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Interactive comment on "A sensitivity study of fast outlet glaciers to short timescale cyclical perturbations" *by* E. Aykutlug and T. K. Dupont

Anonymous Referee #2

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The aim of this paper is relatively straightforward – to investigate whether an oscillating parameter for forcing of a marine ice stream has a different effect on dynamics than that same parameter held constant over time with the same time-average mean; and whether said effect depends on the oscillation frequency. In all of the deluge of idealized studies being carried out for marine ice streams in recent years, i don't think anyone else has asked this simple question – despite all observational evidence for such oscillations – and so i commend the authors for doing so. I like the aim and scope of this paper; outside of that I do not have much else to say. I believe it is publishable with some simple changes, suggested below.

General comments:

1) The authors show the most important oscillating parameter to be C_b. C_b, in

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turn, determines basal stress, but with the nonlinear sliding law it is not equivalent to basal stress. One could envision a scenario where the lowering of C_b leads to a greater lowering of basal stress, due to a noncompensatory increase in velocity, than the increase in basal stress due to a comparable raising of C_b. I am curious about the time-mean of the area-average basal stress in the new statistical steady state, relative to that of the initial nonoscillating steady state.

2) The authors report that an oscillating basal melt rate does not lead to a significant time-average bias, and no results are shown. However, is there an oscillating response of any note – i.e. does VAF or grounding line oscillate around their former mean with any significant amplitude? Or does Fig 4 suggest this not be true from the "thin bands" corresponding to melt rate in the figure? (If the width of the band indicates the amplitude of GL oscillation this needs to be made clear.) If this is the case, i think it should be made clearer, and earlier in the manuscript, what you think the implications of sub-decadal oscillations in melt rates are for fast-retreating ice streams such as pine island.

3) I find it very curious that an annual oscillation in C_b leads to a greater mean response than a decadal oscillation, as it is the opposite of what i would expect, and i wonder if it could be investigated a bit more. Further, your claim that the oscillating response is larger for decadal oscillations contradicts the ice front velocity results. But I wonder if the smaller amplitude of calving front velocity is because the ice shelf has had more chance to adjust to an increased grounding line velocity?

Minor comments:

p224 Line 25: not clear what is meant by "processes" and "changes"

p225 line 16: changes under the grounded ice

p228 line 19: i would be very careful here. applying this "regularization", which many people do, is effectively melting under grounded ice. i don't think that last ~100 meters worth of area to melt under is going to make a difference to the effect of buttressing by the shelf, esp if you have a uniform melt rate – but it will lead to melting having an effect even when the 1D ice shelf is unconfined – which we know is not mathematically correct...

p230 line 9 - ice shelf calving front line 14: results of these perturbations

p231 line 1-2: justification/reference for this claim? (also "are expected")

p231 line 8: i found this sentence confusing

p231 line 22-24: this is retreat to a new (time-average) steady state?

p234 line 2: the basal friction...

p234 line 4: the area that is affected

p234 line 6: remove part of sentence before "fig 5" and make sentence grammatically correct.

Table 2 / Fig 4: Table 2 caption suggests a 3000 year timescale for these responses, which is quite slow. But Figure 4 suggests the retreat and convergence to a new statistical steady state occurs early on. Maybe it is better to emphasize, early on, the actual rates of grounding line movement achieved.

Interactive comment on The Cryosphere Discuss., 9, 223, 2015.