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Biogeosciences Discussions

Interactive comment on "Soil responses to manipulated precipitation changes: A synthesis of meta-analyses" *by* Akane O. Abbasi et al.

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We would like to thank Dr. Baker for providing his valuable feedback on our manuscript. Here is a point-by-point response to his comments and concerns.

Comment 1: The authors present a useful meta-analysis of meta-analyses on the response of a wide variety of soil factors to increased or decreased precipitation. I believe that the authors have collated published data in a manner that merits publication, but I believe that the results of the study could be significantly improved if a consistent manner to combine and interpret data across meta-analyses could be employed, rather than the method of treating each meta-analysis as an individual unit for comparison. I appreciate that the authors do bring up the sample sizes of each meta-analysis when

discussing them and weight the inferences drawn from larger studies more heavily, but I wonder if there is a more effective way to combine the results from the various studies to draw conclusions. Could meta-analyses that presented the same variables have the effect sizes for that variable combined to produce one effect size for the response of the variable to changes in precipitation more generally across studies? This would require knowing the standard deviation of each variable within each meta-analysis but would make for a much simpler presentation and interpretation of the data, as well as a more valid weighting of the results. Response: Thank you for your suggestion, and we agree that having one effect size for each variable would greatly simplify the presentation and interpretation. However, we find it challenging to implement because a few 95% CIs are missing, and there are some overlaps of empirical data used among meta-analyses, and deriving one effect size wouldn't be an accurate calculation. The fact that there are some overlaps of empirical data has been pointed out by the first referee, and for this reason, we included sample size and publication year of each meta-analysis (please see our complete response as part of the interactive discussion here: https://www.biogeosciences-discuss.net/bg-2020-30/). Furthermore, a few of the merits of showing individual meta-analyses include; it visualizes the (in)consistency among the meta-analyses in results, and it visualizes which variables have been more frequently covered compared to other variables.

Comment 2: That is my main request that would require significant alterations to the text and the figures, but I do have some more easily implemented concerns, as well. I wonder if would it be possible to change the abbreviations "IP" and "DP" to something like "up arrow P" and "down arrow P," respectively. This would be easier for the reader to follow in the text, though you might then also want to think about using "W" instead of "P" to refer to precipitation/water to avoid then making it look as though phosphorus content is what is being discussed. Response: Thank you for your suggestion. It is a great point that P might be a confusing letter for phosphorus. We are considering changing "IP" and "DP" to "up arrow W" and "down arrow W".

Comment 3: Is there also a consistent way to talk about results that had a trend with precipitation, i.e. where something was reduced when precipitation was reduced and increased when precipitation was increased? For instance, saying a variable is positively correlated with precipitation across treatments or negatively correlated with precipitation across treatments? This might also be easier for readers to follow. Response: Thank you for your suggestion. While we agree that showing a trend with precipitation could be useful information, it is difficult to make, for example, a graph of x = precipitation change (%) and y = effect size and show the relationship (= trend) because a meta-analytic result could include multiple precipitation change levels. We are, however, able to give a summary of the estimated trend from the meta-analyses in a consistent way, and we are considering revising our writing in that manner.

Comment 4: Finally, I wonder if it also might make more sense to group enzyme results with microbial biomass, as they are a microbial response and that way you don't have to spread their discussion out over multiple sections. This is just a suggestion, however. Response: We initially considered including enzymes in the microbial biomass section. However, as there are respective enzymes for carbon, nitrogen, and phosphorus cycles, we decided to break them into each section. In this way, we were able to summarize enzyme responses in each cycle and relate their responses to other components of the cycle.

Comment 5: 94 – Did you also use Hedge's d for just these variables, or did you then use it for all variables? Response: We used Hedge's d for only these variables.

Comment 6: 122 – This is a place where it would help to be more explicit with your results given that you are saying they are in-line with an expectation, and you can use whatever way you decide to to talk about consistent trends with precipitation (for instance, the response of belowground NPP to both decreasing and increasing precip). Response: Thank you for your suggestion. We are considering adding the trends with precipitation here.

Comment 7: 127 – If these are general trends across meta-analyses, then how do differences in soil type explain these results more than the differences in nature of the C pool being measured? Response: The impact of differences in soil type is just one of the possibilities. Because the meta-analyses suggest that soil type and biome could affect some of the variables' responses to precipitation changes, we show that these could be one of the reasons for the inconsistent evidence described in l. 124.

Comment 8: 149 – Are there any hypotheses as to why Rh is affected by decreased precip in boreal forest and wetlands, but not in tropical or temperate forests? How about for the effect of increased precipitation in forests and grasslands, but not in wetlands? Response: We believe it is primarily due to the small sample size. Zhou et al. (2016), for example, have a sample size of 4 and 5 for the tropical and temperate forests, respectively, for decreased precipitation, and the effect is highly uncertain given the small sample size. The biomes with significant effect - wetlands in decreased precipitation and grasslands in increased precipitation - are 10 and 15 in sample size, respectively. Biological hypotheses can also be drawn, such as differences in microbial sensitivity. We are considering adding a discussion here.

Comment 9: 151 – It is unclear what the conclusion to be drawn from this sentence is. Response: This paragraph introduces variability in effect size depending on biomes, methods, and other factors. We are considering adding a discussion suggested above and concluding that the general effect could be different depending on multiple factors.

Comment 10: 185 – This is an example of where your presentation and discussion of results would benefit greatly from being able to combine effect sizes across meta-analyses for like variables. Response: Thank you for specifying the point where we can improve the manuscript by combining effect sizes. As we described earlier, it is challenging for us to combine effect sizes. We, however, appreciate your suggestion and leave it for the next project to achieve.

Comment 11: 192 – This is a difficult sentence to parse, I'm not sure how best to

remedy it but perhaps something like “However, the product of mineralization and N2 fixation is NH4+, and it increases under DP according to one of three meta-analyses even though fixation could be suppressed.” Response: Thank you for your suggestion. We are considering changing the sentence accordingly.

Comment 12: 225 – This brings up something that is a bit lacking in discussion of these metaanalyses – are any of them biased or targeted in some fashion, or are they all global? And would a geographic analysis of where all the study sites employed in all of the meta-analyses reveal some obvious blind spots or areas that have been overrepresented in the literature? These would be valuable conclusions to be able to make as a result of your study. Response: None of the meta-analyses has targeted region/country/biome to conduct their meta-analysis, meaning that they all include empirical observations from the world. Yet, the observations are concentrated in the US, Europe, and East Asia, and are sparse in other regions. We are considering adding a discussion regarding this point.

Comment 13: 237 – It may be worth bringing up timescale of studies here for reference relative to P-weathering rates. Response: Thank you for your suggestion. We are considering commenting on the time scale of the studies.

Comment 14: 255 – It seems that you may be able to draw the conclusion that moisture appears to be generally limiting for microbes in soil. Response: Thank you for your suggestion. Yes, it is important to have a concluding sentence here, and we are considering adding one as your suggestion.

Comment 15: 260 – What direction was this response? Response: The sentences you pointed to are showing a non-significant effect, so there is no direction. If you meant “Although Blankinship et al. (2011) and Yan et al. (2018) estimated significant effects on the abundance of fungi and F:B ratio (n = 4), ...”, both negative and positive effects of IP on the abundance of fungi, and negative effect of DP on F:B ratio. We are considering the clarification of these effects.

Comment 16: 271 – I am not sure that this is the best way to phrase this result, as it appears more that changes in precip don’t favor one over the other. Response: We had a similar comment from the first referee, and we are considering emphasizing the variability of effects based on the magnitude, duration, and timing of the precipitation treatment in this concluding sentence.

Comment 17: 281 – In what direction could the ratio be altered? Response: As MBC:MBN increased with IP, soil microbial biomass C:N:P could also be increased to have more weight on carbon. We are considering clarification of this point.

Comment 18: 283 – How would the mycorrhizal symbiosis change the dynamics? A bit more detail would be useful to the reader. Response: Strong mycorrhizal symbiosis might be able to help plant’s nutrient uptake under DP and help maintain soil N:P ratio. We are considering adding more detailed descriptions.

Comment 19: 287-292 – This section feels sparse, and would be well-served to also bring up ecosystems or geographic regions that have been under- or over-sampled, as mentioned in a previous comment. Also, what about the paucity of studies that have measured bacterial:fungal biomass responses to increased precipitation? Response: Thank you for your suggestion. It is a great point to include the geographic differences in observations, as well as the paucity of studies in bacterial:fungal biomass responses. We are considering improving this paragraph based on your comment.

Comment 20: 301 – Some more discussion of what this blind spot in terms of N-process rates means for inferring conclusions about the N-cycle in soil would be useful to the reader to understand why this is valuable fruit to pursue. Response: We had a similar comment from the first referee as well, and we agree that we need to elaborate on the importance of these nitrogen process rates variables. We are considering improving the section by clarifying the values of these variables.

Comment 21: 317 – Do you have any suggestions as to what types of data formatting / archiving you ran into that was helpful or a hindrance? You have an opportunity to

say some things from this pulpit, take advantage! Response: Thank you for the great suggestion. We are considering adding a discussion on data formatting and archiving in this section.

Comment 22: 322 – I'm not sure this statement is quite true given the response of microbial biomass and the crude measures of microbial community assayed – it is fair to say that the ratio of fungi to bacterial biomass is insensitive, but that is not the same as the community being resistant. Response: Thank you for your guidance. We agree with your point, and we are considering revising the section based on your comment.

Comment 23: Figures – Could you bold the symbols used to indicate the direction of the effect to make them stand out more? Also, if you are not going to use the raindrops to denote precip effects on each flow-figure then don't use it on any of them. Response: Thank you for the suggestions. The symbols are actually already bold, but we are going to make them more stand out. And yes, we are going to remove the raindrops used in Figure 1.

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