452 you state: "Observations have shown that trace crevasses may act as a preferential meltwater pathway, often resulting in channels forming perpendicular to ice flow (e.g., Chen et al., 2024). " So this is a conclusion of another paper!

559. "Channels also commonly form parallel to medial and lateral moraines due to topographic confinement." Again, is this really a major conclusion of your analysis? Where do you show this? where is the evidence that this is widespread?

560. You refer to Fig 5a here but wouldn't Fig 3f be better? What is your definition of low? Can you say that x% are < some threshold?

560-61. "....highly sinuous channels are present, particularly on moderately debris-covered ice and lower-relief glacier termini." Again, where is the evidence.? See my comments on your section 5.2.

566-575. You may wish to reword or refocus this and the entire conclusion after thinking more about the Discussion section.