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Interactive comment on "Subglacial roughness of the Greenland Ice Sheet: relationship with contemporary ice velocity and geology" *by* Michael A. Cooper et al.

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Cooper et al. presents a quantitative analysis of radio-echo sounding data acquired in aero-geophysical surveys over the Greenland ice sheet by CRESIS and OperationIce-bridge. The primary work is new estimates of basal roughness, calculated in different directions and using two different methods. Building on previous studies in Greenland and the Antarctic, the authors show that many fast-flowing outlet glaciers in Greenland are underlain by relatively rough beds, and that the basal interior of the Greenland ice sheet is quite flat.

When roughness is considered in different directions, the authors find basal roughness

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perpendicular to the ice flow direction to scale negatively and exponentially with the speed of ice motion, whereas there is no such relationship in the perpendicular direction. They also find the degree of anisotropy between roughness in the two different directions to correlate with the speed of ice flow.

The authors interpret differences in directional roughness to stem from streamlining of the bed beneath fast flowing glaciers, suggesting they are underlain by soft basal sediment in those places, whereas the flat interior is interpreted to stem from a hard and flat crystalline bed there.

The manuscript updates previous work by Layberry and Bamber (2001) and Rippin et al (2013), who used similar, although not identical techniques and less extensive radio-echo sounding data compared to this study. While the new results are not fundamentally different from past work, they establish some interesting relationships between ice flow and patterns of roughness, while also corroborating recent findings from regional studies on a larger scale. However, the spatial scale of roughness considered here is, as in past work, not sufficiently fine to make interpretations that are directly relevant to the role of roughness in the sliding process.

The manuscript is overall well written and the data are clearly presented.

The work is robust and well explained in terms of techniques and methods, with the exception of the interpolated roughness, which is justified with the argument that it improves the visualisation. Yet, it is the interpolated roughness product that is subsequently used in the statistical analysis. Ultimately, it would have been pertinent to confirm that the statistical relationships are also found in the original non-interpolated data. If that is not possible, or if the results differ, it is important to explain why and to justify the use of interpolated data on a more technical basis.

There are few typos and the writing is mostly good. My only comment is that there are some (to me at least) odd uses of hyphen. E.g. I would say that “slow-flowing glacier” can be hyphened, whereas “a slow glacier” need not be hyphened. There are also

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some informal and potentially incorrect uses of / which could be avoided. There is also an important difference between ‘break down’ and ‘breakdown’.

The use of referencing is not always proper. For example, Rippin et al. (2006, 2011, 2013, 2014) are cited >20 times, although three of the four articles are about West Antarctica and not Greenland. When referencing regional work from the Siple Coast in West Antarctica, it would be appropriate to include at least a few references from the NSF funded work there. It may be inadvertent or accidental, but there seems to be a slight tendency to self-cite in a places where it would be pertinent and relevant to cite work by others. I also recommend including a better description of previous work which have shown or inferred the presence of soft basal sediments in Greenland (e.g. Booth et al. TC 2014; Kulessa et al. Sci Adv 2017; Hofstede et al. JGR 2018) and studies that have demonstrated potentially important sedimentary controls on ice flow there (e.g. Bougamont et al. Nat Comm, 2014).

The suggestion above may help improve the conclusions, which are not always fully justified. For example, it is strangely vague to state that “This suggests that enhanced glacier flow (i.e. , basal sliding) in Greenland is either unlikely to be controlled by basal traction, following a Weertman-style hard-bed sliding parametrisation (Weertman, 1957), or rather basal traction is not induced by the wavelengths of roughness information 5 quantified in this study.” I would say the latter is correct, and that the authors are not in a position to suggest that enhanced glacier flow in Greenland is unlikely to be controlled by basal traction, whatever the mechanism. The last sentence, “provides scope for” is a really marginal conclusion, which I recommend the author remove as it has already been discussed.

Finally, I wonder whether it would be appropriate to include someone in the CRESIS team as a co-author, even if it is not a requirement.

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