

## ***Interactive comment on “The role of subtemperate slip in thermally-driven ice stream margin migration” by Marianne Haseloff et al.***

**Anonymous Referee #1**

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General Comments:

The manuscript by Haseloff and coworkers addresses the enlargement of ice streams by the migration of margins that are controlled by a transition between temperate and subtemperate basal temperatures. Using a boundary layer approach, the analysis leads to predictions of outward migration rate that are formulated in terms of parameters that can be obtained from the behavior of the adjacent ice stream and ice ridge, with the ultimate goal of enabling the primary results of this study to be incorporated within large-scale ice sheet models. Several special cases are shown to admit simplified expressions that agree with detailed numerical results in particular limits that may be of relevance to different portions of the Siple Coast ice streams. The writing is clear and succinct, and the treatment and results are substantial and worthy of publication

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without major revisions.

Specific Comments:

The analysis is very involved and appears to be technically sound. To further improve the utility of this work and its reception by the broader community, I strongly encourage minor revisions that are aimed at providing further context and physical insight. A dense mathematical treatment is no doubt warranted, but some brevity could be sacrificed to improve the communication of this substantial effort. For example, consider enlightening the audience as to why the focus is on ice stream enlargement rather than the more general case – (e.g., is it considered that a narrowing of ice stream width is less relevant or is it a harder problem for some reason?) the title does not reflect this one-sided focus. How were the particular parameter values listed at the bottom of table 1 chosen and where might they be considered relevant (or what ranges of values might be considered typical)? Figure 10 illustrates three different regimes of behavior, which is helpful, but some brief discussion of the likely importance of these different cases could be beneficial. The mathematics is interesting, but the physical insight it provides is what makes the effort worthwhile and this aspect of the paper could be improved.

In the heat balance treatment, it appears that the bed is ice free and so can warm from subtemperate to temperate conditions without latent heat effects. If the physical situation were different, I would have anticipated that this would strongly retard the rate of margin migration. Some further explanation should be provided for why only sensible heat need be considered beneath the ridge. Similarly, in the description surrounding Figure 3, I found the discussion surrounding the enthalpy gradient model unsatisfying. To be clear, are the contours in panels c, g, and h showing ice at +3C? Perhaps a brief discussion in the supplementary information might be used to outline why its okay once again to neglect latent heat.

What is it about  $V_m < 0$  that necessitates a different treatment strategy? I understand that there has been a deliberate decision to focus on cases with  $V_m > 0$ , but it would be

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helpful to give the reader some insight into why.

Technical Corrections:

Equation 10 doesn't need the :

The density of the bed in Table 1 must be wrong.

Line 22 on page 13 should read "constrained" not constraint

In many of the figures the symbols are so large as to obstruct the underlying lines (e.g. fig. 4). These could be shrunk or even eliminated in favor of combinations of dashes and dots.

The caption for figure 6c is confusing and the symbols for Theta1-3 are difficult to discern. This could be improved. As it stands, the description at the end of 4.3 describes results that are very difficult to see.

On line 32 of page 21 we are told that the stress scale can be found from (37), but further steps are required - maybe show this in the supplement.

On line 16 of page 28, give the physical explanation for the upper limit on chi - the number by itself is not particularly helpful.

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2017-244>, 2018.