

## ***Interactive comment on “Reduced Carbon Cycle Resilience across the Palaeocene-Eocene Thermal Maximum” by David I. Armstrong McKay and Timothy M. Lenton***

**V. N. Livina (Referee)**

vlivina@gmail.com

Received and published: 9 July 2018

The paper by McKay and Lenton "Reduced carbon cycle resilience across the Paleocene-Eocene thermal maximum" investigates paleo data for early warning signals prior to known paleo events and discusses the system resilience in geochemical context. The paper is well-written, applies previously developed and tested techniques, and can be published after a revision.

I suggest the following modifications.

The authors could add definitions and references to the ideas of tipping points and

C1

resilience.

In Figure 1, in the upper panel the time series have local minima at 55Ma, whereas in the enlarged bottom panel these minima are located at 56Ma. Why?

The paper does not include the reference [Held and Kleinen, GRL 2004], which was the first to apply the lag-1 autocorrelation as an early warning indicator of a climatic bifurcation. The authors should cite it in page 2, line 25; in page 4, line 6, and discuss the H&K contribution as pioneers of this technique in climatology.

Variance does not necessarily increase prior to a bifurcation, see the counter-example in [Livina et al, Physica A 2012]. Changes in skewness and kurtosis are often consequences of the asymmetric effects due to the appearing or disappearing potential wells. This can be discussed in more detail in page 2.

It is not clear to me why the authors separate the cases of rolling windows for indicators and binned indicators. As I understand it, the binned indicator is a particular case of a rolling window, when the shift of the window is equal to the size of the window. Why do authors stress that, for instance, DFA is a binned indicator? It can be estimated in rolling windows just the same. Accordingly, I do not understand the comment in brackets in page 5, line 21, which separates rolling window and "metric-based".

When using several sizes of windows for an indicator (the figures in the supplement), the authors could do this not just for three sizes but for a range of windows, with estimation of uncertainty in the indicator curve - see the example of such indicator curves in [Livina et al, JCSHM 2013].

In page 4, line 6, "the methodology was first outlined in [Held and Kleinen, GRL 2004], then used in [Livina and Lenton, GRL 2007]", etc.

In page 4, lines 17-18: while trends may be not the focus of the analysis, their removal reduces the value of the lag-1 autocorrelation, and this should be kept in mind in analysing the indicators.

C2

For the DFA reference in page 5, line 14, please use instead of [Lenton et al 2012b] the original DFA reference [Peng et al, PRE 1994].

In page 1, line 17, what do the authors mean by "differing"?

In page 8, lines 2-3, to avoid line break between 2 and My, use LaTeX command ~

Valerie Livina

---

Interactive comment on Clim. Past Discuss., <https://doi.org/10.5194/cp-2018-57>, 2018.