Response to reviewer 1

The authors thank the reviewer for their constructive comments, our responses to each individual point can be found below:

This technical note compares different methods to quantify hysteresis patterns and introduces a new, more robust way to do so. The manuscript is well-organized, clearly written and potentially of interest to quite some of the readers. From my point of view, it can be considered for publication after addressing a few minor comments:

(1) although being widely used in hydrology, the term "hysteresis" used here is formally incorrect. Hysteresis is defined as the dependence of a system output on its history of inputs (and thus on its internal state). Although discharge is a manifestation of the system state, the discharge-concentration relationships are technically no hysteresis loops but rather closed loops of a functional relationship. In addition, actual hysteresis is characterized by unique input-output relationships below and above given threshold values (e.g. Schmitt-triggers from electronic circuits as examples for sharp hysteresis). I would therefore suggest to qualify the terminology here, for example by stating:"[...] closed loops, thereafter referred to as hysteresis loops".

As the reviewer says, the term hysteresis is widely used in hydrology and is generally understood by the hydrological community. As a result the authors do not think it is necessary to add and additional explanation.

(2) p.7883, l.9ff: I could not quite follow this explanation. In other words, I am not sure if the new method is capable of a more robust representation of figure-of-eight shapes. Even if using the normalized ranges, wouldn't a regular 8-shape (for the sake of the argument say for example horizontally aligned at an angle of 0 degrees) result in a HI of 0 in spite of exhibiting "hysteresis"? It would be great if the authors elaborated a bit on that and clarified this question.

Yes, we agree that this point needs clarifying in the manuscript. The reviewer is correct in saying that a regular symmetrical figure-of-8 loop (i.e. equal size loops on either side) would result in an HI index of 0. But that is a simple fact of an unbiased loop. The new index however, does allow the method of quantification to consider the portions of the loop which are in clockwise or anti-clockwise phase and this information could be extracted for further evaluation. This is an improvement on the previous published hysteresis indices. If the new index is used in conjunction with other existing hysteresis measures such as loop area, it is easy for the user to see that a loop which has a HI of 0 but a loop area which is larger than 0 has to exhibit figure-of-8 behaviour. In addition to this, because the calculation of the new index uses multiple sections across the loop, which will encompass the clockwise and anti-clockwise sections, it is possible to examine the distribution of values gained for the index before they are averaged, thus allowing the user to see the value of the index in each section of the loop. Text will be added to the technical note to clarify that users who are examining figure-of-eight loops may find it helpful to use the new index in conjunction with other loop measures and/or visual examination of the loop shape to ensure an effective interpretation of the results. So to be clear, here we focus on the basic output that can be generated. Once implemented other summary results can be gained that can be used to highlight different aspects of the loop characteristics (one could summarise separately the +/- aspects of the

loops for more complex behaviour). This is beyond our technical note, but we shall briefly note that other characteristics can be quantified as this is a strength of the new methodology.

(3) is there a particular reason not to show the box plots in figure two with equal y-axis scales (at least for panel ii and iv of each storm). this could more clearly illustrate that HInew is somewhat more robust.

Yes, we shall modify the plots so that the y-axes match in each of the ii and iv panels for ease of comparison.