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Geoscientific Model Development Discussions

Interactive comment on "A full Stokes subgrid model for simulation of grounding line migration in ice sheets using Elmer/ICE(v8.3)" *by* Gong Cheng et al.

Anonymous Referee #2

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This paper tries to implement the subgrid scheme of grounding line (GL) movements in Elmer/Ice and test it with the 2D MISMIP benchmark. The "full" Stokes model is computational intense, especially for solving marine ice sheet problems where very fine mesh resolution is usually needed around GL to accurately capture the movement of GL. Thus, a subgrid scheme study like this paper is certainly valuable. However, the current version of this manuscript is probably not ready yet for a consideration of publication, due to the following reasons:

1. The authors use a hydrostatic (first-order) approximation to determine whether a node is floating or grounded, which looks disappointing for a "full" Stokes model. In

Elmer/Ice, to solve the contact problem of GL dynamics, the normal stress (nodal force) was actually used in previous studies (e.g., Durand et al., 2009). It's surprising that this paper doesn't use that, which, from my point of view, is not a Stokes solution.

2. For testing the capability of the subgrid scheme, the authors should at least do the MISMIP3d experiments, in order to see how the GL move in y. The MISMIP benchmark is good, but I don't understand why not trying the MISMIP3d since it's been out there for a couple of years. The authors have some discussions of extending the 2d implementation to 3d, but perhaps it's better to just test it.

3. The writings, particularly the introduction section, still needs improvement.

Some apparent technical comments:

- Citation style throughout the whole paper needs to be corrected

- In the title, there should be a space right after Elmer/ICE, or just remove (v8.3)

- Line 13: change it to "...an indicator of ice sheet advances or retreats"

- Line 15: "on West Antarctica" to "in West Antarctica"

- Line 18: In theory the Stokes model is the most accurate, but in reality it might not the one that shows the best match to observations. So please make an explicit and correct statement.

- Line 25: It is the longitudinal stress gradient, not longitudinal stress, that controls the flow of ice shelf.

- Line 121: change "net surface accumulation/ablation" to "surface mass balance"

- Line 124: change "net accumulation/ablation at the lower surface" to "basal mass balance"

- Line 134: change "short interval" to "short distance interval"

- Line 270-273: For case i, how come the GL position is at the floating part? It may

look reasonable numerically, but it's totally not physical.

References:

Durand, G., Gagliardini, O., De Fleurian, B., Zwinger, T. and Le Meur, E., 2009. Marine ice sheet dynamics: Hysteresis and neutral equilibrium. Journal of Geophysical Research: Earth Surface, 114(F3).

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