Dear Dr. Rutt,

Thank you for your decision to accept our manuscript for publication in Geoscientific Model Development, subject to minor changes. We especially appreciate your careful reading of the revised manuscript. We have addressed your comments in the article text; our responses to your suggestions appear below.

Sincerely,

Won Chang
Patrick Applegate
Murali Haran
Klaus Keller

Topical Editor Initial Decision: Publish subject to minor revisions (Editor review) (28 Jul 2014) by Dr. Ian Rutt
Comments to the Author:
Dear Authors,

Many thanks for your efforts in addressing the points raised by the two reviewers. The manuscript is much improved now, but there are a few places where I think a more in-depth response to Dr Edwards' comments is necessary. I would be grateful if you could address these, after which we can proceed to publication.

I refer to the original page numbers of the article, for ease of reference to the Dr Edwards' comments:

1907/15: Although you have made a minor update to the sentence referred to, I don't think you have fully acknowledged the point made by the reviewer. The emphasis of the sentence needs to change - essentially, the use of semi-empirical models in sea-level prediction is not sufficiently important that they can be used as a motivation for your work. Please revise the sentence fully to reflect the situation in the latest IPCC work.

We have revised this paragraph to read,

"Here, we focus on the Greenland Ice Sheet component of future sea level rise, as estimated by ice sheet models. Enhanced mass loss from the Greenland Ice Sheet is just one component of overall sea level rise, which also includes contributions from the Antarctic Ice Sheets, small glaciers, thermal expansion of ocean water, and the transfer of water stored on land to the oceans. However, the Greenland Ice Sheet is a large potential contributor to sea level rise, and also a highly uncertain one; if this ice sheet were to melt completely, sea level would rise by about 7 m (Bamber et al., 2001, 2013; Lemke et al., 2007), and both the rate of ice loss and its final magnitude are uncertain (Lenton et al., 2008). Ice sheet models provide internally-consistent representations of the processes that are important to the growth and decay of ice

sheets. Although imperfect, such models have been the focus of intense development effort since the fourth Intergovernmental Panel on Climate Change assessment report (e.g., Bindschadler et al., 2013; Shannon et al., 2013; Edwards et al., 2014a)."

In other words, we have deleted all references to semi-empirical modeling and expert assessments of sea level rise from this paragraph (and, indeed, from the paper, because this paragraph is the only place they were mentioned). We believe that this change is consistent with IPCC WG1 AR5, which appears to argue that semi-empirical methods are unreliable tools for projecting sea level rise.

Although we have followed the reviewer's and editor's suggestions in this matter, we think this is an area where individual scientists might reasonably disagree. Our paper is a step toward fully probabilistic calibration of ice sheet models, using only modern observations; adding paleo-data would clearly be helpful, but is technically challenging. In the meantime, semi-empirical models can be calibrated relatively easily to many years of data. Thus, sea level rise projections from semi-empirical models may still be useful while ice sheet model calibration progresses.

1920/12: Again, you have cited the paper referred to by the reviewer, but not addressed the substantive point, which is that there isn't always wide variation in projections of sea level rise.

(See our response to the next comment.)

1920/27: Again, you need to address the substantive point of the reviewer, namely that your presentation of the current state of the art is incomplete.

We divided this paragraph into two parts, which read as follows. The relevant part of our correction is underlined.

"Multiple modes appear in the two-dimensional marginal density plots (Fig. 4), implying that standard methods for tuning of ice sheet models may converge to "non-optimal" parameter combinations... [G]radient descent methods can converge to a point which produces a better match to the data than any adjacent point, but is nevertheless far from the "best" parameter combination."

"This problem may partly explain the wide variation in projections of sea level rise from the ice sheets, as made with state-of-the-art ice sheet models. Two recent intercomparison projects, SeaRISE and ice2sea (Bindschadler et al. 2013; Shannon et al., 2013; Edwards et al., 2014a) used a variety of ice sheet models to project future ice sheet contributions to sea level rise. The two projects used different groups of ice sheet models and different methods for spinning up the participating models. The results of one of these projects shows strong divergence among the results from different models (Bindschadler et al. 2013), whereas the other project's projections agree more closely (Shannon et al. 2013; Edwards et al., 2014). The multiple modes in our posterior two-dimensional density plots (Fig. 4) suggest that some of the divergence among models, for example in the SeaRISE project (Bindschadler et al., 2013), may be due to differences in model tuning: even if the models had similar structures and reproduced the modern

ice sheet topography and ice thicknesses equally well, we would still expect their future projections to diverge because of differences in input parameter choice."

1908: You need to include citations of the other papers mentioned by the reviewer (Goelzer, etc.)

Done.

1918/5: I don't think the revised sentence is clear on the point of concern, namely that it is synthetic volume you are considering.

We inserted the word synthetic; so; we have

"The 95% probable interval produced by our methods is much smaller than that estimated by computing the 2.5th and the 97.5th percentiles of the synthetic volume change values selected by the 10% volume filter used in Applegate et al. (2012)."

Many thanks for your contribution to GMD.

Best wishes,

Ian Rutt