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Ocean Science Discussions

Interactive comment on "How does ocean ventilation change under global warming?" *by* A. Gnanadesikan et al.

Anonymous Referee #2

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Review of " how does ventilation change under global warming? " by Gnanadesian et al.

This manuscript is very interesting, and proposes to study the evolution of ocean ventilation when the climatic change is forced by increasing atmospheric C02 concentration. This subject is of great importance, as oceanic circulation plays a major role for the uptake of anthropogenic carbon and regulates the oceanic heat transfer. The paper shows results from coupled GCM simulations that are highly relevant for the subject. However, I've found that many scientific points or discussions are not investigated thoroughly. I recommend publication after major changes that may improve the coherence of the manuscript.

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Introduction

P3: “global warming produces overall stratification...,sarmiento et al,2004)”: Mention clearly that this feature is robust and common to all existing modeling studies on this subject: cite other relevant papers

P3: Slowing tropical ventilation reduce tropical ventilation: this point is not proved. Reduced wind certainly weaken ocean surface current, but does it necessarily reduced ocean ventilation ? (that is forced by the wind divergence; see LPS theory)

Description of the simulations P3: I accept that the detailed description of the model is referred to other papers, but I would appreciate some more details: model horizontal resolution, etc..

P4: What are the 1860 and 1990 C02 concentration?, it seems necessary to include explicitly this information in the paper. Otherwise these models results may be next cited in a wrong manner if the reader is not precisely inform of the context of the simulation.

Results

P6 figure1: there is no reference for the data (Oxygen, CFC, PV), there is no definition for PV. No values on contour for figure a and b

P6 “The coupled model are able to reproduce the potential vorticity gradientĚ”  it is right that the models generate “realistic” gradients in CFC12-age and PV distribution in the pacific between the shadow zone and the directly ventilated thermocline. However the CFC12-age and PV distribution are not realistic in the center of the subtropical gyre where PV values are too low and age are too old (characteristic distribution for coarse resolution model). Does it mean that the paper focus on the ventilation of the equatorial upwelling region? If it is the case it has to be stated clearly in the introduction.

discussion on the differences between the model: P6 Large differences are although

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simulated at 800m in the North Atlantic Ocean (figure 2). P7 Zonally averaged ideal age differences (figure 3): large differences are although simulated in the Arctic ocean

In general, the discussion about the difference between the simulation is very frustrating. The differences between the simulations are enumerated without any interpretation (causes, originĚ). The discussion has to be deepened to provide diagnostic and interpretation that are useful for the modeling community.

P7: “however the volume of young water in the mid-latitudes of the southern ocean actually increases under global warming in CM2.1 and holds essentially constant in CM2.0”  It would be interesting to quantify these changes, and also provide similar information on other region.

P7: “ the changes resulting from global warming are striking in part because they occur in regions where the variability is relatively low”  why is it striking? ? why a region of high variability is necessarily a region very sensitive to global warming?

Discussion

P8 One dimensional advective-diffusive model: In this model young water is injected at the base of the (vertical!) domain this approach is completely unrealistic, and differs drastically with the processes simulated by the model So this model is not appropriate to provide useful information for the interpretation of the simulation. I recommend to change the boundary condition in order to get feature comparable to model results (old water in the deep ocean!!!). Figure 7 does not provide a justification for using this model as stated in the text (P9), the argument is erroneous. Moreover this model is in contradiction with the theoretical support given in introduction with LPS theory for the ventilation of the thermocline.  the paper needs to be more coherent in its globality.

Interactive comment on Ocean Sci. Discuss., 3, 805, 2006.

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Interactive Comment