Interactive comment on
"Multi-scale event synchronization analysis for unraveling climate processes: A wavelet-based approach" by

A. Agarwal et al.

Reviewer #1

Reply to the Review Comments

We would like to thank the reviewers for reviewing our manuscript, and for their constructive comments and useful suggestions for further improvement. We have revised our manuscript, taking into consideration all the review comments. During the revision, we have also made other changes, facilitated by a fresh reading. Here, we respond to the specific review comments. In what follows, Page numbers and Line Numbers correspond to those in the clean version.

General comments:

Reviewer 1:
The manuscript proposes a new method for the detection of synchronization between event time series based on the discrete wavelet transform. The approach is straightforward being based on the already established event synchronization method but applied on a scale-by-scale basis to wavelet components instead of the original signal. The idea is sound, however, I think that the manuscript needs to be improved, particularly in what concerns the presentation and better explanation of the actual results. In the present form the performance of the method is difficult to assess and thus the claims of the manuscript are not well supported.
Author's Response:
We thank the reviewer for the constructive summary of our manuscript and also for his/her critical and supportive suggestions.

Reviewer 1:
One of my main concerns is the type of synthetic test cases performed since the connection between the smooth and regular signals used for illustrating the method and actual event time series is not clear to me. Is the approach identifying time series correlation or synchronization between events? I think that showing examples of actual event time series (instead of only the wavelet power spectrum) could be helpful. In my opinion, the procedure should be shown in more detail at least for one case study: the time series, the corresponding discrete wavelet decomposition, and the results of the quantity Q.
Author's Response:
First of all, we apologize for not explaining clearly enough the procedure of constructing the considered case studies.
For testing the applicability of the proposed MSES method, we intend to use event series with events occurring at different scales. For this purpose, we generated timeseries using sine functions, which are, at a first stage, indeed smooth and regular (All the mathematical details are presented in Table 1). However, from those generated timeseries, we created event series by thresholding, resulting in events that occur at the desired timescales. The proposed MSES approach was thus applied on the obtained event series, not on smooth and regular time series.

In the revised version we shown (Fig. 3) the generated time series (signal 1&2), decomposed time series, corresponding event series (after applying threshold) and event synchronization (Q) value at multiscale.

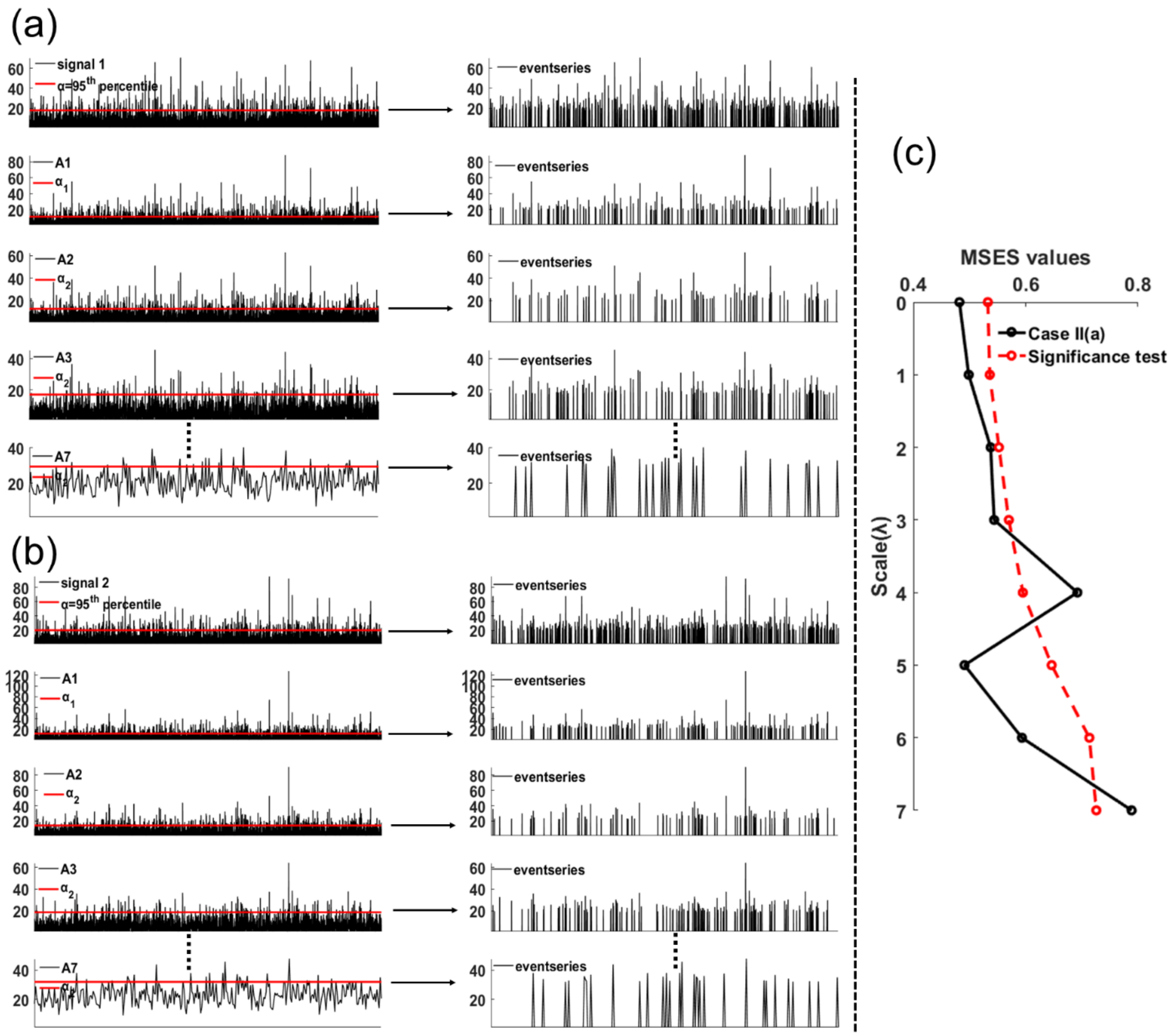

Figure 3 Multiscale event synchronization (MSES) stepwise methodology. (a) Signal 1 and its decomposed component along with corresponding event series after applying the (95th percentile) threshold. (b) Same for signal 2. (c) Event synchronization values corresponding to each scale.

Specific comments

Figure 1: I understand the idea of illustrating the whole proposed procedure using Figure 1, but the figure is only very briefly mentioned in the introduction and not even the caption gives much further detail, for example, a short description of a) and b) panels is not given. The quality of the figure itself is also poor.

Author's Response: Figure 1 is replaced and the procedure is explained in Figure 3.

Eq. (4): I think that the exponent of a_o in eq. (4) should be lambda (and not 2).

Author's Response: Absolutely, we have corrected the same (eq.4) in the revised version.

Figure 2: Is this figure (from another source, included in the caption) really needed? The quality is very bad (particularly the left side) and doesn't really add much new information. Maybe merge Figures 1 and 2??

Author's Response: We thank the reviewer for his/her comments. The purpose of this figure was to help the readers to understand the wavelet decomposition and the relationship between approximate and detailed component but in the revised version this has been removed.
However, another figure (Fig. 2) showing clearly all the details is introduced (see below).

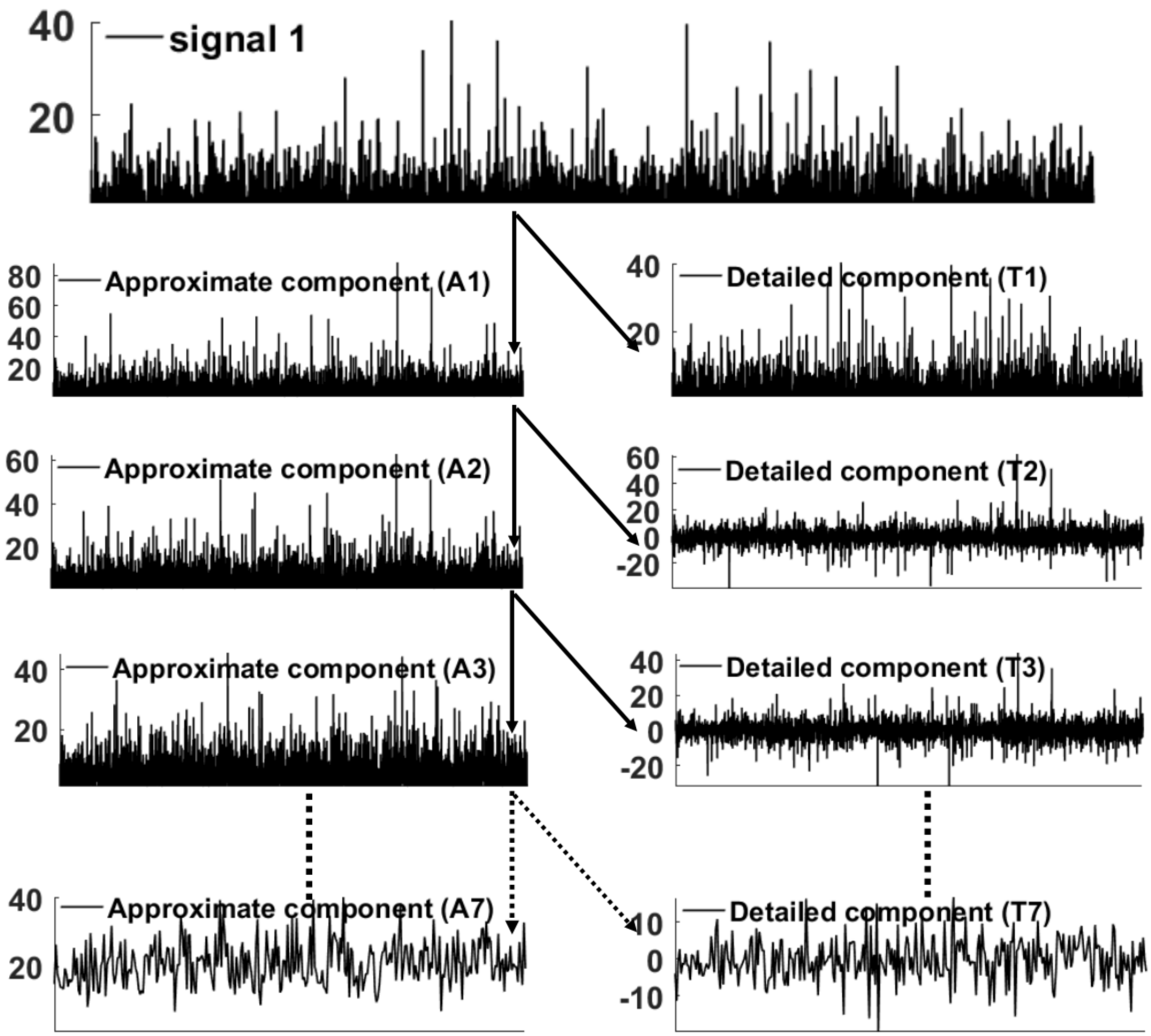

Figure 1 Scheme of Multi-Scale decomposition of signal using discrete wavelet transformation (DWT). The relationship between signal, approximate component and detailed component is shown.

Page 5, line 10: Eq.(11) is redundant.

Author's Response: We thank the reviewer for his comments. In the revised version we have removed the redundant eq. 11.

Figure 3: the wavelet power spectrum is from a continuous wavelet? For consistency shouldn't be shown instead of the spectrum based on the discrete wavelet transform? The connection between the periods in Fig 3 and the scale lambda in Figs 5 to 10 should be indicated.

Author's Response: We again apologize to the reviewer for the confusion created. The wavelet power spectrum for each signal was plotted with the idea of giving a clear understanding of the features present in the synthetic dataset. CWT is not used in the methodology but only for visualization purpose.

Since the DWT based spectrum is plotted at dyadic scales it may not be as clear as the CWT based plot. Therefore we chose to show the CWT to highlight the feature present in the synthetic cases used. The connection between the scale and lambda is included in the new version of the manuscript which is $period = 2^{scale}$.