Response to Comments of Referee #2

We would like to thank anonymous Referee #2 for his/her remarks, which would help us further revise the manuscript. We take this opportunity to clarify this research and its contribution. First of all, despite the recognition of potentially large effect of stemflow and associated processes on the hydrologic budget, few, if any, studies have simultaneously evaluated the hydrologic fluxes redistributed by above-ground shrub stem and below-ground root with stemflow and preferential flow, respectively, under natural rainfall condition. This makes our research a good case study for connecting ecohydrology and hydropedology at the individual shrub scale. The purpose of this study was to evaluate the effects of rainfall variability and shrub species on stemflow generation and then the impact of stemflow on preferential flow induced by the presence of roots, which is connected to water distribution in the soil. While Referee #2 emphasized preferential flow (especially finger flow) in his/her two main reasons for rejecting this paper in its current form, preferential flow (especially finger flow) was not the main target of this study. As stated in p. 1555 line 17 onward, “the objective of this study was to make an attempt to connect ecohydrology and hydropedology through an integrated study of stemflow generation and subsequent water movement in soils.” The first part of our results was all about stemflow, which, as this reviewer pointed out, “There is significant data on stemflow and this might be an interesting contribution.” We have used a combination of stemflow collection with real-time rainfall monitoring, dye tracing, and soil profile moisture monitoring under two desert shrub species to understand the possible connection between stemflow and preferential flow. Our preferential flow data included dye tracing pictures and soil moisture monitoring data, which were presented in Figs. 8 to 12 in the original manuscript. Therefore, we are not sure why this reviewer still felt that there was not much data on preferential flow in our paper. In our experiments, we clearly observed root-channeled macropore flow, but did not find finger flow phenomena (see Figure 8 and 10). Although finger flow in sandy soil is common, resulting from wetting front instability (de Rooij, 2000; Wang et al., 2003), the presence of shrubs in our study localized stemflow along main roots and thereby channelling water down the root zone. This finding is confirmed by the work of Martinez-Meza and Whitford (1996) and Devitt and Smith (2002). Our dye tracer experiment and soil water distribution data clearly revealed preferential flow due to root channel and stemflow.

Referee #2 suggested that the conclusions were far too strong and broad for the research presented. This comment has some merits, so we have rewritten the conclusion using specific results obtained from the experiments in the revised paper instead of making some general extrapolations of our results.

The following paragraphs respond to the specific comments of Referee #2, the original review comments are listed first in their originals (in italic), followed by our itemized responses.

(1) Figure 11 and 12: These figures do not include standard errors even though more than one measurement was taken, which means we cannot draw any conclusion about separation of the treatment effects.

We did not include standard errors because of very small variability (less than 2%) between the three measurements. We can easily add standard error into Figures 11 and 12 in the revised paper.

(2) Figure 6 and 7: The interpretation of the arbitrarily fitted and very weakly correlated function to the data is based on one other paper. There is no real theory to support the suggested function other than: "the [canopy] area contributing to stemflow increases until a threshold" But that would not explain the decrease in F or the curved line in Figure 7, rather it would suggest a sigmoidal or plateau function. I am not a tree physiologist, but I would think that Figure 6 and 7 indicate that complex leaf behaviour under rainfall is properly not captured with a simple funnelling ratio. Given that leaves are not fixed plateaus but can move with wind and under heavy drop impact, I believe that there is probably more than simple stemflow.

We agree. Thus we have removed the arbitrally fitted curves and have acknowledged not strong R^2 values in the discussion.

(3) Cause and effect: The authors seem to suggest several times that plants actively cause stemflow to occur to create a subsoil that is more wet (Conclusions p 1564; Introduction p 1555). I have real trouble believing this. There is nothing in the presented research that suggests an active ecological process and in fact there is no discussion on the question whether this is an active or passive process.

We actually had no intention to suggest that the process was active. We merely tried to state the observed phenomena. As we know, in arid and semiarid environments where potential evapotranspiration is many times greater than precipitation, water is the most limiting factor. Previous studies have indicated that redistribution of precipitation by funneling water from the canopy towards the base of the plant has been shown to increase the moisture available to individual plants (e.g., Pressland, 1976; Herwitz, 1986; Martinez-Meza and Whitford, 1996; Devitt and Smith, 2002). We will change our wording and clarify relevant issues in the revised paper.

(4) Is the preferential flow occurring due to the plant being there and causing

stemflow or is this due to higher carbon content close to the plant or the lower bulk density due to root growth that the water infiltrates further.

It could be both. But our study focused on the former and we only have data to support the former observation. Preferential flow occurred due to the presence of the plant there and causing stemflow and then subsequently moving downward along root channel. This has also been confirmed by Martinez-Meza and Whitford (1996) and Devitt and Smith (2002). However, nutrient enrichment in stemflow could contribute to high organic matter content in the soil close to the plant (Whitford et al., 1997), which may also lead to preferential flow occurrence. Johnson and Lehmann (2006) reviewed that dissolved organic carbon (DOC) concentrations of the stemflow were enriched by 703-2372% relative to rainfall. In addition to DOC, stemflow water contains high concentrations of particulate organic matter (POM) (Parker, 1983). Bundt et al. (2001) reported that soil organic C concentrations in preferential flow pathways were found to be 10-70% higher than that in the soil matrix. This indirectly suggests that stemflow may also induce preferential flow by means of nutrient input to the soil. We further analyzed our data of nutrient contents of the soil around shrub base and adjacent bare area for *H. scoparium* and *S. psammophila*, and found that soil organic mater was significantly higher (1.0-1.6 g kg^{-1}) in the soil around shrub base than that of the adjacent bare soil (0.3-0.6 g kg^{-1}). We will discuss this in the revised paper.

(5) Given my experience with dye experiments and preferential flow I am very worried about the conclusions based on the dye infiltration experiments. Essentially there was only one replication of each treatment. Dye infiltration patterns are notoriously variable and difficult to interpret and therefore 1 replication can never be sufficient. The review paper by Flury et al. (1994) is still a classic and should be read by anyone working with dyes to study preferential flow. There is no guarantee the authors were “just lucky” with their dye experiments

Flury et al. (1994) reported that the disadvantage of the use of dye to study flow paths of water is that the sampling, i.e., excavation of soil, is destructive and experimental results can not be repeated at the same location. However, they also stated that results obtained from staining experiments clearly illustrate the complicated pattern of water movement with a very high spatial resolution. On the basis of specific criteria such as solubility, sorption, mobility, and stability under different chemical environments, Rhodamine-B dye has also been recommended as the most suitable tracers (Wilson et al., 1986; Flury and Wai, 2003). Martinez-Meza and Whitford (1996) and Devitt and

Smith (2002) used Rhodamine-B dye to illustrate the pattern of water movement in the roots of desert shrub. In this study, we also used Rhodamine-B dye and found it can clearly trace flow path of preferential flow in the root area. We present typical rainfall events characterized by small, medium and high amount and intensity (Figure 8 and 9), which would reflect behavior of preferential flow under different rainfall conditions. Moreover, soil water content distribution in Figure 11 and 12 can also complementarily illustrate the pattern of water movement. While variability is always there and the number of replicates may never be enough, we have sufficient number of observations to support our statement. Therefore, we don't feel it was "just lucky."

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