Comment on paper egusphere-2025-2146

General comment:

I have no expertise in watershed hydrology, nor on hysteresis loops. I read the paper from the perspective of a Kohonen algorithm practitioner.

My overall assessment is that it is a very good paper from this point of view. As far as I understand, the application problem is very well posed and explained. The reasons for using Kohonen's algorithm are perfectly introduced and justified. The algorithm itself is very well defined, as well as its practical implementation. The methodology and the different steps are clear and reproducible. Finally, the results are, according to the authors, quite satisfactory.

Specific comments:

The authors present hysteresis loops and the different methods used to classify them (which makes it possible to characterize hydrological events). They explain why traditional clustering methods are not satisfactory, in particular because we may not see what the important factors are. The authors then discuss methods based on the calculation of certain indices, but show that these indices do not always make it possible to distinguish between very different events

To improve the analysis of loops, the authors propose to use the Kohonen algorithm (SOM) for its well-known clustering and visualization of results on two-dimensional maps.

The presentation of Kohonen's algorithm is very well done, very educational. The authors carefully explain the role of each hyperparameter. They offer to choose a distance adapted to the nature of their data. They introduce two criteria for choosing an "optimal" map, which must make a compromise between topographic error and quantization error, both of which must be minimized, although they vary in opposite directions.

The implementation of the algorithm is carefully detailed. The authors explain the different steps, pre-processing, filtering by a moving median, standardization of the lengths of the data vectors (representing loops), normalization (to keep only the shape).
The Kohonen map is trained on a balanced and labeled database (although the label is not included in the input data) where all the observed loop shapes are represented.
The authors present the choices (map size, parameters) they have chosen.
However, they remain inaccurate with regard to the decay function of the alpha parameter and the size. It would be desirable to propose and explain decay functions in accordance with the theory.

Then, once the map has been calibrated from the labeled data, the authors use it to classify the hysteresis loops from several observation stations by projecting them onto the map. They carefully study the clusters obtained and determine the significant explanatory variables through statistical analyses. They compare the conclusions obtained with the conclusions derived from the study of the indices presented in the introduction.
To conclude and allow the use of their methodology, the authors provide a program in Python.

Technical corrections: There is nothing to report, the manuscript is very neat and really very well written.
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Comment about the revised version:

My only negative remark was: “However, they remain inaccurate with regard to the decay function of the alpha parameter and the size. It would be desirable to propose and explain decay functions in accordance with the theory.”

The authors have very well completed the presentation of Kohonen's algorithm and its implementation, making them more precise and educational, which is quite satisfactory. The manuscript is very neat and I have no other comment or remark to make. The application seems to be very interesting, but I have no expertise in watershed hydrology, nor on hysteresis loops. So, I have no comment about the application field.