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Interactive comment on “How do icebergs affect the Greenland ice sheet under pre-industrial conditions? – A model study with a fully coupled ice sheet–climate model” by M. Bügelmayer et al.

Anonymous Referee #1

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General comments

The paper “How Do Icebergs Affect (. . .)” is interesting in the topic, and original for the modeling of iceberg-climate interaction within a global climate model. However, important modeling aspects such as the calculation of the surface mass balance are not explained at all. A main claim of the paper is that the effect of the latent heat exchange with the ocean is bigger than the effect of freshwater fluxes. This seems to challenge the general assumption that the latent heat exchange from icebergs is small, and it would be an interesting finding, if proved correct. However, there is no explicit quantification of the different processes (e.g. latent heat exchange, amount of freshwater discharge from icebergs versus runoff, etc). Instead, the analysis is based on qualita-

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tive descriptions of the (too) many plots. The authors need to back up their conclusions with a more rigorous analysis. Another problem is the metrics chosen to evaluate the impact of icebergs on the mass balance of the ice sheet. Instead of evaluating this impact in terms of the components of the surface mass balance (snowfall, melt, runoff) and the processes influencing ice discharge (velocity and thickness change, position of the grounding line), the authors use “height differences”. These differences are not very informative: reference heights are not given, height differences over which period of time?, what causes these differences? Surface melt is not analyzed, described or evaluated at all in the manuscript, however changes in the surface melt are the main cause of GrIS mass loss during the last two decades (van den Broeke et al., Science, 2009; Enderlin et al., GRL, 2014). Does the model simulate surface melt at all?

Specific comments

From the general conclusions in the abstract it is difficult to separate the scientific findings from the particularities of the model set-up. Therefore, it is not clear which findings are physically meaningful and which ones are related to a “virtual” modeling world. For instance, what means in the real world “taking up the latent heat homogeneously”? Also, the sentences “Yet, . . .” and “Therefore, we conclude. . .” seem contradictory.

The introduction is somehow too long, and sometimes unrelated with the paper. In addition, some statements seem wrong: “the potential impact of the GIS due to interactions with the ocean and the atmosphere (. . .) has never been investigated in a fully coupled global climate-cryosphere modeling framework”. What about Ridley et al. (2005), Vizcaino et al. (2008, 2010)? This work is cited in the manuscript, the statement seems contradictory with the paragraphs below.

The calculation of the surface mass balance needs to be explained in the text. How is surface melt calculated? Line 14, page 194 : “through precipitation and surface temperature”. How are you dealing with the resolution gap between the atmosphere and ice sheet components?

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There are too many figures and the size is too small. I recommend to select the key figures to illustrate the main message in the text, and improve the readability of labels in the color bars.

The definition and treatment of runoff is confusing. Table 1: “runoff=basal and surface melting of the ice sheet”, what about refreezing? Melting and runoff are usually not equivalent.

The simulations setup is not clear: why is runoff not included in the control simulation? Why is “excess snow” included? What is the physical interpretation of “excess snow”? How are the effects of runoff and iceberg separated in the comparison of the simulations with the control run? The setup of FWFf and FWFc is not clearly outlined.

The model validation/evaluation is very poor, generally based on qualitative assessment. What is the volume of the CTRL ice sheet? What is the surface mass balance? And ice flow? How does the topography compare with the real one? (e.g. thickness anomalies). Even if this is described in other paper, a summary should be given here.

Albedo changes are shown in the figures and mentioned in the text, but the albedo calculation is not described in the text.

In the evaluation (3.1), colder conditions in the preindustrial climate and lower calving rates are linked. What is the link in the model between colder temperatures and lower calving rates?

Please quantify calving rates, freshwater fluxes and heat fluxes, surface mass balance, etc. for all simulations.

3.2. Please quantify the changes in sea ice thickness in terms of total area and volume. Cooling translates into reduced ice thickness due to precipitation changes, but what about surface melt?

3.2. The differences in the set-up of control and CALV simulations is not clear. How different are total freshwater and heat fluxes in both simulations? How can you separate

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the effect of the differences in the amount and distribution of these fluxes? The text seems to attribute the differences only to the distribution. But there is no runoff or ice flow in control, so the amount of fluxes should be different as well, and the seasonality.

The analysis of the sensitivity studies (3.3) should be quantitative. This sub-section is full of vague statements. Instead, the authors need to quantify the energy and mass fluxes.

The discussion (section 4) does not always relate the results of this manuscript with previous work, instead it describes previous work. This could be done in the introduction, but in the discussion a comparison must be done. This section is lengthy and does not serve the point to relate this work to previous work. Instead, please answer the question: why didn't other studies find an important role of the latent heat exchange from icebergs?

Technical corrections

GIS is used for “Geographical Information Systems”, I advice to use GrIS instead.

P191I22: “short” (i.e. a few centuries). The cited work describes complete deglaciation, and the scenarios are multi-millennia. I would not call this short, and it is definitively beyond “a few centuries”.

P197, I23: “besides” do you mean “except”?

Interactive comment on The Cryosphere Discuss., 8, 187, 2014.

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