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Ocean Science
Discussions

Interactive comment on "North Atlantic 20th century multidecadal variability in coupled climate models: sea surface temperature and ocean overturning circulation" *by* I. Medhaug and T. Furevik

I. Medhaug and T. Furevik

iselin.medhaug@gfi.uib.no

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First of all we wold like to say thanks for your constructive comments. In the following referee comments are in slanted text with actions taken following in bold.

This manuscript presents very interesting analyses on AMOC and AMO using the 20c3m experiment from 24 IPCC AR4 coupled climate models. The results suggest that the observed 20th century extreme in temperature are due to primarily internal climate variability, not dominated by external forcing, consistent with previous stud-

ies. The manuscript also explores the relationship between AMOC and AMO in the IPCC AR4 coupled models, and found that the models strongly disagree in phase and strength of the covariability. The work shows progressive contribution to the field studying Atlantic climate variability. In particular, the comparison of AMOC variability in different IPCC coupled models and the linkage to the AMO have not been studied widely before. The manuscript is well presented, and I recommend the paper to be accepted for publications in Ocean Science after some minor revisions outlined in the following review comments.

1, The simple conceptual model in Section 4 is very confusing, and does not represent the correct physical mechanism for AMOC variability. The equations (1-6) do not distinguish the mean state and the transient variability. The concept of the flushing time scale is confusing and misleading. I suggest this part and Figure 11,12 be deleted from the manuscript.
According to the suggestions from the referee and discussions with others, the figures are removed and the text is adjusted accordingly both in the discussion and summary and concluding remarks.

2, Page 354, Line 25, the THC component is part of the AMOC, not "is know as" the AMOC, i.e. the AMOC includes both the THC and the wind-driven circulation.
The text has been changed to "In the Atlantic these two components make up the Atlantic Meridional Overturning Circulation (AMOC), ..."

3, Page 356, Line 7, the statement "driven by advection of anomalous dense water from the south" is not true for Delworth et al. 1993, which is driven by anomalous freshwater flux from the northern high latitudes linked to the Arctic.
The paragraph has been rewritten for clarification, and changed according to the reviewer's comment. The text has been changed to: "At present there is no consensus to what degree the AMOC variability is an ocean-only mode excited by (Frankcombe et al., 2009) or damped by (Hasselmann, 1976; Frankignoul et al., 1997) atmospheric forcing; an ocean-only mode with density fluctuations in

the convection regions driven by advection of density anomalies from the south (e.g., Vellinga and Wu, 2004) or the northern high latitudes (e.g., Delworth et al., 1993); a fully coupled atmosphere-ocean or atmosphere-sea ice-ocean mode with the deep water formation rate dominated by variations in the local wind forcing (e.g., Dickson et al., 1996; Häkkinen, 1999; Eden and Willebrand, 2001; Deshayes and Frankignoul, 2008; Msadek and Frankignoul, 2009; Medhaug et al., 2011).”

4, The manuscript should be aware that many IPCC AR4 models do not simulate the correct locations of the deep convection sites, and such modeling biases would strongly affect modeled AMOC variability and its relationship with the AMO, that is probably one of the reason that models strongly disagree in phase and strength of the AMOC-AMO covariability. Only model results showing realistic simulations of the deep convection in the Labrador Sea and Nordic Sea can be trusted for the study of the AMOC-AMO relationship.

This has been addressed in the second last paragraph of the discussion.

Interactive comment on Ocean Sci. Discuss., 8, 353, 2011.