Comment to “Assessment of hydrological pathways in East African montane catchments under different land use” by Suzanne R. Jacobs et al.

General comments:

I acknowledge the effort made by the authors to follow the intricate suggestions given during the first revision. Nevertheless, there are some aspects relevant to the determination of MTTs in the stream waters that yet deserve a particular attention.

There are some misunderstandings on the issues about the MTT determination using water stable isotopes in the new manuscript; these issues may be abridged as it follows:

1) The use of any seasonal variation of tracer input signal for the determination of MTTs, using any type of model, is limited to a short range of years because the characterisation of the tracer signal is limited by the occurrence of spurious errors such as the analytical ones. DeWalle et al. (1997) showed that 5 years is the realistic limit for an exponential TTD.

2) It has been shown (e.g. Stewart et al., 2010; 2012) that MTT determinations using any seasonally varying input signal typically underestimate the old tails of the TTDs and subsequently the corresponding MTTs (because the relationship between the signal modification and TT is very non-linear; Kirchner, 2016a ).

3) A frequent case of 2) is produced when young waters are mixed with old ones; the form of the TTD may become very dissimilar and the MTT of the mixed water becomes strongly underestimated (Kirchner, 2016a).

The authors cannot therefore suggest that applying “more sophisticated methods like time-variant approaches” using the same stable water isotopes data may help to improve their MTT results. Looking for a better determination of MTTs, when they are of the order of several years, is not possible with these data but using other tracers, as sensibly suggested by the authors. Instead, as far as I know, the more advanced and reliable approach using stable water isotopes for analysing catchment waters ages is the unsophisticated analysis of the young water fraction (Fyw) for different stream discharge ranges as proposed by Kirchner (2016b) and implemented by von Freyberg et al. (2018). I would not recommend the use of tracer signal standard deviation instead of sinusoid amplitude because spurious errors may be important for much damped signals as well as for precipitation input signal.

This approach might be very adequate to the purpose of the authors, because different Fyw sensitivities to discharge might be identified in the diverse sub-basins, demonstrating different behaviours of the runoff generation processes.

Detailed comments:

Page 2, lines 1-3: As commented before, this is not a model issue but a tracer one.

Page 6, lines 22-33: Steady state conditions refer primarily to time and homogeneity refers primarily to space; If one property is given, this do not necessarily imply that the other is also given.

In the case of the studied basins, none of both assumptions (homogeneity or stationarity) may be sensibly claimed, given both their large sizes and the diverse water sources analysed in the paper. The relatively similar Fyw assessed for the catchment waters, obtained following a time-weighted approach, may hide their dependences on discharge and possible differences of these dependences among catchments (von Freyberg et al, 2018).

Page 7, lines 23-25: As already stated in the first review, using as behavioural only the parameter sets that are 5% below the best efficiency is not adequate when the best efficiency is so low and results in artificially reduced uncertainties. For instance, on table 5, the GM model applied to TTP-RV yielded a MTT of 3.3 (2.8-4.3) with a NSE of 0.05; for n=75, this NSE has a probability of the null hypothesis higher than 0.05: although all the parameter sets should be discarded as non-behavioural, a short uncertainty range is claimed.

Page 9, lines 27-29: discussed above.

Page 10, lines 11-19: This is a severe argument against table 5, so this table should be changed.

Page 13, lines 22-27: As discussed before, the problem is the tracer, not the model.

Page 13, lines 30-33: The research should be focused to Fyw and its dependence on discharge, instead on MTT.

References:

DeWalle DR, Edwards PJ, Swistock BR, Aravena R, Drimmie RJ. (1997). Seasonal isotope hydrology of three Appalachian forest catchments. Hydrological Processes 11(15): 1895–1906.

Kirchner, J. W. (2016a). Aggregation in environmental systems-Part 1: Seasonal tracer cycles quantify young water fractions, but not mean transit times, in spatially heterogeneous catchments, Hydrol. Earth Syst. Sci., 20, 279-297.

Kirchner, J. W.(2016b). Aggregation in environmental systems-Part 2: Catchment mean transit times and young water fractions under hydrologic nonstationarity, Hydrol. Earth Syst. Sci., 20, 299-328.

Stewart MK, Morgenstern U, McDonnell JJ. (2010). Truncation of stream residence time: how the use of stable isotopes has skewed our concept of streamwater age and origin. Hydrological Processes 24: 1646–1659.

Stewart MK, Morgenstern U, McDonnell JJ, Pfister L. (2012). The 'hidden streamflow' challenge in catchment hydrology: a call to action for stream water transit time analysis. Hydrological Processes 26: 2061–2066.

von Freyberg, J., Allen, S. T., Seeger, S., Weiler, M., and Kirchner, J. W. (2018): Sensitivity of young water fractions to hydro-climatic forcing and landscape properties across 22 Swiss catchments, Hydrol. Earth Syst. Sci., 22, 3841-3861.