Our initial response:

Earthquake sequencing: Chimera states with Kuramoto model dynamics on directed graphs

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Interactive comment on "Earthquake sequencing: Chimera states with Kuramoto model dynamics on directed graphs" by K. Vasudevan et al. Anonymous Referee #1 Received and published: 20 March 2015 The paper entitled "Earthquake sequencing: Chimera states with Kuramoto model dynamics on directed graphs" by K. Vasudevan, M. Cavers, and A. Ware is to implement the Kuramoto model on the non-linear dynamics on a directed graph of a sequence of earthquakes. Directed graphs are derived from global seismicity data and they specified the conditions under which chimera states could occur. The research question is relative interesting and the proposed model sounds reasonable. The physical background of the paper is based on the data related to earthquakes and to investigate chimera states.

(1) But what can we learn from chimera states?

A postulation for the existence of evolving chimera states in data from earthquake catalogues could pave way to

(1) understanding the evolving alterations in stress-field fluctuation in fault-zones frequented by earthquakes; (2) considering steps to quantify partially or fully the ratio of the number of synchronized oscillators to the number of asynchronized oscillators; (3) establishing the parameter conditions under which the Kuramoto model could yield chimera states; and (4) improving the mathematical model to work towards generating global chimera-state maps similar to global seismicity maps. The hope is that confirmation of chimera states in earthquake sequencing would signal their use in earthquake forecasting studies.

(2) Through out the paper, the authors used 7000 transition steps size. The integrating steps are not enough for large number of nodes (>5000). For example, the appearance of Fig. 4(a), 6(a) and 7(a) look like the transition instead of stationary states. Also in C77 the paper, there are two terms related to the original dynamics, consisting of the time delay and the phase lag. But the authors did not mention the values of these two terms.

The remark by the referee on the number of time steps used in this preliminary study is valid. We are currently doing 80,000 to 100,000 times steps. We would like to incorporate the results of these steps in our revised paper that is in preparation now.

The referee is correct in pointing out the use of the two terms namely the time-delay and the phase lag. In this paper, we restricted ourselves to the use of phase lag. We used a phase lag value of (pi/2) - 0.10. In other words, we kept this constant in all of our simulations. In our future studies, we hope to study both the time-delay and phase-lag and their influence on presently-made observations.

(3) In the following, I have some smaller points: Line 16 on Page 2: What do you mean by "the Kuramoto model yields synchronization"?

It is the phase-locking of the oscillators that we attribute to synchronization.

(4) Line 2 on Page 5: It would be better to change the word "propose" in " we propose a simple non-linear mathematical model, the Kuramoto model..." to the word "modify". As in the paper, the authors modified the Kuramoto model for the sequencing of global earthquake data.

We'll incorporate this change in the revised version of the manuscript.

(5) Line 7 on Page 6: The authors focused on a stable solution. But in the following references, for example, Abrams and Strogatz, 2004, chimera states are not stable. That means nodes belong to the synchronized group are not fixed.

It is an interesting comment. We are looking at the synchronized and asynchronized groups for the last few time steps of the Kuramoto model to establish if they contain the same nodes (or oscillators) as stationary solutions regardless of the initial conditions (Zhu, Y., Zheng, Z., and Yang, J.: Chimera states on complex networks, Phys. Rev. E, 89, 022914, 2014). We'll be commenting on this in the revised version of the manuscript.

(6) Line 13 on Page 6: The authors claimed that "We target our present study to defining a pulse-coupled or threshold-coupled oscillator model that would accommodate the existence of chimera states." But through out the paper, the authors did not mention the pulse-coupled or threshold-coupled oscillator model.

The referee is correct in pointing out this. Although our intention is to define a pulse-coupled or threshold-coupled oscillator model and carry out numerical simulations, the present study is limited to the Kuramoto model with the phase-lag term. We'll point this out clearly in our revised manuscript.

(7) On Page 6: It would be good to introduce the literature, for example the authors' previous work on "the Kuramoto model with synthetic networks..", in the section of "Introduction". Line 4 on Page 7: α indicates the phase lag. As claimed in other papers (e.g. Abrams et al. 2004 PRL or 2008 PRL), its value is crucial to determine the existence of chimera states. But the authors did not mention the selection of the value of α. Line 1 on Page 8: the time delay is very crucial to determine the existence of chimera states. But the authors did not mention its selection.

We have responded to this question earlier. We'll rectify this omission in the revised manuscript.

(8) Line 9 on Page 13: a mathematical problem. Suppose that substituting Eq. (6) into Eq. C78 (5), and then replace its coupling term by the real part of the order parameter, one can get the coupling term as Kr $\sin(\psi - \theta)/N$ instead of the last term of Eq. (8).

We have corrected this mistake in the revised manuscript.

(9) Line 23 on Page 15: The authors mentioned the time-delay term of Eq. (1) and listed some references. But none of these references considered the term of time delay.

We thank the referee in pointing this mistake to us and we stand corrected in the revised manuscript.

(10) Line 12 on Page 20: why is it the chaotic dynamics?

This was on oversight. We stand corrected.

(11) In Fig. 1, why the value of the color bar could be less than 0 (proportional to its occurring frequency)?
As mentioned in the figure caption, we use the log(log) scale of the counts in each cell. That should explain the color bar. The purpose is to accentuate the earthquake zones and their juxtapositions to plate boundaries in many instances.

(12) From Figs. 4 - 8, are the nodes' index of panel (a) and that of panel (b or c) the same?
No; While (b) and (c) are sorted, (a) is not. We'll include the regenerated figures in the revised manuscript.