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Discussions

Interactive comment on "A fluid-mechanics-based classification scheme for surface transient storage in riverine environments: quantitatively separating surface from hyporheic transient storage" *by* T. R. Jackson et al.

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Ross Woods, Editor

RE: Interactive comment on "A Fluid-Mechanics-Based Classification Scheme for Surface Transient Storage in Riverine Environments: Quantitatively Separating Surface from Hyporheic Transient Storage" By Jackson et al.

Dear Dr. Woods,

Please find below our responses to all comments and questions provided by Reviewer 3. All points have been addressed below and, where appropriate, revisions have been made to a revised version of the current manuscript. We would like to thank Reviewer 3 for his/her helpful suggestions and comments which will improve the quality of this manuscript.

Sincerely,

Tracie R. Jackson

Responses to Reviewer 3

I greatly appreciate the proposed approach to handling the classification and influence of STS RTDs based on field based measurements. The MS is well written and the information clearly presented.

Comment 3.1) My overarching suggestion is in regard to the application of this research. A clear path regarding the implementation of this fluid mechanics approach within the context of the transient storage models is not provided. There is mention of deconvolving the theoretical STS RTD from the transient storage RTD, but this is mentioned in passing without a reference to recent work along these lines (e.g., Gooseff et al. 2011) or discussing how this could be accomplished.

Along these lines, a more complete discussion regarding the practical implementation of these ideas within the context of two storage zone modeling seems necessary. While it appears the fluid dynamics literature review is quite thorough, a discussion within the context of existing transient storage literature would result in a more significant impact and make the paper more complete. For example, how could these RTDs be used within the current transient storage modeling approaches? This could include classic two zone TSM modeling approaches (e.g., Briggs et al. 2009), different two zone model parameterizations (e.g., Neilson et al. 2010), or approaches where different RTDs can be incorporated (e.g., Wörman et al. 2002).

Response 3.1) This is a good point and we appreciate that you brought this to our attention. We added an additional subsection (subsection 4.2: Application of STS Classification) to the revised manuscript. This section describes how to implement the STS classification scheme and quantitatively separate STS from HTS using a reach-scale tracer test. We propose a method that deconvolves the STS residence time distribution (RTD) from the total transient storage RTD to obtain the HTS RTD. This method is an extension of the work of Haggerty et al. (2002), who performed a reach-scale tracer injection to obtain tracer concentration BTCs in a high-gradient (2nd-order) stream. A multirate mass transfer (MRMT) model with a late-time power-law RTD was used to characterize the late-time behavior (tailing) of the measured BTC and estimate the HTS RTD. We propose to extend this method one step further by deconvolving estimated STS mean residence times from the total transient storage RTD prior to estimating the HTS mean residence time. We highlight that different transient storage models can be used in this approach and that the model chosen is dependent on the RTD measured in the tracer test. When using this approach we direct the readers to Haggerty et al. (2000) for a tabular listing of RTD types (e.g., exponential, power-law, log-normal, etc.) and associated memory functions and harmonic means.

Comment 3.2) Is there a way to use the actual measurements necessary for the fluid dynamic STS relationships past establishing RTDs? For example, could the measurements be used to estimate additional parameters for transient storage modeling? In other words, with all the measurements describing the STS zones, depending on the representative RTD, could these data be used in reach scale model parameterization (e.g., provide an average measure of As)? Would this be necessary?

Response 3.2) We provide an additional section entitled "5. Advantages and Limitations of STS Classification" and discuss these questions within the advantages of using the STS classification scheme in transient storage models. We discuss seven advantages of the classification scheme in terms of constraining transient storage models

to obtain better parameterization of transient storage parameters. The predictive STS mean residence time relationships will provide more accurate estimates of the reach-scale STS volume fraction and effective STS mean residence time. Implementation of the transient storage models will allow for the quantification of the effective HTS mean residence time. We show how, using the mean residence time definitions of Hays (1966), we can provide more accurate estimates of the effective mass exchange rate coefficients for STS and HTS as well as the HTS volume fraction. These relationships will better constrain transient storage parameters during parameter optimization with the exception of the longitudinal dispersion coefficient.

Comment 3.3) Last, I think it is important to discuss the application of these relationships to real systems that are significantly more complex than the idealized situations presented within the MS. It is important to acknowledge that in reality, many of these types of STS zones do not occur in isolation (meaning that an STS zone may consist of one or many types) or these zones may not fit within the types described within the MS. Are there ways to deal with this sort of complication?

Response 3.3) We added an additional paragraph that briefly discusses non-idealized STS types and how to deal with these scenarios. We provide an example of one such case.

Comment 3.4) Within the MS, it would be useful to ensure that the fluid dynamic terminology is clearly defined the first time each term is mentioned (e.g., Kelvin- Helmholtz instabilities, backward and forward facing steps, etc.). This would be useful for the intended audience that may not have easy access to appropriate definitions.

Response 3.4) Thank you for this comment. Sometimes it is difficult writing for a broad hydrology audience, especially as this manuscript incorporates and links ideas across many disciples. The definition of Kelvin-Helmholtz instabilities is provided where it is first mentioned in the text. We defined fluid mechanics terms where they are first mentioned in the text.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 4133, 2013.