

## ***Interactive comment on “Preliminary assessment of model parametric uncertainty in projections of Greenland Ice Sheet behavior” by P. J. Applegate et al.***

### **Anonymous Referee #1**

Received and published: 7 January 2012

This paper assesses the range of the contribution of the Greenland Ice Sheet to sea level rise by 3500 as predicted by the ice sheet model SICOPOLIS for various sets of model parameters. A 125ky time-period is used to spin-up the model starting from present day geometry. The performance of the model (i.e. of each set of model parameters) is assessed by comparing the modeled present-day ice volume to the observation, allowing the culling of the ensemble of model parameters. The model performance in reconstructing paleo-ice volume is discussed in section 3. The main conclusion of the paper is that the range of projected contributions to sea level rise in 2100 remains large even after culling the ensemble.

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The quality of the presentation is good. The subject is within the scope of The Cryosphere and the methods and results presented are an important contribution to assess the uncertainty of ice-sheet model projections.

However I have few major comments that I think should be taken into account and I will advise major corrections for the moment:

1) Because of the topic related with sea-level rise projections, this paper is meant to be read by a wide audience not especially familiar with all the details of ice sheet modelling. Before assessing the effect of a parameter on the model results it is important to clearly address the assumptions in the model and its parametrizations and discuss their effect on the results. I found these discussions too short in sections 2.1 and 2.2. For clarity and to assess the applicability of the paper results the authors should try to answer the following questions:

- What does affect the ice sheet volume in the model?
- What physical process is the parameter meant to represent?
- What are the assumptions?
- How do they affect the model results?

2) For the projections, the paper focuses more on the results for 2100 and one conclusion of the paper is that the ice PDD factor is the dominant factor. There is statements in several sections that SICOPOLIS does not incorporate higher order physics to model the ice flow and thus “lack certain observed physical that may tend to enhance the real ice sheet response”; but there is nearly no mentions (except ref to Straneo et al. in the conclusions) to these observations and the reader don't know exactly how important these processes could be. This comment is obviously related to the first comment.

3) I think that it could be interesting to add a section to discuss how ice sheet models could be improved. As the conclusion is that the range of projected values for sea

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level rise is large, the paper should try to give some clues about how we could reduce this uncertainty? Should we put efforts in trying to constrain the free parameters, should we change the parameterisations, implement higher order physics, couple with climate/ocean models?

Detailed remarks:

- Title: Why using “preliminary”?
- Abstract: I think another conclusion of the paper is that the climate forcing (i.e. the ice PDD factor) is the most influential and that the parameters governing the ice flow are rather non-influential. This could be put forward in the abstract. But it should be discussed more clearly in the paper that this could not be true for very short term projections as highlighted by the recent observations of ice dynamics, and this is why peoples are putting efforts in developing higher order models (see general comment 2).
- Section 2: you could make an explicit mention to the other methods to assess model sensitivity to parameters and initial condition, i.e. the work of Heimbach and Bugnon with SICOPOLIS.
- Section 2.1-2.2 : see general comment 1).
  - Especially describe the source of mass gain (only through accumulation I assume) and mass loss (ablation, basal melting, and I assume that the ice-sheet is not allowed to develop floating extensions (it is how sea-level is used to force the model?) resulting in an ice flux to the ocean).
  - Describe how the parameters affect these sources of loss and gain.
  - Discuss the different assumptions behind the model/parameterisation (for exemple Heimbach and Bugnon show that the model is sensitive to reparti-

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tion of basal sliding and geothermal heat flux, so that using constant values could be too simple.).

- I164-...: “this initial condition is not ideal... The errors in the initial condition should average”; This question could be addressed for example by taking 30 to 85% of the modern ice thickness and running the model with a set of parameter resulting in a good match of the present day volume. Will this set of parameters still lead to a good fit?
- I-224 -... : the present rate of mass loss could be another metric to try to match
- I-315 “values of the ice flow” -> “values of the parameters affecting the ice flow”
- I-345 “. . . the large scale shape of the ice sheet is more strongly controlled by surface mass balance than ice-flow”; this requires more justification or references.

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Interactive comment on The Cryosphere Discuss., 5, 3175, 2011.

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