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Geoscientific Model Development Discussions

Interactive comment on "*tran*-SAS v1.0: a numerical model to compute catchment-scale hydrologic *tran*sport using StorAge Selection functions" *by* Paolo Benettin and Enrico Bertuzzo

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We thank reviewer 2 for the positive comments. The list of points includes insightful suggestions that we will implement in the revised version:

> *1) Section 1, Line 21: Please revise the first sentence. The new transport model has improved the capabilities in terms of what? I understand your point, but it worth it to make it clear for a general audience. A suggestion is to add two or three sentences on, e.g., how the new transport model can be expressed in different ways depending on the ease of its application in a desired study (Botter et al., GRL2011 vs. van der Velde et al., WRR2012 vs. Harman, WRR2015*

> *vs. Benettin et al., WRR2017). Or, for instance, how this new transport model is much less biased to spatial aggregation as opposed to the traditional approaches assigning the TTD a priori (Danesh-Yazdi et al., GRL2017).*

We agree and we will add a paragraph to explain the advantages of the formulation of transport by SAS-functions.

> *2) Section 2, Line 7: Characterization of the SAS function is also part of the requirements (as emphasized in section 2, line 21) for solving the age distribution of the water storage. Please revise this sentence, accordingly.*

We will review this sentence to further clarify this crucial point. Thanks for the suggestion.

> *3) Equation 3: Isn't this conditional on no precipitation takes place at time t? What about those conditions when part of the input precipitation falls directly into the river, contributing to the streamflow? Or what about those conditions when a major portion of the input precipitation contributes rapidly to the streamflow?*

This boundary condition is coupled to equation (1) where precipitation $J(t)$ appears explicitly. For any age $\varepsilon > 0$ (even very small), integration of eq (1) results in $S_T(\varepsilon, t) > 0$ (if precipitation occurred during ε).

> *4) Section 2, Lines 20-24: S0 and k have been written in different formats in the manuscript (i.e., at one place as bold and italic, and at another place as normal). Please make them consistent throughout the manuscript.*

We will correct this. Thanks for pointing this out.

> *5) Section 2.4, title: I know in their former papers, the authors have already emphasized on the distinction between the random sampling and the well-mixed conditions. As such, I am not sure why they equivalently put them together in this title.*

Indeed, there are differences between a "well-mixed" and a "randomly-sampled" reservoir and we do not imply that the two coincide. In a catchment-scale formulation this distinction has no practical consequences and equation (7) holds in both cases. As readers are usually more familiar with the concept of "well-mixed", we prefer to keep the title as is.

6) Section 3, Line 18: You already called ST (0, t0) = 0 a "boundary" condition in Eq. (3).

This is true, but equation (8) is now an ordinary differential equation in the variable T, so the condition $T = 0$ is an initial condition.

7) Section 3, Line 22: I am not following this last sentence.

We will reformulate it to make it clearer. The variable $S_T(T, T + t_0)$ describes the amount of water storage that is younger than the water entered in t_0. In other words, it describes the amount of water entered after t_0 that is still inside the system. When time grows, water entered after t_0 gradually replaces the water entered before t_0, and for very large T all the water storage is made of water entered after t_0.

8) Page 7, Line 12: Not sure what does 1 in ΩQ[1, j − 1] imply? It is essentially ST (i, j − 1), so you meant i instead of 1?

$e[j]$ represents an estimate of the event water so it refers to the first element in the rank storage $S_T(i = 1, j - 1)$.

9) Page 10, Line 12; Page 11, Lines 1-2: This is an important conclusion, but with a relatively weak reasoning. The difference between the curves in Figure 3b after year 2 is not really 2 significant. Author might want to provide another example that clearly demonstrates this conclusion.

We agree with this comment. The conclusion is more of a general consequence of the young storage preference, but it is not well visible in Figure 3b. We will either modify Figure 3 or suggest other examples from the literature where this was more evident.

10) Does the tran-SAS package also include the Markov Chain Monte Carlo calibration scheme (with reference to Page 15, Line 8)? If yes, please add a few lines on how such a scheme is embedded within the package. If no, why not to include?

The MCMC package could not be included in our package for copyright reasons, but the structure of the model function is fully compatible with the DREAM ZS [ter Braak and Vrugt, 2008, Vrugt et al., 2009] software for matlab freely available at http://faculty.sites.uci.edu/jasper/software/.

11) The examples include two different ways of parameterizing the SAS functions, that is, using the power-law and the gamma functions. However, there is no discussion about which model provides a better solution to TTD and CQ. This is a missing, but quite important information for the users of this model and should be well addressed in the manuscript.

The examples actually included parametrization using power-law or beta functions. It is not possible to tell apriori which function provides a better solution because it depends on the specific application and on the desired degree of complexity of the model. For example, the beta function is a more general case than the power-law, so in principle it provides more accurate solutions, but it also makes use of more parameters and it involves longer computations. We will better highlight this point.

12) Section 1, Line 22: "such as" instead of "like"? Also, at Page 14, Line 13.
13) Section 2, Line 24: "expressed in terms of" instead of "expressed as"?
14) Section 2: You might want to define CQ(t) as well to complete your definitions here.
15) Page 11, Line 11: Define the acronym for the random sampling, i.e., RS, earlier in the manuscript where it was first mentioned.

We thank reviewer 2 for these suggestions. We will modify the manuscript accordingly.

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