Review of Lima et al. (2017) in ESD by Shaun Harrigan

A.) General Comments

Lima et al. (2017) presents a methodological framework, based on self-organising maps (SOM) and composite analysis, for identifying the rainfall and large-scale climatic patterns linked to floods using the Upper Paraná River Basin (UPRB) in Brazil over the 1980-2013 period as a case study. Four primary flood-generating rainfall clusters were identified from the SOM analysis along with large-scale climate (moisture, wind and sea surface temperature etc.) conditions during observed flood events, for each of the four clusters. This paper uncovered interesting new insights into the flood hydroclimatology in UPRB, beyond the simplistic 'El Niño is responsible for all floods' hypothesis, with potential for this new hydroclimatic knowledge to be used to improve flood frequency analysis and flood forecasting. There are however a number of places in which I think this manuscript could be improved to best get across key messages as highlighted in my specific comments in section B. Overall, the layout of the manuscript, in my opinion, does not do the work justice. I've made more specific points below, but in several places some methods are mixed in with results and there is no distinct discussion section. There are many different steps within the framework but they all rely heavily on the initial SOM analysis, I outline several methodological points of clarification for the authors. The overall presentation of the paper would be greatly improved with an increased level of copy-editing both in-terms of language and figures. I support publication of this paper in the ESD special issue, in principle, and hope the authors can spend the time to tighten and clarify their approach as it would make a valuable contribution to the hydroclimatogical literature.

B.) Specific Comments

1. Glad to see Hirschboeck (1988) being cited as shows the field of hydrolclimatology has some history, although it is only relatively recently that the benefit of the hydroclimatic perspective is being fully appreciated – this paper is therefore a welcome addition to the growing literature on hydroclimatology. As general point of interest (not required to include), the first definition of hydroclimatology I found was by Langbein (1967).

2. You mention in the abstract (Pg1; L6-9) that a Eulerian-Lagrangian model of ocean-atmosphere circulation would ideally be needed…", "However, some progress may be possible through empirical data analysis.". I agree with you here but this point needs to be raised in the introduction and expanded. What is the benefit of the empirical analysis, what progress can be made, what is the justification of this approach over others/is it complementary to other approaches?

3. Along the lines of the above point, you base a lot of the results on the Self-Organizing Maps (SOM) analysis. I have no issue with the use of SOMs, and commend the authors for a rigorous application of the method, however there is little justification of why this method was chosen over others? What particular advantages does SOMs provide in comparison to other more widely used classical methods of classification and clustering (e.g. PCA, K-means clustering, etc.)?

4. Pg4; L21: To avoid confusion for the international audience I would recommend referring to the flood season as the 'wet season' too rather than just 'warm season' throughout the manuscript. Also, is there an approximate % of total floods that occur in Nov-March (i.e., > 60% or > 95%) rather than just stating "most"?

5. Pg4; L22-27: Peak-Over-Threshold (or partial duration series) – The extraction of a POT series from daily flow can be challenging, especially for more groundwater influenced catchments

with longer memory, hence the need for your independence/declustering criteria. Some literature to support your decision of 15 days could be Mallakpour and Villarini (2015b) or Svensson et al. (2005). On average you have extracted about a POT3 series (i.e. on average ~3 events per year [98 peaks over 34 year record] or POT2.88 to be more precise). However, can you give a range across the 33 basins if there are large deviations from the 98 event average (i.e. I would expect fewer independent peaks to be extracted from more groundwater catchments, and more from flashier headwater catchments) using a fixed threshold as used here.

6. Pg4; last para: What is the grid resolution of the rainfall dataset?

7. Pg5; L9: Is it only climate/SST datasets that are interpolated to 2.5 deg grids, or is rainfall also interpolated? Why is such a coarse resolution used given ERA-Interim is at 0.75 deg resolution?

8. Pg8; L3-13: This is methods description and should be moved to previous methods section, rather in the results section.

9. Pg8; L3-4: I'm not an expert in SOMs so forgive my ignorance, however, your decision to decide on K = 4 clusters appears arbitrary and given it defines everything thereafter (e.g. text from the Abstract: "classify […] UPRB into four categories" and "classify floods into four types".). There needs to be some physical basis/justification to guide this decision.

10. Pg8; L30-31: By concluding cluster 4 reflects average rainfall conditions during the rainy season, you're essentially implying that the largest basin(s) in UPRB flood under average rainfall conditions (i.e. Figure 9 Neuron 4 panel). An alternative explanation could be that the larger basin reports a flood only when rainfall conditions are generally 'wet'/'moderately wet' for long periods of time (perhaps with wet antecedent conditions much longer than 5 days) and over the entire basin, rather than from more localised rainfall anomalies as is the case in clusters 1-3. This is also reflected in the fact the transition probability of Neuron 4 to Neuron 4 is highest (0.843 in Table 1).

11. Understanding rainfall/flood clusters: Are the 5138 days of rainfall data as used to identify the four rainfall clusters (i.e. from Pg7; L27-28) divided evenly (i.e. ~1285 days contributing to each cluster)? Following this, is the composite analysis (Pg9; L8-11) conducted only on the sub-selection of those rainfall days within each cluster that also had a reported flood event across the 33 river basins over the 1980-2013 period? If this is so, how many days within each cluster contribute to the composite analysis?

    I'm getting slightly confused here as you state that all 5138 rainfall days are used as input to SOM (Pg7; L27-28) then mention on Pg14; L20-21 that SOM was employed to find dynamics of "the rainfall field over the basin in the days that preceded the major flood events". Can you clarify this step for me please?

12. Pg10; L20: Need to be more specific when discussing 'El Niño region' (i.e. Niño 3, 3.4, or 4?) or make clear it's the broader area you are talking about – some people get very picky when it comes to ENSO definitions!

13. Pg11; L8: Should neuron 1 feature in sequence of neuron transitions?

14. Pg11; L20-21: The point about large floods being generated under non-El Niño conditions is an important one that should be discussed more in the context of the wider international

literature (You introduce such papers that do state El Niño-flood links in UPRB on Pg4; L11-13 but don't discuss your results again in this wider context). It is often assumed, wrongly, that majority/all flooding in South America is due to El Niño, this work suggests in UPRB things are more complex and uncertainties exist (also see Emerton et al., (2017)).

15. Pg15; L5-6: Could you make a tentative conclusion that about 55% of floods (i.e. 35% in neuron 1 + 20% in neuron 3) are linked to El Niño-like SST patterns? I also acknowledge that El Niño events have more strict definitions regarding strength and persistence of positive SST anomalies in a fixed region of the Pacific.

16. Following the above point, the SST pattern in neuron 4 (Fig. 8) is similar to La Niña-like conditions with negative SST anomalies, so could the 11% of floods under neuron 4 be linked with this large-scale phenomenon, even tentatively? If further analysis suggests so, then it is interesting to conclude that floods in UPRB can occur under both El Niño and La Niña conditions.

17. Layout of paper: It is my opinion that the Impact of the paper would be greater if the layout was slightly modified – there is currently no distinct discussion section and some methods descriptions are mixed in with the results section (e.g. Pg8; L3-13). Renaming Section 4 to 'Results and Discussion' (or having a dedicated 'Discussion' section) and move some of the discussion from Section 5 (currently 'Summary and Conclusions') to Section 4, and rename Section 5 to 'Conclusions' would be my suggestion.

18. Comment on Figures: The foundation of this paper (and indeed the SOM method) is on visual display of results on maps. Figures 3-8 relay on the 'rainbow' colour scheme that makes distinguishing patterns difficult – a divergent colour scheme that had a neutral (or while) colour for zero values with diverging colours for positive and negative anomalies would be much more effective. I do note the authors include the zero contour line, but this is still misleading in places. The "end the rainbow" calls are well known and with good scientific basis (Light and Bartlein (2004) and this 2014 post by Ed Hawkins et al. https://www.climate-lab-book.ac.uk/2014/end-of-the-rainbow/). I can only make this a suggestion for improvement but it's ultimately up to the authors/journal as many papers/journals are still using this colour scheme.

19. Further refinement of figure axes and more descriptive captions would be beneficial: For example, what are the units (if any) in Figure 2; adding "t-5, t-4, … t" to the y-axis in Figure 3 would be more visually impactful.

20. Figure 15 could be combined within Figure 1.

C.) Technical Corrections

Mostly well written but would benefit from a final proof read to tidy-up grammar – (i.e. abstract and summary and conclusions, in particular, tense in Section 3 should be in past tense).

Some things to help cleaning up:

21. Accent on 'Paraná' is not used consistently throughout
22. In-text references to be in correct format
23. Pg 2; L29: change 'basis' to 'basin'

24. Pg2; L34: It is a huge claim that there are no studies whatsoever on the broad topic of flood hydroclimatology in South America. It would be more appropriate to state something like “However, there is a lack of knowledge on the flood hydroclimatology of South America.”.
25. P3; L28: Change ‘Dataset’ to ‘Datasets’
26. Pg4; L30: Acronyms not defined
27. Pg5; L28: Change ‘will adopt’ to ‘applied’
28. Reference for Merz et al., (2014) is for discussion paper and not final published

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