# Response to Anonymous Referee #1

Detailed below are our point-by-point responses to the comments of Anonymous Referee #1. Referee comments are printed in blue font followed by our responses in black.

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I've read this fine manuscript and have also heard a presentation on it at a recent meeting of the IGS, and I feel that the manuscript is just about as perfect as one could expect, and that the science it reports is of high quality and will be of interest to a broad spectrum of Cryospheric scientists.

Normally I give a lot of detail in my reviews, however, this time I will be brief (due to a vicious virus that I came down with while traveling) and record only three minor comments:

1. It is important to make the distinction between "damage" as a heuristic idealization of fracture on an ice shelf, and the actual physics and material properties of fractured ice shelves. Damage mechanics, as I understand it, is an idealization that one adopts when one knows little else about the form of fractures. I take it that there are several key underlying assumptions and postulates that should be mentioned. One might be that it is assumed that there is so much fracture on such a fine scale that the influence is isotropic and is likely to be a linear function of the "density" of such fractures. I think making this important philosophical distinction will add credibility and a sense of elegance to the manuscript. This is accounted for in part by the first paragraph on page 3575, however it might be worth constantly reminding the reader of this in the abstract and introduction.

We thank the reviewer for these positive and constructive comments. We have rewritten the Abstract and Introduction to clarify our definition of damage and the method of calculating this quantity. We also rewrote the introduction to Section 3 to clarify the scope and assumptions of damage mechanics, pointing out that damage can account for fine scale fractures, as the reviewer mentions, as well as large scale fractures, especially in heterogeneous materials for which a diffusion of microcracking accompanies the propagation of a macroscopic crack tip. We also repeat our definition of damage in the Discussion section to further remind the reader, as suggested.

2. Longitudinal stress (line 25 of page 3569) should read "longitudinal tensile stress" (longitudinal stress alone could be misleading as there is the possibility of compressive stress). Also, longitudinal stress associated with the ice-shelf flow is not the only stress that exists in an ice shelf, due to the fact that the ice shelf is influenced by many other processes such as to induce wave-like motions and flexure. Hence, the distinction should be made that the manuscript is considering this form of stress as the main source of fracture in the present study.

This is a good point and an important distinction. We added *longitudinal* here as requested, and repeated this point in several places to remind the reader that what we refer to as damage is associated with enhancement of *longitudinal* flow of an ice shelf. We also now state that other modes of stress or deflection (such as flexural), or the susceptibility of existing fractures to these modes, are not taken into account.

3. I think that some statement "up front" should be given as to how the damage parameter will be computed. I take it that the parameter as shown in the figures is a result of an inverse calculation and not a result of an ab initio computation based on some underlying physics. The reader would benefit from knowing this more clearly in the introduction.

We agree that some clarification is needed up front about how we calculate damage, as the second reviewer also noted. We now describe in both the Abstract and Introduction that damage is calculated from the results of an inverse calculation for ice rigidity. We have also rewritten Section 3.3 to describe the damage and backstress calculation more clearly and in more detail.