

## ***Interactive comment on “Oceanic tracer and proxy time scales revisited” by C. Siberlin and C. Wunsch***

**Anonymous Referee #2**

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General comments:

Siberlin and Wunsch present simulations of numerical tracer distributions in the ocean and discuss the implications for interpreting proxy-based climatic time scales. The manuscript is a kind of follow-up to the paper by Wunsch and Heinbach (2008), now studying the effects of various tracer boundary conditions (i.e. tracer injection scenarios) and employing a different modelling approach (accelerated simulations applying the transport matrix method instead of full OGCM integrations). The main conclusions are that marine tracer (or proxy) equilibrium times can be considerably longer than radiocarbon ages typically used for dating, and that the temporal evolution of tracer (proxy) concentrations at a given location strongly depends on the choice of appropriate tracer (proxy) boundary conditions. The latter also holds for proxy-based age

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models. This means that leads and lags between paleoceanographic records from different locations do not necessarily point to climate regime shifts. They may just display the relevant time scale of proxy propagation in the ocean. The manuscript gives a clear and concise introduction to the problems of deriving and interpreting time scales from oceanic tracer distributions. While these issues have been discussed in the 'modern' oceanographic community since the last 15-20 years they are little noticed by paleoceanographers. The manuscript is acceptable for publication in CP after some minor changes. These issues are listed below.

Specific comments:

(1) The paper refers to two unpublished manuscripts by Gebbie and Huybers (submitted in 2010) which are not accessible (page 1593, line 1; page 1594, line 27; page 1595, line 2, page 1601, line 24, page 1605, line 10).

(2) Page 1601, line 14: The authors propose to discuss three distinct types of tracer boundary conditions but in fact only two cases are extensively discussed. The third type (flux-step or Neumann-Heaviside boundary conditions) is only briefly touched in equation 3 on page 1597.

(3) Paleoclimate implications (page 1606, line 19): The results for  $t_{90}$  discussed in the text (ranging from 500 to 4000 years, mean value  $\sim 1300$  years) differ from the values shown in Table 1 ( $t_{90} = 1300$  yr in the Atlantic and 4400 yr in the Pacific for  $T_{1/2} = 5730$  yr) and in Figures 9 and 10. How did the authors arrive at these numbers? Which boundary conditions were applied? Additional material (table(s) and / or figure(s)) should illustrate these findings.

(4) Discussion of model limitations (page 1609): The authors should add that the discussed uncertainties are probably even larger if models employ reconstructed (and less well constrained) paleo boundary conditions.

Technical corrections:

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- (1) Symbols in Figs. 4, Fig. 6-9, and Fig. 11 should be increased.
- (2) Legend in Fig. 8 is incomplete ('global ocean' is missing).

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