

Interactive comment on

“Optimal Design of Hydrometric Station Networks Based on Complex Network Analysis” by
Ankit Agarwal et al.

Anonymous Referee #1

We thank the reviewer for investing his/her valuable time in our manuscript. Your feedback is vitally important to increase the readability of the work.

We have responded (in black) to each reviewer comment (in red).

General comments

I am not convinced that Fig.2 and Table 2 really help to understand what the result of the implementation of the proposed ranking method gives if applied to a real observation network. The example in Fig.2 is extremely simple and can hardly be extrapolated to a raingauge network including hundreds of gauges. It is unclear what node 5 in figure 2, which illustrates the added value of the proposed ranking method, really stands for.

We agree with the reviewer that from the discussion of this simple example, one cannot derive the conclusion that our method also works for a raingauge network with hundreds of stations. However, we do not derive this conclusion from this example, but use it to motivate the development of the new node ranking measure. Identifying nodes with interesting positions in a network is useful to extract meaningful information from large datasets. Over the year numerous measures have been introduced for this purpose, such as degree and betweenness centrality. In this example we demonstrate the deficits of the existing measures. We feel that this demonstration is better done with a very simple example where the reader can easily understand and reproduce the calculations. Independently from this example, the proposition that our new measure is useful for large networks of raingauges is discussed and evaluated using the decline rate of network efficiency and the kriging error (section 4.3, 4.4). In the revision, we will make (even more) clear that this example is used for easy understanding and motivation, and that we do not derive that our new measure works for the large raingauge network as well.

The role of node 5 in Fig. 2 can be understood with the followings simple theoretical example.

In climate networks, local centers correspond to nodes which are important for local climate phenomena, while bridges correspond to nodes which connect different subsystems of climate, such as monsoon and El-Nino, leading to teleconnections (Paluš, 2018). Bridge node spread a process to the entire network with more force than a local center in a community, even when the local center has more spreading power (more connection) than the bridging node (Lawyer, 2015). By deducing the globe bridge node in a spatial hydrometeorological network, most of the process flow information can be captured.

What about raingauges that are poorly correlated with other gauges that could rather appear as dead-ends or even isolated nodes in the build network?

We interpret this question as a modified question of the reviewer in his/her first review: *“If I understand correctly stations with strong similarities with other stations will have a large number of connections and hence a high WDB value and conversely”*. As we mentioned in our previous response letter the ranking measure that we propose (WDB) is not simply related to the number of links. Hence, the ranking of the nodes will depend on their information contribution to the network, see for example, on page 14, line 15: *“... it awards stations which provide unique information which cannot be generated from other stations in the network ...”*. However, we agree with the reviewer that such a situation needs to be considered carefully. We propose to add a discussion on such situations in the revision, as we have already indicated in our first response to reviewer

#1 (... There is one situation where our method would require additional care: Let's imagine a node that is unrelated to other nodes (no links). Physically, one might imagine this scenario in a meteorological sub-region characterized by fine-scale convective thunderstorms with sparse rain gauge coverage. Hence, precipitation event synchronization across rain gauges in that sub-region would be poor. In that case, indeed, this station would not be the part of the constructed network, and would not be ranked. This station should be treated carefully as it provides unique information. ...)

Some extracted maps from figure 4 showing on a limited size area, the topography along with the location and resulting ranks of the raingauges and maybe also the location of the 10% higher ranked removed gauges could improve a lot the presentation of the method.

We thank the reviewer for her/his excellent suggestion. In the revised version we will attempt to incorporate this suggestion.

Moreover, I confirm that additional validation is needed and this is acknowledged by the authors. At least the resulting variance of the rainfall fields corresponding to the various tested networks in table 4 should be provided. If significantly modified by the gauge selection method – probably moderately for the random selection method – it could have a major impact on the figures in table 4. This should be considered in the interpretations. But evaluations based on a leave-one-out approach should also be conducted.

As recommended by the reviewer in her/his review letter we assure to add a new validation scheme based on leave-one-out approach in the revised version. We will also include variance and variogram of various tested networks.