Clim. Past Discuss., 4, S434–S436, 2008
www.clim-past-discuss.net/4/S434/2008/

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Interactive Comment

Interactive comment on "The carbon cycle during the Mid Pleistocene Transition: the Southern Ocean Decoupling Hypothesis" *by* P. Köhler and R. Bintanja

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Received and published: 8 September 2008

The manuscript by Köhler and Bintanja investigates possible changes in global carbon cycling related to changing climate variability before and after the Mid Pleistocene revolution (MPR). Despite the problems associated with Southern Ocean sensitivity in box models, as pointed out in the review by David Archer, an interesting observation is presented, the major increase in amplitude variations of benthic δ^{18}O, after the MPR which is not reflected in corresponding δ^{13}C, values. This decoupling of what is considered to be driven by global ice volume changes ($\delta^{18}O$) and components of the global carbon cycle (δ^{13}C) is studied by driving their box model with various paleoclimate records.

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Interactive Discussion

Discussion Paper

Most of the measured records, however, don't date back the necessary two million years, spanning the entire Pleistocene. That's why the author's chose to reconstruct them by calculated correlations with a globally stacked benthic δ^{18}O record. As a result amplitude variations in model forcing factors such as Southern Ocean seasurface temperatures (EPICA δD) or temperature changes over the Northern land hemisphere increase equally during the MPR. This is probably the reason why model outputs of global carbon cycle components like δ^{13}C and atmospheric carbon dioxide (pCO_2) both show this trend as well. Measured atmospheric pCO_2 prior to the MPR does not exist for a direct comparison, the amplitude variations of benthic foraminifera δ^{13}C measured in the tropical Pacific, however, appear to be quite insensitive. Modelled δ^{13}C is only brought close to observed values by changing Southern Ocean mixing and upwelling prior to the MPR. This in turn also increases amplitude variations of pCO_2 in the Early Pleistocene, similar to those observed in the Late Pleistocene.

Adding to the discussion of the possible mechanisms involved in such a cryosphere–global carbon cycle decoupling, two aspects would be, at least for me, of interest. First, to which extent can the measured δ^{13}C of the tropical Pacific be considered a global (local) signal? In other words, how do corresponding δ^{13}C in the Atlantic and Southern Ocean box change and how does this compare to measurements? And second, the invoked changes in Southern Ocean mixing impact δ^{13}C and atmospheric carbon dioxide in a similar way. Are there any mechanisms which would impact only one parameter? Otherwise it would seem that variability of atmospheric CO_2 was similar in the Early compared to the Late Pleistocene. This would be an interesting aspect as pCO_2 oscillation is generally believed to have gradually increased towards the MPR. Maybe this was not the case.

Minor comments

1: Page 814, last paragr.: "... sediment box with initially 50000 PgC and a δ^{13}C of 2.75

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is introduced..." How sensitive is the model to the absolute $\delta^{13}C$ used for the sediments and the assumption that this would be the average signature of $CaCO_3$ produced in surface waters? In this respect, what are the components of the particulate inorganic carbon cycle in the model?

2: Page 823, last paragr.: "we have to reject our Null Hypothesis to explain the observed variations in the carbon cycle over the MPR." What are the observed variations the authors refer to? Wouldn't the only relatively small increase in $\delta^{13}C$ amplitude after the MPR argue for no variations in the carbon cycle?

3: Page 831, last paragr.: "This approach can explain terminations I-VII, but none of the smaller G/IG transitions, which occurred earlier in time. However, it also indicates that the climate in the southern high latitudes was remarkably different..." The insolation canon hypothesis by Schulz & Zeebe 2006 cannot explain any of the G/IG transitions themselves, although there are hints (the combination of negative and positive insolation forcing). Nevertheless the hypothesis demonstrates that orbital forcing changed at the MPR which leads to the observed dominant frequencies of 41 kyr prior and 100 kyr after the MPR. If this indicates that the climate in the Southern high latitudes was remarkably different in the Early compared to the Late Pleistocene, I am not sure.

Interactive comment on Clim. Past Discuss., 4, 809, 2008.

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