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Climate of the Past Discussions

Interactive comment on "

Impact of North Atlantic – GIN Sea exchange on deglaciation evolution of Atlantic Meridional Overturning Circulation" *by* J. Cheng et al.

Anonymous Referee #1

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In this manuscript, the transient deglacial simulation with CCSM3 by Liu et al. (2009) is revisited by means of two new sensitivity experiments. These experiments make use of a Partial Blocking (PB) scheme that inhibits oceanic exchanges between the North Atlantic (NA) and the GIN Seas. The results show that the NA-GIN Sea exchange is crucial for the Atlantic meridional overturning circulation (AMOC) overshoot during the Bolling-Allerod (BA) observed in the transient simulation by Liu et al. (2009).

This is an interesting contribution that provides insight into the physical processes that potentially played a role in triggering the BA warming event. Before publication, how-

ever, some revision is needed as described in the following.

(I) Citations:

The citation is really poor. As proxy evidence of an AMOC overshoot during the BA, the papers by Stanford et al. (2006) and Barker et al. (2009) are cited. Both papers show no evidence of an AMOC overshoot. By contrast, a recent paper by Thornalley et al. (2011, Science) shows some records that may corroborate the overshoot hypothesis. The high-impact paper by McManus et al. (2004, Nature) does not provide evidence for an AMOC overshoot during the BA. The Pa/Th record of McManus et al. rather suggests an AMOC during the BA of similar strength than during the LGM, but weaker than during the Holocene. Nevertheless, this important paper should be cited and it should clearly be stated that some - but not all - proxy records of deglacial AMOC variability show evidence for a BA AMOC-overshoot.

Basically the same holds true for the citation of modelling papers. The authors cite the studies by Manabe & Stouffer (1997), Knutti et al. (2004) and Mignot et al. (2007) as suggesting that the "AMOC overshoot is a common and robust phenomenon in freshwater-hosing experiments". In fact, none of theses model experiments really shows an overshoot after removal of the freshwater perturbation. Only a few of the cited studies (Weber & Drijfhout, 2007; Krebs et al., 2007 and Arzel et al., 2008) show a short and weak AMOC overshoot in response to removing the freshwater injection (although it should be noted that Weber & Drijfhout and Krebs et al. basically use the same climate model). The model inter-comparison by Stouffer et al. (2006) nicely shows that an AMOC overshoot is rather an exception than the rule. In Schmittner et al. (2008) AMOC overshoots were triggered by negative freshwater perturbations, while Weaver et al. (2003) applied a freshwater perturbation to the Southern Ocean. In summary, the authors should be more careful with their citations and clearly state that some models simulate an AMOC overshoot, while others do not.

More model studies that support the importance of NA-GIN Sea exchange for deep-

water formation should be cited, as this is the key point of the manuscript. I suggest Schulz et al. (2007, GRL) and Oka et al. (2006, Ocean Modell.) to include but there may be many more.

Last but not least, some references in the model description would be helpful. As not everybody is familiar with CAM3, CLM3, POP and CSIM at least one reference for each model component should be included.

(II) Language:

The paper needs a major revision in terms of language. The paper is full of grammatical errors and inappropriate use of words (e.g. "allodiality"). This shouldn't be a problem as at least one of the co-authors is an (American) English native speaker.

(III) Conclusions:

One of the major conclusions is that "if the deep-water formation in the GIN Sea is kept in a suppressed state artificially, the change of the deep-water formation in the Labrador Sea will be affected too". I don't see this from the results. Fig. 1 rather suggests a similar temporal evolution of Labrador Sea deep-water formation in the PB and DGL-A experiments. The authors should be more specific or revise their conclusions.

(IV) Supplement:

The supplementary figure should be included into the manuscript.

Additional References:

McManus et al. (2004) Collapse and rapid resumption of Atlantic meridional circulation linked to deglacial climate changes, Nature 428, 834-837.

Thornalley et al. (2011) The Deglacial Evolution of North Atlantic Deep Convection, Science 331, 202-205

Schulz et al. (2007) Low-frequency oscillations of the Atlantic Ocean meridional over-

turning circulation in a coupled climate model, Climate of the Past 3, 97-107

Oka et al. (2006) Deep convection seesaw controlled by freshwater export through the Denmark Strait, Ocean Modell., 15, 157–176

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