Author Response to Editor's comments (Clim. Past Discuss., 8, 621, 2012)

The changes listed below were made to the manuscript following the Editor's comments on the revised version of the paper.

Comments by the Editor are labelled **E** and our author response is labelled **A**.

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E: line 10: "that even a short lead"

A: Added (also added in Results and Discussion).

E: line 40: "is reported for Vostok and Taylor Dome"
A: Corrected.

E: line 155: "carbon storage occur at the time" (the terrestrial carbon storage changes begin much earlier)

A: This is revised to "A recently produced carbon-stable isotope record from the EDC core depicts a positive excursion in ($\delta^{13}C_{atm}$) beginning around 12.2 ka which the authors attribute regrowth of the terrestrial biosphere (Schmitt et al., 2012)."

E: line 160: "Shakun et al., 2012), however, the result may somewhat change systematically, if other models are used."

A: Added.

E: line 190: "to assess"

A: Corrected.

E: paragraph following line 190: please include the figure for the jack-knifed lag distributions (as provided in your reply to the referees) to the main text. This clearly strengthens the conclusions.

A: Figure added and referred to in text.

E: line 207: I suggest to add the following text: "...at the onset of deglaciation. In fact when looking at Figure 1A a larger CO2 lag at the onset of the Holocene is also seen in both the Byrd and Siple Dome records, but was not taken into account in the time window of our correlation study. We assume that this larger lag is likely associated to other processes acting on the carbon cycle outside the Southern Ocean." I am not sure that the second sentence is what you imply when you decided not to take the early Holocene into account. You may leave the second sentence out, but I strongly feel the first sentence is an important observation that should be not glossed over.

A: We add something very similar and also revise a little the comparison with Monnin et al.

"There is a suggestion in the both the Byrd and Siple Dome records of a larger lag at the onset of the Holocene (Fig. 1A), but this period is not included in the time-window of our lag assessment as we assume it is likely influenced by processes acting on the carbon cycle outside the Southern Ocean. Monnin et al. (2001) defined the 800±600 year lag at EDC at the onset of deglaciation. The Byrd and Siple Dome CO2 data is not sufficiently dense to constrain the lag at the same point but our overall result is not inconsistent with the Monnin et al. (2001) estimate within its uncertainty range."

E: paragraph following line 215: The discussion of the Shakun et al., 2012 results is not telling the whole story. In fact Shakun is also doing a lag study using only southern hemisphere records, which shows a larger lag of CO2 (720+-330 years). This southern hemisphere stack is really the right thing to compare with your Antarctic record. Accordingly the discrepancy of the lag result in your study and in Shakun et al., is much larger than what you discuss in this paragraph. Please change this discussion. The discrepancy can still be explained by dating and firn model issues in the EDC CO2 record used by Shakun.
A: Revised to include some more detail (the 720±330 is the NH lead)

"A brief comparison with the recent work by Shakun et al. (2012) is also warranted. Their study evaluates the phasing between the EDC CO2 record and multi-proxy hemispheric and global (rather than exclusively Antarctic) temperature reconstructions. They report a CO2 lag behind their Southern Hemisphere temperature reconstruction (620±660 years), a *lead* of CO2 over their Northern Hemisphere reconstruction (720±330 years), and a short *lead* of CO2 over their full global reconstruction (460±340 years). The southern lag and northern lead is attributed to an anti-phased hemispheric temperature response to ocean circulation changes (as also discussed further below), superimposed on globally in-phase warming driven by the CO2 increase. This emphasises the role of CO2 as both feedback and forcing in the deglacial warming. Within the quoted uncertainty bounds the 620±660 year lag for the Southern Hemisphere is not inconsistent with our Antarctica-based result, also considering the aforementioned Δage issues for EDC their Southern Hemisphere lag is likely somewhat overestimated (and the northern and global lead are likely underestimated). The larger uncertainty range around the Shakun et al. (2012) result must be expected given the challenges of synchronising records from multiple proxy types. In our view, the remarkable similarity of the Antarctic temperature and CO2 curves and the independent evidence that the high latitude Southern Ocean was a centre of action in the deglacial CO2 release make the lag determined from an Antarctic perspective critical for constraining the mechanisms involved in the CO2 increase."

E: line 235: "(Anderson et al., 2009) coincident with negative excursions in atmospheric d13CO2 (Schmitt et al., 2012)."
A: Added.

E: line 26: "displaced southward"

A: Assume you mean line 260, revised to: "weakens and displaces southward the Atlantic Meridional Overturning Circulation (AMOC)"

E: line 288-290: See also the study by Bouttes, N., Roche, D. M., and Paillard, D. (2012). Systematic study of the impact of fresh water fluxes on the glacial carbon cycle. Climate of the Past 8, 589-607, which shows that especially the response of terrestrial vegetation models is strongly model dependent.

A: Thanks for this reference. Added a citation in the text: “However, the response of terrestrial vegetation models and the interplay between ocean and vegetation responses is known to be highly model-dependent (Bouttes et al., 2012)”.