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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.

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We would like to answer the main remarks no. 1, 2. and 5. and the final remark of M. Mudelsee (in the following M).

Remark 1:

Apparently the commentator lacks knowledge of the DFA method, which today is well established and probably the best tool for the persistence analysis of time series. We recommend respectfully that M informs himself in (Bender, 2006), Bunde (2003), Rybski (2009), Bunde (2003), Vyushin (2004), Rybski (2006), Kantelhard (2001), Bogachev (2008), Lennartz (2009), Lennartz (2011) and references cited therein (we cut

the list of references for space reasons). The DFA removes automatically trends (in general one chooses a linear trend, but it is possibly to remove also polynomial trends) from the record and yields the correct Hurst exponent α. It is stressed that the removed trend can not be evaluated explicitly by the DFA. However, M recommends tools for trend removal, which are cited in his book. Unfortunately, removing trends for our study is the wrong approach. To demonstrate this we like to point M to an excellent article of (Bunde 2001). As an example, Bunde showed in Fig. 4 of his article a (synthetic) long-term temperature record without any trend. Nevertheless, a very strong trend is present. How that? Natural records without any external trends but with strong persistence inhibit "natural trends" ("intrinsic trends"), which, principally, are indistinguishable from external trends ("external" or "deterministic"trends causes from increasing CO2, UHI or other forcing). The tendency for natural trends increases with the Hurst-exponent of the time series! As a consequence, extracting a trend from a temperature record with the methods described in Chapter 4 of the book of Mudelsee is not helpful, because the extracted trend could be a natural trend – then it belongs to the record and must not be removed - or it could be indeed the sought after external trend. During the last 3 years Lennartz (2009) and (2011) evaluated a sophisticated method that yields the probability that an observed record is natural or not. Natural means that the record inhibits only natural trends, unnatural that it inhibits an external trend. We stress again that it is until now not possible with any method – including the Lennartz-method - to extract an external trend from a persistent time series. Recently, the method of Lennartz was applied for evaluating the percentage of worldwide temperature records being natural (Lüdecke 2011).

Remark 2:

The assessment of the DFT by the commentator seems somewhat odd. The DFT is compared with other, more elaborate methods in (Ghil, 2002). There, the kind of shortcomings of the DFT noted by M are not mentioned (One may keep in mind that FT is THE basis for all of (linear) physics! Would one want to put this in doubt?). The

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DFT is e.g. used in several papers that analyze temperature proxy data, for instance in (Yu, 2011), (Man 2011), and (BEST, 2011). Furthermore, our comparison of the DFT (stalagmite record) with the periodogram method showed good accordance. If two different methods yield the same results both methods seem to be safe.

Remark 3:

On the time limitation of the data and the implication on reliability of the 250 year periodicity see our reply to Bothe.

Remark 4:

We agree fully: the spectral width of the resonances is trivially given by the length of the time of the temperature record. The width is clearly visible in the spectra.

Remark 5:

With the DFA method no hypothesis is necessary for the background noise of a record because it is assessed by the Hurst exponent of the record. The DFA (detrended fluctuation method) yields the correct Hurst exponent α of the detrended record and reveals the nature of the background noise. In M6 we found α = 0.58 $\pm$ 0.2, which means that the noise of M6 is not "red" and not an AR(1) process. On the opposite, the stalagmite record has an $\alpha \approx 1$, which indeed indicates red noise.

Final remark:

The sources of all data are cited in our paper. All the records are accessible and can easily be downloaded from the internet. If M needs advice we will gladly help him if he sends us an E-mail. The only exception is the record of Paris, provided by météo France. The Paris record is not allowed to be given away, because météo France supplies this only for a fee. To our experience météo France will be willing to provide the data free of charge if used for scientific purposes.

References:

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BEST (2011): Decadal variations in the global atmospheric land temperatures, http://berkeleyearth.org/

Bunde (2001) Langzeitkorrelationen in der Natur: von Klima, Erbgut und Herzrhythmus, Physikalische Blätter 57 Nr. 5 (2001)

Bender (2006) Millennial climate variability: GCM-simulation and Greenland ice cores, Geophys. Res. Lett., 33, L04710, 2006

Bunde (2003) Power-law persistence in the atmosphere: analysis and applications, in "Nonextensive Entropy – Interdisciplinary Applications, edited by Gell-Mann and t: Tsallis, New York Oxford University Press (2003) and arxiv:physics/0208019 v2 27.May 2003

Rybski (2009) On the detection of trends in long-term correlated records, Physica A 388, p. 1687-1695 (2009)

Bunde (2003) Scaling in the atmosphere: on global laws of persistence and tests of climate models, Fractals, Vol. 11, p. 205-216 (2003)

Vyushin (2004) Volcanic forcing improves atmosphere-ocean coupled general circulation model scaling performance, Geophys. Res. Lett. 31, L10206 (2004)

Rybski (2006) Long-term persistence in climate and the detection problem, Geophys. Res. Lett. 33, L06718 (2006)

Kantelhard (2001)Detecting long-range correlations with detrended fluctuation analysis, Physica A 295, p. 441-454 (2001)

Bogachev (2008) On the occurrence of extreme events in long-term correlated and multifractal sets, Pure appl. geophys. 165, p. 1195-1207 (2008)

Lennartz (2009) Trend evaluation in records with long-term memory: application to global warming, Geophys. Res. Lett. Vol. 36, L16706 (2009)

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Lennartz (2011) Distribution of natural trends in long-term correlated records: A scaling approach, 10.1103/PhysRevE.84.021129 (2011)

Lüdecke (2011) How natural is the recent centennial warming: An analysis of 2249 surface temperature records, Int. J. Mod. Phys. C, Vol. 22, No. 10 (2011)

L. Yu (2011): Amplitudes, rates, periodicities and causes of temperature variations in the past 2485 years and future trends over the central-eastern Tibetanean Plateau, Chinese Science Bulletin, Vol. 56, No. 28-29, p. 2986-2994 (2011)

Man (2011b): Forced response of atmospheric oscillations during the last millenium simulated by a climate system model, Chinese Science Bulletin, Vol. 56, No. 28-29, p. 3042-3052 (2011)

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