Geosci. Model Dev. Discuss., 7, C1249–C1250, 2014
www.geosci-model-dev-discuss.net/7/C1249/2014/

Geoscientific
Model Development
Discussions

Open Access

Interactive comment on "Representing icebergs in the iLOVECLIM model (version 1.0) – a sensitivity study" by M. Bügelmayer et al.

Anonymous Referee #1

Received and published: 26 July 2014

This is an interesting paper, exploring the impact of iceberg size on climate in three different climate states, while documenting inclusion of an iceberg model in a well used EMC. Their main conclusion is that whether icebergs are small, large, or a mix of sizes (at least using the standard size classes of current iceberg models) their impact on climate is similar and small. This is true even if net flux varies between states – the large-scale radiative forcing is most important for producing change. This is a conclu- sion that would have been expected a priori, but it is good to have the unimportance of iceberg size verified. The authors explain their procedures, and set forth their experi- ments clearly.

I do have a few specific comments that the authors may wish to comment on:

1. The authors seem not to differentiate between ocean and atmospheric components of the melting parameterisation. One of the big effects – the wave-induced erosion – is purely wind-related, while the other large effects, such as basal melting and buoy- ant convection, are oceanic effects. This will impact on the southward extent of the tracks, possibly as significantly as size. Was this effect included, but not noted? If not, its exclusion needs to be made clear.

It is correct that the melt function has not been changed between the OCE or ATM experiments and that this causes the icebergs to melt faster than when only be melted by either ocean forcing or wind forcing, as correctly stated by the reviewer. But we were specifically interested in the movement of the icebergs, on their drift pattern and how this is dependent on the forcing fields. By changing also the melt function, we would have prolonged their lifetime and thus additionally altered their melt flux distribution.

We have added lines 222-224 to state clearly that only the equation of motion was changed:

The differentiation between atmospheric and oceanic forces was only made in the equation of motion of an iceberg. The melting of icebergs, which depends on bottom- and lateral melt (oceanic forcing) and the wave erosion (atmospheric forcing) was not altered.

2. It is not clear what the experiments do in the Southern Hemisphere. Is it only Greenland that is supplying icebergs, and is the ice sheet model also causing changes in calving fluxes in each hemisphere?

In the current model set-up, the Greenland ice sheet is actively coupled and its freshwater fluxes (calving and runoff) are computed explicitly. The Southern Hemisphere ice sheet however, is fixed. It is thus correct, that changes in the Antarctic's topography due to the applied high/low radiative forcing are not considered. Yet, altered ice shelf melting is taken into account because ice shelf melting is parameterized depending on the ocean's temperature. Also iceberg calving is parameterized as homogenous uptake of latent heat around Antarctica. The amount of heat taken up from the ocean depends on the excess snow that is defined by the accumulation rate. Thus, changes in climate also alter the iceberg parameterization. Having both, the Greenland and the Antarctic ice sheet interactively coupled is a goal that, unfortunately, lies beyond this study.

We have included a short paragraph concerning the Southern Hemisphere into the manuscript (lines 149-153):

The Antarctic ice sheet is prescribed according to present-day conditions following the ETOPO1 topography (http://www.ngdc.noaa.gov/mgg/global/global.html). Icebergs are parameterized in the form of homogenous uptake of latent heat around Antarctica and ice shelf melting is computed according to the prevailing ocean conditions. The Greenland ice sheet is coupled actively and computed using the GRISLI ice-sheet model.

3. By only considering Greenland the restriction of the iceberg sizes to 1 km in length is reasonable, even under glacial conditions. However, the Antarctic has a proportion of icebergs at > 10 km size. These provide a significant freshwater flux to the Southern Ocean, but previous models have capped SH icebergs at the same 1 km size as used here. It would have been interesting to see if a predominantly giant iceberg flux from Antarctica led to the same lack of impact, although as the paper focuses on the North- ern Hemisphere this paper only requires comment on this issue, rather than additional work.

Please see comment about Southern Hemisphere above.

Technical points p. 4354, l. 26 ". . . conditions and constant . . ."

We have changed "und" to "and".

p. 4356, l. 10-15: the authors should acknowledge, in the otherwise good description of the development of iceberg models, the extension of the Bigg et al. model to include coupling to an inter- mediate complexity model by Levine and Bigg (2008). It was the first published coupled iceberg model considering climate conditions in both the present and a low carbon diox- ide climate. Levine, R. C., and G. R. Bigg, 2008, The sensitivity of the glacial ocean to Heinrich events from different sources, as modeled by a coupled atmosphere-iceberg- ocean model, Paleoceanogr., 23: PA4213, doi:10.1029/2008PA001613.

Thank you for this citation, we have included it.

Interactive comment on Geosci. Model Dev. Discuss., 7, 4353, 2014.