

Biogeosciences Discuss., referee comment RC1
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Comment on bg-2021-270

Anonymous Referee #1

Referee comment on "Controls on autotrophic and heterotrophic respiration in an ombrotrophic bog" by Tracy E. Rankin et al., Biogeosciences Discuss.,
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This study used field measurements of CO₂ fluxes from control and vegetation removal plots to estimate ecosystem respiration, heterotrophic respiration (HR), and autotrophic respiration (AR) in an ombrotrophic bog ecosystem over two growing seasons. The study analyzed the correlations of temperature and water table with respiration fluxes for the two years. The sensitivity of different respiration fluxes to environmental factors is an important question with implications for understanding ecosystem carbon flux responses to changing climate, as is well explained in the Introduction. I thought the study was well designed and produced a valuable dataset for understanding these fluxes and their controls in bog ecosystems.

In my opinion the statistical analysis portion of the study had some weaknesses that could be addressed.

First, some of the statistical methods are not explained in enough detail in the methods section. In particular, it's not clear how the "multiple regression trees" were conducted or how this method was defined. A full explanation and/or citation for that method would be helpful.

Second, the statistical methods rely on linear regressions. Moisture interactions with respiration in particular are often nonlinear (a threshold dependence is suggested in the Discussion, for example) so I would recommend testing whether linear relationships are an appropriate model for the processes of interest and, if not, applying nonlinear methods where appropriate.

Third, it's not clear why the two years were analyzed separately instead of combined as a single dataset. Since it was all the same site and treatments, it would make sense to treat the whole time series as a common dataset and potentially this would give the overall statistical analysis more power. While it is interesting to see if some relationships differed across years, I think a good default assumption would be that the site should behave similarly in different years unless there is a compelling reason to expect otherwise. I suggest conducting the statistical analysis for the whole dataset across both years and perhaps contrasting those results with analyses for individual years if there are significant differences.

Finally, the results of the statistical analysis that are present are very limited. Only statistical significance metrics, coefficients of variation, and R^2 values are shown. This means that the manuscript never reports the direction or slope of the linear relationships and therefore leaves out a lot of potentially useful information. Statistical significance measures on their own are much less informative if they are not matched with information on how the relationships actually looked. I would recommend at minimum including the linear regression parameters (slope and intercept) in a table. Even more useful would be scatter plots with regression lines showing the data and fit relationships for fluxes and environmental factors (especially if some of the relationships were particularly interesting or significant). Overall, it seems like the study generated a useful dataset but did not fully analyze it.

Other comments:

Line 63-68: This explanation of "plant-mediated HR" did not make sense to me. First it is explained as plants fixing carbon that was recently respired from surrounding vegetation.

This isn't HR, it's reabsorption of respired CO₂. And I don't see why this is a problem for calculating ER. From the perspective of ecosystem carbon balance, it shouldn't matter if the carbon source for photosynthesis came from ecosystem respiration or from the atmosphere — aren't they all carbon molecules in the end? Does it make a difference how far they traveled? Later, plant-mediated HR is explained as having to do with root-soil interactions and litter supply, which seems like a different issue from reabsorption of respired CO₂. A different process that could be called "plant-mediated HR" is supply of C to the rhizosphere that is immediately respired by heterotrophic organisms. This explanation is more consistent with the Discussion paragraph on this topic, which is mostly about rhizosphere priming effects. This does seem like an issue for partitioning AR and HR because it is plant-supplied C that would be cut off by removing plants but it is not strictly AR. But this does not fit with the explanation of "plant-mediated HR" in the Introduction text.

Line 123-125: The wording here sounds like the vegetation removal happened under dark conditions, but I think what is meant is that CO₂ flux was only measured under dark conditions (not light conditions) in plots where vegetation or mosses were removed. Not that the vegetation removal itself was done in the dark.

Line 124: Plots with mosses removed are later referred to as "shrub-only plots." The same terminology should be used throughout the manuscript.

Line 209: The text says that ER and HR were correlated with air and soil temperatures, but based on Table 2 soil T was only significant in one year.

Line 247: Were the influences positive or negative? And how strong? Only providing statistical significance measures and nothing else leaves out the most important information here

Line 225: Again, knowing that this interaction was significant is less useful than knowing what the relationship looked like.

Line 265: The relative influences of soil T and water table on fluxes could be determined from the parameters of the multiple regressions rather than speculating about it based on qualitative looks from the figures as this sentence does.

Line 274-275: The relative contributions of AR to ER under different conditions could be shown directly with a scatter plot of the relevant processes, or by referring to parameters of the linear regressions.

Line 276-277: If there is a real statistical connection between AR and environmental drivers, then why would higher variability in environmental drivers cause the relationship to be weaker? Might this suggest that the apparent relationship is due to some other covariate that varies more slowly over the year? Or that respiration responds to environmental drivers at a particular time scale?

Line 278-280: A threshold relationship with WT could be shown directly with a scatter plot of WT versus respiration. Also, a threshold response is inherently nonlinear which suggests that linear regression may not provide an accurate picture of the relationship.

Line 304: It seems speculative to talk about symbiotic relationships here. The data don't have enough detail to say whether there is a symbiotic component to the observed correlations.

Line 305-309: This should be in the results section

Line 315-317: This should be in the results section

Line 322: Wouldn't this be an interaction term in the multiple regression? The regression would indicate whether the interaction term was significant or not. And conducting the statistics across both years instead of separately by year could give better statistical power.

Figure 1: I think it would be helpful to superimpose continuous measurements of temperature and water table (as lines) along with the dots showing values when fluxes were measured. This would allow those time points to be placed in the context of the whole time series.

Figures 3 and 4: I found these plots difficult to read with all the different colored dots. Connecting the dots with lines or plotting as bars rather than dots might make these figures easier to interpret.

Figure 5: This figure should have separate panels for the two years (similar to the previous figures) or show one long time series. Plotting them on top of each other makes

the plot difficult to read.

Table 2 and 3: The bold and italics notation for different years is difficult to read, especially since the order of years is not consistent. Also, there's no reason not to show all the data. These tables should just have a line for each year (two lines per environmental variable) and show all the values (whether statistically significant or not). And, ideally, include statistics over both years of combined data. Also, the regression parameters (slope(s) and intercept) should be included.