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Discussions
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Interactive comment on "Data assimilation for moving mesh methods with an application to ice sheet modelling" *by* Bertrand Bonan et al.

Bertrand Bonan et al.

bertrand.bonan@kuleuven.be

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Response to Reviewer 2:

The research addresses the use of data assimilation with new numerical techniques for modelling moving boundary problems. We illustrate our approach on ice flow with the aim of efficiently obtaining more accurate estimates for the margins of ice sheets. A relatively simple model of ice flow is used here to investigate the new techniques. The new moving-mesh numerical methods for the ice flow have already been validated for both 1-D and 2-D models of ice flow (see [1] and [2]). The aim of this paper is to demonstrate that it is possible to combine sophisticated data assimilation methods with a moving mesh numerical modelling technique. Given that the techniques are successful on the simplified problem, there is no reason that these cannot be extended

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to much more complex problems. The major advantage of the moving mesh method is that a only small number of mesh steps is needed to accurately determine the boundary positions of the flow, unlike adaptive mesh methods.

In response to the comments:

The method works effectively even with sparse observations, see [2], but the scenario with more dense satellite data is much more realistic now.

The fact that an elliptic problem needs to be solved at each step of the model is the same for any other model of the flow. Here we use a direct solution in the simplified case, but this is not necessary. The elliptic problems can be solved in parallel numerically at each time step in the ensemble filter assimilation method, but if computational power is a constraint, then the 3DVar method gives good results without solving multiple elliptic problems.

Given the comments of the reviewer, we would plan to augment the paper with some examples using sparse data and others using fewer ensemble members to demonstrate the power and limitations of this approach.

Bertrand Bonan, Nancy Nichols, Mike Baines and Dale Partridge

[1] Bonan B. et al., The Cryosphere, 10, 1-14 2016

[2] Partridge, PhD Thesis, University of Reading, 2013

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