Topical Editor Decision: Publish subject to minor revisions (Editor review) (30 Jun 2015) by Dr. Didier Roche
Comments to the Author:
Dear Dr. Koeve,

We have now received two additional comments on the revised version of your manuscript. You will see that the comments are minor and should therefore not cause any issues for the revision.

I am therefore looking forward for the final version of your manuscript.

Best regards,
Didier Roche

Response: We thank the editor and the two reviewers of the revised manuscript version for the time and effort dedicated to reviewing, commenting on and thereby improving our work. We have updated the manuscript accordingly. See also brief detailed responses below.

Report # 1: (former reviewer #5)

The paper in this updated version is much clearer and better structured. The aim and conclusions are more to the point. In that respect i appreciate the addition of Fig. 9 and related discussion. I recommend it for publication once the issues described hereafter have been corrected for.

1) The claim that ice cover has little impact on bulk C14 ages is overrated. I do agree with the authors that sea ice is probably not the main factor explaining past changes in deep sea radiocarbon ages. However, the impact of suppressing sea ice cover in a present-day configuration may not be compared to a LGM climate with larger sea ice covered areas. The authors should add some nuances to their conclusion.

Response: We added a sentence to page 23 (1st paragraph) stating: " …water in the formation region of Antarctic Bottom Water has not **yet** been analysed for the last glacial maximum. In the simulations of present-day conditions in our study where the impact of ice cover on \chem{^{14}C}-gas exchange was switched off, leaving circulation unchanged, this impact was found to be relatively small (Fig. 9). **During LGM, with a different circulation, the relative contribution from differences in ice cover compared to today may have been more important in defining the deep ocean \chem{^{14}C}-age$^{\text{pre}}$.**"

2) The denomination "surface water age" (lines 361 and 368) is not appropriate in the present context. Indeed, "surface water age" refers to a tracer which records the age of water which has touched at least once the surface (Deleersnijder et al., 2002).
I do not favor either the denomination of "reverse age" (sounds like some journey backward in time). I'd suggest the authors to refer to this age which is set to zero at depth as "age relative to depth".

E. Deleersnijder, A. Mouchet, E.J.M. Delhez, J.-M. Beckers, Transient behaviour of water ages in the World Ocean, Mathematical and Computer Modelling, 36: 121-127, 2002, doi:10.1016/S0895-7177(02)00108-5.

Response: We have reworded the text (p. 15) as follows:

Instead, we take a first step into this direction and model the **age of the surface water relative to its last stay below a given depth**. …. The time passed since the last residence below the surface is henceforth referred to as the ``**age relative to depth**". In our MIT2.8 model, for example, the **age relative to depth** ranges up to two years in subpolar and most northern-hemisphere polar waters, up to five years in Southern Ocean polar waters and equatorial upwelling regions, and up to 7 years in the subtropical gyres (Fig.~6). In the ECCO model the *age relative to depth* in the Southern Ocean is lower. In general, in areas of deep convection or upwelling the age **relative to depth is** low …. Our estimates of the **age relative to depth** (Fig.~6) are qualitatively consistent …Regions with low **age relative to depth** show … Still, our **age relative to depth** …

We also updated the caption of figure 6 accordingly:
Age relative to depth (yr) computed for the MIT2.8 \textbf{(a)} and ECCO \textbf{(b)} model **(see text for details)**.

Report #2: (former reviewer #4)

No specific comments. Accepted as is.