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Earth System Dynamics
Discussions

Interactive comment on "Long-range memory in millennium-long ESM and AOGCM experiments" *by* L: Østvand et al.

Anonymous Referee #2

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The authors consider millenium temperatures from reconstructions and model simulations, and use DFA2 and wavelet technique to study the inherent long-term memory in the data. The results confirm and extend previous results obtained by Rybski et al in 2 articles, Lennartz and Bunde, Monetti et al, and Fraedrich and Blender. The article also discusses the origin of the long-term memory (ltm), concluding that ltm exists in the internal dynamics of the system. I think that this result is in strong contrast with the findings of Vjushin et al, who pointed out that particularly without volcanic forcing a reasonable ltm could not be achieved.

Altogether, I find the article well written and very valuable, in particular since it describes nicely and efficiently the reconstruction as well as the models analyzed here. I definitely can recommend publication of the article, but have several remarks the

authors may consider.

1. In finite records, the power law decay of C(t) cannot be observed, in particular when gamma is small. For a formula that describes C at finite record length N, the authors may consult Lennartz and Bunde, Phys.Rev. E, 2009. 2. The authors show power spectra without analyzing them. It would be nice to see the exponents beta obtained from the spectra. Less mathematically oriented climate scientists are aware of the power spectrum, but not of the more advanced DFA and wavelet techniques. It would certainly help them to see the superiority of the new techniques demonstrated in this article. 3. Usually, the exponent beta is only used for the power spectrum, fluctuation functions are characterized by the Hurst exponent alpha, related to beta by alpha=(1+beta)/2. The use of F(t) for both kinds of fluctuation functions is not so smart here, since in DFA2, F(t) describes a mean standard deviation, while for the wavelet it is a variance. There is no reason to use the more complicated Mexican hat wavelet. The simpler Hair wavelets (see e.g. Koscielny-Bunde et al, Phys. Rev. Lett. 1998) can be easier described just by combinations of local averages and thus is also better suited to a mathematically less ambigous readership; it does the same job. 4. As has been pointed out by Kantelhardt et al in J. Geophys. Res. (2006), an initial increase of the fluctuation function by an exponent alpha =3/2 (equivalent to beta=2 that the authors see in HadCM3) is due to an AR1 process that is sumperimpoed to the ltm. The fact that HadCM3 shows this behavior at annual time scales is certainly a severe drawback of the model. 5. SST have been studied by Monetti et al, Physica A 2003. The result that alpha is around 0.8 agrees nicely with the result of the authors. The presented model result for the air temperature is very unusual since local temperatures usually have a lower persistence than SST, around alpha=0.65 (see Koscielny-Bunde et al, PRL (1998) and Eichner et al, cited in the present article).

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