Discussion of "Seasonal variation in vegetation-climate interactions shape the CO_2 exchange in a degraded raised bog"

By Behrens et al.

Reviewer's comments are marked in *italic*.

Authors´ Response to Reviewer #1

This manuscript focuses on understanding the magnitude, seasonal dynamics, and main drivers of carbon fluxes from an abandoned drained peatland. Carbon fluxes were measured using an eddy covariance tower installed at the site, and net ecosystem exchange was further partitioned into gross primary production and ecosystem respiration. The authors then applied a range of statistical analyses to disentangle the effects of key climatic drivers, with particular attention to separating the influences of air temperature, vapor pressure deficit, and radiation. Overall, the manuscript is clear and well written, methods are rigorous, robust and described in a way that allows for replication. The figures are clear and show relevant information, and the analyses performed are adequate for the objectives presented in the paper. I think this manuscript would be a very nice contribution to Biogeosciences as it fits into its scope and would also be interesting to the readers of the journal as it looks at an underrepresented site in the literature. However, there are some points that need to be clarified before publication.

Response: We thank the reviewer for their positive feedback. We will carefully consider the points raised and adjust the manuscript in the relevant sections.

In the following is a point-by-point response in which we outline how we will revise the manuscript in accordance with the reviewer's comments.

While the authors note that data availability is insufficient to robustly estimate seasonal CH4 fluxes and the drivers, it is a bit unclear why there was not a lot of data available (was it precipitation? Bad quality? Below detection limits for the most part?), and which periods were considered for the CH4 budgets presented. Where the gaps evenly distributed across time-seasons? Or where there periods of bigger gaps like the one you mentioned due to rodent damage and lightning? A time series in the supplement would help to see this a bit better.

Response: Thank you for this suggestion. We will add a time series of the CH_4 fluxes in the supplementary.

The main issue preventing the calculation of a reliable annual CH_4 budget is that fluxes were extremely low (close to the detection limit) and random fluxes, not relatable to any measured climate variable. The measurements are collected with an open-path gas analyzer (as mentioned in Line 162) and thus measurements are affected by bad weather conditions (e.g., during rain events). The fluxes missed due to bad weather conditions can be filled if they can be modelled based on their relationship with climate variables. In our case however fluxes were too low and random to relate them to climatic conditions and thus the time series could not be gapfilled reliably. This justification is outlined in lines 339 to 344.

Figure 4 shows normalized daily mean GPP, but there is no mention in the methods section of how the normalization was done.

Response: We will add the calculation of normalized daily mean GPP in the methods section for the derivation of seasonality, in Chapter 2.4.

Flux results are split into monthly aggregates, or seasonal values (non-growing season, growing season) but there are also mentions of early and late growing season stages. While each perspective is individually informative, the combined presentation leads to some redundancy and makes it harder to identify the core results. It would be good to merge or summarise the results a bit better to avoid redundant information both in the text and in the figures, as they all convey similar information (Table 1, Figure 5 and Figure 6). A more selective presentation that highlights only the most informative figures in the main text and relegating secondary results to the supplement would improve readability and focus.

Response: Thank you for this suggestion. We agree that there is duplicated information in Figure 5 and 6. We will therefore remove Figure 5. Table 1 is the main source of information on annual and seasonal budgets while Figure 6 visualizes the differences of monthly flux budgets across the three years.

The filtering and anomaly-based analysis substantially reduces confounding by seasonality, radiation, and the strong covariation between TA and VPD, and represents a thoughtful attempt to isolate short-term driver effects. However, despite these efforts, relationships involving Reco (and to a lesser extent GPP) are still partly conditioned by the partitioning approach, as the nighttime NEE partitioning explicitly assumes a temperature dependence of respiration. As a result, the derived sensitivities should be interpreted as method-conditional rather than as independent estimates of ecosystem process controls. I think this limitation should be more explicitly discussed, or at least acknowledged, in the Discussion, with clearer bounds on the mechanistic interpretation of these results.

Response: We thank the reviewer for pointing out this crucial point. In the context of the mechanistic interpretation of the results, we will add text in the Discussion to acknowledge the artifacts introduced by night-time CO_2 flux partitioning on the temperature-response analysis and on the mechanistic interpretation of the results such as the rising Reco with rising TA (Line 525) or the stomatal closure effect on reducing GPP (Line 530). We will provide further references to support our text.

Minor comments:

- L 90 -95: I understand the meaning of this sentence: “To understand what drives carbon fluxes from abandoned drained bogs and to delineate the mitigation potential of restoration measures under a warming climate demands both precise flux measurements and a rigorous analysis of their drivers.” It is a bit confusing and perhaps missing a comma or two. I think it needs rewording. Here is my suggestion: "To understand what drives carbon fluxes from abandoned drained bogs and to delineate the mitigation potential of restoration measures under a warming climate, both precise flux measurements and a rigorous analysis of their drivers are required."

Response: We acknowledge that the original wording is complicated. The suggestion sounds more concise and we will incorporate it in the final manuscript.

- Please check the manuscript for ‘CO2’ use rather than CO_2

Response: We will correct the formatting throughout the paper.

- Could you provide coordinates for the location of the site?

Response: We will add the coordinates of the site in the site description.

- Figure 2 looks great, a minor improvement would be to align the x-axis of figure 2d and 2b. I think that would allow the reader to see the variations on WTD due to precipitation a bit better.

Response: We thank the reviewer for pointing out the misalignment. We will align the x-axes of Figure 2d and 2b.