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Interactive comment on “Interhemispheric gradient of atmospheric radiocarbon reveals natural variability of Southern Ocean winds” by K. B. Rodgers et al.

Anonymous Referee #3

Received and published: 30 March 2011

This paper intends to test the hypothesis that changes of the Interhemispheric radiocarbon gradient is most likely reflecting perturbations to the winds over the Southern Ocean. For this, the authors used an ocean model (MOM3) and an Atmospheric Transport Model that are run sequentially. They found that the Interhemispheric radiocarbon gradient is mainly affected by changes to Southern Ocean wind speeds through due to its impact on gas exchange in the surface ocean. Here, they proposed that the interhemispheric gradient decreased during the transition between the Medieval Climate Anomaly and the Little Ice Age (about AD 1375) potentially linked to a weakening of the winds over the Southern Ocean.

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Basically, I find the approach used to understand the processes that drive the interhemispheric radiocarbon gradient novel and very interesting. However, the article is in cases unclear and somewhat confusing. In the introduction, the authors do not show clearly the context of the study and the state of the art. They do not justify why they neglect the importance of the CO₂ flux from the tropical Pacific (Feely et al, 1999; Turner and Palmer, 2007). Moreover, others studies using models, such as the one of Le Quéré et al. (2000) and Obata and Kitamura (2003) have shown that the global variability of air-sea carbon flux is controlled by the equatorial Pacific. It is only within the discussion that the authors refer on previous works that suggest the role of the Southern Ocean for the interhemispheric radiocarbon gradient.

I would recommend publication with a few major and minor changes. I feel that the article should be mainly reorganized to improve clarity.

COMMENTS

Abstract

It will be interesting to include in the abstract that the analysis presented here is based on modeling results.

Abstract line 7: “Stuiver and Quay, 1980” not “Stuiver, 1980”.

“Siegenthaler et al., 1980” not “Siegenthaler, 1980 ”.)

Introduction

The introduction is confusing. It needs to be expanded, reorganized and completed with respect to the state of the art. The general context needs clarification. It is surprising that the introduction finishes with an incomplete description of the state of the art.

P350 line 9: Could you clarify how you calculate the hemispheric Δ¹⁴C?

I suggest adding the difference between the two tree-ring derived hemispheric Δ¹⁴C

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reconstructions of southern and northern hemisphere, respectively.

CPD

A more precise definition is needed in the legend of **Figure 1**.

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P350 line 16: The modeling study of Levin et al (2009) revealed that this effect (stratospheric-tropospheric exchange) is small. Can you clarify the meaning of “small”?

P351 line 4: The authors say:” Our goal in this study is to use models to test...” Could you more precise? Which models?

P351 line 7: “The recent study of Skinner et al.,”. This part is not in place.

Model configuration

Clarification is needed.

Ocean model

P352 line 18: “water masses” not “watermasses”

P352 line 25: The authors state: “ A caveat with the OCMIP-2 representation of $\Delta^{14}\text{C}$ is that ^{13}C is ignored, despite the fact that it can play a non-negligible role in determining $\Delta^{14}\text{C}$ ”.

Could you explain “non-negligible role” in this paragraph?

P353 line 7: “etc” should be deleted.

Atmospheric transport model

P354 line 22: Could you specify “the residence time of CO_2 in the terrestrial biosphere is short relative to its radioactive decay ...”? **How much is it short?**

P 355 Line 2: You said: “... this effect is relatively negligible for $\Delta^{14}\text{C}$ ”. It is how much?

Results

P 356:

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The results statement is clear until the line 18. Than clarification is needed to explain how disequilibrium flux was calculated and what the meaning of the observation is. Next, it is demonstrated that the importance of the sea surface on the interhemispheric gradient is too implicit. The calculations leading to this statement need to be explained. For example, the reader needs to know how the value of 1.8GT/yr was obtained to follow the further arguments. Could you explain in more detail how you obtain the flux of 0.9 GtC/yr and the value of 20%?

P357 line 14: What is the unit of 3 (difference between the mid-latitude Northern and Southern hemispheres)?

P357 line 15: Could you add in the text the value of observed gradient?

Figure 3: The legend is incomplete. There are two blue curves. One of them is not described.

P358 line 2: “perturbation” not “perurbation”.

P358 line 10: The description of the third case (p2a-0.5) is not necessary.

P358 line 13: The mean value of the data should be added.

P358 line 18: “is within the range of uncertainty with such models”. Could you indicate the range of values?

Discussion

Needs overall clarification. It would be important to provide a conclusion on the performed comparison.

P360 line 15: “the difference in the interhemispheric exchange timescale for tracers....” Which tracers?

P 360 line 20: Could you add the mean exchange time given by Geller et al., 1997. How do you deduce the net interhemispheric exchange of order 6-12%?

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P 361 line 22: “Disequilibrium” not “Disequilbrium”

P363 line 22: “addition” not “addtion”

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CPD

7, C180–C184, 2011

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