

Interactive comment on “Manufactured analytical solutions for isothermal full-Stokes ice sheet models” by A. Sargent and J. L. Fastook

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General Comments

The manuscript presents a construction of manufactured solutions of 3D and 2D Stokes equations describing isothermal ice flow. With no doubts, this work is a significant contribution to the ice-dynamic model verification and will be of great help to ice-sheet model developers to test their code. I concur with the other referee that this manuscript might be more appropriate for *Geoscientific Model Development* but leave a choice of a journal to the editors and authors. The authors describe clearly methods and the solution constructions, so I would suggest only few minor revisions.

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Detailed Comments

The full-Stokes equations complemented by a constitutive relationship (Glen's flow law in this study) and boundary conditions require solutions for the velocity components and pressure. By choosing a specific expression for pressure, the authors reduce the problem to solution for velocity only, therefore verification of a numerical code is limited for a velocity solver only. It would be nice (it is a mere suggestion, and not a requirement) to see a discussion of possibilities to test numerical solutions for pressure.

A specific choice of pressure in a form of eqns (53) and (83) implies that *exact* solutions of the Stokes equations are such that horizontal divergence of the vertical shear stress components is zero, i.e.

$$[\mu(u_z + w_x)]_x + [\mu(v_z + w_y)]_y = 0$$

where subscripts denote partial derivatives with respecting variables. Would it be possible to use this condition as a constrain to find solutions of the original Stokes equations instead of introducing artificial body forces?

Technical comments

A statement about anti-correlation of the horizontal ice velocity and ice thickness for a steady-state solution (“3.3. A steady-state manufactured solution for a flow with a linear sloping surface and a sinusoidal bed”, lines 17-20) is somewhat unclear. Such a correlation should *always* hold regardless of a dynamical model (full-Stokes, higher order or SIA).

It is difficult to read all figures: text font size needs to be increased. Color-map figures (3-14) need to have vertical and horizontal dimensions and units as well. Also, number of labels on color bars should be reduced and their size should be increased. Probably, it would be more informative if the figures show dimensional parameters instead of non-

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dimensional.

Inclusion of Fortran scripts is redundant. If *TC* does not allow Supplemental Online Information, the scripts should be posted somewhere online with a link provided in the manuscript.

Interactive comment on The Cryosphere Discuss., 4, 495, 2010.