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Comment on wcd-2022-51

Anonymous Referee #3

Referee comment on "Identifying quasi-periodic variability using multivariate empirical mode decomposition: a case of the tropical Pacific" by Lina Boljka et al., Weather Clim. Dynam. Discuss., <https://doi.org/10.5194/wcd-2022-51-RC3>, 2022

The manuscript "Identifying quasi-periodic variability using multivariate empirical mode decomposition: a case of the tropical Pacific" by Boljka et al. starts out with introducing a new statistical method to define modes of variability in the tropical Pacific that are related to ENSO. The method is non-linear and non-stationary and can therefore lead to potentially very different results to traditional linear and stationary methods. The manuscript then further gets into developing a new conceptual model for ENSO based on previous models and further gets into presenting a prediction model of ENSO based on the modes from the new statistical method. The topic addressed by this manuscript is interesting and potentially worth publishing. However, the manuscript is very hard to follow and many aspects are not well explained. It is difficult to see what the outcome of this work is and how the new method can help us to understand ENSO, rather than just being a fancy 'trick'. I cannot recommend to published the current version of this manuscript and would recommend a major revisions before it may get published. Detailed comments below.

major points

(1) The new method: The authors do try to explain the method, but unfortunately it fails to be clear enough. This would need to be improved. It would help greatly if the authors could more clearly explain what the elements of an MEMD mode are. Ideally in reference to something that most readers now (e.g. EOF-modes). An EOF-mode, for instance, has an eigenvector (pattern), eigenvalue (amplitude) and principle component (time series), they are ordered by explained variance, and are orthogonal to each other both in terms of eigenvectors and PCs. What are the elements of an MEMD mode?

Overall it appears that the method is a fancy trick (that is hard to understand) to time filter the data. What is the value? What do we learn from this method that we did not

already know?

Often it is easy to illustrate this with an idealised constructed example that has strong similarity to the real world, but at the same time can be controlled, so that the 'truth' is known.

(2) Red noise test: It is not clear how this is done. Fig. B1 shows one blue dot above the 95% line, but is unclear what this blue dot is and how this would relate to the two MEMD modes IMF12 IMF13. How are the two modes selected and what does it have to do with Fig. B1?

(3) Data from 1870 for thermocline depth and winds: It seems unlikely that much is gained in this analysis by using data going back way before we have any confidence in the observed data. Why is this done? Why does this analysis require such a long period of time using probably very poor data?

(4) Section 3.2 "Conceptual oscillator models of ENSO": This section is largely unclear and much of it appears to be unrelated to the topic. This needs substantial rethinking. HOW does it relate to the MEMD?

I recommend to strongly reduce this section.

(5) Section 4.2 "Prediction": This section is hard to follow. It is not easy to understand what is predicted here. It seems to be a highly filtered part of the NINO3 SST? Not clear what is learned from it. Highly filtered SST is more predictable?

(6) last two sections: They seem to not clearly fit to the initial outline of this study, which is to introduce the new method. The connection is not that clear and it seems to drift into other aspects.

Other points (in order as they appear in the text):

line 101 "... ENSO teleconnections to the North Atlantic ...": The authors seem to indicate that they include SLP into the MEMD mode analysis to include teleconnections to the North Atlantic. This seems strange and is not further explored. It would also miss much more obvious teleconnections to many other regions on the globe. I would suggest to delete any

reference to the NAO.

line 112 "This gives greater weight to SST data ...": Unclear! Later the authors state that the PC of the EOF-modes are used. So the data horizontal grid resolution should not matter. This needs clarification. Further, why would the SST be weighted higher? The later discussion focus on the ENSO dynamics including winds and thermocline. So, it should be equally weighted?

line 116 "... whereas MSLP (not shown) is computed in the North Atlantic sector (80°W - 30°E, 25°N - 70°N)": Unclear why this is included. It seems unrelated to this work. This should be removed.

line 135 "... methods methods ...": -> "... methods ..."

lines 139-145; description of the EMD method: Can this be visualised? What does the time series of the first mode look like? A figure may help.

Does this define a mode order? The first mode is the highest frequency and the last the lowest?

lines 139 "(i) first we identify local minima and maxima of the timeseries ... "; description of the EMD method: I am already lost at step one. What time series? The data used are several fields, which have many time series. How does this work for MEMD modes?

line 232 "IMF12 and IMF13": What does "12" and "13" mean? How have these two been selected? Is it a coincident that they follow in order?

The authors find two modes: Does this mean two independent modes? For instance, a periodogram may have 2-5 points in a series above the 95% confidence limit. Each point is an independent estimate of harmonic functions, but it does not mean that there are 2-5 "modes". So how should we interpret that there are two modes? Does it mean the time scales are broader?

lines 234-242 discussion of modes IMF12 and IMF13: This description of the time scale behaviour of the modes is not clear. Does it make sense to show the power spectrum of these two modes in comparison to the NINO3.4 SST power spectrum? I assume they both would have strong peaks at the peak in NINO3.4 SST but have much less variance at all other frequencies?

line 240 "... (e.g., in Fig. 3b), ...": It is unclear how Fig. 3b relates to what is said in this sentence. Wrong Figure reference?

Analysis of phase: Why do the authors use 12 phases? A cycle is often illustrated by 4 phases (0,90,180,270 degrees). 12 seem to be too much. It would be better to use 0-360 degrees.

In Fig.3 and others: How is phase zero chosen? Often phase zero refers to the peak of the reference time series, but here it seems SST is the reference and it is negative at phase 0.

line 288 "... phase of the PC1 (of IMF13) timeseries ...": Unclear what a PC1 in this context means. PC1 is part of the EOF-modes?

Fig. 3 legend: The legend is not clear. There are several black lines and grey lines. Dashed or dotted cannot be seen in the legend.

lines 491-492 "This suggests an issue ..., since the recharge-discharge mechanism, ... is correctly represented": Logic here is unclear. Where is the issue if it is correct?