Geoscientific
Model Development
Discussions

Interactive comment on "Accuracy of the zeroth and second order shallow ice approximation – numerical and theoretical results" *by* J. Ahlkrona et al.

J. Ahlkrona et al.

josefin.ahlkrona@it.uu.se

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We fully agree with J. Brown in that singularities may occur, especially for an irregular bed topography, and that this is a problem for SIA and SOSIA.

In Brown's first example, the boundary is steep, $h \to 0$, and even though this geometry is a solution to the SIA equations, we can expect difficulties for SIA since the assumption in SIA that the ice thickness behaves as $c\epsilon$ where $c = O(1)$ is not valid there. In such a case, the full Stokes equations should be applied.

We have to assume that the bedrock is sufficiently smooth and that it is sufficiently resolved numerically by the surface mesh. Otherwise, we expect difficulties also for

the full Stokes equations. If it is necessary to introduce corners in the boundary with loss of regularity then we must rely on the full Stokes equation or special expansions around that corner. For any model equation, it is preferable to choose the level of resolution of the bedrock such that it is smooth.

One of the purposes of this paper is to show that the SOSIA is not second order accurate in ϵ, and that there are singularities in Glen's flow law causing the error to be very high in certain set ups, even for a regular bed. We do see that the SOSIA is an improvement to SIA in some cases but that this unfortunately requires ad hoc tweaking of the regularization of Glen's flow law.

We also agree with J. Brown in that we do not think it is useful to continue publishing papers on the SOSIA, and this paper is rather an attempt to put an end to the use and discussion of SOSIA (which is still used in recent publications).

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