The Cryosphere Discuss., 7, C1734–C1735, 2013
www.the-cryosphere-discuss.net/7/C1734/2013/

Interactive comment on "Creep deformation and buttressing capacity of damaged ice shelves: theory and application to Larsen C ice shelf" *by* C. P. Borstad et al.

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Received and published: 11 September 2013

We thank Dr. Bassis for his constructive comment, and we agree that we should be more clear about the scope and limitations of our theory and modeling. We are happy to incorporate these clarifications as we revise our manuscript.

As correctly pointed out by Dr. Bassis, if we had started from a three-dimensional consideration of damage we would have to neglect vertical variations in damage in order to derive our depth-integrated formulation. However, we need not apply the effective stress linear mapping (Equation 8) to a fully general three-dimensional volume element. In the manuscript, we explicitly chose to apply the linear mapping to an equation

that was already in depth-integrated form (Equation 9). The implication is that we are limited to describing damage as a two dimensional variable, and we should be more explicit in pointing out this limitation and in defining damage as the *influence of fractures anywhere within the ice column on longitudinal deformation at the surface*. We do not make any assumptions about the vertical distribution of damage, nor does our procedure for inferring damage from surface measurements indicate the location of fractures within the ice column. We will clarify these points in our revised manuscript, as related comments were also made by both reviewers.

As for modeling damage evolution, there is nothing that fundamentally precludes a depth-integrated evolution law from being applied to model an ice shelf. Most damage evolution laws that have been applied to polycrystalline ice are empirical in form and tuned to laboratory-scale experimental data. The damage calculations we present in our manuscript provide analogous (but full-scale) validation targets for a developing and testing a depth-integrated evolution law. We do not want to give the impression that we write off the merits of three-dimensional damage modeling, however. Indeed, we grant that processes such as hydrofracturing should be modeled in three dimensions to properly study the underlying physics. It may then be possible to parameterize such processes in a two dimensional plan-view model that is much less expensive computationally and can be more readily adopted in a large scale ice sheet model.

Interactive comment on The Cryosphere Discuss., 7, 3567, 2013.