Response to reviewer: Remi Dupas

Thank you for your comments, our response to the individual points you raise can be found below:

This technical note reviews some of the hysteresis-descriptor variables used to analyse high frequency storm concentration time series. Two major shortcomings of the widely used hysteresis index (Lawler et al., 2006) are highlighted: the influence of initial concentration and of initial discharge in the case of 8-shaped hysteresis. A new hysteresis index is presented to overcome these two shortcomings. It worth noting that this is one of the rare studies where uncertainty in the data is accounted for in classifying hysteresis loops. This technical note is well-written, logically organized, and the figures are clear. This technical note would benefit from two major improvements

(1) An alternative method already exist to deal with the problems of changing baseline value and 8-shaped hysteresis loops. See Rossi et al. (2005) and also Stutter et al. (2008) and Dupas et al. (2015) for examples of application. Here is an extract from Stutter et al. (2008): "Further analyses were undertaken using the 'pollutogram' approach developed by Rossi et al. (2005) approximated by the relationship: F(x)=xˆβ where F(x) is the fraction of the total mass of the determinant during the storm event and x is the total mass of water during the event. The parameter β is a coefficient representing the relationship between the mass and water volume over time which may be plotted as the cumulative proportion of the total mass transported against the cumulative proportion of water transported. Values of β of 1 indicate that the determinant mass arrived predominantly towards the start, or end of the event, respectively. A value of β = 1 denotes either that the pollutant mass and water volumes are proportional, or that the pollutant concentrations stay constant over the event." Maybe mention this method.

Thank you for this suggestion. There are a number of different methods which can be used to examine storm behaviours, some of which we have discussed in this technical note. The method you describe is another viable method for examining storm behaviour, however the pollutogram is designed to examine discharge-load relationship, which are subtly different to discharge-concentration relationships. This is important in our work as we consider variables such as turbidity from which a load cannot be directly calculated unless converted to suspended sediment. With this in mind, the authors would prefer not to add this method to our discussion as we only wish to include methods which directly examine discharge-concentration relationships as we have indeed identified in the introduction to the paper.

(2) Maybe mention the fact that the new HI gives a description the size and direction of the biggest loop in the case of a 8-shaped loop but the information that it is a 'figure-ofeight' is lost. See also comment (2) Anonymous Referee #1. The method mentioned in (1) leads to the same information loss.

Please see the response provided to Reviewer 1 (comment 2). In brief, the new index provides a useful method for quantification which reflects the proportion of the loop which is in clockwise and anti-clockwise phase in the case of figure-of-8 loops. If the index is coupled with a visual inspection of the loops, then no information is lost, or indeed if the information is extracted separately from each loop as noted here: 1) If the value obtained for the HI is small but other metrics such as loop

area are large in comparison, then it can quickly be determined that the loop is a figure-of-eight. 2) In addition, the multiple sections of the loop which are measured as part of the index calculation can be examined before they are averaged, and therefore a switching between positive and negative values indicates the switching from clockwise to anti-clockwise behaviour, resulting in a figure-of-8. The amendments proposed in response to comments made by reviewer 1 should also help to clarify the point raised here and will we add text to note these additional behaviours that can be quantified as another positive aspect of the new approach.

Minor comments:

P 7876 l2: “in extreme flow events” -> why not all storm events?

Agreed, this could apply to any storm events, text will be modified.

P 7877 l14: a major interest of hysteresis-descriptor variables is that they enable statistical analysis of near continuous high-frequency measurements, when the amount of data exceeds the capacity of manual analysis.

Agreed, the hysteresis index therefore is a useful tool, and if it is used along-side other metrics such as loop-area it can provide detailed information about the loop shape without having to visually examine each loop. See comments above and in response to reviewer 1.

P 7881 l20-22: the hysteresis shapes are already described before using the method presented in the paper. Maybe specify that this is based on preliminary visual observation of discharge-concentration plots.

Yes, this is based on visual inspection, this was done to ensure that a large range of loop shape and sizes were available to thoroughly test the proposed new method. Text will be added to clarify this point.