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Interactive comment on "A continuum model of ice mélange and its role during retreat of the Antarctic Ice Sheet" *by* David Pollard et al.

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This paper presents a new and innovative approach to the simulation of ice melange as an integrated component of a continental-scale ice sheet model. The subject is topical, and such developments are necessary for ensuring that future-focused Greenland and Antarctic ice sheet simulations capture processes relevant to their likely evolution, particularly with regard to how each ice mass might contribute to changes in future sea level. The basic approach of the paper is to use and modify equations of the shallow shelf approximation to simulate the ice melange as a thin and poorly-aggregated 'ice shelf' that exerts some back force against the calving face of the true ice shelf. Taking a continuum approach rather than employing fracture mechanics enables the scheme to integrate more easily with the ice sheet / shelf model equations.

The paper is very well-written, methodical, and clear, it is well illustrated and the arguments are easy to follow. My comments are primarily suggestions that could better define the effects of the melange, which would implicitly address some of the 'uncertainty' in simulating this kind of poorly-observed process.

Fundamentally my greatest concern is that there is a significant disconnect between the training scenario - a narrow Greenlandic fjord under present conditions - and the test scenario - the entire Antarctic ice sheet under a drastically warmer than present climate. Because of this, I feel that the Antarctic results, and the conclusions that depend on them, are not sufficiently convincing. By considering only two scenarios, the reader is left with no sense of any thresholds or dependencies in the system, which I feel are essential in terms of process understanding. I would like to see the following experiments added to help demonstrate the relative importance of the various model components in dictating how effective melange backpressure actually is:

1) Rather than just one 'Pliocene' scenario, why not use a range of step warmings in both atmosphere and ocean, with and without the melange feedbacks, to define the point at which melange becomes irrelevant? These should start at modern conditions and increment gradually, because at the moment the imposed 2deg C ocean warming is so high that it will almost certainly lead to rapid melt of the melange before any buttressing can exert an influence on GL location.

2) Following from that, there needs to be better separation of the model components, so a set of duplicate experiments are necessary in which, for a small or modest warming scenario, the effects of removing each of the important model components can be seen - i.e. - for a given ocean warming, show how GL retreat differs when a) ocean melt of the melange is turned off, b) shelf hydrofracture is turned off, c) tidewater cliff collapse is turned off. These kind of sensitivity experiments are alluded to in the conclusions, but not shown, which I think is a shame.

If these experiments all show that the inclusion of melange processes has no effect

on GL retreat, then the conclusions of the paper will be a lot more robust, and the modelling community will be happy that we don't need to add such schemes to existing models.

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