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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.

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Response to general appreciation

The way we see it the two advantages of SOSIA mentioned (namely 1. its error with respect to the solution to the Stokes equations is intended to decay more rapidly with the aspect ratio and 2. it includes some additional stresses), are essentially the same and the additional stresses only improve the accuracy where those same stresses are not of great importance. The additional stresses such as $t_{xx(0)}$ would for instance not

increase the accuracy if the SOSIA were used in an ice shelf, since the assumptions of the SOSIA are erroneous there.

We ourselves checked these equations many, many times, but if needed to convince the GMD-readers we can use a symbolic algebra package to check the momentum balance.

Response to specific comments

1. We refined the mesh (both for the SIA/SOSIA-code and Elmer) until the figures of the error (Fig. 2, Fig 4) were not changing anymore (at least for aspect ratios over 1/5120, for 1/10240 a small mesh effect is still visible). This means that the numerical error is much smaller than the model error.

2. We have analytical expressions for $t_{xz(0)}$, $v_{x(0)}$, $t_{xz(2)}$ when $n = 1$, where σ_{res} is indeed no longer needed. We will make some experiments with $n = 1$ and connect them to the analysis of the analytical expressions. We have done numerical experiments indicating that the scaling relations used to derive the SOSIA are accurate for $n = 1$.

3. In fluid dynamics, boundary layers are usually assumed to be thin. We will rephrase the sentence to something like "In fluid dynamics boundary layers are usually assumed to be thin, but as found in Ahlkrona et al. (2013) it is ...".

Response to typographical issues

1. Thank you, we will change this.

Interactive comment on Geosci. Model Dev. Discuss., 6, 4281, 2013.