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Discussions

Interactive comment on "Complex networks for streamflow dynamics" *by* B. Sivakumar and F. M. Woldemeskel

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Response to Referee Comment – S. Scarsoglio (RC C2857):

We thank S. Scarsoglio for her very positive and constructive comments on our work as well as for her useful suggestions to further improve our manuscript. We agree with all her comments and suggested improvements. We will incorporate the comments and suggestions during the revision of our manuscript, including the application of the degree centrality method (in addition to clustering coefficient we used earlier) to analyze the streamflow data. Our responses to the individual comments are as follows.

Referee Comment: The paper considers a network-based approach to study the streamflow dynamics by using monthly data from about 600 US stations over a pe-

riod of 52 years. The manuscript is clear in its objectives, it is also very well organized and contextualized within the state of the art and the current knowledge gaps. Results are deeply analyzed and their possible impact in addressing open problems in hydrology and water resources is evaluated as well. The paper definitely deserves attention for a possible publication in HESS.

Author Response: We thank the reviewer for her very positive and constructive comments on our manuscript.

Referee Comment: I understand that the main focus is on the local clustering coefficient and I also understand this work reports preliminary results, but it would be very useful evaluating the streamflow connections also by means of the degree centrality (i.e. (number of first neighbors of node i)/(total number of possible neighbors)), which is probably the most intuitive network parameter. I think the results can be improved through the analysis of the degree centrality with the same thresholds used for the local clustering. Comparison of the spatial connections highlighted by these two parameters is able to give a more complete network perspective.

Author Response: We thank the reviewer for her suggestion to use degree centrality (in addition to clustering coefficient used earlier) to analyze the streamflow data to put our network analysis in an ever better perspective. We certainly agree with this suggestion. We have carried out the degree centrality analysis for the streamflow data, with the same threshold levels (T = 0.70, 0.75, 0.80, and 0.85) we used earlier in the clustering coefficient analysis. The results are presented in Figure 1. In the revised manuscript, we will include the description of the degree centrality method and its application to streamflow data. It would be more appropriate to include the degree centrality analysis before the clustering coefficient analysis. Therefore, the description of the degree centrality method will be presented under a new Sub-section 2.2 (with Sub-section 2.3 for clustering coefficient), and the results will be presented under a new Sub-section 4.2 (with Sub-section 4.3 for clustering coefficient).

Referee Comment – S. Scarsoglio (RC C2857): Are the monthly streamflow data expressed in terms of monthly anomalies? Please specify this aspect in Section 3.

Author Response: The monthly streamflow data are average monthly values (not anomalies). We will make this even clearer (in Section 3) in the revised manuscript.

Referee Comment – S. Scarsoglio (RC C2857): Data exhibit huge variations in their characteristics, one of these is the basin drainage area. In this regard, are the data used for the analysis area-normalized? If not, please elaborate whether the different areas can induce substantial bias and spurious correlation.

Author Response: We thank the reviewer for pointing out this issue. The data used for the analysis are not area-normalized. Therefore, with the significant differences in basin drainage areas, it is indeed possible for some bias and spurious correlation. The extent of the impact of the differences in basin areas on correlation remains to be seen. We will examine this (and other relevant basin factors) in more detail in a future study. In addition to this, we intend to apply, in a future study, the network approach in the context of regions (Hydrologic Unit Code – HUC), which could also shed additional light on correlation. In the meantime, we will briefly discuss these issues in the revised manuscript, to address the reviewer's concern.

Referee Comment – S. Scarsoglio (RC C2857): In the correlation analysis (4.1), are the neighbors selection based on the geographical distance from the reference node? Is it possible to have some statistical information on the distance (in terms of PDF, if significant, or just in terms of mean and standard deviation) for the three values (5, 15, 30 neighbors)? For each station, compute the average distance from the neighbors, and then evaluate the distance distribution for all the stations for the three values (5, 15, 30).

Author Response: Yes, the neighbors are selected based on the geographical distance from the reference node. We appreciate the reviewer's suggestion to obtain some statistical information on the distance, as such could shed some additional light on

the correlation results. We have now carried out the relevant analysis regarding the average distances for the three number of neighbors we considered, i.e. 5, 15 and 30 neighbors. For these three cases, the mean distances are 41, 73, and 111 km, respectively, and the standard deviations are 37, 63, and 94 km, respectively. We will incorporate these results with relevant interpretation in the revised version. For the benefit of the reviewer, the probability density distributions of the average distances for the the above number of neighbors are presented in Figure 2. We do not, however, see the need to include this figure in the revised version.

Referee Comment: - Page 7268, line 9: "and" should be removed; - Page 7269, line 1: Fig. 6b should be Fig. 6c; - Page 7270, line 6: "and" should be remove.

Author Response: We thank the reviewer for pointing out these editing corrections. We will incorporate these corrections to our manuscript during the revision.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 7255, 2014.

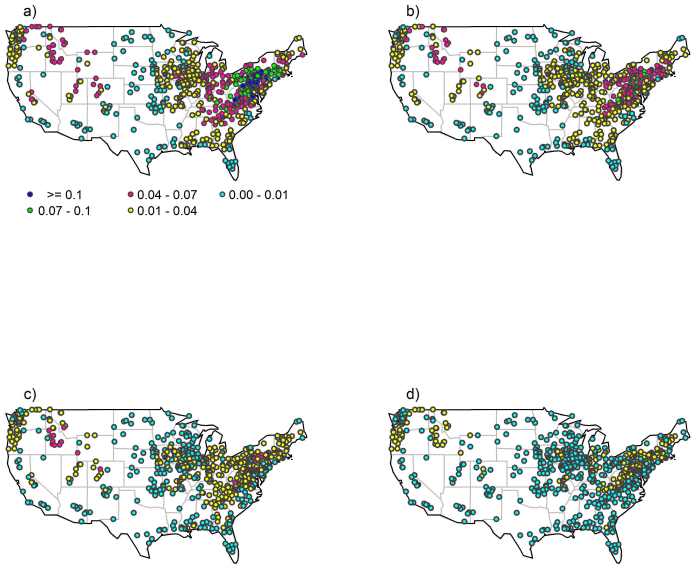

Fig. 1. Degree centrality for four correlation thresholds: (a) 0.70; (b) 0.75; (c) 0.80; and (d) 0.85.

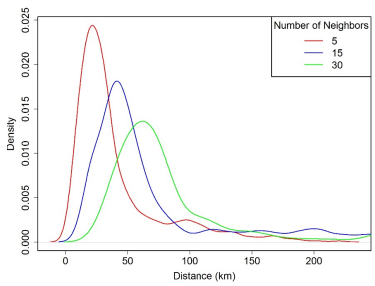

Fig. 2. Density distribution of average distances for three different number of neighbors