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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Technical note: Transit time distributions are not L-shaped" *by* Earl Bardsley

Anonymous Referee #4

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The purpose of this contribution is to assert that probability distributions for water transit time through hydrologic systems cannot be monotonically decreasing. The author calls distributions like this "L-shaped." He demonstrates through a thought experiment and discussion of commonly used distributions why water that was present in the storage cannot also leave the storage at a time of zero. Overall, the argument makes sense, but I am not sure I really understand the contribution of the manuscript given that this issue has been recognized in the literature and even the author claims that a more correct form of the distribution may not result in different hydrological conclusions. Technically, the author's primary point about the incorrectness of the early-time behavior of the transit time probability distribution is fine, especially for stationary distributions of a generally smoothed shape. However, I don't think fitting theoretical distributions

where $f(0) = 0$ is more informative or helpful hydrologically, particularly if the distribution maxima is close to $t = 0$. The author recognizes the challenge of selecting distributions based on fitting as being problematic, but moreover, he fails to extend his analysis to understanding the actual shape of transit time distributions. There is now a significant literature illustrating how complex these distributions are without making any assumption of distribution shape (e.g., van der Velde et al. 2012, 2015, Benettin et al. 2015ab, Birkel et al. 2015, Kim et al. 2016). They are dynamic in time and perhaps unique on any given time (e.g., Duffy 2010, Rinaldo et al. 2015). Again, this short technical note is not incorrect, but I don't know how valuable or impactful it will be, particularly without recognizing the recent literature on dynamic transit time distributions and the fact that actual transit times may not be smooth shaped functions or parametrically characterized.

Specific comments: I spent some time Googling "L-shaped" probability distributions because I found it to be an odd descriptor of a probability distribution. It is used some, but it is not very common and if impact and attracting readers is a goal (and it should be), then I would consider revising the title. Maybe "transit time distributions with an early-time probability maxima" would work? I actually cannot think of good title, but I did immediately question the term "L-shaped" distributions.

P1, L19: insert often before assumed

P2, L7: delete the second "and"

P2, L12: Yes, but at f(0), the probability could also simply be low (i.e., not zero) particularly if there are some parcels of water with almost instantaneous exit like those falling on the recorder.

P3, L10: change from "have not undergone store transit" to undergone transit through the storage.

P3, L14: Missing reference, but I think the author is referring to Rodhe et al. (1996).

P5, L7: should be referring to Eq. 3.

P6, L9-10: A real problem here is that the author is ignoring a significant body of work and much of the latest work on catchment transit time where the community seems to be avoiding parametric distributions in the first place. A good example is the storage selection approach (e.g., see Rinaldo et al. 2015). There are fewer and fewer papers in the literature using parametric, stationary distributions.

P6, L19: comma after "regard"

P6, L21-23: It might be helpful to reference a few studies that have found transit time distributions similar to those the author describes. For example Rodhe et al. (1996), Simic and Destouni (1999), and Davies et al. (2013) from the Gårdsjön Catchment and McGuire et al. (2007), Fiori and Russo (2008), Dunn et al. (2010), and Darracq et al. (2010) show distributions as described by the author. Furthermore, many of the studies that show transit time distributions from dynamic models, do not assume L-shaped distributions (or any functional form for that matter).

P6, L7: Is there a question of time step or bin interval? It seems to me that for very fine bin intervals, it is possible to have transit time pdf with a mode very near t = 0 and hydrologically this will not result in transport that this very different from an L-shaped distribution. The other issue is that often continuous pdfs of transit time are actually implemented discretely in time such that for times near zero, they may be indistinguishable from L-shaped distributions like a gamma with alpha < 1.

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