

Reviewer #3, re-review of Shinwa et al.

In my first review, I asked the authors to state clearly in the main text the number of rejected data points. This is important in the case of difficult measurements, like CO₂ in ice cores, so that the reader has a clear understanding of any potential risk of data selection-induced bias. The authors responded that two samples had been rejected for experimental reasons, and I thank them for that and indeed am reassured that there is virtually no risk of selection bias. But I saw no place in the revised manuscript where this was stated. The authors still need to put this in the main text. A good place would be page 7, line 7, after the sentence “In total, the datasets contain 237 CO₂ measurement points.”

On page 5, line 12. the text states: “Moreover, the convective zone was confirmed to be very thin during the last deglaciation by Parrenin et al. (2012). Thus, we assume that h_{conv} is negligible during MIS 6.”

There is now new information on the timing of the onset of CO₂ rise during the last deglaciation from the WAIS Divide ice core (Marcott et al., Nature, 2014). This new timing information shows that CO₂ began its *sustained* rise about 300 years after the abrupt warming inflection point that marks the onset of deglaciation. The situation is admittedly confusing, because one earlier CO₂ point appears to be high (above the LGM baseline), but later points are back down at the LGM baseline. So it appears likely that this single CO₂ point does NOT represent the onset of *sustained* CO₂ rise.

These observations call into question the conclusion of Parrenin et al. (2013) that the onset of CO₂ rise may have been synchronous with the onset of deglacial warming in Antarctica. By logical extension, the Parrenin et al. (2012; 2013) convective-zone conclusion can no longer be true, that there was no convective zone at EDC during the last deglaciation. The 300-year lag of CO₂ behind temperature instead now requires a modest convective zone (~10 m), at least according to the d₁₅N method used by Parrenin et al. (2012; 2013).

Indeed, if one adopts the stated age uncertainty estimates of Parrenin et al. in the timing of CO₂ onset relative to temperature onset, one must in any case state a *range* in implied convective zone thickness rather than a single value. My understanding of Parrenin et al. (2013) is that the convective zone thickness is only implied to be zero if CO₂ and temperature rose synchronously, and the stated uncertainties in timing (up to 500 years later CO₂ rise) allowed a convective zone of up to 15 m or so, if my memory is correct.

The use of d₁₅N for age control in the present manuscript therefore should include an uncertainty corresponding to the rather limited knowledge of MIS 6 convective zone thickness (perhaps a range of 0 -15 m?). This may require a small timescale expansion of the stated age uncertainty.

For this reason, I would recommend modifying the sentence in quotes above, to “Moreover, the convective zone was confirmed to be thin (<15 m) during the last deglaciation by Parrenin et al. (2012; 2013), when taking into account subsequently-published CO₂ data from WAIS Divide (Marcott et al., 2014). Thus, we assume that h_{conv} is effectively negligible during MIS 6, with a range of +/- m.”

Technical corrections:

Page 9, line 6 “...firn column-induced smoothing....”

Page 9, line 7 there seems to be a missing period at the end of this sentence (“...short stadials”)

Page 9, line 17 this sentence is quite long and difficult to read. Perhaps you can simplify and cut one clause so that it reads: “Due to the lack of an MIS 6 temperature proxy in Greenland, and due to the difficulty of placing marine temperature proxies on a precise common chronology with the EDC ice core, in this work CH₄ measurements on the EDC ice core were used as markers of rapid warming in the NH....”

Page 12, line 13 “ Some studies (for example, Menviel et al. 2008) mention...”

Page 12, line 18 cut extra “during”

Page 12, line 24-25 “...low accumulation at EDC and its wider age distribution, the estimation...”

Page 13, line 3 “compared to”

Page 13 line 6 “..conducted during the MIS 6 period are needed.”