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Earth System Dynamics Discussions

Interactive comment on "Detecting hotspots of atmosphere-vegetation interaction via slowing down – Part 1: A stochastic approach" *by* S. Bathiany et al.

Anonymous Referee #2

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This is a very interesting contribution and a follow up in the early-warning literature. In most cases it is difficult to know where a transition occurs- especially in high dimensional systems. In these cases early-warnings may not at all be possible to have any value. The authors here show that even if this is the case, EWS theory can be used to identify potential parts of the system (hotspots) which may be driving the transition or in which the transition actually occurs. They also offer a protocoll for identifying them and in a later work they demostrate the application of their approach.

General comments My major concern with the present paper is the high complexity of the method. In parts it is difficult to follow, and it would definitely benefit the paper≈õ

readability. I would propose to have an appendix of a clear step by step example. This would improve the understanding greatly. what would happen if elements are not removed?

Given this, I am wondering on how better the method performs in case 3 when compared to measuring signals directly from the different elements. It seems that as different elements have different stability properties, and since the time series are available one could compare the signals directly without going the proposed complicated protocoll. In the same way, isnt the mean of each element already telling something? Is there not perhaps more information in the combination of mean and ews derived directly from the elements? The authors show that it the signal becomes weak in case 2 but it is the same in all elements. I may be missing something but it would add to their argument if one compares signals directly to infer the different hotspots than compared to their method.

The results are presented for two cases of noise. Even if the difference in the noise source is an important issue, how possible it is not pertinent to the specific model? In practice it is difficult to discriminate additive vs multiplicative, usually both are present. In that case what would be the best approach? And how the method will perform? In line with my previous observation, to simplify matters, wouldnt be better to present on method? And move the other in the appendix? Or even better, show the performance of the method when both sources of noise are present?

Specific comments: p646, line 7: spatial EWS are one way of overcoming issues with estimating EWS in timeseries. not necessarily for alleviating the issue of inadequate sampling or incorrect (with relationship to the right timescales)

p 648 l 20: what is the meaning of the timescale tau?

p650 l20 I think it would interesting to show the P value as B is changing. In that way one can see that the P value of grid cell 2 slowly changes and then jumps to a lower value after the collapse of grid cell 1. Now in figure 2 parameter B represents the distance to the transition for element 1 and not of the whole system. Showing the actual Pi values for both elements would have made clearer the loss of stability in the system and thus the relationship to the EWS.

p651 and figure 2: I think you see the signal for both elements one more than another as in one case the system is going close to the bifurcation itself, while in gridcell 2 only partly and then it jumps to over the transition. I m not sure that the increase in variance wouldnt be seen only with the additive noise when there is no feedback. It would practically be invisible but theoretically the system would be approaching the bifurcation so the EWS should change. Perhaps concentrate on one source of noise (multipicative that you suggest that has more sense, or combine both) and makes the paper more simple?

p651 l25: It should be clearer written why the elements are not bistable anymore. I guess the authors mean that would the system not be connected, the individual elements would not be able to shift under the current parameterization?

p652 Why does the signal become less strong?

why not symmetric the effect of the impacts of one element to another table 2? wouldnt that be more realistic for this model?

p655 the number of parts is given by N/nmax. in the example N=25 and nmax=3. Should not that be 6? This part is a bit unclear? What is an area? In the algorithm it is supposed the small number of Np to 2, but in the table there are areas with only Np=1 (like 13, 18, 23).

p656: part D: when an element is thrown out of the analysis, the EOF is calculated in the other parts but without the element that was eliminated?

p 656 l 19 How important is the elimination of elements for the results? If eliminating elements as the authors suggest emphasize the contribution of the hotspots to their identification, isnt this creating bias to the results? why are estimates of all elements

present in figure 7 if elements are eliminated?

p657: why is the covariance matrix better to use then the correlation for the the multiplicative case? is it perhaps so only for this model that multiplicative noise has higher sensitivity to the model outcome? wouldn t be better to estimate EOF on both additive noise as well?

p658: would that mean that one would need at least 10000 points for the method to work?

p658 l22: Which are the different conditions?

in all figures with transitions: does the elements in all systems shift at the same time? These are equilibrium values plotted and it is interesting to see if in the real timeseries there is a lag. Perhaps it should be made clear in the figure captions.

Technical corrections p650 l2: units of sd of noise difficult to understand the meaning of k (in units?)

fig 3 axis x labels missing. note that all elements have the same measured indicators

fig 10: should better be occurence than frequency?

Interactive comment on Earth Syst. Dynam. Discuss., 3, 643, 2012.