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Discussions

Interactive comment on "Rainfall interception and redistribution by a common North American understory and pasture forb, *Eupatorium capillifolium* (Lam. dogfennel)" *by* D. Alex R. Gordon et al.

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1) "Gordon et al. present observations of understory rainfall interception in the southeastern US. Dogfennel, the understory plant they study, is a tall and dense forb that the authors show can have a major effect on rainfall partitioning. The topic is of great interest to HESS readers, as rainfall interception is an important component of the water cycle that is nevertheless relatively poorly studied and represented in models. The authors make a compelling case that this is particularly so for low-stature and understory vegetation, such as the dogfennel communities they study."

Response 1) We thank Reviewer 1 for their appreciation of the manuscripts' strengths and insightful comments regarding the study weaknesses. We have addressed these comments as described below and believe our revised manuscript has been greatly improved.

2) "The overstory throughfall fluxes, which act as the normalization factor in the most important event-level rainfall partitioning estimates and are thus essential to the authors' conclusions, are interpolated rather than measured. The authors acknowledge this potentially major source of uncertainty only briefly when discussing the spatial variability (l280, Fig. 5). I feel that this issue needs to be addressed head on, as I have several concerns. First, it further introduces spatial variability. However, the spatial variability of understory throughfall (and overstory throughfall) is not analysed, despite the redundancy in the measurements. Second, there could well be an association between overstory throughfall and relevant dogfennel parameters such as their density. Such an association would need to be addressed if the authors want to draw robust ecosystem level conclusions. Third, there may be a temporal bias here as well, but it is difficult to say because the study periods in which overstory and understory throughfall measurements were conducted are neither stated nor compared. Fourth, while the interpolation of spatially averaged overstory throughfall (supplement) provides a decent fit overall, the linear association is clearly insufficient for small rain events. For zero rainfall, it predicts negative throughfall. The authors, however, analyse small events in great detail. It is not clear to me how these issues impinge on their estimates of understory throughfall for small events."

Response 2: The reviewer is correct that we estimated the stand-level overstory throughfall flux using recent data measured at the site. Unfortunately, it is not possible to directly measure overstory throughfall AND measure understory partitioning simultaneously. This is because the direct measurement (via tipping buckets or bottles, etc) of overstory throughfall would disturb or remove understory throughfall and stemflow. We respectfully disagree that we have "only addressed [this issue] in a cursory manner." In fact, we explicitly state in lines 133-138 (and in the supplement) how and why we estimated overstory throughfall, and discussed how this constrains our ability to broadly interpret understory throughfall and stemflow patterns. The reviewer raises two issues regarding the overstory throughfall estimation methods: (i) the linear association between rainfall and overstory throughfall “predicts negative throughfall” in small events; and (ii) there “may be a temporal bias” as the data for estimating overstory throughfall were collected prior to the start of this study. Regarding point (i), the reviewer is absolutely correct. However, overstory throughfall estimates for our small storms were not negative; so, after returning to the analysis spreadsheet, we realized that the wrong method was reported. Overstory throughfall (TF_o) was estimated from the association between TF_o (as a % of rainfall) and storm size (R) using the so-called "Aston" curve: TF_o[%] = a * (1 - EXP (-b * R[mm])). This does not return negative TF_o for small storms. We apologize for this error and have updated the supplemental figure to reflect the correct method. Regarding point (ii), we do not believe that there is any significant temporal bias. The canopy is mature and there has been no known/noticeable disturbance or change in canopy structure. As a result, although one can never be entirely certain, we assume that the association between overstory throughfall and storm size has not changed. This is now explicitly stated in the methods in lines 135-138.

3) “the uncertainties that arise from the ad-hoc estimation of dewfall are not addressed or quantified.”

Response 3: The dew estimation was, in fact, done post-hoc: after dew was observed during sampling. Still, we have edited the manuscript in lines 140-145 to explicitly state the conditions surrounding our post-hoc dew estimate, including: (1) the assumption underlying the dew estimates (equating it with canopy water storage capacity), (2) the implications of this assumption (that dew estimates are maximums), and (3) confirmation of dew occurrence using quantitative meteorological measurements (beyond the binary/qualitative present or absent, to the eye, during sampling).

4) “Apart from the issues raised above, the statistical analyses of rainfall partitioning

are insufficient. The authors do not report the overall partitioning over the entire study period (e.g. stemflow vs total rainfall or overstory throughfall) and the associated uncertainties. The analyses at the event level that are shown are insufficient for three reasons. First, the overall partitioning is not reported. The individual ratios (e.g. stemflow divided by rainfall) in Tab. 1 cannot be averaged to obtain the overall ratio. The authors, however, do just that in the conclusions (they even report the median rather than the average) when they write: ‘Eupatorium capillifolium (Lam., dogfennel) in the understory of an urban forest fragment intercepted 20.4% of verstory throughfall from Pinus palustris (Mill.).. I would expect both errors (aggregating ratios, median instead of mean) to overemphasize small events, and thus to overestimate throughfall/rainfall. The event-level fluxes need to be summed, see e.g. doi:10.1029/2000WR900074, doi:10.1016/S0022-1694(01)00393-6, doi:10.1088/1748-9326/ab1049, for how to estimate overall partitioning and its uncertainties (due to spatial variability, stems that were not instrumented, observation errors, etc.). Second, only summary statistics such as the median are shown (Tab. 1). A scatter plot would allow the reader to draw additional inferences, such as in what way stemflow increases disproportionately for larger events. Third, it is not clear how the data were spatially aggregated. Three clumps were instrumented, and I assume they were averaged over, but how?

Response 4: We appreciate the reviewer’s comments on the statistical analyses and, firstly, we agree that the overall median is not the standard statistic reported for annual precipitation partitioning fractions – it is the sum. Therefore, we now include the total precipitation partitioning fractions from scaled summations across the study. Secondly, the reviewer requested a scatter plot of event summed data with respect to storm size. This has been added to the manuscript (panels a-b in the revised Figure 4). Thirdly, regarding spatial considerations, no spatial analyses (beyond comparison of CV and normalized stemflow values) were done. Even these spatial analyses are rarely done (see recent review: doi: 10.1007/978-3-030-29702-2_6).

5) “I could not follow the rationale behind the interception capacity measurements.

How long were they dried in the oven? Did the leaf itself (not the intercepted water) lose weight during that period? Why not compare it to the weight before wetting? The other issue, which is that the submersion in the lab is very different from the wetting due to rainfall in the field, would remain. This needs to be spelled out clearly, cf. doi:10.1016/S0022-1694(01)00393-6.

Response 5: We agree with the reviewer that the water storage capacity estimation methods require clarification. The details requested by the reviewer (and some additional information) is now provided in Lines 178-188. We also agree that we should clarify differences between this method and how leaves/stems wet in nature. This has been added to the manuscript.

6) "The throughfall funnels are not described in detail, and there is not a single picture. The authors argue that they provide more robust estimates because they are larger than most rain gauges that are commonly used for such purposes, but at approximately 25x25 cm, this difference does not strike me as particularly noteworthy. Given the relatively large density of dogfennel plants, however, it is not clear to what extent the plants and hence the throughfall were disturbed by the installation of the funnels.

Response 6: Dimensions of funnels are described, and we now provided a photograph of a deployed throughfall gage in the supplemental materials. To clarify: we did not state that these funnels were bigger than most funnels – rather, we noted that funnel size was larger per unit canopy area for the studied plant, dogfennel, compared to trees.

7) "I would not be able to reproduce the scaling of the rainfall interception capacity measurements from the leaf to the plot scale. The authors mention in l176 that they use estimates of leaf area, but these estimates are never introduced. Equations would also help, as would a consistent terminology (surface area seemingly refers to very different things in the same paragraph)."

Response 7: We agree and have provided greater detail on the scaling methods for

water storage capacity in lines 195-202, stating "Specific water storage capacity estimates for the stem (0.436 mm) and leaves (0.195 mm) were then scaled to Su [mm as L m-2] using stem and leaf surface area estimates per plant (171.9 cm2 plant-1 and 807.5 cm2 plant-1, respectively), and multiplied by the site plant density (5.68 plants m-2) and divided by 1000. Plant stem and leaf surface area estimates were determined from 5 representative plants that were cut from the site and separated into leaves and stems, then the sum of leaf and stem areas (determined as mentioned earlier in the paragraph) were divided by 5."

8) "It is not clear how dogfennel density (e.g. at what scale) was determined and whether the numbers given in Section 2.1 refer to the clumps the authors study or to other areas."

Response 8: We agree. Details for estimating stem density are now provided in lines 115-117, stating "Dogfennel density was estimated in ten 10x10 m plots by counting the stems clump-1 for 3 randomly-selected clumps in each plot. For each plot, the mean stems clump-1 were multiplied by the number of clumps plot-1. Finally, all stems plot-1 were summed and scaled to 1 ha."

9) "The three clumps the authors study are not described in detail. How do they differ? What do they look like? Does that have an impact on the rainfall partitioning?"

Response 9: The plants from each clump are described in detail in Table 1. From the details in Table 1, the plants were all very similar.

10) "The regression analysis shown in Fig. 5 (of doubtful value because it relies on the unrealistic assumption on overstory throughfall) is not described. According to the figures, it looks like the authors regressed the ranks rather than the actual observations, which would need justification. So would the fact that the authors apparently did not consider the joint influences of explanatory variables."

Response 10: We have removed the bottom panels of Fig. 5 and now provide scatterplots in the supplement (new Figure S5) that shows no statistically significant correlations for the variables (or no significant differences for the categorical variable) presented in the old Figure 5. No multivariate statistical methods were applied to assess multivariate influences over stemflow variability as all bivariate results were very highly un-significant ($r2 \sim 0$ and $p > 0.9$).

11) “Figure 6 compares rainfall partitioning of herbaceous plants and trees, but I suppose the climatic conditions differ between the two and thus constitute a major confounding factor. These concerns are, however, not addressed.”

Response 11: We have removed Figure 6 from the manuscript for two reasons (1) there is already a synthesis work published that we can cite and (2) we believe that this synthesis figure merits greater consideration in a different, broader paper.

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