

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

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Response to reviewer comments RC3

We thank you for your thoughtful comments and making us aware of open questions. Please find below a list of specific responses to the individual points.

The discussion paper "Real-time observations of stable isotope dynamics during rainfall and throughfall events" presents a suitable approach for continuous observation of stable water isotope composition in precipitation and throughfall at the plot level. The paper is very well structured and written. The presentation of results is in general very clear and straight forward. I think, however, that the discussion could be extended in order to explain the findings or show that with the given data no explanation is possible.

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The focus of the paper is to test the methodological approach. But as the approach was tested in a natural environment, possible natural influences should be discussed e.g. the possible effect of different initial rainfall  $d_{18}O$  values for different events and and its possible relation to low isotopic ratios for events with antecedent dry conditions. This could be linked to the level of rainout of the air mass before the events. The discussion also lacks relating the results to the existing literature. Some examples are given below, but the revision should not be restricted to these examples. Right now, the discussion only provides two citations and one of it is a self-citation. Beside this, the following specific comments should be addressed before the publication of the manuscript in HESS.

Page 2, Line 5: "These effects": The before mentioned effects include "mixing with water from previous events", which does not affect the mean amount of weekly sampled TF compared to Pg. Please improve the wording.

Response: We inserted "...and the difference in isotopic composition..." after "mean amount"

Line7: Not the absolute interception loss is higher for small events, but the relative loss compared to rainfall.

Response: We rephrased the sentence to "...the volume weighted mean of the interception loss..."

Line 8: Insert "depth" after TF at the end of the line.

Response: Changed as suggested.

Line 13: "isotopic composition" please indicate whether this is related to TF or something else?

Response: We inserted "...of TF".

Line 16: "94 gauges" These are TF collectors?

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Response: We replaced “gauges” by “TF collectors”.

Line 18: Change “temporal” to “spatiotemporal”.

Response: Changed as suggested.

Page 3, Methods: The bulk sampling method needs to be added to the methods section.

Response: We rephrased l. 2-4. It now reads: “From there, a stream of water was pumped to the membrane contactor with a peristaltic pump at a constant flowrate of 5 mL/min while at the same time water exceeding this flowrate was spilled and collected via an additional funnel into a sampling bottle. This overflow was volume-weighted, contributing to the event-based bulk sample.”

Line 32: Delete “when measured below the canopy” as TF can’t be measured elsewhere than below the canopy.

Response: Changed as suggested.

Page 4, Line 7: “periodical back flushing” How often was this done?

Response: We rephrased the sentence to: “. . . could be facilitated by back flushing with deionized water as needed or periodical rinsing (every 2 to 4 weeks) with weak acids, respectively.”

Line 17: As it hasn’t be said until this point that there was 1 collector for rainfall and one for throughfall the reader can’t understand to what “each collector” is referring to. Please clarify.

Response: Thanks, we replaced “each” by “the”.

Line 23-25: Were all these meteorological variables used in the publication? If not than keep only those that were used.

Response: Changed as suggested.

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Page 5, Line 20: “high rainfall intensities” Consider rewording as the reader does not know if “high” is related to this event or to all events sampled.

Response: Will be rephrased.

Line 22-23: Please reword as it is not the samples that are shown but the isotopic ratios of these samples.

Response: We inserted “. . .isotope ratios of discrete liquid, . . .” in l. 21 and replaced “sampling” by “analysing” in l. 23.

Page 6, Line 4: Change “compared” to “correlated to each other”.

Response: Changed as suggested.

Line 5: The authors might add that the correlation is significant, but rather moderate.

Response: Added as suggested.

Line 6: Insert “percentage of” before “interception loss” as the absolute interception loss is probably higher for greater rainfall intensities.

Response: Changed as suggested.

Line 8: There is no positive correlation. The weak correlation is not significant.

Response: Rephrased as suggested.

Line 13: Please rephrase this sentence. “2-2.5 per mille” were not found “in d18O values”.

Response: We rephrased the sentence to “The data of the bulk samples (Fig. 4, right) were grouped into 0.5‰classes. The maximum of 2 - 2.5‰ in Dd18O values was calculated only for two events, while for 23 of the 28 events Dd18O was 1.5‰ or less.”

Line 17: How was dryness or wetness of the canopy before an event started monitored? I assume that dry and wet is interfered from a certain period of time without

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rainfall. This should be described in the revised manuscript.

Response: We inserted "..., i.e. after at least 6 hours without rainfall..." after "dry canopy"

Line 23: If the information about Dd2H is important then I suggest to take it out of the brackets and include it in the sentence with "and" and "respectively". Otherwise it should be omitted.

Response: Changed as suggested.

Page 7, Line 11-12: Is this in line with the literature? E.g. see (Qu et al., 2014). Please extend the discussion.

Response: Will be extended in the discussion accordingly.

Line 21-22: Figure 3 only shows one significant correlation. Please correct this sentence.

Response: Rephrased as suggested.

Line 21: An explanation should be given why there is a negative correlation of rainfall intensity with interception loss. I can imagine that this is in line with what others have found for bulk samples. If possible respective references should be added.

Response: Will be extended in the discussion accordingly.

Line 21-22: Is this in line with results reported in the literature? See e.g. (Dewalle and Swistock, 1994; Kato et al., 2013)

Response: Will be extended in the discussion accordingly.

Line 22: I don't understand what the authors mean with "There is no clear pattern for only one of these variables. . ."

Response: We rephrased the sentence. It now reads "The explained variance by any of the considered variables alone was generally small, illustrating the complexity of the

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processes contributing to interception loss and the transformation of Pg isotope ratios when becoming TF."

Line 26-27: This needs to be related to what was reported earlier in the literature (e.g. Allen et al., 2013).

Response: We rephrased to "This allows for the interpretation that antecedent conditions have a clear impact on isotopic enrichment of TF as also described in previous studies (Keim et al., 2005; Allen et al., 2014; Stockinger et al., 2015; Allen et al., 2017)."

There is more room for interpretation here. For instance, the difference of d18O in rainfall and throughfall is presented for different events and discussed, but the level of d18O of rainfall for different events is not presented.

Response: Added as suggested.

For events for which the degree of rainout from Ocean to inland is low, levels of d18O of rainfall could be higher. Would it be possible that high initial levels d18O in rainfall lead to rather smaller increases of d18O from rainfall to throughfall?

Response: We see your point but currently can't think of a physical reason that would support this hypothesis. We additionally looked at the relationship without finding any significant correlation.

Page 8, Line 7-9: Scatterplots only presented for bulk samples.

Response: We refer to the results shown in Fig. 4 to 6.

Figure 1: For me it is not absolutely clear whether Pg is collected by the same collector for the water that goes through the tipping bucket and that one that is sampled. So is there only one collector for each, Pg and TF, and the water go first through the tipping bucket and then the pump samples the water? Please clarify this in the figure. I think that the triangle within the box illustrates the tipping bucket, right? This must be shown more clearly.

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Response: Changed in Figure 1 as suggested.

Figure 2: Add "depth" after "Time series of rainfall".

Response: Changed as suggested.

Figure 2: In the text it says that the event duration was only 2 hours, but in the legend a "three-hour bulk sample" is mentioned.

Response: In order to also collect the water dripping from the canopy, the throughfall sampler was emptied later. We changed the legend to "bulk sample (event)".

Figure 2: Please provide the date of this event in the legend.

Response: Added as suggested.

Figure 3: I don't the point in part a) and b) of figure 3. The only additional information is the p-value. But the p-value should be added to the left side figure part for all correlations, e.g. in parentheses below the correlation coefficients. If the reason for a) and b) was to have interception on the x-axis, then it should be plotted as the first variable in the left side figure.

Response: p-values are added for all correlations as suggested.

Figure 3: This is not a scatter plot of throughfall samples. Please rephrase the figure caption.

Response: Changed as suggested.

Figure 3: Please indicate in the figure that the intensity is that one of rainfall (and not throughfall).

Response: Changed as suggested.

Figure 3: Please explain in the legend what is shown the lower left und the upper right part of the figure on the left side. Include an explanation, why the size of the correlation coefficients differ. Is that really needed? The small numbers are hard to read.

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Response: Explanation in the legend is added as suggested. The size of the correlation coefficients is changed (all the same size).

Figure 3: I suggest adding d18O of rainfall and throughfall and the length of the antecedent dry period to the scatter plot.

Response: d18O data are added to the scatter plot as suggested. We didn't show the data about the length of the antecedent dry periods because not all relevant time scales were sufficiently represented in our dataset.

Figure 4: Please shift the right figure to the left side as it is mentioned first in the text.

Response: Changed as suggested.

Figure 5: Which of these events are shown in figures 2 and 6?

Response: We added a legend to figure 5.

Figure 5: There are events for which Dd18O increases with time and others with an opposite trend. Does Dd18O correlate with d18O of rainfall per event?

Response: We looked at this relationship without finding a significant correlation

Figure 6: Indicate the date of this event.

Response: Changed as suggested.

Figure 6: Delete "amounts," from the first line of the figure caption.

Response: Changed as suggested.

Figure 6: The colours of d\_Pg and d\_TF are hard to distinguish.

Response: Will be changed in the figure.

Figure 6: Why did throughfall start before rainfall?

Response: Rainfall started before 19:27 already, but data is shown from the time when

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temperature at the contactor was stable.

References: Allen, S.T., Brooks, J.R., Keim, R.F., Bond, B.J., McDonnell, J.J., 2013. The role of pre-event canopy storage in throughfall and stemflow by using isotopic tracers. *Ecohydrology* 7, 858–868. <https://doi.org/10.1002/eco.1408>

Dewalle, D.R., Swistock, B.R., 1994. Differences in oxygen-18 content of throughfall and rainfall in hardwood and coniferous forests. *Hydrol. Process.* 8, 75–82. <https://doi.org/10.1002/hyp.3360080106>

Kato, H., Onda, Y., Nanko, K., Gomi, T., Yamanaka, T., Kawaguchi, S., 2013. Effect of canopy interception on spatial variability and isotopic composition of throughfall in Japanese cypress plantations. *J. Hydrol.* 504, 1–11. <https://doi.org/10.1016/j.jhydrol.2013.09.028>

Qu, S., Zhou, M., Shi, P., Liu, H., Bao, W., Chen, X., 2014. Differences in oxygen-18 and deuterium content of throughfall and rainfall during different flood events in a small headwater watershed. *Isotopes Environ. Health Stud.* 50, 52–61. <https://doi.org/10.1080/10256016.2014.845565>

Please also note the supplement to this comment:

<https://www.hydrol-earth-syst-sci-discuss.net/hess-2018-301/hess-2018-301-AC3-supplement.pdf>

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