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Interactive comment on “Evaluation of the criticality of cracks in ice shelves using finite element simulations” by C. Plate et al.

D. MacAyeal

drm7@midway.uchicago.edu

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The referee raises a point that I have often wondered about (largely because my training in continuum mechanics is limited to fluid flows, with relatively little experience in elastic and other material constitutive relations): How does one reconcile the fact that two different stress fields would be computed for one application of external boundary stresses depending on whether the viscous (or "Glennian") or the elastic constitutive relation is used?

A subsidiary question relates to the fact that one of the papers cited in the reviews looks at how temperature variation through the ice column in an ice body might concentrate the stress at some depth and thus influence fracture propagation. This is only possible for a viscous rheology where the viscosity thickens with cooling temperature;

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Interactive Discussion

Discussion Paper



Interactive
Comment

Elastic parameters (as far as I know) are not strongly temperature dependent (for linear elasticity).

Here's how I reconcile the fact that two different stress fields are computed depending on whether you assume elastic rheology on one hand or viscous rheology on the other:

Both are right. The elastic stress regime is what is correct immediately after the application of boundary conditions on the ice boundary. The viscous regime is what is correct after a long time period has passed so that differential viscous relaxation has relieved the elastic stress where the viscosity is low and has concentrated the stress where the viscous relaxation has not relieved the elastic stress.

I provide a figure to illustrate this point.

Finally, I wonder now whether glaciologists should consider two classes of fracture formation: those which "creep" open when the stress field is dictated by viscous rheology, and those which suddenly open when the stress changes and the elasticity of the ice immediately dictates the stress field.

Thanks for letting me struggle with the concepts of this paper.

Interactive comment on The Cryosphere Discuss., 6, 469, 2012.

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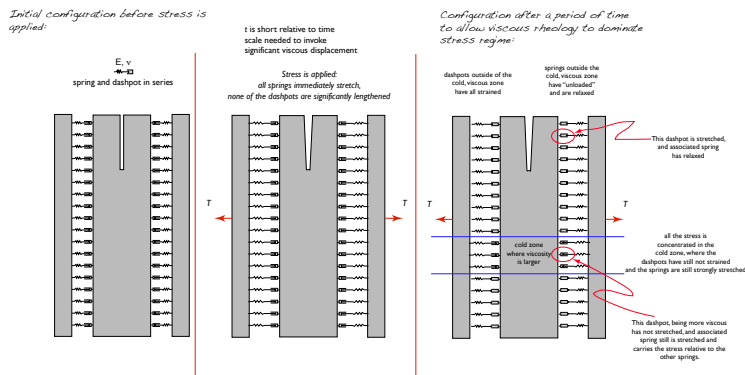


Fig. 1.