

Interactive comment on “Characterising hydrological response in urban watersheds based on inter-amount time distributions” by Marie-Claire ten Veldhuis and Marc Schleiss

Anonymous Referee #1

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Review of “Characterising hydrological response in urban watersheds based on inter-amount time distributions” by ten Veldhuis and Schleiss

The study propose a methodology for sampling flow data sets from water courses in urban watersheds based on samples of equal volume.

Data

The stream gauge data used in this study has a temporal resolution of maximum 15 minutes (p4l17) but all results reported are for longer aggregation periods: in Figure 8 minimum of 12 hours and in Figure 9 and 10 a minimum of 3 hours. With data available at 15 minutes resolution it should be possible to detect rapid changes in the flow and

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the manuscript seriously lack comparisons at the sub-hourly scales. One exception is in Table 3 where the flashiness index is reported for 15 min observational resolution; but here it is unclear whether the 99%-tile of the flow measurements at 15 minutes resolution would give the same answer. Please investigate this and add the results to the discussion. As illustrated by Figure 3 the inter-amount time methodology result in much less data points than the original data set, but it is very unclear why it provides a better data basis for discussing the hydrological properties than the original 15 minute resolution data.

“Missing data were treated as zeros” (p4|23): how does this influence the results and the estimation error?

The catchments used in the study are to some degree sub catchments of each other. This could mean that some stream gauges are correlated (e.g. 507 and 530 (Figure 1)) but this is not discussed in the manuscript. This should be discussed in general and specifically in relation to the results where all catchments are discussed (e.g. Tables 2 and 3 and Figures 5, 7, 20 and 13).

Figure 1 is very hard to read and could benefit from being enlarged. Also, some will not know where in the world Charlotte, NC, is and it would be beneficial to add a panel of the North American East Coast with a marking of where the study area is.

Figure 2 is not providing any insight and should be removed.

Inter-amount times

The definition of inter-amounts (p4|24-p5|2) is brief and to the point. The section on normalization of inter-amounts (p5|13-12) is also brief and the arguments for the methodology are good. The section on sample estimate (p5|13-p6|18) is somewhat harder to follow. The section thoroughly explain how to convert a time series of flow measurements to a series of inter-amount times and the possible error introduced by the approach but in the results section a measure of the error associated with the present

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15 minute resolution data and the present catchments is not reported. This is really needed as it should be really limited how important this is at this fine temporal resolution of the flow data.

CV, skewness and medcouple are used to compare inter-amount time and flow distributions. In general the discussion of the results (p915-p1119) are for daily values. This section could be much more interesting by adding results for higher resolution since the native data resolution is so much higher than the daily scale. At p10128-29 a bimodal histogram for catchments with low flow regulation is discussed but not shown, please add these in a supplement. From p10130 to the end of the section is repetition that could and should be left out of the manuscript.

The distribution of changes in inter-amount times is used to identify rapidly increasing and decreasing trends (p11110-30). Figure 6 summarizes the results (again at daily scale) between flow based and inter-amount time based investigations but I cannot see how there can be both inter-amount times and flows in the figure. And it is not clear how to quantitatively get more knowledge from the inter-amount times since the qualitative conclusions will be the same between flows and inter-amount times (even though the skew will be in opposite directions). Please elaborate on this and correct the figure.

Inter-amount times are further compared to flows in Figure 8. Figure 8 is a really good example of all the problems you get from having box-plots on a log scale. For both values span several orders of magnitude and is vastly skewed (as indicated by the large difference between the mean and the median). The associated discussion (p11131-13115) is very hard to follow and whether a given percentile is following a power law (p12110-12) or not is effectively impossible to see from the figure. I would suggest a form of normalization of the results to avoid the logarithmic axes in Figure 8 and make the scaling discussion much more accessible.

Flashiness

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From the very first sentences of the abstract (p11|1-5) flashiness is highlighted as a key parameter where inter-amount time distributions can really make a difference. In the introduction it is concluded from literature that it is difficult to predict the flashiness of urban watersheds, but no methodologies or results are directly presented. Please add a more thorough introduction on how flashiness is normally calculated from traditional flow data.

The flashiness indicator formulated in the study (p6|23-24) is very briefly described and a discussion of why this choice was made and why this is a good indicator for flashiness is completely lacking. Please add these.

The results and discussion for flashiness and minimum observable scale (p13|32 + p14) is not easy to follow. In the first section (p13|33-p14|10) It is discussed that very high peak flows cannot be measured correctly every time with 15 minutes resolution data; but is this interesting at all and is it important to know flow variation at this high resolution? Please add a discussion of this. In the next section ('Table 2' should really be 'Table 3') a clear correlation between minimum observable scale and flashiness is reported (p14|18-20) as well as a clear correlation between flashiness and basin area (p14|20-22 + Figure 10); these make perfect sense, but would they be different if flow-based flashiness indicators had been used? Please add a comparison to other flashiness indicators. In the very end of the section (p14|30-34) a discussion of results not shown is given indicating that the manuscript would benefit from addition of a supplement containing results from all catchments and also the further analysis that has apparently been carried out.

Multifractal analysis

The whole section on scaling (p15|1-29) could really be shortened to one sentence simply stating that scaling is great for both flow and inter amounts accompanied by the left side of Figure 11 unless you can show that there is a statistical significant better fit of one of them. Also the identified departures from linearity (p15|6-88 and the right

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side of Figure 11) should be statistically significant to be relevant for discussion. Please provide relevant statistics to support the conclusions drawn or shorten the section.

Conclusions

In the conclusions it is stated that: “Flows sampled over fixed time intervals did not clearly exhibit this transition. This is result of peak flow variability being poorly sampled by fixed time window sampling.” (p16||28-29) but until you add results where you utilize the 15 minutes resolution this cannot be concluded.

Another sentence: “Based on inter-amount times distribution we were able to define a flashiness indicator that incorporates both the rising and falling components of the hydrological response” (p17||28-29) seems to be unsupported as the flashiness indicator, as I have understood it, really only tell how many hours of mean flow one can expect as peak flow within a given much shorter time frame (e.g. an indicator of 100 hours for 15 minutes inter-amount times mean that the 99%-tile peak flow is 400 times the mean flow) and how the rise and fall of the peaks are incorporated is not clear.

It is also concluded from the multifractal analysis that: “This showed that inter-amount times can help better predict peak flow characteristics at small unobservable scales based on coarse resolution data. Additionally, they provide new interesting alternatives for the stochastic modelling and downscaling of flow data.” (p17||18-20) and “Scaling analysis showed that inter-amount times provide a promising way to better predict peak flow characteristics at small unobservable scales from coarse resolution data” (p17||31-32) but this was not discussed at all before in the manuscript and if it is true you should really add results to support this.

Figures

In general the figures need some work before publication. The fonts used are generally very small (e.g. the legend for Figure 1 which is unreadable when printed). The use of sub-figure numbering is inconsistent between text and figures (e.g. Figure

4c and d are not mentioned in the caption and for Figures 6, 8 and 9 the sub-plot labels are missing). In Figure 9 there is no marking of which color corresponds to which data set. Inconsistent use of 'IATs' (Figure 11) and 'inter-amount time' (Figure 8) as well as 'Flow' (Figure 2) and 'Amounts' (Figure 11) and 'medcouple' (Figure 7) and 'MC' (Figure 5). What are the units of the x-axes of Figure 6? Also put the unit directly on the x-axes of Figure 4 and not only in the text of the figure. For Figure 8 the x-axis seem confusing. For the inter-amount times the volumes are based on time and should be reported something like "0.51 mm (12h)" but for the flow plot the axis should only be time. Similarly for Figure 11 where the x-axes for flow and inter-amount times should be different.

Concluding remark

Indeed, this approach is very interesting as it generate data sets with higher sampling frequency when high flow occur and lower sampling frequency for low flow periods. This is nicely pointed out by the authors. However, from the reported results I am not convinced that the methodology adds so much to the field. It is also unclear how exactly the authors see that this knowledge can be utilized in future research as 1) very high resolution flow data is used in this study and 2) it is unclear how the results can be used to better describe watersheds with much coarser data available as it is already pointed out that considerable uncertainty is associated with estimation of the peak flow from 15 minutes resolution data; how will than then look if only daily data is available?. Also downscaling of coarse flow data is mentioned, but for the same reasons as just mentioned it is very unpredictable how this will work.

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