Geosci. Model Dev. Discuss., 7, C293–C294, 2014
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Geoscientific Model Development Discussions Open Access

Interactive comment on "A linear algorithm for solving non-linear isothermal ice-shelf equations" *by* A. Sargent and J. L. Fastook

Anonymous Referee #2

Received and published: 4 April 2014

1 General statement

The manuscript "A linear algorithm for solving non-linear isothermal ice-shelf equations" by Sargent and Fastook presents a method to decouple the non-linear equations governing ice shelf flow into two linear systems that first solve ice stress and then ice velocity. They first derive the equations in a one-dimensional context and then to a two dimensional case. The paper is clearly written and easy to follow. However, if the derivation of the one-dimensional case seems appropriate, I think that one assumption made for the two-dimensional case is not appropriate for the general case of ice shelves. The authors assume on p.1841 that the incompressibility equation for the Morland-MacAyeal diagnostic is:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \tag{1}$$

while it should be:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \tag{2}$$

The assumptions of the Morland-MacAyeal model state that the horizontal velocity is independent of z, not the vertical velocity, which varies linearly with z according to the incompressibility equation (MacAyeal, 1989, p.4073 and eq.(7) p.4074; MacAyeal, 1997, p.99 and eq.(3.23) p.101).

This assumption affects eq.(29) and (30), and therefore the two-dimensional case. Deriving another set of stress equations seems much more challenging in this case as there is no obvious couple of variables (τ_x, τ_y) that could be introduced in eq.(24).

2 References

MacAyeal, D., Large-scale ice flow over a viscous basal sediment: Theory and application to Ice Stream B, Antarctica, J. Geophys. Res., 94 (B4), 4071–4087, 1989.

MacAyeal, D., Eismint: Lessons in ice-sheet modeling, department of Geophysical Sciences, University of Chicago, 428 pages, 1997.

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