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Interactive comment on "Towards quantifying the increase of rainfall interception during secondary forest succession" *by* B. Zimmermann et al.

Anonymous Referee #3

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General comments:

The authors conducted a large scale throughfall measurement campaign in 20 secondary forest plots in Panama which were 3 to about 130 years old. Throughfall changed rapidly with ongoing forest succession and surprisingly approached values of mature forest only after about a decade. A simple regression model explained throughfall better than a more complex modeling framework. The third conclusion drawn by the authors is not clear to me (see the following). In my view, another highlight of the work is the link which the authors draw to data on changes in soil permeability with ongoing forest succession (see Bruijnzeel (2004) on the importance of the link to the soil). Unfortunately that section is not explored in depth. It would also be good to have the authors make some guesses on how transpiration changes with ongoing

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Interactive Discussion

Discussion Paper

succession (just a few words on that!) if they are discussing succession effects on runoff/streamflow. The paper is well written but requires some more precision and consistency in the terms used.

I find the paper both relevant and interesting and therefore would recommend it for publishing in HESS.

To me it is not fully clear how the authors arrive from their sections 2.3.5 and 3.5 at the conclusion that "the influence of young secondary forests on interception in real-world fragmented landscapes might be detectable only in regions with a substantial fraction of very young forests"(P8000 L20-26 and P8016 L16-22). How do "young" and "very young" differ and how do they compare to "old" and "mature"? Which direction has that "influence", where can it be "detected" (in streamflow/runoff?) and what is the other fraction of the region you are talking about that serves as your reference to judge the "detectability" of your "influence" (pasture or mature forest)? Do you mean that a forest <5 years has hardly any interception and behaves pasture-like and thus needs to cover almost the whole catchment in order to have a detectable influence - which is a rise in interception compared to pasture? Or are you referring to the fast adaptation of the interception of forests <10 years to values reached by forests >10 years or "mature forests"? In opposite to the substantial fraction of "very young forests" needed to have an detectable influence on interception, an unsubstantially small fraction of young forest (>10 years but < 130 years) which already behaves like "mature forest" will yield the same big "influence" on interception in a region since the increase in interception compared to pasture is dramatic as succession proceeds. Does all of that refer to interception only or does it also include the change in soil hydr. conductivity? I am lost! Please clarify!

Further, the paper would benefit from a small section in the discussion where the authors set their measurements in perspective to other studies and discuss (only briefly!!!) how throughfall might change throughout the year when trees shed leafs and rainfall intensities change and how their measurements extrapolate to a full year. From tem-

perate forests I learned that interception rates in winter can even be higher than in summer due to the change in rainfall intensity and distribution, although trees are leafless then. What do the authors think (again: only briefly!) how changing rainfall pattern and changing foliage influence interception/throughfall throughout the year in their study area?

Specific comments:

Please be more consistent in your wording / in the terms or definitions you use: either use inventory data OR forest structure parameters OR forest monitoring data / throughfall site OR throughfall plot OR study plot / forest age OR recovery time OR succession time / old plots OR mature plots OR mature sites OR BCI plots etc.. Always make clear to which plots you are referring to when you say "all plots" and always provide the reader with the number of replicates used. Do the prediction sites always include the throughfall plots? Also introduce your concepts of "mature", "old", "young" and "very young forests" in earlier sections. Are you only referring to "secondary forests" if you are talking about "mature forests"?

P8000 L20-23: I am not sure if I can draw that conclusion from your work. Please see later comments and general comment!

L24: "undesirable effects" assumes that every reader knows what effects you are talking about and which ones of those are desired. Please indicate the effect found in case of forest re-growth and its direction. Do initial stages refer to "young" or "very young" forests?

P8004 L1:15: In the "study area" section you indicated, that there is a mosaic of different land use patters in ASP. Although I believe that there is little relationship between throughfall and distance from the forest edge (Klassen et al. 1996), I still find it important to mention how big the forest patches were in which you set up you plots. Specifically: How far are your samplers from your plot boundary and from the edge of the whole patch?

P8005 L3-6: You write that you identified the species of all trees/shrubs/palms. In the introduction you are also referring to the importance of vegetation type for throughfall generation/interception (e.g. invasive plants versus natural succession). Thus I really would welcome a list of the most (!) dominant species of trees/shrubs/palms in your plots, maybe sorted by plot age classes – or even plot-wise (Appendix)! Which ones are deciduous? I suppose all species were fully foliated during your measurements? Is there any information on the species in the BCI plots too? That might also help to discuss if BCI is a good reference for ASP.

L8-9: I would recommend a bit more detail here (e.g. on camera settings like exposure (see Beckschäfer et al, 2013) or height at which the pictures were taken, at what time were they taken etc.) to ensure comparability with other studies. Is HemiView only the software?

L16: How far were your rainfall collectors from obstructing objects (houses, trees etc.)? Did you apply any correction to rainfall data (e.g. considering wind/radiation etc.)?

L 19-20: Where the gauges relocated randomly to "several randomly selected locations" during the measurements (like recommended for throughfall studies e.g. by Lloyd and Marques 1988) or where only the locations of the samplers chosen randomly and samplers were not moved during the two months? At what height did you measure? Please indicate!

L22: What about the "very young plots" and "mature plots" you are referring to elsewhere?

P8006 L3: Please indicate the date of your sampling campaign.

L9: You mention here that you sampled on event basis too. What happened to this data? I would find it helpful if you could at least give a little more detail on the rainfall characteristics (intensities/distribution) found during the year and during your study period.

L12-16: You mentioned palms/shrubs in your plots in another place. Palms often have higher stemflow compared to co-occurring trees. (e.g. Jordan and Heuveldop 1981, Lloyd and , Marques 1988). The same is valid for e.g. Bananas or other herbs. Did you consider that in your 1% assumption? Did you find any hints on a stemflow : BA relationship in your unpublished stemflow data?

L20: What does "long-term" data mean? I was assuming you only measured for two months!

P 8007 L2: I think it would be better to refer to "throughfall" instead of interception, since 1) the calculation of interception requires knowledge about stemflow (which you only have for the BCI-Sites) and 2) you are, to a large extent, referring to throughfall measurements throughout the paper.

Section 2.3.2 A reference to Table 2 would be helpful here.

P8008-P8009 Section 2.3.4: I cannot comment on this section, since I am not familiar with the method. But it appears that my understanding could be greatly improved if it is simplified a bit.

P8009 L27: What does it mean when you say "We pooled forest inventory data ... within ... age classes"? Which age classes? What is n for each age class? From Fig.4 I learned that you have a lot of outliers in the age class from 10-20 years. Would that look different if you e.g. choose e.g. 5 classes?

P8009 L26 and P8010 L7: Please use "prediction sites and throughfall plots" if that is what you used. You defined the names of your different plots already in Fig. 1, so please stick to those!

P8010 L6-10: I assume that this section shall provide the answer to you research question #3 in the introduction. I don't understand how you estimate "landscape scale estimates". What is the landscape you are referring to? Whole ASP? How big is the fraction of young/very young forests or of forests for which you can predict interception

in your area? See also my general comment and the comment on the conclusion section below.

P8010 L20: Throughfall can also be higher as incoming precipitation if a sampler is located underneath a "dripping point" in the lower canopy to which intercepted water is diverted which originates from a larger "collection area" in the upper canopy.

P8011 L1: What is recovery time?

L5: and elsewhere: again: Please make sure if you talk about "mature forests" or "mature secondary forests"! P8012 L25-26 and 8013 L6-7 and Fig 4: How did you estimate the "credible interval limits of relative throughfall in mature forests of our study area"? Were they taken from the sources provided in Fig.4 ? Did they originate from BCI data? Or were those "priors" you used in your model? I don't get it!

P8013 L18: On P8007 you mentioned that you that you are going to use "openess hereafter" for canopy openness. Please continue to do so if you said elsewhere that you intent to do so!

P8014 L4-6: I find it really good that you relate your throughfall data also to soil permeability! But how long does it take to recover permeability? This cannot be seen from Tab1 and Fig 4! (This is needed in order to hold on to your first conclusion!).

P8015 L12: You cannot "improve" the relationship between forest structure and canopy interception. You can improve your models or your understanding of the relationships.

P8016 L16-22: Again: The paragraph is hard to understand and confusing. We need to know what young secondary forests are (in opposition to "very young secondary forests"). Why do you think the influence of "young forests" might only be detectable where there are a lot of "very young forests"? Also the uncertainty with which you predict/measure throughfall does not have any impact on the throughfall of secondary forest which you somehow claimed in the first sentence but in contrast clarified in the last sentence of the paragraph. But I also wonder about that clarification: Why

should one confuse the limited detectability of an interception signal with the relevance of the change in interception during succession? Why does a substantial fraction of "very young forests" overcome uncertainties in throughfall predictions/large variations in throughfall during succession that both influence the interception of young forests? Please clarify!

8022 and 8024 Please visualize the throughfall : age and throughfall : BAratio relationships. (Appendix?)

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