Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-254-AC3, 2019

Hydrology and Earth System Sciences Discussions

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Interactive comment

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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Received and published: 19 August 2019

Please see "Response to Reviewer #2: Prof. Dunkerley" at the attached supplement file for the detailed response by the authors.

General Comments: The authors report on a detailed study of stemflow in two dryland shrub species, and its relationship with rainfall properties. The data come from field observations of selected branches that were equipped with stemflow collecting collars, and exposed to a number of natural rainfall events. Seven branches were instrumented for each of the two shrub species. The stemflow was recorded by directing the flow into tipping-bucket rain gauges having a 0.2 mm sensitivity.

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Discussion paper

Although the work appears to be generally thorough, there are some significant issues with it that I consider require clarification before the work could be accepted for publication.

Reply:

We would like to extend our sincere gratitude to Prof. Dunkerley for these constructive comments and suggestions. They were of great help to improve this manuscript. We have carefully revised this manuscript as required.

R2C1: The authors are concerned with the relative timing of rainfall and of the resulting stemflow. The difficulty here is that the relative timing is affected by the size of the collecting areas that contribute either rainfall or stemflow to the measuring gauges. The canopy of S. psammophila for instance is reported as 21.4 m2 (line 170), whilst the collecting area of the pluviography TBRG in the open is just 0.018 m2. Thus the canopy area of the shrub is more than 1,000 times larger. Therefore, the tiny tipping bucket (capacity about 3.65 mL, by my estimation) can potentially be filled more rapidly by stemflow than by rainfall in the open. In this way, the time until first tip (regarded by the authors as the onset of stemflow) probably occurs closer to the onset of rainfall as a function of canopy area and its effect in reducing the bucket filling time.

Therefore, among the seven instrumented branches, the timing of stemflow initiation should vary, and it might be possible to relate this to the plant morphology. However, the authors do not report the canopy collecting area for the 7 branches that they monitored for each of the two shrub species. Therefore, calculations of the kind just sketched cannot be made nor the results evaluated properly. This imposes uncertainty in the interpretation of the stemflow timing data. The ideal, of course, would be for the collecting area of foliage and branch to be as close as possible to the collecting area of the open-field rain gauge.

Indeed, the manuscript lacks any detail of the foliar area on the branches that were monitored for stemflow. For instance, leaf area and leaf wettability are not mentioned or reported. Likewise, there are no data on the shrub canopies as a whole, such as leaf area index (LAI) or canopy gap fraction. The lack of such information again makes the results somewhat difficult to interpret or to compare with results from other taxa and environments.

Reply:

Thank you for this comment. As suggested by Prof. Dunkerley, the initiation of rainfall and stemflow, and the time intervals between them were indeed strongly affected by the corresponding areas to collect them. Therefore, we had carefully discussed the influence of interception area affecting stemflow volume, depth, fraction and funnelling ratio at 53 branches of C. korshinskii and 98 branches of S. psammophila at Yuan et al. (2016; 2017), including the leaf area of individual branches, branch size, the specific surface area of canopy representing by leaves and stems at both the leafed and leafless states, respectively. By installing TBRGs at 7 branches of each species, this study mainly concentrated the branch-scaled inter-/intra-event stemflow variabilities and the influence of rainfall characteristics affecting them. The influence of leaf area index (LAI) and crown area were not discussed at the shrub scale. The reasons were detailedly explained as below.

(1) Stemflow variables and 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, which could be upscaled to stemflow variables of individual shrubs (Yuan et al., 2016; 2017). The branch-scaled study of stemflow process was conducive to better understand stemflow production at shrub scale particularly for the modular organisms. Therefore, this study focused on the branch-scaled stemflow volume, intensity, temporal dynamics and funnelling ratio of the two species, and analyzed the influences of

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Discussion paper

rainfall characteristics affecting them.

(2) Stemflow variables were averaged at seven different-sized branches of each species.

Seven branches were selected to automatically record stemflow via TBRGs at different BD categories of C. korshinskii and S. psammophila, respectively. 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 as stated at Point (3) of Reply to R2C3 and Point (4) of Reply to R2C2. Thus, we tried best to guarantee the selected experimental branches to represent the experimental shrubs, and the selected shrubs to represent the C. korshinskii and S. psammophila plots in this study. That was the comprehensive results by balancing the statistical significance and TBRG expenses. Average stemflow variables were took at these seven branches to present the branch stemflow variables of the representative shrubs at C. korshinskii and S. psammophila plots. We mainly compared them at different rainfall amount (RA) categories, and discussed the influence of rainfall characteristics affecting them. Therefore, the variances of branch morphologies within species were not relevant to the average branch-scaled stemflow variables. However, they had been described as important background information at Table 1. The canopy traits were also stated at Section 2.3 (Lines 197–199, Page 9).

(3) Recording stemflow process with the tipping bucket rain gauges had been justified.

Tipping bucket rain gauges (TBRGs) provided the intra-event monitoring of stemflow and had been widely applied (Iida et al., 2012), although they underestimated the inflow water with systematic mechanical errors (Turner et al., 2019). The bigger bucket volume might bring the larger underestimation (Iida et al., 2012). Therefore, RG3-M rain gauges were used in this study with the relatively smaller bucket volume of 0.2 mm (the equivalent volume of 3.73 mL, email-confirmed by the Onset company). Besides, we corrected the TBRG recording via the regressions with manual measurements as per

Equation 4 to further mitigate its underestimation (Line 164, Page 8).

TBRGs offered the ability to collect the volume and timing of inflow water throughout an event (Turner et al., 2019). When the bucket was filled by rains and tipped, it was recorded as the beginning of incident rains. Comparatively, stemflow started in a much more complicated manner. Because it could not be initiated until the canopy was saturated. The larger branch leaf area could help to initiate stemflow earlier for trapping more rains, but might also result in a later generation by consuming more rains to wet canopy. Furthermore, stemflow generation also affected by the traveling time from canopy down to branch base, which was strongly affected by the bark roughness. Therefore, compared with the simply positive relation between TBRG orifice area and rains initiation in the clearings, the larger leaf area to intercept rains could not guarantee a quick start of stemflow. Our results indicated C. korshinskii and S. psammophila averagely initiated stemflow 66.2 and 54.8 min later than rains began during the 2014–2015 rainy seasons. Time lags of stemflow generation to rains was also supported by Germer (2010) and Cayuela et al. (2018). In general, TBRG was not perfect to precisely record stemflow timing, but might be the plausible devices to record stemflow process by far.

R2C2: Data processing is poorly explained. Stemflow intensity, given in mm h-1, requires that the volume of water delivered to the TBRG used to record stemflow (recorded in mL per bucket tip) must be associated with the area over which the equivalent stemflow depth is evaluated. I could not see this explained anywhere in the manuscript, and it needs to be made clear. If it was the cross-sectional area of the branch being monitored (typically about 3 cm2 by my rough estimation) then this needs to be set out in the manuscript. If the authors did use basal branch cross-sectional area, then of course the stemflow intensity can easily exceed the rainfall intensity, as a function of the very small area over which the stemflow is recorded as arriving - far smaller than the collecting area of the rainfall pluviograph. If this area were to be doubled, then the stemflow intensity would be halved (and so on). Therefore, the area used by the authors in their calculation needs to be stated (and justified by some relationship to plant water availability). Data processing is also poorly explained in terms of the data on stemflow volume presented by the authors (e.g. in Table 3). Are the stemflow volumes reported there, and discussed at many places in the paper, the sum of the stemflow on the 7 monitored branches, or the arithmetic mean of the stemflow from the 7 branches, or are the figures scaled-up to estimate the stemflow delivered by the entire test shrub? (The test shrubs had a total of 180 and 261 branches (line 173) only 7 of which were monitored for each shrub species (amounting to a sample of 4% and 2.6% of the branches, the adequacy of which is not discussed by the authors). Whatever the authors did, it is not made clear and this needs to be corrected. Especially in relation to stemflow, all relevant parameters used in data processing must be set out clearly and systematically.

Without knowing the details of the calculation procedure, the relative intensity of the stemflow and the open-field rainfalls are difficult to interpret. No formulae are presented by the authors that would allow this to be checked. My own feeling is that the stemflow flux would be a more useful figure - that is, the flow rate delivered to the base of the branch, expressed for instance in mL/minute or L/hour. If this is accompanied by a clearly-stated area over which the flow is tallied, then a stemflow intensity can be calculated.

Reply:

Thank you for this comment. The poorly-explained data processing has been carefully revised. We have detailedly described the definitions and calculations of stemflow volume, intensity, time lag to rains and other meteorological features at the revised manuscript. The representativeness of the selected was stated as below.

(1) Stemflow intensity has been computed following the definition as the stemflow volume per basal area per unit of time.

The RG3-M TBRGs had been applied to record stemflow in this study. Stemflow depth

(SFRG, mm) was computed with tip amounts within event by multiplying 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 truly received. Therefore, following the definition of stemflow volume per basal area per unit time (Herwitz, 1986; Spencer and Meerveld, 2016), we re-computed stemflow intensity with the branch base area at different temporal scales, including the event (SFI), the 10-min (SFI10) and the intervals between neighboring tips of TBRG (SFIi) (Equation 11–13 at Lines 246–248, Page 12). Furthermore, we established the quantitative connections of stemflow intensity with funnelling ratio for the first time (Equation 14 at Line 264, Page 12). By replacing the event-based volume of rainfall and stemflow with their intensities at the traditional expression, this new method enabled to calculate funnelling ratio at both inter-/intra-event scales (Lines 554–555, Page26).

(2) The detailed definition and calculation had been described for stemflow variables and rainfall characteristics.

The definitions and calculations had been described for stemflow volume (SFV, mL) (Equation 10 at Lines 235, Page 11), stemflow duration (SFD, h), time lags stemflow generation (TLG, min), maximization (TLM, min) and ending (TLE, min) at Lines 249–257, Page 12, the regression for rectifying the TBRG recordings with manual measurements (Equation 4) at Lines 164, Page 8, evaporation coefficient (E, unitless) (Equation 1–3) at Lines 158–160, Page 8, the allometric equations for estimating leaf area of branches at C. korshinskii and S. psammophila at Lines 215–218, Page 10.

(3) Stemflow variables had been averaged at different BD categories to analyze the most influential rainfall characteristics affecting them.

Stemflow variables were averaged at different-sized branches to present the branch-scaled stemflow variables of the representative shrubs at C. korshinskii and S. psammophila plots. We carefully checked the results of stemflow variables, and listed the average values of seven branches during rainfall events with different intensity peak amounts at Table 3 (Lines 817–824, Page 41). Please see the detailed description at Point (2) of Reply to R2C1.

(4) Seven representative branches were selected for stemflow recording at each species.

This study selected 4 shrubs for measuring stemflow and 1 shrub for establishing allometric equations of biomass and leaf areas at each species (Yuan et al., 2016; 2017). Please see Point (3) at Reply to R2C3 for a detailed description of the representativeness of selected experimental shrubs. The morphological features had been measured for all the 180 and 261 branches at these 5 shrubs of C. korshinskii and S. psammophila, respectively, thus to determining the standard branches for stemflow recording in this study. BD categories were grouped to guarantee the minimum branch amount at each category for meeting the statistical significance. The ≤5-mm branches were not included in stemflow measurements, because they were too weak to bear the fossil collars for trapping stemflow. Considering the high meteorological sensitivity of stemflow temporal dynamics, we tried best to select the experimental branches at the same shrub, which were most likely exposed to the similar rainfall characteristics. Moreover, the qualified branches should have the outlayer-of-canopy positions, no intercrossing with neighboring ones and no turning point in height from branch tip to base (Lines 209–210, Page 10). Therefore, apart from the ≤5-mm branches at both species, the >25-mm branches at C. korshinskii for not enough qualified individuals, and 15–18-mm branches at S. psammophila for TBRG malfunctioning, there are averagely 28 and 41 branches available for stemflow recording per shrub of C. korshinskii and S. psammophila, respectively (Table R2-1 as below). Finally, 7 branches were selected at each species, which took 25.0% and 17.1% of the available ones per shrub at C. korshinskii and S. psammophila, respectively. Additionally, the high expense of TBRG was an important reason to limit the amount of experimental shrub and branch for automatic recording of stemflow (Turner et al., 2019).

Table R2-1. Branch morphological features of the experimental shrubs of C. korshinskii and S. psammophila.

R2C3: In summary, what I find to be missing from the manuscript includes

-some discussion of why 7 stems were studied and whether this is a sufficient sample

-some consideration of the filling time of the buckets in the tipping-bucket gauges used for rainfall and stemflow measurement, and the effect of this on the lag time before the start of stemflow (and the cessation of stemflow after rain ends)

-more detail on the shrubs - including the variability of canopy size etc across the population from which the two sample shrubs were drawn, and some information on leaf area and wettability, if available

-a proper accounting of how stemflow flux was calculated and how the area over which the intensity was scaled was selected.

Reply:

(1) Please see Point (4) at Reply to R2C2 and Point (3) at Reply to R2C3 for explaining the representativeness of selected 7 branches and 4 shrubs for stemflow recording, respectively.

(2) Although TBRGs offered the ability to collect stemflow production at high temporal resolution and time lags to rain, they suffered from systematic errors owing to the rate of water delivery to tip buckets (Turner et al., 2019). The TBRGs missed the records of inflow water during tipping intervals, and they consumed water to wet buckets at the beginning (Groisman and Legates, 1994). The calibration was needed to rectify the volume recordings via regressions with the manual measurement results. However, it

was difficult for rectifying the temporal data currently. Therefore, applying the TBRG with relative high accuracy was necessary. Iida et al. (2012) reported that the tipping time increased with the bucket volume by comparing different models of TBRG, including the RG3-M (3.73±0.01 mL), OW-34 (15.7±0.3 mL), UIZ-TB20 (198.3±3.3 mL), TXQ-200 (188.7±10.3 mL) and TXQ-400 (403.9±6.9 mL). We chose RG3-M with the small bucket volume of 3.73 mL to mitigate the underestimation in this study. Please see Point (3) at Reply to R2C1 to justify the feasibility of applying TBRGs.

(3) The plot investigations had been carried out at April of 2014 for the 20-year-old C. korshinskii and S. psammophila. For C. korshinskii, three subplots with the size of 5 m×5 m had been selected along the plot diagonal, including subplot A (5 shrubs) and C (6 shrubs) at the ends and subplot B (6 shrubs) at the middle. As indicated at Table R2-2 as below, the average canopy height and area were 1.9±0.1 m and 4.8±0.6 m2, respectively. Because the runoff and sediment plots had already been constructed at the center of S. psammophila plot (Fig. R2-1 as below), we selected the subplot (13 shrubs) at northeastern part with the size of 20 m×20 m. The average canopy height and area were 3.5±0.2 m and 19.1±2.2 m2, respectively (Table R2-3 as below). Thus, standard shrub could be determined to represent the two plots. Finally, five experimental shrubs of each species had been selected for stemflow measurements and allometric equation establishments of C. korshinskii (2.1±0.2 m and 5.1±0.3 m2) and S. psammophila (3.5±0.2 m and 21.4±5.2 m2), respectively.

As stated at Point (4) of Reply to R2C2, the standard branches could be determined and seven branches were finally selected for stemflow recording. According to the allometric equations established for estimating leaf area of individual branches (LA, cm2) (Yuan et al., 2016; 2017), LA of experimental shrubs were estimated in the range of 837.7–6394.7 cm2 and 626.3–7513.7 cm2 at different BD categories for C. korshinskii and S. psammophila, respectively (Table 1 at Lines 805–807, Page 39). Rainfall intervals, the time intervals between neighboring rains (RI, h), was applied to indirectly represent the branch wettability. The drier barks could be estimated when RI was larger.

The results of MCA and stepwise regression indicated that RI tightly corresponded to time lags of stemflow ending, but there was no significant quantitative relationship between them for for C. korshinskii ($R2=0.005$, $p=0.28$) or S. psammophila ($R2=0.002$, $p=0.78$) (Fig.7) (Lines 846–847, Page 49).

Table R2-2. Investigation of canopy morphology at C. korshinskii plot.

Table R2-3. Investigation of canopy morphology at S. psammophila plot.

Fig. R2-1. The established runoff and sediment plots at the S. psammophila plot.

(4) Stemflow intensity had been re-calculated on the basis of branch basal area. Please see the detailed description at Point (1) of Reply to R2C2.

R2C4: More detailed comments:

lines 49-50: it is difficult to generalise from these few data to all "water stressed regions" (and need to define what a water-stressed region is)

Reply: Done. We have revised the “water-stressed regions” into “dryland ecosystems with annual mean rainfall ranging in 154–900 mm” (Line 53, Page 3), which was cited from the reporting of Magliano et al. (2019).

R2C5: line 57: mL/g of what? biomass?

Reply: It was the unit of stemflow productivity (Yuan et al., 2016; 2017), which represented the stemflow volume of unit biomass. The description has been added at Line 57, Page 3.

R2C6: line 61: a flow in units of mL/min is a flux, not a speed

Reply: Done. We change the “speed” into “flux” at Line 61, Page 3.

R2C7: line 69: should presumably say ’not until AFTER canopies became saturated’

Reply: Done (Line 73, Page 4).

R2C8: line 70: need to define RA when this contraction is first used. It is used again in line 138 before being defined.

Reply: RA has been firstly used and explained at Line 52, Page 3.

R2C9: line 76: missing a space before 0.4

Reply: Done.

R2C10: lines 77-78: need to include branch surfaces also line 83: need to state which measure is maximized

Reply: Done. "branch surfaces" has been included at Line 79, and the "stemflow flux" has been stated at Line 84 of Page 4 at the revised manuscript.

R2C11: line 85: explain why time lags are important: presumably the last stemflow would occur as a very small (negligible) flux, so why is the timing of the last stemflow important? More generally, the authors could say something about why the time variation of stemflow during rainfall is important. Do peaks of stemflow flux exceed soil infiltration capacity, perhaps? Otherwise, why is this important?

Reply: Thank you for this comment. Stemflow might take a minor part of rainfall amount, but it greatly contributes to the survival of xerophytic plant species (Návar, 2011), the maintenance of patch structures in arid areas (Kéfi et al., 2007), and the normal functioning of rainfed dryland ecosystems (Wang et al., 2011) (Lines 52–57, Page 3). Previous studies failed to depict stemflow processes and quantify their relations with rainfall characteristics within events, particularly for xerophytic shrubs (Lines 20–23, Page 1). Time lags of stemflow generation, maximization and ending to rains depicted dynamic stemflow process, and were conducive to better understand the hydrological process occurred at the interface between the intercepted rains and soil moisture (Sprenger et al., 2019). It was important to discuss the temporal persistence in spatial patterns of soil moisture particularly at the intra-event scale (Gao et al., 2019) (Lines 86–92, Pages 4–5).

R2C12: line 100: no need to repeat the number of rainfall events here, and again in line 222 and again in line 248. Once is sufficient.

Reply: Done.

R2C13: line 106: please define 'stemflow intensity' and provide a formula somewhere in the paper

Reply: Done. The definition and formula had been detailedly described at Lines 236–248, Pages 11–12.

R2C14: line 139: please explain what 'analogue' means here

Reply: Done. The "analogue period of time to dry canopies from antecedent rains" had been revise to "same period of time to dry canopies from antecedent rains as that reported by Giacomin and Trucchi (1992), Zhang et al. (2015), Zhang et al., (2017) and Yang et al. (2019)" at Lines 168–170, Page 8.

R2C15: lines 147-148: all these timing data are a function of the tipping-bucket filling time (see discussion earlier in this report). When using a TBRG, it is difficult to tell precisely when rain begins or ends, owing to the time that might be required to fill the first tipping- bucket.

Reply: The better understanding of stemflow temporal variables was conducive to address the eco-hydrological importance of stemflow as stated at Reply to R2C11. TBRG was not perfect to precisely record stemflow timing, but might be the plausible devices to record stemflow process by far. Please see Point (3) at Reply to R2C1 for justifying the usage of TBRGs to record stemflow process.

R2C16: line 153: how is raindrop morphology reflected in this? please explain

Reply: The raindrop momentum was calculated with raindrop size and velocity as indicated at Equation 5–9 (Line 184–188, Page 9), which represent the comprehensive effects of raindrop morphology (size) and kinetic energy (velocity).

R2C17: line 160: why is mean intensity used here?

Reply: The average rainfall intensity was used here to compute the average raindrop diameter and finally raindrop momentum on event base. The 10-min maximum raindrop momentum (F10, mgÂůmÂůs–1) and the average raindrop momentum at the first and last 10 min (Fb10 and Fe10, respectively, mgÂůmÂůs–1) could be calculated with I10, Ib10 and Ie10 as indicated at Equation 5–9 (Line 184–188, Page 9), respectively.

R2C18: line 168: since this paper reports a study of branch stemflow only, the title of the paper should be amended to indicate this clearly (i.e., not a study of stemflow on an entire plant)

Reply: Done. We have revised the title to "Temporal-dependent effects of rainfall characteristics on inter-/intra-event branch-scaled stemflow variability in two xerophytic shrubs" as suggested as Reviewer 3.

R2C19: line 171: to what extent were the studied shrubs representative of the wider population? please present some data.

Reply: C. korshinskii and S. psammophila were the dominant shrub species at the arid and semi-arid regions of northwestern China, including Inner Mongolia Autonomous Region, Ningxia Hui Autonomous Region, Xinjiang Uygur Autonomous Region, Qinghai province, Gansu province, Shaanxi province, Shanxi province (Chao and Gong, 1999). Since both species had good drought tolerance, they were commonly planted for soil and water conservation, sand fixation and wind barrier (Li, 2012; Hu et al., 2016; Liu et al., 2016; Zhang et al., 2018). As the typical xerophytic shrub species at this region, they had extensive distributions particularly in arid and desert steppes (Li et al., 2016) at Lines 129–132, Page 6. Besides, please see Point (3) at Reply to R2C3 for explaining the representativeness of the selected 4 experimental shrubs for the C. korshinskii and S. psammophila plots.

R2C20: lie 181: please explain what is meant by 'canopy skirt locations'. The photos suggest that there were many overhanging leaves and branches. Some of the stemflow collars were placed quite high off the ground (as far as can be judged from the photos, as no quantitative information on this is included in the paper). How do the authors know that the stemflow at these heights would actually reach the ground, and not drip off the branches?

Reply: The "canopy-skirt locations" has been revised to "the outlayer-of-canopy" at Lines 210ïijŇ Page 10. The photo shot the lower part of branches to show foil collar and TBRG for stemflow trapping and recording, which might not provide a very clear view of leaves on the upper branches. In contrast to the centered branches, stemflow of branches at the outlayer got less influences from the neighboring ones. We automatically recorded stemflow volume and timing via the RG3-M TBRG with height of 25.7 cm. Therefore, the foil collars were installed at branches nearly 40 cm off the ground (Lines 223–224, Page 11). It might be the minimum height for foil collars so as to keep the hose straight, which channelled stemflow down to TBRGs. The lost by dripping off was believed to be acceptable, compared with the commonly-used method to trap stemflow at breast height (1.2 or 1.3 m off ground) at tress particularly at rainforest, where the stemflow volume was much larger.

R2C21: line 189-190: what was the external diameter? this should be included as the dimensions of the stemflow collars are critical - it does not seem sufficient simply to assert that they caught no rainfall or released drips of throughfall from above.

Reply: The "external diameter" has been revised to "orifice diameter" at Line 234. The limited orifice diameter of foil collars minimized the accessing of throughfall and rains into them (Yuan et al., 2017) (Lines 225–227, Page 11).

R2C22: line 270: how were rainfall intensity peaks identified? What makes one peak an intensity peak?

Reply: SFIi, the instantaneous stemflow intensity, was computed in terms of the tip volume (3.73 mL), branch basal area (mm2) and time intervals between neighboring tips recorded by TBRGs as indicated Equation 13 (Line 248, Page 12). The largest SFIi was defined as the peak intensity at the incident rains.

R2C23: line 292: is the reference to the volume from a single branch or the total from the 7 branches?

Reply: We focused on the average stemflow variables of 7 experimental branches, and analyzed the most influential rainfall characteristics affecting them. Please see the detailed explanation at Point 2 of Reply to R2C1 and Point 3 of Reply to R2C2.

R2C24: lines 300-310: this is difficult to read, owing to the need to recall the meaning of the very many contractions. Some reminders of what these mean would be useful here.

Reply: As indicated at the suggestion commenting at Line 70 of R2C5, the contraction was only explained when it was first used. For an easy reading, the list of symbols had been prepared as appendix at the revised manuscript (Lines 592–593, Pages 27–29).

R2C25: line 342: a stemflow intensity of 1232 mm h-1 is large. What was the flux? I presume that in the case of the authors own work in the present study, the flux was within the capacity of the tipping-bucket gauges (typically a few hundred mm h-1 at maximum) since the rainfall was not very intense. Some comment on this would be worthwhile.

Reply: As indicated at the manual of RG3-M TBRG (https://www.onsetcomp.com/products/data-loggers/rg3-m), data could be automatically recorded at rains with the maximum intensity of 127 mm·h–1. The unit depth (mm) of inflow water recorded by TBRG was interpreted to the equivalent 1000 cm3 water on the 1-m2 ground surface. However, stemflow intensity was computed with branch basal areas. It approximately ranged in 34–770 mm2 for C. korshinskii and S. psammophila in this study, which took less than 0.8‰ of 1 m2. Therefore, it could be estimated that the RG3-M TBRG offers the ability to record stemflow with the maximum intensity greater than 15000 mm·h–1.

R2C26: lines 383-384: but these fluxes would surely depend on the antecedent leaf and branch wetness, and on meteorological conditions such as wind speed and vapour deficit (the latter is not reported, incidentally).

Reply: Thank you for this comment. The evaporation coefficient (E, unitless) had been included at the revised manuscript. E was computed with air temperature, relative humidity and wind speed as indicated at Equation 1–3 (Lines 158–160, Page 8). It represented the comprehensive influences of these meteorological characteristics. By performing the multiple correspondence analysis (MCA), E and rainfall duration (RD) were tested to closely relate with stemflow duration (Lines 360–362, Page 17). However, the stepwise regression analysis finally confirmed the dominant influence of RD affecting SFD (Lines 381–382, Page 18). Rainfall intervals, the time intervals between neighboring rains (RI, h), was applied to indirectly represent the branch wettability. Please see the detailed description at Point (3) at Reply to R2C3.

R2C27: Table 2: why are only 3 rainfall events listed here? More than 40 more are simply lumped under "others" and no details are provided. Why?

Reply: Event A, B and C represented three categories of events with the single, double and multiple intensity peak amounts. It had been described at the note of Table 2 (Lines 808–816, Page 40) and Section 3.1 (Lines 301–303, Pages 14). There were 17, 11 and 15 events at Event A, B and C, respectively. Because the remaining 11 events had the average RA of 0.6 mm, no more than three recordings had been observed within event which was limited by 0.2-mm resolution of TBRGs. Therefore, they could not be categorized and grouped as Event others (Lines 303– 06, Page 14).

R2C28: Figure 4 shows units of m/h which I presume should be mm/h

Reply: Done.

Reference: Allaby, M.: A Dictionary of Ecology, 4th Edition., Oxford University Press, Oxford, 2010.

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Fig. 1. Fig. R2-1. The established runoff and sediment plots at the S. psammophila plot.

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Table R2-1. Branch morphological features of the experimental shrubs of *C. korshinskii* and *S. psammophila*.

BD categories	*C. korshinskii*				*S. psammophila*			
	BD (mm)	BL (cm)	BA (°)	BN	BD (mm)	BL (cm)	BA (°)	BN
≤5	4.1	90.4	64.1	40	4.8	166	66	2
5–10	7.3	124.9	61.8	82	8.0	204	64	53
10–15	12.5	161.1	51.7	36	12.9	253	58	82
15–18	16.3	170.6	48.7	13	16.5	280	52	56
18–25	19.3	192.3	51.3	9	20.3	302	50	59
>25	NA	NA	NA	NA	28.7	366	50	9

Note: BD, BL, BA and BN are the basal diameter, length, angle and number of branches.

Fig. 2. Table R2-1. Branch morphological features of the experimental shrubs of C. korshinskii and S. psammophila.

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Table R2-2. Investigation of canopy morphology at *C. korshinskii* plot.

Plots	Shrubs	Canopy heights (m)	Canopy area (m^2)
A	1	1.7	4.6
	2	1.2	2.1
	3	1.9	3.7
	4	1.4	2.5
	5	2.0	5.7
B	6	1.7	5.5
	7	1.8	4.3
	8	1.8	3.8
	9	2.1	6.8
	10	2.5	11.6
	11	2.3	6.7
C	12	1.3	3.4
	13	1.9	5.9
	14	1.9	2.7
	15	1.8	2.8
	16	2.0	4.0
	17	2.2	5.5
Average		1.9±0.1	4.8±0.6

Fig. 3. Table R2-2. Investigation of canopy morphology at C. korshinskii plot.

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Table R2-3. Investigation of canopy morphology at *S. psammophila* plot.

Shrubs	Canopy heights (m)	Canopy area (m^2)
1	3.8	24.0
2	3.8	18.5
3	3.6	21.8
4	3.7	24.0
5	3.2	20.6
6	2.6	13.2
7	2.9	5.8
8	3.3	25.9
9	3.2	8.3
10	4.4	22.5
11	4.4	29.7
12	2.9	7.4
13	3.8	25.7
Average	3.5±0.2	19.1±2.2

Fig. 4. Table R2-3. Investigation of canopy morphology at S. psammophila plot.

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