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Discussions

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

Anonymous Referee #3

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This technical note has one single subject; that the authors is dissatisfied with travel time distributions which have a nonzero value at time t=0 (the moment of tracer application). The authors seems to use a causality argument - travel velocities are finite, and therefore not a single tracer particle could have reached the outlet in no time. However, the travel time distributions, expressed as probability density functions, of Kirchner et al. (2001) which he criticizes explicitly cover the case of spatially distributed tracers, e.g. natural tracers in rainfall or a homogeneous sprinkler system. Thus, there are tracer particles which are precisely at the outflow at t=0, which do not disperse, leading to sharp peak, and others further away which do disperse and lead to long tails in the distribution which is the central focus of the Kirchner et al. work. The author seems to be uneasy with divergent pdf's. They are rather common and not problematic as

long as the singularity is not too strong - more precisely, if the integral over any finite time interval is always finite. In one dimension, this it the case when the singularity is weaker than $1/t$ - e.g. the $1/t^{0.5}$ of eq. 11 in the Kirchner et al. article. The reviewer cannot see that the printed equation (11) contains an error with brackets - there could have been an extra pair of brackets around the argument of the second exponential, but this is optional and does not change the equation. The current author uses units where the mean travel time, τ_0, is set to 1 (why?), but then there is a factor 1/2 missing in the definition of z_0. This is an error, but since he does not develop that further, it is overall not an important one. Unfortunately, the author does not provide a framework to mitigate the "problem" of $f(0) > 0$ (if this is a problem at all). Arbitrary changing integration limits can't do the trick. He also does not demonstrate (analytical or, if not easily possible, numerically) that whenever $A < x^*$ (line 24 on page 5), then $f(0) = 0$. The problems we have in evaluating and interpreting tracer studies are not here. One has to tackle instationarities, differences in hydraulic conductivity, imperfect recovery (e.g. detection limits at high dilution) etc., which is a can of worms in many cases. Honorable approaches like the CXTFIT software are restricted to 1D, whereas Hydrus-3D suffers from too many parameters. It is here where we should put our emphasis in tracer hydrology; the "problem" discussed in this contribution is not significant and does not lead to problems with causality or ill-definedness of the expresssions obtained. The primitive exponential distribution is for demonstration purposes only - like the harmonic oscillator in physics - and is to be found in textbooks and reviews on tracer hydrology, but the research field is far beyond this. For pointwise tracer injections away from the stream / outlet with your detector, you will have $f(0) = 0$, but this is not what is discussed in Kirchner et al. (2001).

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