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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Measurement and modelling of rainfall partitioning by deciduous *Potentilla fruticosa* shrub on the Qinghai-Tibet Plateau, China" *by* Si-Yi Zhang and Xiao-Yan Li

Si-Yi Zhang and Xiao-Yan Li

zdxzqyzsy@163.com

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Dear J. Van Stan,

We would like to thank you for your valuable and constructive comments. The comments are very helpful to the improvement of the manuscript, and will be well incorporated into the revision of the paper. The following paragraphs respond to your comments one by one.

General comments:

Manuscript #2016-589 by Zhang and Li examines/models rainfall partitioning of a shrub species in an alpine semiarid site (Qinghai Lake, China). Although there are some

interesting aspects (i.e., directly measured variable canopy structural parameters in the model), my opinion is that this study does not require publication in an international top-tier journal outlet. Thus, I recommend rejection from HESS. Rather, I believe this study is better suited for a journal outlet focused on the region within which it is situated as substantial (and excellent) work has already been published on the precipitation partitioning of plant canopies in this area (the authors' works cited section includes many examples). Yes, this study adds one more shrub species to the list of plants studied (with some details on canopy structural variability), but is that broad enough? Besides this issue, I have other concerns:

Thanks! This study not only adds one more shrub species to the list of plants studied, what is more important, this study adapts the revised Gash model according to the seasonal change of canopy structures of deciduous shrubs, which is rarely reported before. The new version model performs better than the original model and can be used in other deciduous ecosystem.

The modelling of rainfall partitioning on a deciduous shrub is rare. Although there are a lot of work has already been published on the precipitation partitioning of shrubs, the modelling of precipitation partitioning of shrub is not as common as that of forests (Muzylo et al., 2009), partly due to the difficulty of water flow measurement techniques for shrubs (David, 2010). The published models are firstly developed for forest. The canopy structures of shrubs are obvious different from those of forests. Some canopy structure parameters of shrub can be much easier to be directly measured than those of trees because that the shrub is smaller than tall trees. What is more, in most published researches, the model parameters of canopy structure and some weather condition are set as constants (Muzylo et al., 2009). However, the canopy structure often changes seasonally. Especially, the deciduous vegetation canopy changes greatly from leafless to leafed season. This paper focused on the influence of the characteristic of a short shrub canopy and its seasonal changing on the rainfall partitioning. Deciduous shrubs are common top biological communities in arid or semiarid region, not limited in the

Qinghai-Tibet Plateau, China. The new version of model can be applied to similar ecosystem with deciduous shrubs.

1) Methods are missing details. Specifically... 2) **Was only 1 rainfall gauge used? For the past several years, rainfall measurement protocols have necessitated three rainfall gauges (i.e., see International Cooperative Programme – ICP Forests). If only 1 rainfall gauge was used, please justify and acknowledge the difference between this study and current standard rainfall measurement protocols.

Yes, only one rainfall gauge was used. The same as the technical recommendations of ICP Forests, the rainfall gauge was located in a relatively flat, open area, and about 1 m above the ground. The canopy had no influence on the rainfall gauge as its height is much lower than the that of the rainfall gauge. It is common to use only one or two rainfall gauges in local gross rainfall measurement in rainfall partitioning researches according to what I know (eg: Muzylo et al., 2012; Návar, 2013; Macinnis-Ng et al., 2014). And I do not find that the rainfall measurement protocols have necessitated three rainfall gauges in the downloaded Meteorological Measurements MANUAL from http://www.icp-forests.org/pdf/manual/2016/Manual_Part_IX.pdf.

**How were the few throughfall gauges distributed in the patches? Seeing as very few throughfall gauges were deployed (see point 2) and throughfall is spatially heterogeneous, knowledge of the arrangement of gauges is necessary to provide the reader an idea of how well represented the spatial heterogeneity was in the study's observations. Since there were so few gauges, were they roved around? Other concerns about throughfall observations shared later (see point 2)

Thanks! The shrub patches are relatively homogeneous with dense and short stems. It is difficult to deployed too many and too large throughfall gauges, because larger gauges might stick on the stems and collect the stemflow. We had put more throughfall gauges in the patches in the experiment, but we found some throughfall was anomalous later, those stuck on stems had collected much more water, even more than the

gross precipitation, maybe some from the stemflow. These conditions are very different from those of forests. The anomalous throughfall was not included in our analysis. We also found the spatial heterogeneity of throughfall in a patch is little. We deployed six gauges in the patches cores and three within the boundary.

**What were the dimensions of the stemflow collection devices? It is mentioned that "sinks" of aluminum foil (P6, L12) were used to collect stemflow. How big was the sink area? Sinks that extend far from the shrub stem may be gathering throughfall as well as stemflow. This might explain stemflow accounting for nearly 30% of gross rainfall – a rather high, albeit possible, proportion. Knowing the dimensions of the stemflow "sink" will strengthen (or weaken) confidence in the quite large stemflow production. Also, how long after a storm event were stemflow gauges manually measured? If stemflow measurements were not taken immediately after a storm, were there efforts to minimize evaporation losses from the collectors? Other concerns about stemflow observations shared later (see point 3)

Thanks! We made the sinks as small as possible as the rain intensity in the region is small. The sinks edges were about 1$\sim$ 2 mm away from the wrapped shrub stems (Figure 1). The throughfall fell in the sinks was less than 1.5% of the stemflow and it was ignored. The stemflow gauges were nearly sealed with one small hole 5 mm in diameter connecting the plastic tube for the stemflow draining in and one small hole about 3 mm in diameter for air discharge. The air discharge hole was opened for air pressure balance when the stemflow flowed in. The evaporation losses from the collectors through the two small holes was little and could be ignored.

Figure 1 Stemflow collection apparatus on a branch (photo courtesy of Si-Yi Zhang)

3) Throughfall variability may have been too under-sampled. There were very few throughfall collectors (n = 9 total, n = 3 per plot: P7, L11-14) each with a small collection area (3.34 cm diameter: P76, L12), which likely prevents accurate throughfall estimation considering the well-documented spatial variability of throughfall. 4) Thanks! The

shrub patches are relatively homogeneous with dense and short stems. It is difficult to deployed too many and too large throughfall gauges, because larger gauges might stick on the stems and collect the stemflow. We had put more throughfall gauges in the patches, but we found those stuck on stems had collected much more water, even more than the gross precipitation, maybe some from the stemflow. These conditions are very different from those of forests. The anomalous throughfall was not included in our analysis. We also found the spatial heterogeneity of throughfall in a patch is little. We deployed six gauges in the patches cores and three within the patches boundary.

5) Stemflow estimates may not be representative due to selective sampling. Stemflow observations were selected from very few storms (n = 8: P6, L16). Did these storms represent the continuum of storm magnitudes and intensities generally experienced at the site? If not, meteorological conditions that favor stemflow generation may explain the high stemflow proportion. Stemflow observations were also selected from very few stems (n = 6: P6, L17). Where were these stems located in the patches? Were they on the edge or interior to the shrub patch? Were the patched trimmed to install stemflow collars (which may create an artificial edge effect)? This is important to know as location within the patch can affect stemflow generation. Also, how did the selected stems, and canopy draining to those stems, compare to the range of canopy characteristics at the site? 6) Stemflow observations was measured eight times during the study period, i.e., 11, 20 and 29 June, 17 and 31 July, 22 August and 2 and 11 September, respectively. Unfortunately, some stemflow and throughfall data was missed in July 17, 2012. The other seven periods included 55 storms (See Table 3 in the original ms, q: The number of rains which generated stemflow) ranging from 0.2 mm to 106.2 mm. The average rainfall duration and intensity were 11.17 h and 0.9 mm h–1. The mean max 10 min rainfall intensity is 0.8 mm per 10 min with a max of 10.4 mm per 10 min, equaling 4.8 mm h-1 and 624.0 mm h-1, respectively. There were 12 rainfall events whose max 10 min intensity were larger than 1.6 mm per 10 min (9.6 mm h-1), accounting for 311.4 mm and 58.6% of the total rainfall amount. These storms can represent the continuum of storm magnitudes and intensities generally experienced at the site.

Four of the six stems were interior to the shrub patch and other two were on the edge. The patched were not trimmed to install stemflow collars. The typical stems were selected representing different diameters, stem length, coverage and location.

7) I have some minor concerns with the edits to the reformulated Gash model in this study. I say “minor” because it is regarding only 2 assumptions that simplified evaporation estimates: 8) (a) The authors’ assume that “shrub canopy evaporation has no difference from the stem evaporation” (P10, L18 – P11, L1) but provide no data in support of the assumption. Without data supporting the authors’ claim, I’m inclined to believe that stem and canopy evaporation rates would be different due to reasons commonly identified in past literature: (i) canopy shading the stem, (ii) different albedo of leaf and stem sur- faces, (iii) wind speeds being reduced from canopy edge to the interior stem, and (iv) complex stem bark surfaces (like shown in Fig. 3b) may shelter entrained water from meteorological conditions driving evaporation. (b) Thanks. We agree to the fact that there is difference between the stem and canopy evaporation rates due to the reasons the reviewer identified. We proposed this assume just think it could be better than the original assume that the trunk evaporation only happens in the drying out period. The original assume of course is not the real fact, too. Especially, in the leafless period, rain can fall on the stems and then evaporated directly. The shading of the leaf canopy was considered, and the evaporation rate of the wet stems is , where cl,j and cs is the leaf and stem coverage, respectively, and is the evaporation rate measured by Bowen ratio and energy balance method. The evaporation is a complicated process, and it is difficult to distinguish evaporation rates on different surfaces. The original and present assumes both are for simplify in modeling these process.

(c) The authors’ also assume that “evaporation from the canopy and from the ground is equal, because the height of the shrub is only about 35 cm”; however, the physical drivers of evaporation can differ between the ground and shrub canopy despite modest differences in elevation. (d) Thanks! The same as the previous question, we agree with what you said. We proposed this assume just think it could be better than the original assume which ignoring the ground evaporation. The ground of the shrub patch intervals is covered by herbs, and the herbs also intercepts precipitation. The herbs coverage is much higher than the shrub coverage. As the height of the shrub is only about 35 cm, the ground evaporation could not be ignored. In a similar ecosystem, Zheng (2015) reported that in the growing season, the mean evaporation rates for the shrub and nearby grass land were 2.80 mm d-1 and 2.52 mm d-1, respectively. The results of Zheng (2015) showed that the evaporation rates of the two parts can be roughly equal and the grass land evaporation should not be neglected.

9) The manuscript is in need of significant English language editing. As it would take too much time to identify and suggest changes for all of the necessary language editing, an example in each section are provided to guide the authors during their revisions: 10) Thanks! The English will be improved throughout the text by an English language editing company before it is resubmitted.

Abstract, P1, L10– "has not get enough attention" should be "has not gotten enough attention". . . but, my opinion is that the language shouldn't be so colloquial. It would be better to state something like "has not received enough attention"

Thanks! It has been modified as "has not received enough attention".

Introduction P2, L11– "The gross precipitation reaches the canopy. . ." should be "The gross precipitation that reaches the canopy. . ." and the authors incorrectly state that the canopy partitions precipitation only into interception, stemflow and "free" throughfall. This ignores all "release" throughfall produced from canopy contact. Why not just say "interception stemflow and throughfall" as the general term "throughfall" implies the sum of free and release throughfall?

Thanks. We have modified the sentence according to your suggestion.

Methods P6, L7– "rainfall events were discretized by assuming without rainfall between events of 12 h. . ." should be something like "rainfall events were discretized by assum-

ing a minimum inter-event time of 12h. . ." Minimum inter-event time is a common term in precipitation partitioning literature (i.e., Dunkerley, 2015, Hydrol Process, 29, 3294 and Llorens et al., 2014, J Hydrol, 512, 254). I would also recommend the authors' follow the convention for introducing species: latin name (taxonomic authority, common name). Thereafter, the use of the abbreviated latin name is typically used.

Thanks a lot. The sentence "rainfall events were discretized by assuming without rainfall between events of 12 h. . ." was modified as your suggestion.

Results P15, L13 – I think the line "which occupying 14.4% of the total observed interception" should be "which accounted for 14.4% of the total observed interception"

Thanks. We have modified the sentence according to your suggestion.

Discussion P17, L11-12 – "The proportion pt also has important in the stemflow of course" needs to be rewritten for clarity as I'm unsure what the authors are saying.

It is rewritten as "The proportion pt also has important influence in the generation of stemflow of course, as it determines the percentage of interception that converts to stemflow."

Conclusion P26, L9 to P27, L2 – this statement is unclear. Does "available water that free fell and drained along the stem" mean "stemflow"? Why would "free" falling droplets "drain along the stem"? Or, does this statement simply mean "throughfall and stemflow"? Please revise for clarity.

Thanks! The sentence was revised as: 21.44% of gross rainfall was intercepted by the canopy, throughfall and stemflow, accounting for 29.26% and 49.30% of gross rainfall, respectively, were available water that reached the soil ground during the growing season of 2012.

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Fig. 1. Figure 1 Stemflow collection apparatus on a branch