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Climate of the Past Discussions

Interactive comment on "Synchronizing the Greenland ice core and radiocarbon timescales over the Holocene – Bayesian wiggle-matching of cosmogenic radionuclide records" *by* F. Adolphi and R. Muscheler

Anonymous Referee #2

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Adolphi and Muscheler present a transfer function that describes the age offset between the layer-counted Greenland ice core chronology (GICC05) and the tree-ring based IntCal13 D14C calibration curve. The age synchronization is based on wiggle-matching of the IntCal13 D14C record to ice core 10Be data, which is justified because centennial-scale variability in both records is dominated by changes in cosmogenic production rates in the atmosphere. The authors adopt a previously published method to estimate the age offset in a probabilistic, Bayesian framework.

The manuscript is well-written and easy to follow. The authors have great attention

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for detail, which results in realistic uncertainty estimates that reflect all the probable causes of uncertainty. My only concern is that it's hard to discern what is really new here. A very similar paper was published last year by the same authors (Muscheler, Adolphi and Knudsen, 2014), MAK14 hereafter. The manuscript under review uses the same 10Be and D14C data as MAK14, and while the mathematical details differ, the approach is conceptually identical (i.e. converting ice-core 10Be to 14C using a carbon-cycle model, and then wiggle-matching it to IntCal D14C). Unsurprisingly, the transfer function the authors derive is essentially identical to the one derived by MAK14 – only smoother due to the choice of a 1000 year window length. The main improvement is a reduction in the uncertainty estimates, suggesting that MAK14 were too conservative in estimating their error.

The work is very thorough, and I have only a few minor comments that should be addressed in a revised manuscript. I leave out the first two digits ("29") in all listed page numbers.

- I think section 2.2 (statistical method) would fit more logically between the current sections 2.4 and 2.5. When reading the section on the statistical method, the reader has no idea what is meant by "10Be-based D14C anomalies" (P38, last line). This becomes clear after reading section 2.4. An alternative solution would be to add an introductory paragraph to section 2.2 in which the conceptual framework is laid out, so the reader understands that 10Be is converted to 14C using a carbon cycle model, and then filtered to isolate the centennial component.

- Due to their proximity, the GISP2 and GRIP sites should experience identical atmospheric 10Be loading; yet GISP2 receives slightly more accumulation than GRIP (about 5%). Could this help in partitioning out wet and dry 10Be deposition? The lower 10Be concentrations at GISP2 (by 0.12 atoms/g), as well as the higher 14C/10Be scaling factors (Figs 6 and 7) are both consistent with a fraction of dry deposition. I fear that the accumulation difference may be too small to do this reliably, though.

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- Section 2.1: please indicate the data resolution for the D14C data also.

- P37 L1-L4: I think the reality is more fluid than portrayed. I suspect that in practice the 10Be-14C synchronization is dominated by a few prominent events, and therefore somewhat “discrete”. Likewise, continuous (rather than discrete) CH4 synchronization has also been achieved between ice cores (Mitchell et al., Science 342 964-966, 2013).

- P40, L25: “....and may thus diminish the climate influences in the 10Be record”. Could it also increase the climate influences in the 10Be record, if the observed correlations are spurious?

- Section 2.4.1: What is the motivation to only investigate the sensitivity of the model to the oceanic carbon exchange? While the ocean is of course the largest carbon reservoir, the terrestrial carbon fluxes are actually larger than the oceanic ones. A recent paper also suggested that changes in terrestrial carbon reservoirs are more important during Holocene (Bauska et al. Nat Geo 8, 383-387 2015)

- Section 2.6: I think it’s important somewhere to point out that you’re comparing the 14C anomalies, rather than 14C itself. These anomalies are not really well defined; from section 3.1 I assume you’re using the centennial (<500 yr) variations. Please describe how your filter the records to separate the <500 and >500 yr variations.

- P45, L16-17: How much is the uncertainty of 3 ‰ relative to the standard deviation of the data itself? In other words, what is the signal to noise ratio?

- P48, L21: “this would imply a strong polar bias”. Please elaborate, this is not automatically clear.

- The generated transfer function should be provided as a text / excel file in the supplement.

- Typos / Language:

P35 L15 and throughout: acronym should be capitalized, so GCR instead of gcr.

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P36, L4: 14C / 12C *ratio*

P38, L23: Please define what is meant by “D14C anomalies”. I don’t think this is done anywhere in the manuscript.

P39, L4 and L8: Bronk Ramsey (“r” omitted)

Throughout there are long sentences that would benefit from inclusion of a comma to clarify sentence structure. Some examples:

P35 L23: After production, ... P36 L11: On the other hand, ... P36 L28: ... synchronization tools, ... P40 L19: ... to the ice sheet, ... P41 L18: ... these effects, ... P45 L26: ... as before, ...

Interactive comment on Clim. Past Discuss., 11, 2933, 2015.