Clim. Past Discuss., 8, C2198–C2204, 2012
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Climate of the Past Discussions

Interactive comment on "Multi-periodic climate dynamics: spectral analysis of long-term instrumental and proxy temperature records" *by* H.-J. Lüdecke et al.

H.-J. Lüdecke et al.

moluedecke@t-online.de

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Answers to the Referee#1 comments:

Abbreviations: Discussion paper (CPD), revised paper (CPR).

The minor points: p. 4495, line 8: Generally, the standard deviation (SD) is over the whole record length. Each individual record as an anomaly is divided by its SD (normalized record). Next, we generate the mean record. Caused by the averaging procedure, the mean has still a small deviation from SD = 1 and is again divided by SD resulting in M6.

p. 4495, lines 27-28: The Fourier analysis shows a line spectrum. The dynamics is described by the addition of the sine (cosine) functions corresponding to the individual spectral lines. Every sine (cosine) function is completely predictable. Then their sum is also completely predictable. (we think this is trivial. Maybe we misunderstood what the question is? Scafetta (2010a), (2012) and Loehle (2011) are speaking of "climate forecast" by harmonic oscillations. Schlesinger (1994) interprets the global harmonic period of 65-70 yr as intrinsic dynamics. He did not "forecast" but it seems for us plausible to carry forward the evaluated periodicities in the future. We cite some of these papers in CPR, p. 10, line 200-204.

p. 4498 lines 1 and 2: The detrended fluctuation analysis (DFA) is well established and represents the best approach for the description, evaluation and application of the autocorrelation (persistence) of time series. The main parameter of the DFA is the Hurst exponent α. Some DFA literature: (Bender, 2006), Bunde (2003a), Rybski (2009), Bunde (2003b), Vyushin (2004), Rybski (2006), Kantelhard (2001), Bogachev (2008), Lennartz (2009), Lennartz (2011) and references cited therein. In the CPD we cited only 3 DFA paper. Should we cite more in CPR?

p. 4498 lines 16-22: The strongest lines were chosen for the reconstruction (just because they give the strongest contribution to the climate dynamics). This is not exactly low pass filtering: one of the lines in the larger than 30 year periods is NOT chosen. Had strong lines with higher frequencies (periods smaller than 30 years) existed, then they would have been included. (Note: if we had included all lines, the reconstruction would have been trivially the measurements, precisely). There was NO low pass filtering on the data for the Fourier transform, which might have weakened the appearance of a warming by CO2.

p. 4499 lines 6-11: There is a good agreement of phase of the $\sim$250 yr sinusoid of SPA and RM6 (s. attached as Fig.1). Note that the SPA record ends in 1935 AD). In CPR, a corresponding remark is added.

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Discussion section: There are a number of scenarios known in which a system with energy input and dissipation can pass from oscillation to chaotic dynamics (Feigenbaum, Ruelle-Takens, Intermittency.. but also abrupt transitions like in the Lorenz model). The Feigenbaum scenario in which, when changing a "control parameter“, successively a series of subharmonics ("period-doubling“) appears, is most easily visually recognizable (e.g. in the spectra). Therefore, it is the most discussed scenario. We just happened to see the combination of line frequencies matching this. And then the wavelet diagram confirms the appearance of the subharmonics (starting notably from a 125 year period, while now the 1st subharmonic of 250 years is dominant). We speculated about the nature of the control parameter. We must keep in mind that the SPA spectrum shown is an average over time-varying spectra as visible in the wavelet diagram. We cannot name a candidate for further studying this kind of transition (we are discussing with a colleague who is just now trying to identify chaotic dynamics in climate systems, in view of the constraints in predictability). A suitable candidate would have a dynamics on a shorter time scale, so that a sufficient number of periods were recorded. Perhaps El Nino would be an example? Its recurrence varies. Thus we would suspect chaotic dynamics. As far as we know there is no understanding of the "causes“ for the El Nino oscillations. Thus we would think it is "intrinsic“ dynamics and such systems always have parameter ranges in which they are chaotic. We found a very similar wavelet diagram as for the SPA in the Taimyr tree-ring data (Ljungqvist 2010), which equally shows the period doubling.

Major point p. 4502, lines 3-7: Let us stress again, that there is no low pass filtering when Fourier-analysing the data. Thus we do not see that GHG effects could have been "filtered out“. If we draw a conclusion about anthropogenic effects, it is based on the distinction between periodic dynamics and "secular“ effects, (like a monotonic temperature increase due to GHGs). We show that a perfect reconstruction of the data is possible using ONLY the periodic dynamics, and that no secular effect is missing. If we included higher frequency lines in the reconstruction (which are also periodic dynamics and cannot originate from secular anthropogenic influence) it would have

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brought the reconstruction even closer to the measurement data. Now, we admit, that the plain conclusion "no anthropogenic warming“ can be questioned: 1) We have from the temperature measurements only one period of the 250 year cycle. This is not sufficient to prove "periodic dynamics“. We definitely find a 250 year cycle dominating the temperature dynamics in the SPA data. It continues with the right phase into the M6 250 yr cycle. But, admittedly, this is plausibility and no rated proof. 2) It has (rightly) been argued in the discussion that a secular change due to CO2 etc. could have been incorporated by the Fourier transform into the 250 year cosine function. Although we would estimate that, due to the historically short time span of anthropogenic CO2 emission, the amount of heating "masked“ in this way could only be small. We omit in CPR conclusions about anthropogenic warming.

Further suggestions: The manuscript of Mann et al. was known to us. However, as explained in paragraph 6. of our paper, the red noise hypothesis, which needs a Hurst exponent of about $\alpha = 1$ is not valid for M6. M6 has a Hurst exponent of 0.58. As Scafetta (2012b) points out, for Hurst exponents between 0.5 and 1 we have “persistent noise”, not ‘’red noise”. We welcome the suggestion of citing the studies of Scafetta (CPR, page 10, line 202).

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H.-J. Lüdecke, A. Hempelmann, C.O. Weiss

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Please also note the supplement to this comment:
http://www.clim-past-discuss.net/8/C2198/2012/cpd-8-C2198-2012-supplement.pdf

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Interactive comment on Clim. Past Discuss., 8, 4493, 2012.

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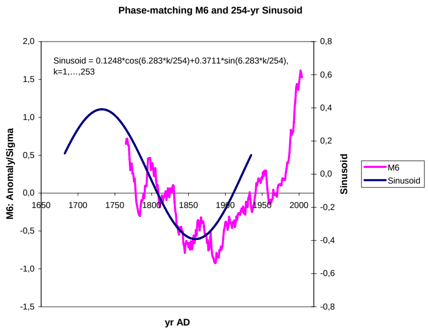

Fig. 1.

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