Clim. Past Discuss., 7, C1961–C1963, 2011
www.clim-past-discuss.net/7/C1961/2011/

Climate of the Past Discussions

Interactive comment on "Role of CO₂ and Southern Ocean winds in glacial abrupt climate change" *by* R. Banderas et al.

Anonymous Referee #2

Received and published: 5 December 2011

General Comments

If I understand this paper correctly, it uses a coupled model simulation to argue that gradual (millenial-scale) increases in CO2 concentration or wind strength during glacial conditions can lead to an abrupt (centennial scale) climate change. In this climate change, the Nordic Sea because warmer and saltier and the deep Atlantic overturning (AMOC) becomes much stronger. This is a very interesting result, but there are several puzzling aspects which I believe the authors must clarify before publication. I list these in "Specific Comments" below. I expect that once these clarifications are made, the paper should be a good contribution to CP.

Specific Comments

1. Roughly doubling of CO2 from current conditions is predicted to make the high latitude North Atlantic warmer and fresher, with a moderate decrease in AMOC strength (see AR4 IPCC report Working Group I). It seems strange that under glacial conditions, a 10% incease CO2 would make northern North Atlantic saltier and make a big increase in AMOC. Why the opposite behavior during current and glacial conditions?

2. There is not a clear discussion of the mechanism for the AMOC to strengthen (more than double). If a previously ice-covered Nordic Sea becomes ice free, doesn't this just change the location of the deep water formation (DWF)? That doesn't necessarily change the density of the DWF site or the AMOC strength. If the density in the DWF region increases relative to the density in the Southern Ocean, that might have a major effect in strengthening the flow. But then the density comparison should be between the previous DWF location (further south) and the new DWF location. In today's climate, high latitudes have large freshwater sources and lower latitudes are closer to subtropical evaporation, so higher latitudes typically are saltier than lower latitudes. I don't know what it was like during the ice ages but I would expect the new higher latitude DWF site should be fresher than the old lower latitude DWF. Apparently it isn't.... why? This should be addressed by the paper.

3. I found the discussion of the Nordic Sea salt budget hard to follow.

4. The Conclusions refer to the model being configured "so that the system resides close to a threshhold associated with drastic changes". How was this chosen? Do the authors have any more information about the characteristics or location in parameter space of this threshhold?

Technical Corrections

a. Abstract and/or Introduction should briefly define what is meant by "abrupt".

b. Ocean model is rather coarse resolution for the complex topography of the Nordic Sea, Greenland-Iceland-Scotland Ridge, etc., and the atmospheric model is even more

coarse and does not contain complete dynamics. It would be helpful to comment on how this might influence the model results.

c. In graphs (especially Figs 1, 4 and 6), it would be helpful to extend a grid throughout the graph (based on tic marks) to make it easier to read quantitative information from the graph.

Interactive comment on Clim. Past Discuss., 7, 3489, 2011.