The Cryosphere Discuss.,
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The Cryosphere Discussions

Interactive comment on "A simple equation for the surface-elevation feedback of ice sheets" *by* A. Levermann and R. Winkelmann

Anonymous Referee #2

Received and published: 7 May 2016

The authors derive a simple relationship for the elevation-melt feedback based on an analytical 1D flowline profile model of an ice sheet. The relationship allows calculation of the critical mean height that leads to melting of the ice sheet, given a prescribed rate of accumulation that changes with height and temperature anomaly. It also allows the decay time to be estimated, which compares well with more complex models for the Greenland ice sheet domain – serving as a validation of the approach. The method is described well and looks promising for distilling this feedback into a simple relationship. I would therefore only suggest some minor changes before publication.

The decay time equation is interesting and could certainly be useful for risk management planning. However, it seems that its validity is questionable for higher volume losses, ie, 50% or more. The authors discuss this briefly, but then the tables give decay times for both 50% and 100% volume loss as if it has equal weight to the 10% loss

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time estimates. I would recommend differentiating these results somehow, and emphasizing that this approach is more useful for diagnosing the earlier stages of decline.

In addition, I am missing the transition from height reduction to volume loss. The fraction α is introduced to represent the volume loss, but as I understand it, this is applied interchangeably with the mean height reduction. A justification of why mean(H) = V is needed.

Finally, I realize the authors are interested in promoting this as a tool for risk assessment, but I think the manuscript would benefit more from discussion of the theoretical implications of the approach. What does the form of your equation mean in terms of the process(es) represented? Why does the rate of fastest melting saturate (Fig. 4) – what in the equations limits the time scale of melt? When could this be violated?

Minor comments

Title: As with the first reviewer, "Surface-elevation" feedback seems incorrect. Either "Temperature-elevation" or more likely "SMB-elevation" feedback makes more sense to me.

Page 2, line 9: is been losing => has been losing

Page 2, line 16: Suggest deleting "as it should be" and "a little".

Page 3, line 46: The sentence starting with "The framework" seems to belong to a new paragraph. Furthermore, so far, no framework has been introduced so it seems out of place without a bit of introduction.

Page 3, line 47: imclude => include

Page 3, line 51: dimension => dimensions

Page 6, line 98: Consider rephrasing "observed". This is open to debate.

Page 7, line 112: melt-down => melt. Also note that the lower branch (ie, the melted state) is also a stable state, as shown in Fig. 1. Consider rephrasing slightly.

Page 8, line 132: It seems that this point “a_0 to decline linearly” should be mentioned earlier. This is in fact a pretty critical assumption to the whole approach, no?

Page 8, line 133: off-set => offset

Page 12, line 225: can thus be used when => can thus be used if

Page 13, line 241: dominate => dominant

Page 13, line 243: the 015 Paris => the 2015 Paris

Page 15, line 254: melt-down => melt

Figure 4: Grid lines would help to be able to compare the panels. It would also be easier if they were presented in a vertical column, to emphasize the shift in time scale for higher temperatures.

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