Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-290-RC1, 2019

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "New water fractions and transit time distributions at Plynlimon, Wales, estimated from stable water isotopes in precipitation and streamflow" *by* Julia L. A. Knapp et al.

Markus Hrachowitz (Referee)

m.hrachowitz@tudelft.nl

Received and published: 17 June 2019

In this manuscript, the authors present high-temporal-resolution data sets of stable water isotope compositions in precipitation and streamflow for the Plynlimon research catchment. They then use these data to demonstrate its value for the characterization of catchment-scale transport characteristics in the form of "new water fractions" and transit time distributions. The paper is well-written and offers a detailed description and analysis of the presented data. In particular the comparison of the new 7-hourly data with previously collected weekly data gives the reader rare and interesting insights

Printer-friendly version

Discussion paper

into value of high resolution sampling. I would thus be more than glad to see this paper eventually published. However, I do have a few comments and questions, which I hope will help the authors to further strengthen the manuscript.

(1) I was a bit surprised by the discussion of the differences between "new water fractions" from 7-hourly and weekly samples, respectively (in particular, sections 5.1 and 5.3, together with figures 8-10). The way the analysis is presented now, it seems to the reader that it should be a surprise that the "new water fraction" increases with increased sampling interval. Of course, this is purely related to an ambiguous definition of "new water": the longer the time interval considered as "new", the more water label as "new" will reach the stream. Therefore, phrases such as "Which new water fractions are the correct ones [. . .]" (p.13,l.16) are very surprising. Instead, the reader may benefit more from this analysis and the concept of "new water", if this inherent ambiguity was clearly stated and explained upfront and the effects of it then shown in the subsequent analysis. It may thus be more informative to first provide an unambiguous definition (e.g. new water = 7 (or 14)-days sampling) and to then show a figure in section 5.3 with a direct comparison of the 7-day(!) or 14-day water fraction - as inferred from both, aggregated 7-hr sampling intervals and the weekly intervals, respectively. This would directly illustrate the gain of information when switching from low- to high-resolution sampling. Ideally, they would be identical. But are they?

(2) Related to the above, the discussion and treatment of what the authors refer to as "dry deposition" of chloride could benefit from a bit more detail. If I understood correctly, samples with high chloride concentrations are removed from the analysis. This can of course be done. However, I think it would be important to remind the reader that this is only a meaningful thing to do as long as the "new water fractions" and/or transit time distributions sought are limited to very short time periods. The longer the definition of "new water" or the transit times of interest (here: up to 7 days; Fig.13), the more uncertainties the exclusion of these concentrations will introduce into the analysis. Why? Even if entering the catchment by dry deposition, the chloride

mass deposited will not disappear and will be transported through the system with the subsequent rainfall events to eventually reach the stream. I may have missed something, but should dry deposition not, at least to some degree, be accounted for when considering volume-weighted estimates?

(3) It is great to see that the authors also provide an analysis of transit time distributions and their sensitivity to changes in wetness conditions and season. However, the sections 5.4-5.6 could strongly benefit from a bit more context. This sort of analysis has been done earlier, albeit with different methods, both in Plynlimon (e.g. Benettin et al., 2015; Harman, 2015) and elsewhere (e.g. Heidbuechel et al., 2012; Hrachowitz et al., 2013; van der Velde et al., 2015; von Freyberg et al., 2018). It may be interesting to compare the results and interpretations of this manuscript to the findings of at least these previous papers.

. Minor points:

p.2,l.8-9: “Because these tracers do not react…”. We do not have any really passive tracers. The tracers we use are essentially all subject to some non-passive behaviour (as the authors also acknowledge somewhere later in the manuscript). Please rephrase.

p.2,l.28: I agree, but it may be interesting for the reader to add an explanation of why this may be beneficial.

p.2,l.32: Agreed. But I thought Kirchner et al. (2010) did not only ask the question but also provided some interesting insights. Please rephrase.

p.3,l.2: “…if the evaporated waters then evaporate completely…”. Not sure I understand what you want to express here.

p.3,l.4: agreed, but this is only one possible effect on isotopes. Maybe rephrase to make this clearer. In addition, was it necessary to correct for altitude here? If yes, how was it done?

p.3,l.10-11: or where anthropogenic chloride inputs can be estimated (e.g. fertilizer; Hrachowitz et al., 2015)

p.3,l.18: if they are both transported conservatively(!) with the water then they *need to* yield similar results.

p.3,l.25: please provide references, e.g. Neal et al (2013) or Kirchner and Neal (2013) would fit nicely in here.

p.7,l.14-17: If 65% of the samples were subject to overflow and if the intra-interval isotope variations can be considerable, how reliable is the subsequent analysis then? This would warrant some discussion later on in the manuscript.

p.8,l.10: Kirchner et al. (2004) would fit nicely as reference here.

p.10,l.1: "can" or "are"?

p.12,l.10: ". . .less than 3% of streamflow. . .". When? On average? Or during a specific period?

p.12,l.13-15,21-22: this is obvious. See comment (1) – perhaps a better idea to make this the starting point and then illustrate the effects of it.

p.13,l.18-20: agreed. But should this not be a standard procedure at least since Niemi (1977)?

p.14,l.23-24: see also Hrachowitz et al. (2015)

. References:

Benettin, P., Kirchner, J. W., Rinaldo, A., & Botter, G. (2015). Modeling chloride transport using travel time distributions at Plynlimon, Wales. Water Resources Research, 51(5), 3259-3276.

Harman, C. J. (2015). TimeâĂŘvariable transit time distributions and transport: Theory and application to storageâĂŘdependent transport of chloride in a watershed. Water

Resources Research, 51(1), 1-30.

Heidbüchel, I., Troch, P. A., Lyon, S. W., & Weiler, M. (2012). The master transit time distribution of variable flow systems. Water Resources Research, 48(6).

Hrachowitz, M., Savenije, H., Bogaard, T. A., Tetzlaff, D., & Soulsby, C. (2013). What can flux tracking teach us about water age distribution patterns and their temporal dynamics?. Hydrology and Earth System Sciences 17, 533-564.

Hrachowitz, M., Fovet, O., Ruiz, L., & Savenije, H. H. (2015). Transit time distributions, legacy contamination and variability in biogeochemical 1/fα scaling: how are hydrological response dynamics linked to water quality at the catchment scale?. Hydrological Processes, 29(25), 5241-5256.

Kirchner, J. W., & Neal, C. (2013). Universal fractal scaling in stream chemistry and its implications for solute transport and water quality trend detection. Proceedings of the National Academy of Sciences, 110(30), 12213-12218.

Kirchner, J. W., Feng, X., Neal, C., & Robson, A. J. (2004). The fine structure of waterâĂŘquality dynamics: The (highâĂŘfrequency) wave of the future. Hydrological Processes, 18(7), 1353-1359.

Kirchner, J. W., Tetzlaff, D., & Soulsby, C. (2010). Comparing chloride and water isotopes as hydrological tracers in two Scottish catchments. Hydrological Processes, 24(12), 1631-1645.

Neal, C., Reynolds, B., Kirchner, J. W., Rowland, P., Norris, D., Sleep, D., ... & Vincent, C. (2013). HighâĂŘfrequency precipitation and stream water quality time series from Plynlimon, Wales: an openly accessible data resource spanning the periodic table. Hydrological Processes, 27(17), 2531-2539.

Niemi, A. J. (1977). Residence time distributions of variable flow processes. The International Journal of Applied Radiation and Isotopes, 28(10-11), 855-860.

Printer-friendly version

Discussion paper

van der Velde, Y., Heidbüchel, I., Lyon, S. W., Nyberg, L., Rodhe, A., Bishop, K., & Troch, P. A. (2015). Consequences of mixing assumptions for timeâĂŘvariable travel time distributions. Hydrological Processes, 29(16), 3460-3474.

von Freyberg, J., Allen, S. T., Seeger, S., Weiler, M., & 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.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-290, 2019.