

Review: “Ice motion across incised fjord landscapes”

by Barndon et al.

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Hello and nice paper! This one seemed like a good one to sign given that I reference my own work. Feel free to take the comments and suggestions with a grain of salt: I am excited that you all are working in this area and looking forward to chatting more about it. Feel free to reach out offline with any questions, <colinrmeyer@gmail.com>. Cheers, Colin R. Meyer

1 General

In this paper, the authors analyze ice flow over deeply incised fjords using a finite-element model that includes a nonlinear ice rheology, a model for temperate ice, and a sliding law. This extends earlier work by Gudmundsson (1997) and Meyer and Creyts (2017), both of which focused on idealized geometries, and applies it to a realistic landscape. In Meyer and Creyts (2017), I performed a seedling version of this type of work, when I analyzed data from the Gamburtsev mountains in Antarctica. I have thought about continuing along this thread and doing something like this piece of work, so I am glad that they have gone down this path. The paper is in good shape: it is relatively straightforward. I have a few remarks and some small comments, but otherwise, I am happy to support publication after minor revisions.

2 Remarks

1. I emphasized the role of the critical angle to form Moffatt eddies in my paper, but this idea doesn't seem to show up in the current paper. I find this curious, since it was a crucial piece of information that I used to assess whether a certain area may support Moffatt eddies. Something like my figure 10(c) would add value to figure 1 in the current paper. Or at least connecting the slope angles to the onset of Moffatt eddies. Apologies if I missed this point.
2. The oblique simulations follow directly from the oblique simulations that I performed – my figure 9. It is cool that we see similar things, which is a point that the authors could make. The novelty of the simulations is clear, so there is no need to avoid pointing out connections to prior work.
3. The question of the effect of Moffatt eddies on the effective sliding law is fascinating and something I have wanted to dig into more. Thus, I agree with your conclusions that “future work should focus on parameterising the net influence of this behaviour,” but I will admit that I was a little sad not to see more of that included in the current paper – building off the discussion around figure 8.
4. At the end of the paper, I am left struggling for the main message. I agree that ice flow over deeply incised fjords will “induce significant complications into ice

sheet motion,” but this wouldn’t be surprising after Gudmundsson (1997). The connection with the sliding law is novel, and could be the main message but it is underdeveloped. The different directions of flow are interesting but not clearly actionable. For this reason, the conclusions section falls a little flat. I think including some onset angles as suggested above and doing some statistics to suggest how widespread this phenomena could be along the path to developing a stronger conclusion.

3 Specific comments

1. around line 100: I think it is worth referring to the Schoof and Hewitt (2016) enthalpy model, given that it is a different formulation.
2. simulation ensemble: my sense/memory is that the velocity and ice thickness shouldn’t matter for the eddy formation.
3. I have wondered about how subglacial Moffatt eddies might be tested in the geologic record. Would there be special deposits in these areas?

References

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