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The Cryosphere Discussions

Interactive comment on "Numerical mass conservation issues in shallow ice models of mountain glaciers: the use of flux limiters and a benchmark" *by* A. H. Jarosch et al.

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We would like to thank reviewer #1 for the detailed comments on our manuscript, especially for carefully reviewing the equations presented. In this brief reply we would like to address the main question within the general comments of reviewer #1 regarding the usage of an upstream scheme in comparison to our proposed MUSCL superbee scheme. We will reply to the specific comments of reviewer #1 in a combined overall reply to all reviewers as soon as the general discussion is closed and all reviewers have posted their comments.

1 Upstream scheme

To evaluate the performance of an upstream scheme in comparison to our proposed MUSCL superbee scheme, I have implemented an upstream scheme such that the upstream ice thickness

$$hup^i_{k+\frac{1}{2},l} = \begin{cases} h^i_{k,l} & \text{if } s^i_{k+1,l} \leq s^i_{k,l} \\ h^i_{k+1,l} & \text{if } s^i_{k+1,l} > s^i_{k,l} \end{cases} , \tag{1}$$

and Eq. 15 in the manuscript becomes

$$D^i_{k+\frac{1}{2},l} = \frac{2A(\rho g)^n}{n+2} \left(\frac{h^i_{k,l} - h^i_{k+1,l}}{2} \right)^{n+1} hup^i_{k+\frac{1}{2},l} \left[\left(\frac{s^i_{k,l+1} - s^i_{k,l-1} + s^i_{k+1,l+1} - s^i_{k+1,l-1}}{4\Delta y} \right)^2 + \left(\frac{s^i_{k+1,l} - s^i_{k,l}}{\Delta x} \right)^2 \right]^{\frac{n-1}{2}} , \tag{2}$$

as suggested by reviewer #1. The diffusivity at $(k - \frac{1}{2}, l)$ is constructed accordingly. Our code example in the supplementary material (attached) includes now the upstream scheme computation for the same experiment as described in sect. 7.1 in our manuscript. Figure 3 in the manuscript will be updated to include the upstream scheme plotted in green and this new version is included here as Fig. 1.

In this experiment at 200 m horizontal resolution, the relative volume error for the upstream scheme $RE_{\text{vol}} = 70.728$ %, for the type I scheme $RE_{\text{vol}} = 146.000$ %, and for the MUSCL superbee scheme $RE_{\text{vol}} = -1.012$ % (cf. Tab. 1 manuscript). Even though the upstream scheme performs better than the type I scheme it still fails the benchmark. Only the more complex MUSCL superbee scheme passes the benchmark and reproduces the explicit solution.

All these results will be included in the revised manuscript.

Kind regards,
Alexander Jarosch

Please also note the supplement to this comment:
http://www.the-cryosphere-discuss.net/6/C2182/2012/tcd-6-C2182-2012-supplement.zip

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Interactive comment on The Cryosphere Discuss., 6, 4037, 2012.

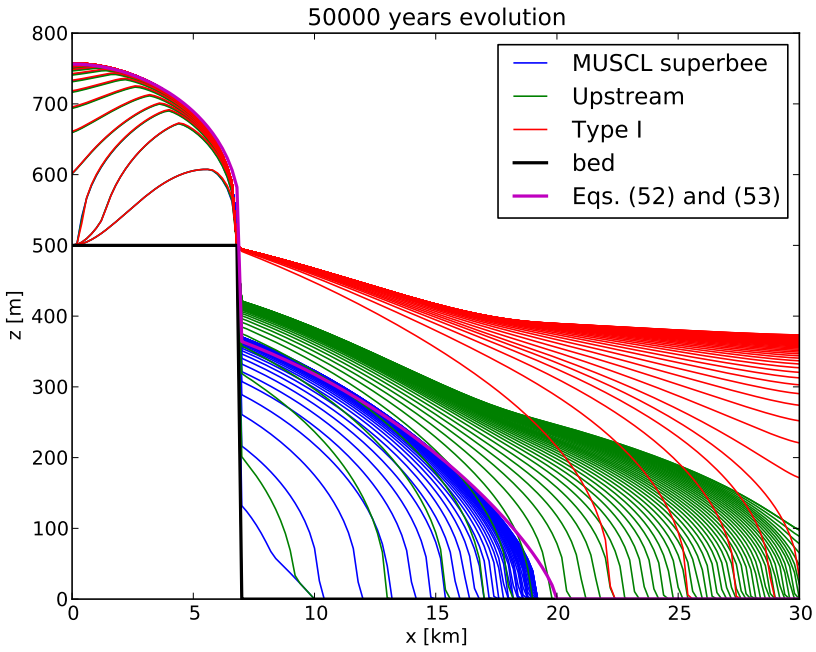

Fig. 1. Replacement for Fig. 3 in manuscript which now includes the upstream scheme result as well