

Review of Chowdhry Beeman et al.

The manuscript has had major revisions and is improved. However, more work is in my view still needed to justify some of the conclusions (see major points). I also have a rather long list of more technical points that need to be clarified or corrected.

Major points

- Regarding the phasing differences between temperature and CO₂ at different Antarctic sites. The discussion of these results is very brief and the statement in the conclusions "we confirm that the deglacial temperature rise did not occur homogeneously across the Antarctic continent" is in my opinion not yet justified. It would help a great deal to include a table which shows the phasing results and uncertainties for the stack and for the individual cores for each change point. Then we could more easily see if the phasing differences are indeed significant and at what level.
- I am not completely convinced by the method to assess uncertainty in the phasing estimates. The additional comments in the supplement on significance testing largely repeat what is already in the main text. One way to test this and convince this reviewer and readers would be to trial the method on some artificial data with known change points and AR(1) noise.
- In comparing the lag results with other studies the authors use qualitative language like 'nearly.. roughly consistent.. etc'. Please use more quantitative language. For example the phasing at T1 in Parrenin et al was -10/± 160 years and here it is 449 ± 257 years. This needs some more explanation than 'only roughly consistent'. If these results are indeed to be a target for carbon cycle modeling, then we need to be confident that this number will not change again in several years, can we be? Please address this concern in the revised text.

Technical points

- Abstract. List the lead/lag and uncertainties for the four coherent changes instead of using ambiguous terms like 'nearly' and 'most likely led'. The note in the supplement indicates that the lags are near Gaussian so I can't see why not to report as such. Or, if you have a strong rationale for avoiding quantitative descriptions then make that argument clearly in the text.
- Line 9. For clarity drop "During the large, millennial-scale changes".
- Line 11. Again, give the lead/lag and uncertainty.
- Line 30. The ACR occurs midway (in time) through the deglaciation, not 'near the end'.
- P2 L35: missing citation.
- P2 L38: Marcott 2014 does not present evidence of increased Southern Ocean upwelling during the deglaciation as far as I'm aware. Better would be Anderson et al., Science 2009 and Skinner et al., Science, 2010.
- P3L35-36: No. The study used Byrd and Siple CO₂ data not Law Dome CO₂ data.

- P3L39: "Roughly in phase.. etc'. No, instead list the lag and uncertainty for the intervals mentioned in this sentence.
- P4L5: and others?
- P4L6: You mean during the satellite era?
- P4L24: "The standard deviation of the records at each timestep is assumed to be representative of the uncertainty concerning the conversion from isotopes to temperature," ... No I do not agree with this. Clarify or drop.
- P5L35: This sentence is unclear, please revise.
- P7L36: Python
- Fig 3 caption, L3: Probabilities.
- Fig 3: The dotted lines are a good addition. The caption should refer the reader to the relevant section of the text to understand where this threshold comes from.
- P8L18: The choice of the .0003 threshold over the..
- Fig 6. Caption: is the blue text including the result for the equivalent change point in Parrenin et al.,? Clarify in the caption.
- The result for deglacial onset appears substantially different to Parrenin et al. i.e. 10+- 160 yr CO2 lead (Parrenin) to 449+_257 yr ATS2 lead (this work). Some specific comments on the main source of this timing difference are needed.
- P14L37: 'Though the T1 onset and the ACR end are both thought to originate in AMOC reductions (Marcott et al., 2014), our results allow for the CO2 - ATS2 phasing to be reversed during the two events (i.e. with temperature leading at T1 and CO2 leading at the ACR end).'
- P14L37: "CH4 changes nearly synchronously with CO2 at both points, but the phasings are opposite in direction and different in magnitude." What is the basis for this statement? You did not assess CH4 phasing.
- P15 L4:" Within the range of uncertainty, our lead-lag estimates are only roughly consistent with those of Pedro et al. (2012) and Parrenin et al. (2013)." They are either consistent or they are not - use precise language.
- P14L35... Add some words to clarify this result: "However, the cumulative probability of the ATS2 change point is much greater before 17.7 ka than after (*see Figure 7*); hence our results are do not support McConnell et al's proposed volcanic forcing of the temperature change.
- P14L47: suggest to cite here Buizert et al., Nature, 2018 (<https://doi.org/10.1038/s41586-018-0727-5>) which finds that EDML has a consistently different atmospheric response to AMOC perturbations than other Antarctic records. Being geographically closer to the Atlantic does not necessarily imply EDML should resolve Atlantic temperature anomalies with more fidelity than other cores, the reason is the ACC barrier, which anomalies must mix across to enter the polar ocean; this likely happens to a large extent down-stream of the Atlantic sector (see Pedro et al., 2018, <https://doi.org/10.1016/j.quascirev.2018.05.005>).
- P16 L15: "This variability suggests complex mechanisms of coupling that can be modulated by external forcing". Expand on what you mean by this, why

should the modulation be external and not internal? As it stands this statement is not justified and not convincing.

- Figure 5: This was a very good addition, but plotting time series around the map, makes the panels much too small. I suggest a standard layout with the map above or below.
- P16 L17: .. between West and East Antarctica...
- P16 L18: what is meant by 'regional external influences'? Influences other than regional temperature?
- P16 L20: be more precise about what these differences are and why you think they are significant and at what level (a Table comparing the results for all sites would help).
- P16 L24: drop 'as is the investigation of the role CO₂ in global temperature change.' It is repeated further down.
- Supplement: The note on Gaussian uncertainties should be moved to the main text. The note on assessing significance is central to the results and should also be integrated into the main text (and see major comments above).