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Interactive comment on "Nonparametric lower bounds to mean transit times" *by* Earl Bardsley

Anonymous Referee #1

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This paper proposes using a simple nonparametric linear programing approach to improve the actual used methods to obtain mean transit time, calculating instead the lower bounds of the mean transit time. The subject is of big relevance in hydrology, and coming up with newer and improved methods than the existing ones is always good for the scientific community. The paper was very well written However, there are some points I would like to address on this review. Finally, I agree with the author that it would be very interesting to use this approach in catchments with very well studied datasets with known mean transit times for a certain period of time. Note: This review does not analyze in depth the mathematical part of the approach because it goes beyond my expertise.

General comments:

1.) I would like to clarify to the author that mean transit time and mean residence time are not the same. The first one could be defined as the time elapsed of the water from

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input to output, while the second one is the mean residence time of all the water you have in the system at a certain point. It is true that in the literature it has been used interchangeably in some occasions but fortunately that has happened less on the last 10 years if I am not wrong. I suggest three references where they explicitly point out the difference between both concepts; I think this could help clarify the idea. I don't think this affects the outcome of the approach the author is proposing, but I do think is very important to have these concepts very clear when working with them and specially when developing new methods involving them.

- McGuire, K., and McDonnell, J. (2006). A review and evaluation of catchment transit time modeling. JoH. http://doi.org/10.1016/j.jhydrol.2006.04.020

- Botter, G. et al. (2011). Catchment residence and travel time distributions: The master equation. GRL. http://doi.org/10.1029/2011GL047666

- Rinaldo, A., et al. (2015) Storage selection functions: A coherent framework for quantifying how catchments store and release water and solutes. WRR. http://doi.org/10.1002/2015WR017273

2.) Following the previous point, it grows the concern if the author has read enough of the available literature and methods proposed by other authors trying to obtain as well better transit time estimations. With this I am not intending on attacking the author in any way, but I am just concerned that if our interest is to advance in science we should take the time to observe what are the more appreciated methods proposed on the scientific community before we add one more to the pile. Doing this can help the author as well in improving his own approach. For example, in many of the transit time studies, a problem that limits having good transit time estimations is the storage (groundwater, evaporation, etc.) interaction with the system, for which there are several methods trying to attack this approach. Would the author be able to use this approach to consider as well the water that was in the system previous to the input studied?

3.) Here I copy some of the different studies that take into account the previous water in the system in one way or another in addition to Botter et al (2011) and Rinaldo et al (2015) above mentioned:

- Heidbüchel, I. et al. (2012). The master transit time distribution of variable flow systems. Water Resources Research. http://doi.org/10.1029/2011WR011293

- Harman, C. J. (2015). Time-variable transit time distributions and transport: Theory and application to storage-dependent transport of chloride in a watershed. WRR. http://doi.org/10.1002/2014WR015707

-van der Velde, Y. et al. (2015). Consequences of mixing assumptions for time-variable travel time distributions. HP. http://doi.org/10.1002/hyp.10372

-Rinaldo, A. et al. (2016). Reply to comment by Porporato and Calabrese on "'Storage selection functions: A coherent framework for quantifying how catchments store and release water and solutes"'. WRR http://doi.org/10.1002/2014WR015716

4.) As a suggestion for better understanding that the author might take or not. I think that some parameters could have more user friendly names. For example μ^* could have an L or low as sub-index. That would force to change the name of D to a sub-index like 'u', 'upp' or 'h' from highest. These small changes could make smoother for the reader to follow up the terms coming up throughout the paper.

5.) I am positively impressed that with this approach there is no need of catching the tail while using a gamma distribution. That is an upgrade for the gamma distribution methods. But it would be interesting as well to test different N values to see if it would provide different μ^* values. Meaning, is μ^* dependent on the size of N chosen?

6.) Would it be possible for unknown catchments to know that a μ^* with r=0.9 is 2/3 of the mean transit time? Or was this just a casual coincidence?

Specific comments:

7.) Page 2 Block 25: what are the X values with negative sub-indexes physically? Am

I correct if I assume them to be the previous inputs to the input I am studying? If that would be the case, then it would be other precipitation as well? Or is it stream water, or groundwater? Let's assume the case where my X values with positive sub-index are precipitation values, would that mean that all my X values with negative sub-indexes are precipitation values from days prior to the positive ones?

8.) P4 Eq 1: if we assume t=0 you would obtain an X-N which is not defined before.

9.) P6 B15 eq 5: Same as before, with t =ϵ there would be an Xϵ-N not defined, that without saying that none of all the X obtained in that equations are defined due to the epsilon. I understand the author takes them as very small, but the nomenclature is confusing since those are sub-indexes. Perhaps it would be better if it's properly stated that for this case we will assume that the indexes with ϵ are as if there was no ϵ.

10.) P6 B25: the progression of this sum is a bit confusing, I think it would go from ωK-τ+1, ωK-τ+2,. . . to ω K.

11.) P8 B25: I think the author meant β, instead of α in the text "The gamma scale parameter 'β' is specified. . ."

12.) P10 B0: Could the author explain better how is it that higher value on P(0) an illusion? If I were to not consider that value there would be a shift on the μ. I could not follow the author's idea.

13.) Fig 3: X axis is missing units (months I assume)

14.) It would be nicer if Fig 1, Fig2 and Fig 4 are done for black white printing and as well for color blind readers.

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