Review for "Basal control of supraglacial meltwater catchments on the Greenland Ice Sheet" by Josh Crozier, Leif Karlstrom, and Kang Yang

General Comment

This is an interesting paper that presents original research on how the topography of the bed below the Greenland ice sheet shapes the overlying surface ice topography, and how this in turn controls supraglacial internally drained configurations (IDC) as well as subglacial drainage patterns. The scope of the paper is broad, and the research is detailed and well executed. The authors combine a number of techniques, including remote sensing DEMs and radar, upward continuation of bed topography, and fluvial morphometric analysis, to interrogate the topographic controls on IDC and how they depend on ice flow characteristics, as well as their role in establishing subglacial meltwater pathways. There is a lack of studies that address the broad aspects of glacial hydrology, in particular the interplay between supraglacial and subglacial drainage and their connection to bed and surface ice topography, so this is a welcome contribution. The paper is well written and structured. I do have two general comments and some minor issues I would like to see clarified prior to publication:

- Supraglacial flow direction: Throughout the text, there appears to be several contradictions stating the direction of supraglacial drainage (i.e., line 33 "stream channels () flow in directions not parallel to the surrounding ice surface slope or slice through topographic ridges", but then lines 26-29 in page 12 "%d should generally increase and approach 100% since streams do not flow uphill. Similarly, Δ should generally increase and approach 1, since water should generally flow in the direction of steepest descent." Please clarify throughout the text.

- Figures: Figures should be larger, it is hard to see some of the details. Font sizes should be the same for the different labels, and label quality seems compromised in Fig. 2 and Fig. 9. See my specific comments below for other small issues.

Specific comments

Page 1 line 7: "a suite of recent datasets" reads vague, rephrase to make it more specific

Page 2 line 13: Can you give numbers for gradual and steep surface slope?

Page 3 line 4: Reference missing after "meltwater routing"

Page 3 line 26-27: Add a few words at the end of the introduction about examples of IDC and their spatial scales

Page 4 line 10: "Bed DEM". Correct typo.

Page 10 line 7: The stream power law was originally proposed by [1].

Page 10 line 20: Values of n for equation 7 are given, but the choice of the power m is not discussed in the paper. Can you add one or two lines in this paragraph about your choice of m, and how it may influence your results? In river systems, m depends on both hydraulic geometry (which is empirically different in supraglacial systems, see [2, 5] and an empirical basin hydrology relationship [4, 3]. I am curious about how to estimate m in supraglacial channels

Page 13 line 29: Is the assumption of essentially zero effective basal pressure consistent with your choice of C0? Please discuss in one or two lines.

Page 15 line 12: The discussion of the slope-area exponent is distracting, I would suggest removing or reducing it.

Page 15 line 24: Fix typo "slope-are".

Page 15 lines 28-33: This paragraph got me a bit confused see marked-up pdf attached. Throughout the text, you are using fluvial erosion models (stream power law) based on the fact that supraglacial channels behave fluvially. The sentence "slope-area discrepancies that could indicate a fluvial signature in observed stream networks" seems to contradict this fluvial model adopted throughout the paper. Please clarify or rephrase the writing.

Page 16 line 10: Give more details about the "changes" you are referring to the sentence reads vague.

Page 16 line 16: It should be "affected" and not "effected". Please fix typo.

Page 16 line 29: fix typo: "IDC-scale scale".

Page 17 line 9: Add numbers for the basin density, either here in the text or in Fig. 11. This will help the comparison among basins, which is already done in qualitative terms.

Page 17 line 11: Missing "that" in "expect changes in topographic basin density predicted with changing ice flow conditions should generally correspond".

Page 17 lines 12-14: In this discussion, it would help the reader if you refer directly to the panels in Fig. 11.

Page 18 line 11: The wording of this sentence suggests that a rapid development of subglacial channels increases subglacial pressure. I suggest changing 'rapid' to 'slower'.

Page 18 line 17: Fix typo: "effecting" should be "affecting".

Page 18 line 24: I believe you mean Fig. 10 instead of Fig. 11

Figures and tables:

Fig. 1: Can you make the white arrows a bit larger, or increase the white contrast? It appears that both figures (in particular B) have been shrunk horizontally. Could you fix it to make panel B a bit wider?

Fig. 2: Give references for the data sources, even if not directly mentioned, if they are used in the study.

Fig. 3: This figure would benefit if enlarged. Consider having two panels in vertical by two in horizontal.

Fig. 4: Color scale labels should be the same font size than x and y axis labels, and bigger panels would make visualization better.

Fig. 5: Font sizes should be the same for the x, y, labels and the color bar.

Fig. 6: Consider adding the 6 km cutoff filter on the title of panel B.

Fig. 7: What is the shaded part in the plot? Consider either removing it or explaining its significance in the caption, as appropriate. Also missing a label for the x axis.

Fig. 8: Consider changing the title of panel C to "misfit", and detail the misfit calculation (as it is now in the title of panel C) in the caption. Consider, additionally, showing the percentage misfit in this panel, as this is the metric discussed in the results.

Fig. 9: Larger overall figure and larger labels would help to visualize the results.

Fig. 10: Both panels have shaded areas on them please explain what they mean in the caption or remove them, as appropriate.

Fig. 11: The discussion of the results of this figure is about basin densities, but no numbers are given as a reference. I would suggest to give the basin density measurements for each scenario, and give them in the caption.

Table 1: Lines 2 and 3 seem to belong to the main text, not the table caption. Consider relocating them.

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References

[1] A. D. Howard and G. Kerby. Channel changes in badlands. *Geological Society of America Bulletin*, 94 (6):739–752, 1983.

[2] R. A. Marston. Supraglacial stream dynamics on the Juneau Icefield. *Annals of the Association of American Geographers*, 73(4):597–608, 1983.

[3] G. Parker, P. R. Wilcock, C. Paola, W. E. Dietrich, and J. Pitlick. Physical basis for quasi-universal relations describing bankfull hydraulic geometry of single-thread gravel bed rivers. *Journal of Geophysical Research: Earth Surface*, 112(F4), 2007.

[4] K. X. Whipple and G. E. Tucker. Dynamics of the stream-power river incision model: Implications for height limits of mountain ranges, landscape response timescales, and research needs. *Journal of Geophysical Research: Solid Earth*, 104(B8):17661–17674, 1999.

[5] K. Yang, L. C. Smith, V. W. Chu, L. H. Pitcher, C. J. Gleason, A. K. Rennermalm, and M. Li. Fluvial morphometry of supraglacial river networks on the southwest Greenland Ice Sheet. *GIScience & Remote Sensing*, 53(4):459–482, 2016.