Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2018-301-RC1, 2018

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Real-time observations of stable isotope dynamics during rainfall and throughfall events" *by* Barbara Herbstritt et al.

Anonymous Referee #1

Received and published: 19 July 2018

In this manuscript, the authors present results of a novel method to determine stable isotope ratios of H and O (delta2H and delta18O values) in water of incident rainfall and throughfall below a selected individual tree in high temporal resolution making use of the latest developments in infrared laser spectroscopy.

Overall, the conducted research is sound and the manuscript is well structured. However, the language is sloppy and imprecise and needs to be considerably improved.

In the following, I offer a number of line-by-line comments to improve the manuscript before it can be accepted for publication in Hydrology and Earth System Sciences:

p. 1, l. 1-2: The title is misleading and incomplete. The measurement is not real-time but highly resolved (but with a temporal delay), the considered stable isotope ratios

must be specified, because rainfall and throughfall do not only consist of water but include numerous solutes, which also have to a large part several stable isotopes. Therefore, the title should be something like "Temporally highly resolved measurement of stable hydrogen and oxygen isotope ratios in water of rainfall and througfall with a novel infrared laser-based method" p. 1, l. 6: Like in the title the considered isotopes and their molecule need to be mentioned. p. 1, l. 6: It is unclear what the difference between exchange and mixing is. Add an explanation. p. 1, l. 8 (and throughout the manuscript): It is unclear what you mean by "amount". Do you talk about the rainfall/throughfall rate or volume? Be clear. p. 1, l. 10: What do you mean by "gross precipitation"? The water of the incident rainfall? p. 1, l. 16-18: This three-line statement has (almost) no content. Specify, what exactly makes your method to a tool for more insight. p. 1, l. 20: Tracers of what? Water sources? Water flow paths? Mixing processes? All of them? But then it would no longer be ideal, because usually a tracer is expected to be specific for a single source or a single process. p. 1, l. 21-22: This is again too unspecific. What exactly were water isotopes used for? p. 1, l. 24: What is crucial? The knowledge of the isotope ratios? But there was also a catchment hydrology before the isotopes could be measured and there are catchment hydrologists who do not use water isotope ratios. p. 1, l. 27: "important role" for what? Location, rate and volume of water input into the soil? p. 2, l. 1: The parentheses should be around the year only. p. 2, l. 3: Why should "redistribution in the canopy" have an isotope effect? p. 2, l. 5: The mixing was already mentioned in l. 4. p. 2, l. 6: Perhaps better "deciduous and coniferous" in context with "type", because spruce and beech are plant species. p. 2, l. 7: To what do the numbers refer? Interception loss? Throughfall in % of the rainfall? Vegetation cover? p. 2, l. 8: Enrichment of which isotopes in which compound? p. 2, l. 8-10: Is this really done? The following sentence is much more plausible. p. 2, l. 13-15: This sentence is confusing. I do not understand it. p. 2, l. 16-18: The temporal persistence of spatial throughfall patterns clearly depends on the length of the observation period and on the vegetation type. Please specify both. Furthermore, it is unclear what the cited authors

studied: throughfall volume, rate or water isotope composition? p. 2, l. 20: Are you talking about the same study that you cited just before? Who “hypothesized”? You? p. 2, l. 21: The collection of representative throughfall volume/rate data is a classic in ecosystem sciences and it is rather well known how it can be reached. See e.g., Kimmins, J.P., 1973. Some statistical aspects of sampling throughfall precipitation in nutrient cycling studies in British Columbian coastal forests. Ecology 54, 1008–1019. Do you refer to representative stable water isotope ratios? p. 3, l. 12-14: However, if you want to investigate the mean water isotope ratios of throughfall, you also need a high spatial resolution of your samples to collect a representative throughfall sample as stated earlier in your introduction. Just one pair of samplers above and below the canopy is not sufficient for this purpose. p. 3, l. 24-25: Perhaps, the explanation can be a little bit expanded to avoid that the reader has to consult the cited paper. p. 30: The spatial variability of throughfall cannot be appropriately measured with a single collector of limited size. Usually, a large number of collectors is needed to collect a representative sample. I suggest that you make clear that your results refer to a point measurement, which is very likely not representative for the throughfall at larger scale. p. 4, l. 19: Where was incident rainfall measured? Above the canopy or in an adjacent forest clearing? p. 4, l. 20: Acer campestre (in italics) L. - i.e. spell genus name with upper scale A and include author Abbreviation. p. 5, l. 10: What does this deviation from the meteoric line tell us? What is the reason for non-equilibrium fractionation? The d value only appears in Fig. 6 but is not addressed in the discussion. p. 5, l. 14 (and troughout the manuscript): Capdelta values are given without the lower case delta (i.e. DELTA18O, not DELTAdelta18O). p. 5, l. 20: Why did you chose exactly this event? Add properties of the event (date, total volume, intensity). p. 5, l. 21: “grab” samples, anyway being sloppy jargon, sounds strange in the context of water. I at least cannot grab water... p. 6, l. 13: Usually, one starts with the left figure and then goes to the right one. p. 6, l. 29: “cm^3” is not the unit of an area. p. 6, l. 33: “without bubbles at any contactor” p. 7, l. 11-13: This statement seems almost trivial. What do we really gain by this higher temporal resolution? How

do you interpret Fig. 2? I am a bit disappointed of the depth of the discussion. p. 7, l. 21-22 and Fig. 3: Why do you highlight a non-significant correlation between interception loss and ïĄĎ18O? Furthermore, you should not show a regression line for non-significant correlations. p. 7, l. 22: It is unclear what you mean by “There is no clear pattern...” Perhaps: “The explained variance by any of the considered variables alone was generally small, illustrating the complexity of the processes...” p. 7, l. 24-25: This sentence is confusing. It is clear that a bulk sample represents a mean isotopic signature, while at higher resolution the extreme values can be seen, which is trivial. p. 8, l. 1-2: Furthermore, there is a pronounced spatial variation of throughfall quantity and quality, which cannot be captured with a single collector (see above). p. 8, l. 4: This repeats l. 22 (as the whole Fig. 6 is repetitive of Fig. 2 – albeit for another arbitrarily selected rainfall event). p. 8, l. 7: extent p. 8, l. 11: The ultimate objective would be the prediction of the mean input signal of throughfall into soil for a whole forested catchment or even the spatial distribution of this input signal, which would require much more extensive instrumentation. p. 8, l. 14: I think that “point” level is more appropriate, because you cannot extrapolate your measurement with a single collector to a larger area. Plots I think of are at least 10 x 10 m large and on such plots you might easily need > 10 collectors to measure the mean throughfall properties with an acceptable uncertainty. p. 8, l. 18: I would really be keen to learn about what we can gain by measuring the stable isotope ratios of water at this high resolution. Can we distinguish different processes or even quantify the contributions of these processes to the total throughfall? p. 8, l. 22: I agree that this is crucial, but again point at the problem of spatial representativity of the measurements which cannot be reached with the approach used in this paper. p. 8, l. 28: I wonder whether the authors are aware of the modelling efforts of Rutter et al. (1971), Agric. Meteorol., Gash and Morton (1978), J. Hydrol. and Gash (1979), Q. J. R. Meteorol. Soc. I think that it could be a way forward to add an isotope module to these models. Fig. 3: Add how many events were sampled to the figure legend. Furthermore, part of the lettering is too small. Fig. 4: Number subfigures. Fig. 6: I suggest to combine this figure with Fig. 2. Both figures show stable

isotope results for arbitrarily chosen individual events but only Fig. 6 is accompanied by the necessary information about the (micro-)meteorologic conditions. Furthermore, the d values are only shown but not interpreted. Either you add an interpretation of these results or remove the d values entirely. Furthermore, I am confused by the legend stating “in vapour”. I understood that you indeed measured isotope ratios in vapour produced from a liquid sample in your contactor but you referred these values back to the liquid sample via a temperature-dependent calibration function. Do you indeed want to show the isotope ratios in vapour (not referred back to the liquid sample)? Why?

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