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Interactive Comment

Interactive comment on "^{14}C-age tracers in global ocean circulation models" *by* W. Koeve et al.

Anonymous Referee #4

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This paper describes a suite of numerical model experiments to identify the various factors - circulation, reservoir age, gas transfer parameterization, ice cover, etc - that control the distribution of 14C in the ocean. 14C is an important tracer in studies of both the modern and paleo oceans and is frequently used to evaluate model performance by comparing simulated 14C with observations. Understanding what controls its distribution in the ocean is therefore critical. The main conclusions of this papers are that (1) bulk 14C (the directly simulated tracer and what is "observed") is influenced by both circulation (time elapsed since the parcel was at the surface of the ocean and mixing in between) and the "preformed 14C" of the water parcel (the concentration or age - usually called reservoir age - the parcel had when it was at the surface), and (2) the gas transfer parameterization.

Neither conclusions will come as a surprise to those studying ocean radiocarbon. In fact, much of this paper could be regarded as "textbook-ish" in nature and describes

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results that are generally considered "known". But the literature is full of papers which will mention in passing these caveats and then blithely go on to ignore them and use bulk 14C - simulated or measured as the case might be - to make/jump to conclusions. The present work shows very concisely and clearly the dangers of using bulk 14C in a naive manner. So despite the lack of novelty and that this isn't a 'model development' paper per se I'm entirely in favor of publishing it.

I only have a few comments/suggestions. While I liked the novel use of multiple idealized tracers (Sec. 2.2) to tease apart the different controlling factors, at the end of the day their relevance was somewhat lost to me. For example, for the purposes of this paper it might be quite acceptable to begin with the assumption that nonlinear mixing has a relatively small effect on 14C, such that the bulk 14C age is to a good approximation a sum of ideal age and reservoir/preformed age. That this should be the case under plausible ocean conditions was theoretically demonstrated by Holzer et al. (2010) - which really should be cited - using a Green function approach. Khatiwala et al. (2012) then applied this to ocean Green functions inverted from tracer observations to show that this is indeed the case. Here the authors have demonstrated it to also hold for 14C simulated in ocean models. So while I'm not suggesting the authors get rid of all this, I would suggest they simplify/shorten the presentation, and also try to put their results within the theoretical analysis of the two studies mentioned above. Incidentally, the authors use the term "preformed age" where I believe the more common term is "reservoir age". Ideally the authors could switch to the latter rather than introducing yet another term.

Apart from preformed/reservoir age the other conclusion concerning gas exchange is also interesting and deserves to be better highlighted as it seems from the comparison of ECCO and uVic that even a smallish change in the gas transfer coefficient can easily lead to the opposite conclusion as to which model is closer to observations. In this context I suggest the authors cite Graven et al. (JGR 2012) who looked at the impact of gas exchange on 14C.

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In summary, I recommend publication of this clean and interesting study that should be quite useful to many oceanographers who exploit 14C for a variety of problems.

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