

Interactive comment on “Basal control of supraglacial meltwater catchments on the Greenland Ice Sheet” by Josh Crozier et al.

Anonymous Referee #1

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General Comments

This paper uses previously established transfer functions to make three points:

1) that 1-10 km scale topography on the ice sheet is controlled by bed topography. I don't disagree with this statement because its more or less the conventional wisdom and others have demonstrated this to be the case. It is certainly not new and I don't feel the results presented really shed any new insight relative to Greenland.

2) Changes in sliding will radically alter the surface topography and catchments, leading to smaller catchments with more moulins and less efficient drainage. This point is somewhat of a stretch given that the high sliding really only occurs in the summer – most of the evolution of the glacier takes place over the other 9 or 10 months of the year.

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Moreover, they appear to use a very high slip ratio of 11 given that from what I can tell its derived using winter velocities in regions with quite warm (perhaps even temperate ice), with high slopes, so one would expect deformation to be significant (~50/50 as Ryser et al, JGlac 2014 show). Ryser et al show slip ratios this high in summer, but only for a few brief peaks each summer (the annual average slip ratio is much lower). Citing this work as well as others on actual slip ratios would make sense. From Figure 6, its seems like the misfit is somewhat insensitive (broad minimum) to this parameter, so how is the ice sheet so sensitive to change in sliding. In short, the feedback they suggest between catchment size and sliding is not at all well supported. It's also not clear how much faith we should put in a theory derived for small perturbations applied to high-amplitude topography with a linear rheology in place of a non-linear rheology. Such cases can be illustrative, but one has to be careful about then inverting and assigning too much quantitative credence to the results.

3) There is a lot about thermal-erosion that's not really well explained. There numerous cases where major drainages are observed to be bridged due to large melt channels. So, I am not really sure what the major point is.

Nearly every Figure is referenced parenthetically, without ever explaining what the figure is supposed to be showing. Statements like “We computed xyz results to make some point. The results show that. ...” Would be helpful. The captions themselves are generally terse and don't really explain the figures well, especially without supporting explanation in the text. In some cases, the figures appear to be referred to out of order (5 before 4). With respect to the number of figures, this is probably a case of less is more (i.e., fewer, better explained, and more relevant figures).

The appendix seems to be largely a rehash of Gudmundson's work with a few symbols changed. A whole section to define Fourier transforms is unwarranted.

In summary, I don't see that this paper adds much new knowledge or insight in its present form. It probably needs a complete restructuring and rewrite.

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Specific Points

P1/L18 – disperse -> dispersed

P1/L18/19 – more dispersed yes, but under the scenarios that would reach this point, the volume of melt water would be greater (i.e., warming world), so it is not clear whether the efficiency would increase or decrease.

P2/L18 – set however off with commas (, however,)

P2 L26/27 – would be appropriate to cite Joughin et al 2013 Cryosphere here (and perhaps elsewhere). Their paper has a quite a bit of discussion on the interaction of basal and surface topography and the effect of water routing.

P2 L31 – insert a comma before “which” P3 L6 – “it is unclear whether dynamic stream incision is efficient enough compared to other topographic influences to influence IDC-scale topography and meltwater routing” Not sure I understand this statement – as noted below, a quick google search can turn up many pictures see large stream channels cut by overtopping streams. P3 L24 – don’t make Greenland Ice Sheet an acronym as GIS is too commonly used for mapping. You are not word constrained and in most cases you can be brief by just saying Greenland or the ice sheet. P2 paragraph that starts with L20 or L26 – there probably should be a reference to Smith, Raymond, and Scambos 2006, JGR F101019 as they look at the transfer of bed topography to the surface of the Greenland ice sheet. Their findings with respect to anisotropy would make sense to discuss later in the paper as well. P3 L31 – replace “resolution” with “posting” as you note in the next couple of sentences the resolution is anything but 150 m. Ditto for P4 L 2, and L3 (using sampling spacing if you want to avoid repetitive use of posting). P4 L4 – “All” to “The” P4 L14 – Define RSF. P5 L6 – hyphenate no-flow condition P13 L26 add a “the” before “~1-10” P13 L30 This is almost identically restates what was said 4 lines earlier. P14 L1-1 again somewhat repetitive and somewhat repeating the obvious that could be inferred from previous work with transfer functions and observations of bed and surface topography. P14 L16-17 – “If ice surface

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adjustments to variable basal conditions or ice flow perturbations are sufficiently rapid, surface topographic basin configuration should also vary on seasonal timescales.” If this were the case, then such changes should be occurring now. To the extent any such changes have occurred they escaped notice of numerous groups observing elevation time series. L14 L24-25 “basal sliding” its important to keep in mind the periods of strong basal sliding relatively brief and most of the year there is no surface melt, so this period of low sliding likely dominates the transfer of bed to surface topography. This statement also applies to the following paragraph. P15-L5-10 – again the winter pattern is likely to dominate and offsets any summer change with a wholesale redistribution of the drainage patterns. P15 Section 4.3 There is a significant amount of thermal-fluvial erosion – most stream channels are down-cut by by 10s of centimeters to meters. There are many examples of large stream channels – simple google melt-water stream channels Greenland and select the images tab. The really deep ones are not necessarily that common, but they often occur in locations where a major drainage catchment feeds a lake, that overtops, cut a channel many meters deep, to connect up with another drainage or to find a moulin. I think part of the problem with this section is that its poorly written and its not really clear the point the authors are trying to make.

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2018-74>, 2018.

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