The Cryosphere Discuss., 5, C1448–C1451, 2011
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The Cryosphere Discussions



# *Interactive comment on* "A numerical model for meltwater channel evolution in glaciers" *by* A. H. Jarosch and M. T. Gudmundsson

**Anonymous Referee #3**

Received and published: 2 December 2011

## 1 General Appreciation

This is the first paper to explicitly model the downcutting of supra-glacial channels amd their eventual closing off into intra-glacial channels. It contains movel and interesting results about channel incision depth and rate of channel formation, and demontrates their dependence upon slope and meltwater flux. For this reason it should be published. Like many pioneering papers, it isn't quite sure which problems it should be addressing, but I think that that is an issue for future papers to deal with. It is mostly very well written - there is a list of minor points.

The motivation in the introductory section needs to be strengthened to make this a really satsfying read. In addition, the paper would be much improved if the issues of

width and penetration depth were explained, rather than just reported, but I can see that this may not be a trivial task.

## 2 General Points

1. 2607:15-20 Motivation a bit weak. Not sure why you are improving models - what problems in old ones do you want to address? What are their omissions? Where and how do you expect your more complex approach to improve on things?
2. I don't really see a clear statement as to why the penetration depth is tens of metres rather than 1m or 100m.
3. I guess this could be related to the width scale of the channel - but again I don't see a clear statement of what sets this.

## 3 Minor Points

1. Eqn 1. only applies to a linear fluid - the viscosity varies in space and is acted upon by one of the two differential operators.
2. 2608:20-21. Don't see why this is an obvious name. Probably better to get rid of sentence.
3. 2609: Open channel hydraulics. Not being an expert in these matters, it looks as though Raymond and Nolan followed Rothlisberger's (1972) approach but with some presumably more accurate or appropriate equations? Is this right?
4. 2690:9 GIve us some numerical values for $n_c$ - intuition gives us values for all other numbers.



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5. 2610: Analytical maximum depth - belongs in introduction. Give us some numbers for the analytical depth so we can approach the rest of the paper informed - is the depth 1m, 10m,100m, 10km? i.e. is it relevant to glacier studies?

6. 2610:11 Are you sure it's $A^{-n}$? This is a huge number - $10^{75}$ in SI units.

7. 2611:11 adverbial form needed - 'perpendicularly'

8. 2611:23 'stay almost perfectly symmetric' -> 'remain almost perfectly symmetrical'?

9. 2612:5 which three afore-mentioned processes?

10. 2612:5 'would' -> 'were to'

11. 2613 State a typical time-step - hours, days, weeks etc.?

12. 2613:13 'is pinched' -> 'pinches'

13. 2613:24 I'm not convinced by the statement that downward migration ceases once the channel pinches off. Is the heating distribuition uniform? - the Röthlisberger solution assumes uniformity by not having gravity in it. I think you need a more careful statement here.

14. 2614:3 What motivated the choice of this subset?

15. 2615:5 why does increased slope result in increased flow towards channel? - maybe answer this in conclusions

16. Figure 5. Having 500m as the initial point serves no purpose - have it as a depth or distance travelled, and start at zero.

17. FIgure 5 caption: "Evolution of channel bottom" is ambiguous. Something more precise which depends on how you relabel the vertical axis, but makes clear that it is the distance migrated.

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Interactive comment on The Cryosphere Discuss., 5, 2605, 2011.