

Interactive comment on “Natural periodicities and north–south hemispheres connection of fast temperature changes during the last glacial period: EPICA and NGRIP revisited” by T. Alberti et al.

Anonymous Referee #1

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This paper makes time series analyses of 25 kyr long sections of the $\delta^{18}O$ records from the NGRIP and EPICA Dronning Maud Land ice cores during the last glacial period (20–45 kyr BP). The approach is based on so-called Empirical Mode Decomposition (EMD) which was introduced by others some years ago and which is applied here. The paper comes to the conclusions that millennial-scale climate changes (Dansgaard/Oeschger (DO) events) are excitations of a climate system in a single state, while longer time scale behaviour (5–25 kyr time scales) might be due to transitions between different two climate states. It finally comes to an estimate that Antarctic

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climate leads Greenland by 3.6 kyr.

General judgement:

I see that some of the results are interesting and bring new views to the discussion, mainly Fig 6 and the potential analysis, but scientific interpretation on this finding is then very short. I see a lot of shortcomings in the present form of the study, which will be explained in detail below. These need to be fixed, before such a paper can be accepted.

Major points:

1. Common understanding nowadays is, that climate of both hemispheres are during rapid changes (DO events) interconnected by the bipolar seesaw (*Stocker and Johnsen, 2003*), which can explain, that a gradual warming in the south during cold phases in the north switches to a gradual cooling synchronous to a rapid warming in the north. This understanding was used also to predict northern climate change during the last 800 kyr based on southern data alone (*Barker et al., 2011*). This intrinsic knowledge of rapid climate change is essential and needs to be taken into consideration when making time series analysis, especially when calculating leads and lags as done here in the final section including Fig 7. Lead-lag analysis on the kyr-time scale therefore needs to define exactly, which points of the records in the north and south are analysed, e.g. as done in typically during synchronisation efforts, for which of both hemispheres is used (*EPICA-community-members, 2006*). is a global signal, there exist an interhemispheric gradient, but rapid changes in should be seen at the same time in both hemispheres.

None of these details of the bipolar seesaw are considered here.

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2. The restriction of the time series to only the 25 kyr between 20 and 45 kyr BP is never motivated. I suggest to use all available data, please also note that the work of *EPICA-community-members* (2006) (only Marine Isotope Stage 3) was extended in the last interglacial by *Capron et al.* (2010a,b).
3. In any kind of time series analysis the timing of events plays an important role, so analysis should be performed on the most recent age scale available. While in the paper I can not remember that any information at all was given on which age model both data sets were taken, so probably on those used when published (which are probably outdated), I encourage to use GICC05 or successor (*Svensson et al.*, 2008) for the NGRIP record (but check at <http://www.iceandclimate.nbi.ku.dk/data/>) and AICC2012 (*Veres et al.*, 2013) for the EPICA record. I acknowledge that published times series $\delta^{18}O$ might not be readable available on those age models on the internet, but authors of the original papers certainly might help bringing those records on the new age models.
4. Finding periodicities of 24-25 kyr (6th EMD mode of both records, Table 1) in records which are only of 25 kyr long is rather questionable.
5. Your significance test (Fig 4) rejects the 0th and 1st EMD mode of EPICA and the 0th EMD mode of NGRIP, however, the 1st EMD mode of EPICA is later-on still used, e.g. when calculating S_H (Eq 5, used in Fig. 5). What is the use of the significance test then?
6. The European Project for Ice Coring in Antarctica (EPICA) consists of two ice cores, the EPICA Dome C (EDC) ice core and the EPICA Dronning Maud Land (EDML) ice core. Here, only data from EDML are used. It is therefore necessary to say so throughout the text and I suggest to replace “EPICA” with “EDML” or “EPICA DML” throughout.
7. When discussion leads-lags (section 5), this is not done as state of the art, so

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some more recent papers and insights are necessary here, e.g. see (*Barker et al.*, 2011; *Veres et al.*, 2013) for a start. But most importantly, as explained above, the role of the bipolar seesaw is essential and it needs to be checked what then can be said at all in lead-lags here and if the method applied is meaningful at all then.

8. The whole paper is very technical, describing mathematical methods in various parts of the text, not only in the methods section. This is necessary for reproducibility, but interrupts the flow while reading. I suggest to focus more on the interpretation and move some of the description to an appendix, e.g. in section 4 (potential analysis) all but the first and last paragraph (starting with line 11, page 1138) are details of the applied method which should be moved.
9. Method: I am not familiar with the EMD approach and I can not judge its robustness. However, I and the reader might want to understand why this method was preferred and chosen, when others, more classical approaches such as Fourier analysis might also be applied. So, some reasoning arguing for the approach are necessary.

Minors points:

1. Throughout the text: When a range in a data set is given symbols are wrong, e.g. page 1131, line 15: reads “1 ÷ 2 kyr”, but should be “1 – 2 kyr”.
2. Caption of Fig 5: “An offset was applied”, which kind of offset?

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