John Van Stan, Referee 2 (Received and published: 13 August 2019)

We thank the reviewer for his time and useful comments, which we have attempted to incorporate in manuscript revisions. We have also attempted to clarify and further justify the impact and utility of this work in response to specific reviewer concerns. Below are explanations of our responses to the reviewer's comments (R1-C: Reviewer comment; AR: Author response). We note that several of the reviewer's comments were also noted by Reviewer 1 (R1), and in the responses below, we refer to those responses to avoid repetition.

Major Comments

R2-C1: The discussion paper by Acharya et al. estimates total forest rainfall interception (canopy, understory, litter and topsoil) from shallow soil moisture sensor data using a modified Gash model (that replaces the 'precip required for throughfall drip' with the 'precip required for soil moisture response'). HYDRUS model-based estimates of the topsoil component were removed from the total forest rainfall interception (hereafter "total interception"). This was done for a large number of pine plots (n=36 in line 91, but n=34 in line 302?), then total interception estimates were compared with literature values and other site data (density, LAI, groundcover, age, etc.). The methods are clearly described (the manuscript is very well written), it provides an interesting alternative to deploying throughfall and stemflow gauges, and it would no doubt interest HESS readers. There are, however, some shortcomings that I believe should be addressed before publication.

> **AR1:** We thank the reviewer and appreciate the kind words. We note that several of the reviewer's comments were also noted by Reviewer 1 (R1), and in the responses below, we refer to those responses to avoid repetition.

R2-C2: 1) There are very few soil moisture sensors per plot (n=3?). To estimate rainfall interception, throughfall sampling (using gauges roughly the same-to-larger size as the soil moisture sensor areas) would require 30-50 roving gauges, and 100s of stationary gauges (see publications by Zimmermann, 10.1029/2009WR007776 and Voss, 10.1016/j.jhydrol.2016.06.042). Stemflow monitoring would also be required, although stemflow from the pine species studied is generally negligible. The dense throughfall (and stemflow) sampling is to account for wet and dry points due to canopy rainwater redistribution; yet, for soil moisture sensors, lateral flow is another issue. Preferential flow of net rainfall fluxes laterally is possible and has been reported by the few studies searching for it (e.g., Spencer and van Meervel, 10.1002/hyp.10936). I would like to see these issues discussed; i.e., the total interception estimates are highly localized (sub-plot) estimates that do not account for lateral soil moisture flow.

> **AR2:** Regarding number of sensors, we refer to our response to Reviewer 1 (**R1-AR7)**, where we note that Zimmerman and Zimmerman (2014) suggest only 5 trough-type collectors/ha for longer-term studies such as ours to maintain errors within 10%. We also propose that smoothing of rainfall inputs in the subsurface appears to yield stable and reasonable results with relatively few measurement locations. Regarding stemflow, we acknowledge in the text that "…estimation of β_s using Eqs. 1-7 cannot directly account

for stemflow, which can be an important component of rainfall partitioning in forests (e.g., Bryant et al., 2005)", but as noted by the reviewer, stemflow in pine species is generally small. Regarding lateral flow, we refer to **R1-AR5**, where we discuss lateral and preferential flow in detail, leading to new text in the methods and discussion sections. Finally, regarding the suggestion that we refer to our measurements as localized, sub-plot estimates, we agree and have added that description to the methods section:

"*Soil-moisture sensors were located to capture representative variation in stand geometry and structure (i.e., below the tree canopy and within inter-canopy rows) to capture variation in surface soil moisture response to rainfall events. While this spatial layout was intended to characterize the range of forest canopy and groundcover heterogeneity across a plot, the three measurements locations were within a 10-m radius and thus represent localized (sub-plot) interception estimates."*

R2-C3: 2) There are no data from the study sites for evaluation (only comparison with other studies' data). Perhaps a full-fledged throughfall monitoring campaign is not necessary in this case (throughfall and interception field studies are available for similar pine stands already). Instead, the authors could estimate canopy, groundcover, and litter water storage components and, subsequently, evaporation. This could be done by sampling leaves, bark, litter and performing water storage tests in the lab.

AR3: Regarding the lack of data for evaluation, we refer to our response to Reviewer 1 (**R1-AR4)**, where we acknowledge the concern that results were not validated using contemporaneous and co-located data. In that response, we also propose new text to better contextualize the limitations of our comparisons with other studies and to stress the potential for this novel application, rather than suggesting its quantitative robustness. Regarding the suggestion to estimate canopy, groundcover, and litter water storage components and, subsequently, evaporation, we contend that this was exactly our approach (i.e., we estimated the total storage of those components (β_s) and how that storage capacity interacted with rainfall and evaporation to yield interception), though we did this analytically rather than sampling and measuring materials in the lab.

R2-C4: 3) The proposed method is not quite a "simple" method, especially when applied at the stand scale as this would require a greater number of soil moisture sensors. Additionally, it involves HYDRUS modelling and the issue of lateral soil water transport is, at present, unaddressed.

AR4: Regarding simplicity, we agree that the method only remains simple and tractable if the number of sensors required to adequately estimate interception remains relatively small. We refer to our responses to Reviewer 1 (**R1-AR7** and **R1-AR24**) in this regard, where we contextualize the number of sensors used in this study and discuss the simplicity of effort required and potential benefits. Regarding the need for HYDRUS modeling, we acknowledge that the extra step of modeling infiltration reduces the simplicity of the approach and also likely increases uncertainty in our estimates of β_s; however, this limitation may be avoidable with sensor placement closer to the surface (we used 15 cm, we recommend 5 cm). This methodological improvement was

recommended in the original manuscript and is now further stressed in the methods and discussion of the revision (see **R1-AR5**). Regarding lateral transport, we also refer to **R1-AR5**. The general contention that we have under-sampled a spatially heterogeneous process is certainly reasonable, though it seems equally fair to point out that our estimates of interception capacity are stable and robust across sites in spite of this, and that they align remarkably well with literature values and expectations of stand-structural attributes. While further validation is clearly needed, it seems equally valid to note the promise of the method based on the small number of samples. In our response to Reviewer 1 (**R1-AR7**), we describe new text at the end of discussion that explores reasons that our results are both stable and consistent with stand structure. One plausible explanation is that soil moisture measurements may integrate over larger areas than a single point, making their spatial extent closer to a trough than a funnel collector, and thereby implying reduced sampling intensity.

Detailed Comments

R2-C5: a) I don't think the term "loss" in "interception loss" is necessary. As "rainfall interception" is a process that returns rainwater to the atmosphere, it is a "gain" to the atmosphere. Would the authors consider simply using the term "interception" or "rainfall interception" throughout?

AR5: Modified as suggested.

R2-C6: b) The discussion paragraph beginning on lines 298 focuses on the spatiotemporal variability of interception. All the literature discussed is concerned with canopy interception; however, field studies exist which show that variability in seasonal canopy materials can influence litter interception, particularly seed pods: eg:
Levia et al., 2004, doi: 10.1623/hysj.49.5.843.55133
Van Stan et al., 2017, doi: 10.1002/hyp.11292 <-Please note that I am the corresponding author on this publication and only share it as it is directly related to the topic being discussed – a topic little researched.

AR6: The seasonality of canopy materials and this citation have been added to the discussion of spatiotemporal interception variation.