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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Aggregation in environmental systems: catchment mean transit times and young water fractions under hydrologic nonstationarity" *by* J. W. Kirchner

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I really enjoyed reading this paper, however, I have to admit that it took me a while to find enough time to read through over 100 pages of the two papers combined. The paper nicely and very elegantly addresses the question how we should deal with hydrologic nonstationarity to estimate MTT and TTD. The paper is very well written, however, much too long (see comments below) and is certainly of high relevance to the readers of HESS. I have a couple of concerns, of which one could be a major factor changing the main outcome of the paper – if JK can resolve this I think the paper can be published in HESS.

General comments: 1) I agree with the general approach to use any kind of model to test his approach if the sine wave fitting and calculated change in amplitude and phase shift using the MTT and Fyw will support the one or other approach. However, I miss a very relevant component in the model – evapotranspiration – which will either concentrate certain compounds in the catchments (Cl) or "remove" certain compounds (stable water isotopes). Several studies (e.g. Hrachwoitz et al., 2014, Sprenger et al., 2015, HESS) have shown how relevant this part of the hydrological cycle can be including a very strong change in the sine wave of the precipitation signal. I hardly doubt, that a model including ET will come to the same results regarding the strong relation between sine wave dampening and young water fraction.

2) The paper is very detailed with a lot of information and great thoughts of JK and many additional information that alone make the papers certainly worthwhile to read. Unfortunately, I fear, that a lot of these comments and thoughts will not be read, since they are hidden in this very long paper. I will make a couple of suggestion to shorten it, but JK may consider to move some parts of the paper to a new paper or an appendix with a clear message, where the reader is able to find his thoughts and ideas much better.

Specific comments:

The introduction builds very much on paper 1 – however, it misses a more thorough literature review to this topic of non-stationarity and the need to develop other approaches and find solutions to infer catchments TTDs.

Section2.1 – Again, very informative and a lot of relevant and interesting ideas – however, it drifts a bit away from the main goal of the paper and makes the paper much longer to read and may result that less mathematically informed readers may stop her. Could JK not move much of this chapter in an Appendix – so modellers can have a more detailed look, but other readers can more easily grasp the main message.

Section2.3 – I would propose to name the 3 input time series according to the Köppen

climate zones they are in or any other short information. The catchment information is only relevant in this chapter, but not for the whole paper, so JK could avoid to always refer to the catchment names and the climate characteristic of the time series. Section 3.2 – there has been quite a bit of work done on this field – JK cites some of it, but it would help the chapter to include more of this work. In my opinion, the chapter is too close to the model and its assumptions and the parameters sets derived – if he could provide a more general conclusion, the chapter would certainly be helpful, but at the moment, it is mostly a very nice and interesting side way – I would move it to a Appendix chapter.

Section 3.3 – Interesting, in particular for catchment modellers – however, it includes a new idea, which distracts from the main idea of the paper. I JK would have included the potential of tracer data or young water fraction to constrain the parameters, than the chapter may be helpful to support his ideas, but at the moment it is not. Maybe I also miss some things, as it is not completely clear to me how he derived Figure 8.

Section 3.6 – I would propose to shorten this section, in particular in relation to the figures related to the section. They do not show more detailed information than Figure 10-13. I think the main message of this approach can be summarized in a table or in the text and the figures could be moved to an appendix. I also believe that the illustration in Figure 14 is not necessary.

Section 3.7 – Interesting, but sometimes not clear how JK derived the data fro Fyw of the different flow percentiles. This should be better explained in a method chapter, so the reader is able to follow the ways he calculates the data from the three catchments, which are not explained in the beginning in detail.

Summary and Conclusion: Since the paper is already very long, I would highly recommend to shorten the S&C. I think it is not necessary to repeat the main ideas and steps and relate them to the figures – which is a very uncommon format anyway. I would expect from JK the highlights and his vision for the future following his ideas.

The figure captions are very long and often too detailed – I agree that a figure should be understood only with the figure caption, but JK includes already interpretation of the figure. In addition, shortening the names of the precipitation time series would help as well.

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