Clim. Past Discuss., 8, C60–C66, 2012
www.clim-past-discuss.net/8/C60/2012/

Climate of the Past Discussions

Interactive comment on "The impact of different glacial boundary conditions on atmospheric dynamics and precipitation in the North Atlantic region" *by* D. Hofer et al.

Anonymous Referee #2

Received and published: 22 February 2012

This paper examines the effect of different glacial boundary conditions in the context of the last glaciation (ice-sheet topographic height, radiative forcing, ocean SSTs and sea-ice) on North Atlantic precipitation distribution and intensity and atmospheric dynamic changes. The authors find that ice-sheet altitude has a first order affect on displacement of the jet stream and storm track southwards. An associated increase in precipitation is modelled. Changes in radiative forcing and ocean boundary conditions have a less pronounced yet similar affect. A number of simulations have been performed for different periods of the Last Glacial Maximum (LGM) and the methods used and assumptions made are valid. It is important to note that the authors stress that the results are not necessarily realistic, particularly in the case of altitude change,

but inform on the sensitivity of the LGM to changes in glacial boundary conditions.

The material and scope of the paper is suitable for publication in Climate of the Past. However, I feel a number of structural and presentational issues need to be addressed before it is ready for publication. The manuscript is particularly difficult to follow in places (especially with so many acronyms). Furthermore, although the authors aim is to examine the impacts of glacial boundary conditions on North Atlantic precipitation changes and atmospheric dynamics there is little discussion of why this is potentially important and what the implications for further palaeoclimate or even future modelling studies might be. This warrants more discussion. In several places, it lacks focus and it is difficult to extract what is actually a new and an informative result. Since ice-sheet height is shown to have the most profound effect on North Atlantic precipitation perhaps the paper should focus closely on this rather than the other two boundary conditions. This may also reduce the number of experiments described which became very confusing at times. Below I highlight additional suggestions:

1. The inclusion of sophisticated methods to analyse storminess during the LGM is motivating and encouraging for other palaeo-modelling studies. The question of ice-sheet height on atmospheric circulation and storm tracks in the North Atlantic has actually been looked at by several authors in the context of the Greenland ice-sheet being removed in the future (see for example Petersen, 2004; Junge, 2005; Dethloff, 2004). They have used methods of interpretation similar to yours. Within your discussion it might be worth comparing your analysis to these briefly. Do different locations of ice-sheets have similar impacts? Does a different climate have a major impact on the result?

2. The evaluation section is rather long in length. It is important to evaluate the global climate in order that your sensitivity results can be analysed in the context of any deficiencies in the model. However, I would focus more on the North Atlantic region since this is the region of your study and less on the global anoma-

lies.

3. SAT differences over the reduction in height of the Greenland Ice Sheet have been shown to be not only the result of a lapse rate feedback but also due to the changes induced in the atmospheric dynamics (e.g. Dethloff, 2004). Is this the case over your ice-sheets? A brief sentence on this would be informative. By focussing more on the effect of topography than the other two boundary conditions this could be expanded on more.

4. It was unclear whether the change in topographic height accounts for additional freshwater fluxes in the simulation. This could have an effect on the ocean circulation and hence heat transport in the North Atlantic, which in turn would feedback on the atmospheric dynamics.

Technical Corrections:
Abstract
Line 7: define what you mean by lower boundary conditions
Line 5: “21ka ago” Change to “21 thousand years ago (ka)”
Line 6: “65 ka ago” Change to “65ka”
Line 11: large altitude, consider revising to “A high surface elevation of the Laurentide ice sheet leads to...”
Line 20: change “as the” to compared with...

Introduction
P64, line 24: please explain briefly why differences in the underlying mechanisms that make the climate during the last glaciation different from today are of great interest!
P64, line 24: define “ka”
P64, line 25: insert some references to show the extent of this period being studies
P65, line 4: insert “such” before “as the Nordic Seas...”

P65, line 4: what do you mean by discrepancies?
P65, line 8: Please explain briefly why proxy data for the early part of the LGM is very sparse
P65, line 15: “remove settings of the...”
P65, line 16: modify to “such an approach HAS already BEEN successfully applied...”
P65: line 18-22: It is not clear what the difference is meant to be between PMIP1 and PMIP2
P65, line 29: replace “than in” with “compared with”
P66, line 20: “of a lower...” replace with “derived from a lower...”
P66, line 23: “low sea-level”, please quantify
P66, line 27: “three parameters”. I think you mean boundary conditions
P66, line 28: please state at what spatial scale and the region you are focussing on

Model description and experiments
P67, line 15: insert “surface” after land
P67, line 15: insert “grid” after sea ice
P67, line 19: replace “in a” with “with” and “of the atmosphere ...” with “for the atmosphere...”
P68, line 3: insert “time” before “periods”
P68, line 3-4: perhaps list as bullet points the time periods. Also inert the acronym used for present day and preindustrial
P68, line 9: please state what reaches an equilibrated state, ocean, atmosphere or both?
P68, line 12: replace “Finally” with “Second,” and replace “33 yr” with “33 model years”
P68, line 13: please revise ”...based on the last 30 yr of it” to be clearer. For example “based on the last 30 model years of the simulation...”
P68, line 17 and line 20: replace “settings” with “set-up”
P68, line 22: please elaborate very briefly what you mean by substantial uncertainties, does this weaken your conclusions?

P68, line 23: do you mean equilibrium in the ocean?
P68, line: remove “one of”, this does not make sense!
P 69, line 11-21: please make this clearer, perhaps using bullet points.
P69, line 18: change “parameter” to “parameters”
P69, line 23: change “...are set to the same values as in PI” to “equivalent to the PI simulation...”
P69, line 24: topography is not a parameter consider revising
P70, line 3 and 4: insert “lower” after Wm-2
P70, line 8-11: are the radiative forcing changes global?
P70, line 12: remove “they”
P70, line 27-P71, line 3: the acronyms are a little confusing, please define clearly. For example what does EU mean?

Evaluation
P71, line 10: please insert “both in the past and present” after “climate state”
P71, line 12: insert “proxy” before “reconstructions”
P72, line 5: what do you mean by a weak warming? Please quantify
P72, line 24: replace “than known from observations” with “than that derived from observations”
P72, line 28: polewards of 60 degrees North or South?
P73, line 12: how large are the anomalies in the North Atlantic since this is the area of interest in this study?
P73, line 23: please give some example references where temperatures at ocean edges are not increased relative to the surroundings
P74, line 18: What do you mean by significant? Is this difference from a statistical test and that all other values are statistically insignificant?
P78, line 2: please define what you mean by ocean surface, e.g. temperatures?
P78, line 4: replace “...topography on the atmospheric dynamic...” with “...topography on atmospheric dynamics...”

Other Comments:
Please keep precision of precipitation and temperature values to one decimal place.

Figures:
Labels on all figures are clear. However, I found, particularly in the case of Fig.3, Fig.4 and Fig.6 the SAT colour-scale became saturated and difficult to interpret. Also, in order to interpret anomalies easier it is often useful to make the region around zero white/grey. i.e have contour intervals that enclose zero i.e -0.1 to 0.1.

Fig 4 and Fig 6: white appears to be in the colour-scale for temperatures below -45 and -35 degrees Celsius respectively. However, you state regions not coloured are not statistically significant. Please alter so confusion doesn’t arise.

Fig.8: It is almost impossible to distinguish the differences between the winter precipitation anomalies for different topographic heights. This may be an artefact of the colour-scale chosen. The horizontal bars are more informative but represent differences relative to MWLIN for the c) e) g) and so is misleading since the plot underneath is relative to PI.

Additional References:
Dethloff K, Dorn W, Rinke A, Fraedrich K, Junge M, Roeckner E, Gayler V, Cubasch U, Christensen JH (2004) The impact of Greenland’s deglaciation on the Arctic circulation. Geophys Res Lett 31 (L19201). doi:10.1029/2004GL020714

Petersen GN, Kristjánsoon JE, Ólafsson H (2004) Numerical simulations of Greenland’s impact on the Northern Hemisphere winter circulation. Tellus 56 (2):102-111

Junge MM, Blender R, Fraedrich K, Gayler V, Luksch U, Lunkeit F (2005) A world without Greenland: impacts on the Northern Hemisphere winter circulation in low- and high-resolution models. Clim Dyn 24 (2-3):297-307. doi:10.1007/s00382-004-0501-2