

Interactive comment on “The origin of the 1500-year climate cycles in Holocene North-Atlantic records” by M. Debret et al.

M. Debret et al.

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Reviewer 1: Anonymous

Specific comments

1. Reviewer 1: I have a crucial question after reading this paper. How should we interpret the agreement between IRD and cosmogenic radionuclide records shown in figure 3 in Bond et al. (2001) if solar forcing is not the common cause? I agree that the agreement is not perfect but there seems to be reasonable agreement throughout the complete Holocene. Bond et al. obviously used a very broad spectral filter that seems to include the whole range of frequencies discussed by Debret et al. A simple example: The so-called little ice age represents a period of low solar activity and high IRD. However, if I understood Debret et al. correctly they do not see a solar influence

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on IRD during the late Holocene. Is this correct?

We do not pointed out this relationship because the too short period. The figure 3 of Bond et al, 2001 is not clear enough to highlight that the correlation between cosmogenic and IRD signal is sufficient. Indeed the millennial cycle (1000 yrs) are present in the both records until ~5000 years. After and for the recent part of the Holocene there is less correlation as shown by the wavelets analyses. The agreement seems good because of the limitation of Fourier Transform analyses. Wavelets add the instationnarity parameter of the climate that fourier transform are unable to detect. However we agree that fort the last millennia it's a bit difficult to disentangle the problem because only one cycle is concerned with a probable reappearance of 1000-yr cycle. We added in the text the possibility of the reappearance of 1000-yr cycle for the last millennia that may be in accordance with Little Ice Age well recognized in North Atlantic Area.

2. Reviewer: The main focus of this paper is the discussion of cycles. However, I think the discussion by Debret et al. is incorrect when they give the impression that the 1500yr cycle is "remarkably regular" or "mysteriously regular". For example, Bond et al. (2001) are aware that the 1500 year cycle during the Holocene is not a clear clock-like cycle. They clearly state: "Those drift-ice cycles compose part of an enigmatic, at best quasiperiodic, "1500-year" cycle ...". Based on the newest NGRIP dating Ditlevsen et al. (CP 2007) conclude that "the recurrence times (of D/O events) are indistinguishable from a random occurrence". So, I am not convinced that there is a "mysteriously regular" 1500 year cycle.

The terms of "remarkably regular" are not from Debret et al, but Rahmstorf, 2003 and/or Mayewski et al., 1997. And it was "mysteriously regular" (Rahmstorf, 2003) before the work of Ditlevsen et al, 2007 (Climate of the Past) for glacial time and only glacial time. For Holocene, Bond et al suggested quasi-periodic at the best. Here we suggest that the behaviour of climate is not stationary that is consistent with "quasi" periodic feeling from Bond et al, 2001 while 1500-year cycle come from ocean internal forcing.

3. In the cycle discussion (figure 3) I think an important aspect is missing. How much of the signal can be explained by the 1500 (1650) yr cycle and are the cycles statistically significant. For example, wavelet analyses suggest a dominant 2500-yr cycle in IRD. However this cycle does not convincingly show up in figure 2. Figure 3 suggests that this cycle is present throughout the complete Holocene which should lead to a significant cycle in all spectra, correct? In addition, the phase relationships between cycles in different records are not studied by Debret et al. I think it would be important to know if the cycles in the different records are in phase (or constant phase shift). To me this seems to be a crucial test to check if there is really a common cause behind these records. The 1450 yr cycle seems to have periodicities from 1450 to 1700 yr in different records. Over the Holocene, these cycles will run out of phase by more 1000 years. This cannot be explained by dating uncertainties and I don't see how one can infer a common cause behind the different cycles if there is indeed a variable phase shift.

You are right but in a first approach here we wanted to point out the major differences in the amplitude of the signal, from many major records, keeping the phase studies for future. We add a statistical test.

4. Debret et al. state that circum-Atlantic records cannot be explained by solar forcing but require changes in ocean circulation. Does this include only the 1500 yr band as it is suggested by their analysis. This should be clearly written.

Only the 1000 and 2500-year band appear associated to solar activity so 1500-year band originate from oceanic behaviour. We reworded in the text.

5. There are other examples where Debret et al. could be more precise to avoid misunderstandings (e.g. "match perfectly" ... this implies 100% agreement).

Ok, we corrected it.

6. Debret et al. use the residual D14C to check for the solar influence and they write

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that Bond et al. (2001) did the same. This is incorrect. Bond et al. used ^{10}Be and the ^{14}C production rate to check for the solar influence. D^{14}C is influenced by the carbon cycle and the cycles in the residual D^{14}C record depend very much on the applied detrending method (especially for the longer cycles as e.g. the 2500 yr cycle).

You are right. However $\delta^{14}\text{C}$ and ^{14}C display same 2500-yr band. To clarify we changed and use ^{14}C production rate from Dr Paula Reimer. For the ^{10}Be of Bond et al, it's a composite series between two cores and start only around 3000 years that is an issue for recognizing solar forcing. Instead we used ^{10}Be published by Vonmoos et al, 2006 which is more continuous however the results are similar. For the 2500 years band, special care was taken not to create cyclicity with the detrending methods. The 2500 years cycle is well known in the solar activity (for example: Komitov et al, 2004).

Vonmoos, M., Beer, J., Muscheler, R., (2006) Large variations in Holocene solar activity - constraints from ^{10}Be in the GRIP ice core, *J. Geophys. Res.*, 111, A10105, doi:10.1029/2005JA011500

Komitov B. , Bonev B., Penev K. and Sello S. (2004). The Solar Activity during the Holocene: Amplitude Variations of the Quasi-century and Quasi-two-century Solar Cycles *Proceedings of the International Astronomical Union*, 2004: 705-706 Cambridge University Press, 2004 International Astronomical Union, doi:10.1017/S1743921304007380

7. The 1500 yr cycle is present in the residual D^{14}C during the early Holocene and in IRD during the late Holocene. What is the implication? Is there a solar 1500-yr cycle but it does not influence climate? Why is it present in the climate data when it is not present in ^{14}C ? Coincidence?

We do not have the answer. May be the link between forcing and climate, which require amplifications or resonances, is not permanent. Climate response could be hampered by internal mechanisms.

8. Details:page 680 line 22: wouldn't it be more accurate to say that "... climate records cannot exclusively be explained..."

Yes, we correct it.

9. Page 681 line 7: Why does solar forcing rule out any direct link with the ice-sheet oscillations? Solar forcing could influence ice-sheet oscillations.

May be, but we prefer ice calving and sea ice because IRD are linked to Iceberg and sea ice.

10. Page 681 line 23: Again, Bond et al. do not report a 1500-yr oscillation

Yes, we correct it.

11. Page 681 line 25: The calculation of the background noise spectrum is not well explained (at least for non-experts). It should be expanded or it needs a reference to where this method is discussed.

For all local wavelet spectra, Monte Carlo simulation was used to assess the statistical significance of peaks. Background noise for each signal was estimated and separated using singular spectrum analysis. Autoregressive modelling was then used for each noise time series to determine the AR (1) stochastic process against which the initial time series was to be tested. AR (1) background noise could be either white ($AR(1)=0$) or red noise ($AR(1)>0$). We added this in the text.

12. page 682 line 1: how does the 1000yr & 1500yr filter work. I guess it needs a certain bandwidth that is not explained in the text.

The bandwidth is 200 years for the Gaussian filters; we used e.g. 900-1100 years and 1400-1600 years respectively.

13. page 682 line 2: add that it is a correlation between filtered and raw data

Yes, we correct it.

14. page 682 line 3: "1000 yr filter not conclusive" during the last 5000 yr. To me it is very conclusive during the last 2000 years.

Yes, it seems but only for the last 1000 years and it's difficult to determine with only one cycle. Even true, this is secondary with respect to the aim of the paper on Holocene period.

15. page 692 line 16: "first part of the Holocene". I understand "first part" as the period during the early Holocene which seems to be in contradiction to the interpretation by Debret et al.

Yes, we correct it.

16. page 683 line 12: There seems to be a mix up of references. Emiliana Huxleyi & Jackson et al.

Yes, we correct it.

17. page 686 line 2: there seems to be a typo in the formula: $t-b/a \rightarrow (t-b)/a$

Yes, we correct it

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