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Biogeosciences Discussions

Interactive comment on "Change in hydraulic properties and leaf traits of a tall rainforest tree species subjected to long-term throughfall exclusion in the perhumid tropics" *by* B. Schuldt et al.

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Review of Schuldt et al. manuscript: Change in hydraulic properties and leaf traits of a tall rainforest

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General comments

This manuscript describes a throughfall exclusion experiment in a perhumid tropical rainforest. The experiment is very nicely set up and contributes much-need hydraulic

data from the wet tropics. In fact, although throughfall exclusion experiments are not new, the data presented in this ms are particularly novel as they represent the only hydraulic traits of their kind from this habitat. The experiment appears to be well thought out. The data appear to be collected and analyzed properly, with just a few problems and set-backs (please see specific comments). The experiment represents an immense effort, which, remarkably, appears to have been shouldered mainly by the authors. Although I feel there are problems with some of the methods and presentation of the results, the ms addresses relevant ecological questions and represents a significant contribution to the field.

The concerns I have with the manuscript involve some technical details and the general presentation of the manuscript, which appears to have been somewhat rushed.

The hydraulic conductivity measurements appear to be calculated only for vessel lumen (not including any cell wall at all). This has important ramifications for the interpretation of the results. I would suggest calculating conductivity as sapwood-specific conductivity, rather than lumen-specific conductivity. Or at least include sapwood-specific conductivity in their Table 4. The ms is very scant on giving absolute values. Because these data are so unique, I think at least treatment mean values should be presented so other scientists can use them in the future. Similar to the hydraulic traits, absolute values are not given for the diameter increment data. These data are needed to determine if the wood that was analyzed at the end of the experiment was actually produced during the experiment. This is crucial to their conclusions. Similarly, I think the authors should address as best they can whether or not the stems in the desiccated plots shrunk (dehydrated) or just slowed down in growth (please see specific comments). Lastly, although structured reasonably well, the ms has many typos, grammar mistakes, and wordy text. I would suggest the authors ask a native English speaker to look over the grammar for them. I have given many suggestions for improving the text at the end of this review, and would be happy to do a more thorough job if they wish.

Specific Comments

It is somewhat difficult to understand how you “desiccated” the plots from your abstract. Perhaps it would be better if you actually said, “soil desiccation in “roofed plots” was achieved by diverting throughfall (and stemflow?) with aluminum panels”.

Page 8554, line 19: But this result wasn’t significant (20% reduction in increment), right?

Page 8554, line 20: Do you mean, “drought treatments did not increase mortality in mature trees”?

Page 8556, line 8: absolute growth is higher in large plants, but not relative growth. Per unit biomass, growth actually declines as plants get bigger. So.. I guess I don’t understand why vessel size should increase with plant size (or height). Actually, I might suggest ending the paragraph after the Zach et al reference and omitting the last sentence. However, if you want to link productivity with hydraulics you could site one of Tim Brodribb’s recent papers on the subject. He works with vessels in leaves rather than wood, but shows a close correlation between Ks (leaf) and C assimilation.

Page 8556, line 11: Typo – “...diameters to improve water transport may incur cavitation risks...” You might also consider citing work that does not support this view “(...Jimenez et al., 2009, but see Maherali et al. 2004)”.

Page 8557, line 26. Basal area is a much better description of stand structure than stem density. Do you know the basal area in your control and treatment plots?

Page 8558, line 10: When you say “close gaps around tree stems”, do you mean that your roof captures stemflow as well? It sounds like you’ve done a wonderful job (what a huge effort!) setting up the plots. I am just trying to figure out how much of the throughfall (100%) and stemflow (?) has been captured by the roof.

Page 8559, line 10: what were the TDR probes calibrated for... soil water potential?

Page 8559, line 15: Wow - that was bad luck... and expensive I bet.

Page 8559, line 26. I am curious why you cite unpublished data for using a pressure plate to measure soil water desorption. It’s a pretty standard method – I’m sure you could find the procedure in most soil methods texts.

Page 8560, line 24: I think you mean “water displacement”. It would also be nice to cite a methods paper. I know water displacement sounds simple enough, but it is not as intuitive as most people think.

Page 8561, line 6: What is the purpose of the additional wood density measurement? I suggest just choosing what ever measurement you think is best and present only those data.

Page 8561, line 11: I would suggest using the term “dendrometer” or “dendrometer bands”, as this is probably a more familiar term.

Page 8561, line 16: I don’t understand why you calculated “relative stem increment” by dividing the gross increment by the basal area. This is not a procedure I am familiar with and you don’t reference it. I agree that you have to control for plant size, but I don’t think this would work. There are several approaches to standardizing diameter increment for plant size. One thing you might consider is to use a correlative approach. In my experience, taking the log10 of both original diameter (at the start of the experiment) and diameter increment will yield a linear relationship for data of your sort. You can then plot diameter increment (y axis) against stem diameter (x axis) using OLS regression (using the log10-transformed data). Assuming your data do not violate any correlation assumptions, the residuals from this correlation represent diameter increment that is unassociated with stem diameter. You need to make sure you use ordinary least squares (OLS) regression for this and not standardized or major axis regression, as the residuals from these later two procedures are not orthogonal to the x axis (original diameter).

Page 8561, line 15: Did the trees in the roof plots decrease in diameter after banding? Rainforest trees often do this during dry periods. This could be misinterpreted as

reduced growth.

Page 8561, line 22: Are you sure the wood in these branches were produced during the experiment? When did you collect them? Also, your branch lengths are very short and I would assume that you did not have closed vessels during your Ks measurements. I don't think this is a huge issue, but should probably mention it.

Page 8562, line 13: "Ks" usually refers to sapwood-specific conductivity. When people read your paper, they may not read the methods and will interpret your data incorrectly if you use "Ks". I would strongly urge you to use a different symbol to denote your measurement of lumen-specific conductivity (perhaps Klumen?). Also, it seems a bit strange to me to calculate conductivity in this way. Assuming I'm understanding your methods correctly, you measure Ks as the rate of flow (at a given length and pressure) per unit lumen area (no cell wall whatsoever)? Thus, Ks should simply be a function of the vessel area to density ratio. For example, if "Ks" increases, this must be due to an increase in vessel diameter and a decrease in vessel number (or increasing pit/end wall resistance). Because you measure both vessel diameter and density, I'm not sure what additional information your conductivity measurements give. I would strongly suggest that you at least include sapwood-specific conductivity in Table 4. You have all the data you need to calculate it. Because your data are so unique, they are also valuable, and other scientists will probably interested in them.

Page 8562, line 25. Are you sure this increment was put on during the experiment? What was your absolute diameter increment prior to collecting these wood samples?

Page 8564, line 1: I don't understand why you would calculate HV as a function of leaf number. I also don't think it's necessary for your argument.

Page 8566, line 4: From looking at figure 1, soil water potential only decreased by ca. 1.5 MPa. Also, don't need the "-" in front of "3 MPa". Ditto for following sentence.

Page 8566, line 22: Please state how much lower (or higher). For example, here, did

the conductivity decrease by 2% or 200%? Also, please use the symbol for conductivity after you define it. It is spelled out here. Alternatively, use a shorter, simple handle, such as, "hydraulic conductivity" rather than "axial hydraulic conductivity [es] in the xylem". Actually, I think you mean conductivity of the lumen, not xylem.

Page 8567, line 5-9: I don't know what 15N has to do with your experiment. You don't discuss it in the introduction or the methods (unless I missed it) and I can't think why you include it here. I don't think it adds anything. Although the 13C makes sense for your experiment, I don't think you discuss what it means or why you measured it in the methods.

Page 8567, line 11: What are the absolute diameter increment values? Were your stem sapwood samples from only this increment?

Page 8568, line 4: How much higher?

Page 8569, line 3: Why do you say they must have grown during the experiment?

Page 8569, line 6: But you measured both vessel diameter and density. Can't you just plot each against Ks and tell the reader how much of the variance in "ks" is explained by each? I actually think a more productive tack might be to calculate vessel lumen fraction (% sapwood that is vessel lumen) and S (vessel area / vessel density) and plot these against sapwood-specific Ks (viz Zanne et al. 2010). This is because it gets to your question about whether or not increases in conductivity result in lower WD – increasing VLF should directly compromise WD, but increasing S should not.

Page 8569, line 9: Do you mean diameter? If not, how do they adjust their shape, and why would plant water status (xylem potential?) affect it?

Page 8569, line 25: I'm not sure why this is an "alternative strategy". It seems to be the same thing, only said a different way. Maybe you can omit this sentence?

Page 8570, line 7: But your table 4 shows a significant difference for N.

Page 8570, line 16: Again, I don't understand what 15N has to do with your study.

Page 8570, line 21: I'm not sure you can say that stomatal conductance did not change as a result of desiccation. 13C data can be pretty unreliable, as a general rule, unless you have a long-term study and differences in gs were considerable. Also, the carbon that went into the leaves that you harvested may have been fixed prior to the experiment (from starch reserves, which can be significant in trees). Do you have any gas exchange data?

Page 8570, line 22-23: I might suggest, "... , suggesting that stomatal conductance and rubisco concentrations were similar between roof and control plots."

Page 8570, line 28: You use many different terms for conductivity (e.g., "axial conductivity", "axial hydraulic conductivity in xylem", etc.) , and sometimes you use a symbol (Ks) to represent it. I would suggest to try and use the same, short description (perhaps "lumen conductivity") consistently throughout the text.

Page 8571, line 1: The words "which" and "but" are always preceded with a comma. Also, I think you mean "roof plots, which also had higher wood density..."

Page 8571, line 5: You should be able to address the shrinkage question easily – did the diameters of the trees in your roof plots decrease after building the roof, or did their growth just slow down?

Page 8571, line 6: You probably don't need to say "it has to be mentioned...", just mention it.

Page 8572, line 12: This is a difficult sentence. Maybe you could simplify to, "...that tall trees in high light habitats are more susceptible to drought than understory trees in low light habitats."

Page 8572, line 24: What does SLA have to do with hydraulics?

Page 8572, line 26: ...presumably due to evaporative demand. Pretty much any of the

other variables in Darcy's law could also be responsible for decreasing HV and Kl (e.g., leaf potential, soil potential, sapwood-specific conductivity, or VPD.

Page 8572, line 28: I would suggest, "...lower wood density". Also, again, because you don't include sapwood outside vessel lumen, your conductivity measurements do not imply a tradeoff with wood density. For example higher lumen conductivity (as you calculate it) simply means that there are fewer, but larger vessels (similar to Amy Zanne's "S"). Really, only higher lumen fractions (percentage of sapwood area that is lumen) should compromise wood density... and even then, it usually only marginally affects density.

Page 8573, line 16: But table 4 shows a significant decrease in leaf area.

Page 8573, line 19: It may simply be the case that the roof plots just didn't get dry enough to result in differences between understory and overstory trees.

Table 1: Did you measure soil temperature?

Table 2: Your theoretical Ks appear far too high. Is there a mistake in your calculations? Are your n values correct? This should be the total number of replicates (individual trees), not samples, right?

Table 3: I think you mean "shade crown". Ditto with your n values. I'm assuming that your statistical tests were performed properly – on replicates (trees), not samples? It might be better to say, "...upper-case letters denote significance (alpha?) between roof and control plots."

Table 4: I don't understand what statistical test you preformed on the ratios. These data are important to your study, but are really difficult to interpret here. I might suggest reducing the number of columns from 8 to 7, structured in this way: column 1 = mean sun values, column 2 = mean shade values, column 3 = mean non-roof (control) values, column 4 = mean roof values, column 5 = P values for shade vs. sun test, column 6 = P values for control vs. roof tests, column 7 = P values for canopy position by treatment

interaction.

I would also suggest you include hydraulic data in this table that will be useful to other scientists (your data are unique!): vessel lumen fraction, vessel area:vessel density, as well as the traits you have already – but please include absolute mean values, so they are useful to others.

Figure 1: The depth on your x axis for soil water potential are the same (0-5). Also, I think the water potential and RWC are really saying the same thing. I would also suggest elimination the VWC figures, as they don't really have any physiological effect on plants – only the water potential does. Then you could increase the figure size a bit more and see more detail.

Figure 3: 15N probably not needed

Figure 4: Typo – "...+/- 1 SE"

Figure 5: Probably not needed.

Technical corrections

Page 8554, line 10-12: I think "hydraulic conductivity of vessel lumen was reduced..." might be clearer than saying something was "normalized" (standardized?) to vessel lumen area?

Page 8554, line 13-14: This sentence is confusing. Do you mean drought resulted in larger, but fewer leaves?

Page 8554, line 25-26: Typo – "... that may increase with climate change (Hulme ..."

Page 8556, line 27-29. You've already mentioned this in the previous text – probably not needed.

Page 8557, line 3: Typo – "... and indentify traits sensitive to soil water shortage".

Page 8557, line 6-8: I think this really belongs in the methods – a bit too much detail

for the introduction.

Introduction: I might suggest ending your introduction with your hypotheses. You do a nice job building up to your hypotheses, but then digress into methods at the end.

Page 8563, line 9: Typo

Page 8563, line 19: I would suggest reviewing the MS carefully and try to simplify all your wording. Much of it is really quite wordy. For example, I might suggest rewording this sentence like: "After scanning, leaves were dried to constant mass at 70 C and weighed on a laboratory precision balance. SLA was calculated as fresh leaf area divided by dry leaf mass, and Huber values (HV) were calculated as sapwood cross-sectional area divided by fresh leaf area."

Page 8564, line 5: Typo – "Concentrations of..."

Page 8565, lines 3-4: Do you mean "mean annual precipitation" and "mean monthly precipitation"?

Page 8565, line 18: Typo – "... 5 percent lower...". Also, please use the symbol for volumetric soil moisture (theta) after you define it. Or, better yet, don't use a symbol at all and just write it out each time.

Page 8565, lines 24-25: I think I know what you mean. I might suggest re-wording to something like, "Improving the roof (date?) reduced leaking during heavy rains and resulted in fairly constant soil moisture at all soil depths within roofed plots (figure ?)."

Page 8566, line 3: You don't need to say "according the soil water retention curves". It would probably be best to just say, "Soil metric potential decreased..."

Page 8566, line 14: Typo – "REWtop decreased by 90% in the roof plots..."

Page 8566, line 18: Typo – "REWlow decreased by 50% in the roof plots..."

Page 8566, line 24: You've already stated how you calculated conductivity, probably

don't need to say it again here.

Page 8566, line 26: Typo – "...did not change..."

Page 8566, line 27: Could be simplified to: "Although HV did not change, leaf number decreased by 30% in the roof plots."

Page 8567, line 1: How much higher? Also – Typo – "Desiccation resulted in higher wood density of branches in the sun canopy, but not in the shade canopy."

Page 8567: I would suggest keeping your results to just the results – just bare facts. Methods and results seem to sneak in from time to time.

Page 8567, line 23: Probably want to call to Table 4 after this sentience.

Page 8568, line 17: Typo – "...74% of fine roots were located..."

Page 8568, line 19-20: I'm not sure what you mean by "an exponential biomass depth distribution decrease with depth". Do you just mean course roots decreased exponentially with depth? Also, it's probably best to avoid words like "extremely".

Page 8568, line 20-21: Typo – I think you mean "few roots below 100cm". Also, are these data from the Hertel et al. paper as well?

Page 8569, line 2: I might suggest to try and shorten and simplify this sentence and other like it throughout the text.

Page 8569, line 12: "...of the terminal twigs in roof plots." Also, the following sentence is really long and convoluted.

Page 8570, line 3: Perhaps clarify/simplify to: "Foliar analysis suggests that soil desiccation did not result in impaired rates of nutrient uptake, as has been found in other studies (references)."

Page 8573, line 4: "...occur only rarely".

Page 8573, line 9: Typo

Thank you very much for the opportunity to review your manuscript. I enjoyed reading it very much and think it is a fantastic experiment. Good luck with everything!

Sean

Interactive comment on Biogeosciences Discuss., 7, 8553, 2010.