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Discussions

Interactive comment on "Temporal-dependent effects of rainfall characteristics on inter-/intra-event stemflow variability in two xerophytic shrubs" *by* Chuan Yuan et al.

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Please see Response to Reviewer #1 at the attached supplement file for the detailed response by the authors.

General Comments: The paper by Yuan et al mainly aimed to characterize the inter-/intra-event stemflow dynamics of two xerophytic shrubs and to quantify their relationships with the corresponding inter-/intra-event rainfall characteristics. They concluded that rainfall characteristics had temporal-dependent influences on corresponding stemflow variables. From my point of view, the study has potential to make a contribution to a better understanding of, in particular, the intra-storm stemflow processes and the

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Discussion paper

underlying mechanisms governing its dynamics. The experimental design and data analysis are generally acceptable, while clarity is needed in presenting the design. The figures adequately summarize the results. I recommend this paper for publication in HESS after some moderate revisions had been addressed by the authors.

Reply: We appreciated the anonymous reviewer for the comments and suggestions, which were of great help to improve the overall quality of this manuscript. The manuscript had been carefully revised, and we tried best to submit a qualified manuscript as required.

R1C2: L 69: Change "initialed" to "initiated".

Reply: Done (Line 73, Page 4).

R1C3: L 72: I would use "leafed period" instead of "leaf period".

Reply: Done (Line 77, Page 4).

R1C4: Section 2.2: What is the time interval for recording rainfall and the stemflow in subsequent section? This needs to be clearly stated.

Reply: Sensors were installed at the meteorological station to record wind speed (Model 03002, R. M. Young Company, USA), air temperature and relative humidity (Model HMP 155, Vaisala, Finland). They were logged at 10-min intervals by a datalogger (Model CR1000, Campbell Scientific Inc., USA) (Lines 142–146, Page 7). We recorded stemflow and rainfall via the Onset® (Onset Computer Corp., USA) RG3-M tipping-bucket rain gauges (hereinafter referred to as TBRG). When the bucket (with resolution of 0.2 mm and the equivalent volume of 3.73 mL) was filled and tipped, data of stemflow or rainfall was stored at the dynamic time interval. It depended on rainfall and stemflow intensities. In general, we recorded meteorological features of WS, T and H at 10-min intervals. However, the rainfall and stemflow was recorded at dynamics intervals between neighboring tips with the fixed 0.2-mm resolution (Lines 221–222, Page 10).

R1C5: L 184-186: According to Table 1, stemflow data of S. psammophila are not available for branches with a BD of 15-18 mm rather than 18-25 mm. Please verify this.

Reply: The typo here of “18-25 mm” had been revised to “15-18 mm” at Line 213, Page 10.

R1C6: Section 2.4: I miss the information about how many rain gauges the authors used in recording stemflow. Did each branch connect to a rain gauge? It seems to be the case from my view of Fig. 1, which makes a total of 14 rain gauges. Please explicitly state to avoid guessing.

Reply: TBRGs had been applied in this study to automatically record stemflow volume and timing. Each TBRG connected to one experimental branches of C. korshinskii and S. psammophila. Seven branches were selected at different BD categories for each species. Therefore, we had installed 14 TBRGs for stemflow measuring in this study. It had been clearly described at the revised manuscript (Lines 220, Page 10).

R1C7: L 203: I would change "base area" to "orifice area", which is a more accurate terminology for rain gauge.

Reply: Done (Line 234, Page 11).

R1C8: L 200-210: As for mL of SFV, it should be calculated as: SFV = [mm (branch stem- flow recorded by tipping-bucket rain gauges) / 10] cm2 (orifice area of a rain gauge). I think the authors missed a 10. Therefore, for the calculation of stemflow volume and stemflow intensity, I suggest that authors provide the corresponding mathematical equations; it would be concise and easier for readers to follow.

eply: Thank you for commenting on the poorly explained data processing at this manuscript. At the previous version of this manuscript, we just gave the factors for calculating stemflow volume (SFV, mL), i.e., stemflow depth recorded by TBRG (SFRG, mm) and orifice area (186.3 cm2). The equation for SFV computation had been described at the revised manuscript (Equation 10) (Lines 235, Page 11). Besides, the definitions and calculations of stemflow intensity (Equation 11–13, Lines 246–248, Page 12), time lags to rains (Lines 252–257, Page 12) and other meteorological features (Equation 1–9, Lines 158–160, Line 164, Lines 184–188, Pages 8–9) had also been clearly described at section 2.2 Meteorological measurements and calculations and Section 2.4 Stemflow measurements and calculations.

R1C9: L 211-215: According to the calculation of TLG, TLM, and TLE, these variables can have either negative or positive values. I encourage the authors to clarify here their respective meanings, i.e., what positive values are suggesting and what negative values are suggesting. Again, it would be easier for readers to better understand their following results.

Reply: Thank you for this comment. Associated with the results in this study, the meanings of positive and negative values of TLG, TLE and TLM had been described at the Section 3.2 Stemflow volume, intensity, funnelling ratio and temporal dynamics at the revised manuscript. During the 54 events, no negative values were observed for TLG and TLM but TLE. It indicated that stemflow generally initiated and maximized after rains started for both species. However, stemflow might be ended before (negative TLE) and after (positive TLE) rains ceased. (Lines 326–329, Page 15).

R1C10: L 258-259: It would be more straightforward to add a row in Table 2 showing how many rainfall events occurred for each category (Event A to C, and others).

Reply: Done (Line 808, Page 40).

R1C11: L 291-298: If it is possible, I would also expect to see some results about the differences of stemflow variables varied among BD categories.

Reply: Thank you for this comment. As suggested, we compared SFI and FR at different BD categories of C. korshinskii and S. psammophila. Shown at Table 4, FR of C. korshinskii decreased from 163.7 at the 5–10-mm branches to 97.7 at the 18–25-

mm branches. The decreasing trend of FR were also noted for S. psammophila in the range of 44.2–212.0, as branch size increased. The results were in consistence with the findings for trees and babassu palms in an open tropical rainforest in Brazil (Germer et al., 2010), in the coastal British Columbia forest with mixed species (Spencer and Meerveld, 2016), for trees (Pinus tabuliformis and Armeniaca vulgaris) and shrubs (C. korshinskii and S. psammophila) at Loess Plateau of China (Yang et al., 2019). Because funnelling ratio was calculated as the ratio between stemflow and rainfall intensities, SFI was also compared at different BD categories. It was negatively related with branch size for both species. As indicated at Equation 14–15 (Lines 264–265, Page 12), the decreasing stemflow intensity with branch size might partly explained the negative relations between funnelling ratio and BD. However, we did not compare all the stemflow variables at different BD categories. Because of the high expense of TBRGs (Turner et al., 2019), no more than two branches were selected for stemflow recording at each BD category. The results were much more convincing to analyze the average stemflow variables among BD categories, and compared them at different rainfall amount categories with enough events for meeting the statistical significance.

R1C12: Section 4.1: I would like to discuss with the authors about the use and importance of stemflow intensity and RSFI. I admit that stemflow intensity would be a good variable to show the dynamics of intra-event stemflow, while I am not convinced by authors about the importance of comparing the absolute values of stemflow intensity versus rainfall intensity (also demonstrated in L26-30 of Abstract). Their study is based on monitoring branch stemflow, and branch stemflow intensity was a bit higher than rainfall intensity in their study. However, in terms of stemflow's ecological and hydrological importance such as in providing additional soil water and sustaining vegetation growth, we pay more attention to the whole tree/shrub (rather than a single branch). From my understanding this variable is highly dependent on the size of a shrub/tree, because a lager shrub/tree (normally has larger basal diameter or canopy area) would generate substantially higher volume of stemflow, therefore stemflow intensity calculated based on collecting from individual trees/shrubs would be far greater than rainfall intensity, as examples please see Fig. 3 in cayuela et al. (2018, Journal of Hydrology) or Fig. 7 in Germer et al. (2010, Journal of Hydrology). Stemflow and rainfall differs in their paths entering into rain gauges; the orifice area makes sense for rainfall because this area is precisely where rainfall falling into and rainfall depth is then normalized, while stemflow is part of intercepted rainfall by the canopy and then comes down stems, which indicates that infiltrating soil area of stemflow is quite different than that of a rain gauge (i.e., orifice area). Therefore this variable may be prone to underestimate stemflow‘s eco-hydrological role for small shrubs, as such, in terms of ecological importance this variable seems to be less appropriate to be used for inter-specific comparison or even intra-specific comparison of varying sizes. Moreover, the authors were also recommending a future combination use of funnelling ratio and RSFI in stemflow studies. While I agree with the authors that RSFI is helpful in better understanding of the intra-event convergence effects, funnelling ratio assumes trunk/stem basal area is the true area that stemflow is delivered to the soil, whereas RSFI here is based on stemflow intensity which I have discussed above. RSFI may also be prone to underestimate stemflow‘s eco-hydrological role for small trees/shrubs while overestimate that of big trees/shrubs. I encourage authors to discuss both the advantages and limitations of stemflow intensity and RSFI as well as their application.

Reply: Thank you for commenting on the calculation and importance of stemflow intensity and RSFI at this manuscript. It indeed underestimated the eco-hydrological significance of stemflow by ignoring its receiving area of branch base as suggested. Therefore, we had revised the calculation of stemflow intensity on basis of basal area, and introduced funnelling ratio to assess the convergence effect of stemflow at the revised manuscript. Please see the detailed explanations as below. (1) Stemflow intensity had been re-computed on basis of branch basal area, and quantitatively connected to funneling ratio. The RG3-M TBRGs had been applied to record stemflow in this study. Stemflow depth (SFRG, mm) could be directly computed with tip amounts and tip resolution of 0.2 mm. Similar with the interpretation for rainfall recording, the 0.2-mm per tip represented 200 mL water deposing on the 1-m2 ground surface. Based at the same receiving areas, we calculated stemflow intensity as the ratio between SFRG and rainfall duration at the previous manuscript. However, it underestimated the eco-hydrological significance of stemflow by ignoring the limited area of trunk/branch base, over which stemflow was received. As suggested at this comment, stemflow intensity should associate with the area over which the equivalent stemflow depth is evaluated. Therefore, we re-calculated stemflow intensity and followed the definition of stemflow volume per basal area per unit time (Herwitz, 1986; Spencer and Meerveld, 2016). In this study, we calculated stemflow intensity at different time intervals, including the event base (SFI), the 10-min (SFI10) and the dynamic intervals between neighboring tips of TBRG (SFIi) (Equation 11–13) (Line 246–248, Page 12). Furthermore, we established the quantitative connections of stemflow intensity with funnelling ratio for the first time as indicated at Equation 14–15 (Lines 264–265, Page 12). RSFI had been deleted at the revised manuscript. By replacing the event-based volume of rainfall and stemflow with their intensities at the traditional expression (Herwitz, 1986), the new method enabled funnelling ratio to be computed at high temporal resolutions within event. (2) Stemflow variables and the meteorological influences were analyzed at branch scale. C. korshinskii and S. psammophila are modular organisms with multiple branches. Each branch of them lives as independent individual which seeks its own survival goals and compete with each other for light and water (Firn, 2004; Allaby, 2010). They provide ideal experimental objects to measure the branch stemflow volume and production processes. By introducing branch basal diameter (BD, mm) as intermediate variable, stemflow volume, intensity and funnelling ratio could be upscaled from branches to shrubs (Yuan et al., 2016; 2017). Therefore, the study on branch stemflow variables was conducive to explain the meteorological influences on stemflow at shrub scale particularly for the modular organisms. To guarantee the representativeness of experimental shrubs and branches, the thorough plot investigation had been carried out. Please see Point (3) at Reply to R2C3 for describing the determination of standard shrubs at the plots of C. korshinskii and S. psammophila, and see Point (4) at Reply to R2C2 for explaining the determination of standard branches

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of the two shrubs. To address the branch scaled measurements of stemflow, the title had been revised as "Temporal-dependent effects of rainfall characteristics on inter-/intra-event branch-scaled stemflow variability in two xerophytic shrubs" as suggested by Reviewers 2 and 3.

R1C13: L 433-437: These sentences are somewhat redundant (have been mentioned in above sections) and can be simplified or simply deleted.

Reply: Done.

R1C14: Figure 3: Data points are average values for 7 branches for each event? Since the authors selected 7 branches of varying BD for each species to measure stemflow, a relative larger difference in stemflow would be expected among branches. It would be an option to adding error bars if they won't make the figure blurring too much.

Reply: Stemflow variables were averaged at seven branches of C. korshinskii and S. psammophila, respectively. Inter-event variations of the average stemflow variables during the experimental period had been shown at Figure 3. The relatively high expense of TBRGs limited the number of experimental branches that could be measured (Turner et al., 2019). However, each experimental branch was carefully selected following the strict criteria. Please see Point (4) at Reply to R2C2 for explaining the representativeness of the selected seven branches. A total of seven branches were selected for automatic recording via TBRGs at different BD categories of each species. That was the comprehensive results by balancing the statistical significance and TBRG expenses. To better meeting the statistical significance, we took the average value of stemflow variables at the seven branches at each species, and focused on the comparison of them among different rainfall amount categories. We just discussed the influence of rainfall characteristics in this study, and no analysises were performed to explore the influence of branch traits affecting stemflow volume and process. The variation of stemflow variables had been described as the average±standard error (Iida et al., 2017) at Table 3 (Lines 817–824, Page 41). However, since eight stemflow variables with 54 recording points each were shown at the same figure, the error bars were not drawn at Fig.3 just to keep the intra-event variation of stemflow variables clean and tidy (Lines 835–837, Page 45).

R1C15: Figure 4:The unit of rainfall stemflow intensity should be mm h-1 rather than m h-1. Also changes should be made in the legend, since both lines and points are included in this figure, it would be misleading by labelling “Lines in blue” or “Lines in red” without mentioning points. Moreover, since 7 branches for each species were selected for monitoring stemflow intra-event dynamics, I am wondering which branches for two species were demonstrated in this figure.

Reply: Done. The typo unit (m h-1) had been corrected to mm h-1, and the misleading legends had been revised, and the branch size of C. korshinskii and S. psammophila had been added at Fig.4 (Line 837–840, Page 46).

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2019-254/hess-2019-254-AC1-supplement.pdf

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