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 blue.

Author Response to Reviewer #2

This article presents an analysis of vegetation-climate interaction from measurements at an abandoned, degraded raised bog. I found the article interesting and the analyses were thorough, and I think the content would fit nicely within the scope of Biogeosciences. However, some revisions and clarifications are required.

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

The introduction is well written and provides the necessary background information on the topic. You could include the "low hanging fruit" of rewetting/mitigation potential message from your abstract in the introduction since that was missing. This message is important considering that across several countries there are abandoned drained fields that may be persistent sources of emissions.

Response: We thank the reviewer for this suggestion. The aspect of the low-hanging fruit is incorporated in the Introduction in lines 54-57.

In the first paragraph you can consider introducing natural peatlands as sources of methane, since in the second paragraph you talk generally about carbon emissions and not just CO_2 emissions. Carbon balances can/should also encompass lateral losses. While in temperate peatlands this loss may be small, it can decide whether a site is a net C sink. I recommend to either adjust this or be more specific that you are writing about CO_2 fluxes only in this paragraph.

Response: We will add the mention of CH_4 emissions from natural peatlands in the Introduction as well as lateral carbon loss as an additional carbon flux in the Discussion in Chapter 4.1 where the annual budgets are discussed to provide the full picture. We will further mention that the quantification of lateral carbon loss was outside of the scope of this study.

The methods were generally clear, but some more detail is required: see my line comments below.

The seasonality detection was nice and avoids subjectivity to define season stages.

For the driver analysis in section 2.6, is there a reason why SWC wasn't included? It could have been an interesting addition for the driver/anomaly analysis and perhaps provided some insight into flux regulation that WTD doesn't provide. But I could see that it may have had high collinearity with WTD.

Response: SWC was not included because the measurements had some gaps due to sensor failure. The WTD timeseries, which correspond closely to SWC, was more complete.

Thus we used WTD as a proxy of moisture availability in the peat. We will make sure this point is clarified in the Methods section.

Assuming you used the REddyProc implementation of the nighttime partitioning method and didn't implement your own, Reco is fit on night NEE and TA using sliding 7 day windows in steps of 4 days to define the parameters. It is modelled for day and night, i.e. it doesn't keep the observed night NEE in the timeseries. For the driver analysis, since Reco is fit using TA, it will of course be a dominant driver (as you show later) and therefore those results are unsurprising. Because of the fitting windows/steps, your daily flux anomalies are likely smoothed.

Response: We thank the reviewer for pointing out this crucial point. As mentioned in our response to Reviewer #1 we will add text in the Discussion to acknowledge the artifacts induced by the usage of partitioned data on the temperature-response analysis and 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).

A complication that isn't considered/discussed is effect of gapfilling and partitioning on the driver/anomaly analysis. Only the night-time conditions are considering during the fitting of Reco, but then you are examining daily anomalies of the fluxes and drivers. I think the effect of e.g. daily VPD may not truly be represented for Reco considering the way it is fit and the typical diurnal cycles of VPD, though there are likely memory effects. This has some carry over effects to GPP. There is also the effect of the gapfilling of NEE on the daily driver analysis, since some of the drivers were also used as predictors for the gapfilling. These issues are hard to avoid unless you stick to only analysis of the measured data – and generally for understanding drivers using the direct flux observations would be the best. Unfortunately then you would only get the effect of drivers on daytime and nighttime NEE and not the partitioned fluxes. The analysis is still interesting and you can derive insights from it, but you should mention these circular/confounding issues in the Discussion.

Response: We thank the reviewer for pointing out this important aspect. We see that the true effect of VPD on Reco, e.g. in the form of suppression of autotrophic respiration during daytime, may not be truly represented in partitioned data and can only manifest if it modulates the temperature-sensitivity of night-time respiration. We will incorporate this limitation in the Discussion.

In our current analysis we included a filtering based on the amount of gapfilled fluxes on each day, removing days with more than 75% of gapfilled data. In the revised version we will consider a more conservative threshold and include only days with minimum 50% measured data. We will provide proof of the stability of our results by testing how the threshold for maximum gapfilled data per day affects the driver analysis results. We will repeat the analysis for thresholds covering a broad range of 10 to 80 percent and provide a comparison of the resulting driver strengths in the supplement. Further, we will implement a bootstrapping in the regression analysis, repeatedly resampling the data and running the multiple linear regression for each threshold so we can provide confidence intervals for each driver strength for each threshold of allowed gapfilled data. The results of this additional analysis will be provided in the Supplementary.

Within text, we will make sure these points are clarified in the Methods (Section 2.6) and our attempt to minimize the circular/confounding effect of climate variables on the driver analysis is discussed sufficiently in the revised version.

It was unclear sometimes in the results if you were using the nighttime partitioned data introduced earlier, or your own partitioning you introduced in section 2.7, e.g. the results in

Section 3.7 and Figure 9 (clearly your own method was used for the monthly responses in Figure 8). Or even if the gapfilled NEE/NEP data was used in e.g. Figure 9 for the analyses.

Response: This is an important point, and we will make it clear in the revised version. Our own models introduced in Section 2.7 were only used to derive the parameters Q_{10}, A_{max} and α, not to partition CO_2 fluxes. We will clarify this point in Section 2.7 to avoid confusion. Further, for the analysis regarding the response of fluxes to high TA and VPD conditions (Sections 2.8, 3.7 and Figure 9) we only used observed CO_2 fluxes and the partitioned GPP and Reco related to those observed CO_2 fluxes. We will clarify this point in the Methods Section 2.8.

CH_4 budgets were included in a table but were not discussed or referred to in the text, though you noted the issues with gapfilling earlier. You could refer to them in Section 3.2 when you write that gapfilling performance was poor / uncertainties were too high (or exclude them entirely). See my line comments about the low number of data points.

Response: In Section 3.2 we mentioned that models for gap filling CH_4 fluxes failed, "making the annual CH_4 budget highly uncertain" (line 243). We will remove the unreliable CH_4 budgets from the table, provide the complete time series of measured CH_4 fluxes in the Supplementary (to show the gap and randomness of the fluxes) and make sure the justification for not including CH_4 in the carbon budget estimation is clear throughout the text.

The article was generally written well with good figures but there were some grammar issues, incomplete sentences, and incorrect units applied which need to be corrected. I pointed out some but probably didn't catch all of them – please check carefully.

Response: We thank the reviewer for pointing out these oversights. We will read the text carefully and make sure all mistakes are corrected in the revised version.

Units: See line items. Spaces between the units (e.g. g C m^{-2} a^{-1}, not gC). Annual flux units should have a time unit a^{-1} or yr^{-1}. CH4 flux you had units of mmol m^{-2} s^{-1}, which I assume should be nmol m^{-2} s^{-1} since otherwise that is a huge flux and would exceed your detection limit. A couple of issues with radiation and VPD units.

Response: We will carefully check all units and correct any issues.

Inconsistent uses of subscripts at times, e.g. Q_{10} and Q10, CO2 and CO_2.

Response: We thank the reviewer for pointing out these errors. We will thoroughly check the text and correct any formatting mistakes.

Check language around when discussing WTD, it can be confusing to know if you are talking about shallower or deeper water tables at times when it is "less" or "more" etc. Sticking to e.g. deep and shallow, raised or lower etc. is clearer.

Response: To avoid confusion, we will change from water table depth (WTD) to water table (WT) in the revised version, to be able to mention "low" as deep and "high" as shallow water tables, as this terminology will be less confusing for the readers. Also, we will make sure the terminology is used consistently throughout the text.

The tense in the MS was not always consistent, check carefully.

Response: We will make sure the tenses are used correctly and consistently throughout the revised version.

Line comments

Abstract

L9: The first sentence does not flow that well, I would rephrase it. Carbon dioxide is also not defined yet if it needs to be.

Response: We will rephrase this sentence as: Pristine peatlands act as natural carbon sinks. Through disturbance - in most cases anthropogenic drainage - they turn into CO_2 sources, responsible for 2–5% of annual greenhouse gas (GHG) emissions globally.

L14: methane (CH4) if it needs to be defined

Response: We will add the definitions of CH_4 at the first mentions in the Abstract and Introduction.

L15: northwest Germany

Response: We will correct this.

L16: Perhaps clarify the units that 15 cm is below ground and that WTD is in the notation of positive units -> deeper. Or just write water tables consistently deeper than 15 cm if you don't have space here.

Response: We will use WT (water table) instead of WTD (water table depth) to avoid confusion (please see our response to a previous comment).

L17: gC m-2 a-1 -> g C m-2 a-1

Response: We will correct all units in the manuscript.

L18: greening or growth?

Response: We did observe an earlier greening that goes along with the earlier CO_2 uptake, however as we derive the start of the growing season from GPP we will change this wording into "[...] triggered an earlier onset of CO_2 uptake and substantially increased maximum CO_2 uptake capacity from April to June. [...]"

Introduction

L31: carbon dioxide should be defined again if it needs to be

Response: We will add the definitions of CO_2 at the first mentions in the Abstract and the Introduction.

L34: "leading to carbon losses in form of CO2": be more specific here, the aeration enables microbial peat oxidation and this is the largest C loss pathway. Carbon losses could also entail DOC/POC losses, but microbial peat oxidation enabled by drainage is normally the greatest.

Response: We will highlight the high proportion of carbon lost through drainage-induced aeration more by rephrasing to:
"[...] leads to the aeration of the peat column, easing the constraints on microbial decomposition, leading to carbon losses in the form of CO_2."

L68: “when WTD is consistently high (> 20 cm)” do you mean consistently deep? Intuitively when one talks about high water tables you think of it being close to the surface.

Response: We agree that the usage of “WTD” is more confusing than the alternative “water table” (WT). In the case of WTD, if a “depth” has “high” values, it means the water is furthest from the surface, thus a high water table depth translates to a low water table. To alleviate this and make the phrasing more intuitive we will switch to the use of “WT” in the whole manuscript, and the sentence will read “when WT is consistently low (deeper than -20 cm)”

Methods

L110: in this first paragraph I would write the former land use of the site, based on L115 it was for peat extraction so clarify this.

Response: We will add the former land use of the site (peat extraction) in the Methods.

L120-125: consider adding the common names of the plants

Response: We will add the common names for all plants mentioned in the paper.

Figure 1: include the footprint model that you used to calculate the climatology in the caption.

Response: We will add the mention of the Kljun flux footprint model as well as the reference for it in the figure caption.

L135: in the meteo measurements, you have included the company names and locations for some of the instruments but not all. E.g. for Onset Hobo, you have included Bourne, MA, USA but for Hukseflux, Stevens Hydraprobe and others they are not included.

Response: We thank the reviewer for catching this inconsistency. We will add the missing information for all instruments.

L146: german -> German

Response: Will be corrected

L154: “The first”: the MX2001?

Response: We will clarify by mentioning the MX2001 logger directly:
“ The MX2001 WT data logger had several power outages”

L155: I assume what happened was the Thünen instate logger was corrected for linear offsets relative to the MX2001?

Response: The time series of the complementary WTD data spanned from 19.09.2023 to 05.03.2025. Therefore, data from the MX2001 from 2023 and from 2025 are needed. Because the MX2001 logger was moved in January 2025 the data from 2023 may differ from that in 2025. The complementary data was used as reference and data from the MX2001 before 19.09.2023 and after 05.03.2025 were individually debiased with OLS. We will make sure this point is clarified in the text and add:

“[...] The MX2001 WT logger had several power outages and was moved in the beginning of 2025, resulting in data gaps and a non-continuous time series. The complementary WTD logger covered the period from 19.09.2023 until 05.03.2025. To create a full time series spanning from the beginning of 2023 until the end of 2025, data from the complementary data was used as a reference, and the time spans before 19.09.2023 and after 05.03.2025

were inserted from the MX2001 data. To remove offsets due to the sensor positions, data from 2023 and 2025 from the MX2001 were individually fitted to the complementary WT data, with an ordinary least squares (OLS) regression (R^2 = 0.91 for 2023 and R^2 = 0.88 for 2025)."

L158: R in R^2 should be in italics

Response: Will be corrected.

L160: LI7200RS -> LI-7200RS

Response: Will be corrected.

L162: LI7700 -> LI-7700

Response: Will be corrected.

L163: strictly the fluxes were not measured at 10 Hz, rather the 3D wind speeds and gas concentrations were. You calculated half-hourly fluxes.

Response: We will change the wording to: "Gas concentrations and wind speeds were measured on a tripod at 2.77 m height and with a frequency of 10 Hz."

L164: include the full EddyPro version number, most probably v7.0.9

Response: That is correct, we will insert the full version number.

L165: raw 10 Hz data was->were filtered

Response: Will be corrected.

L166: the simple covariance maximisation technique is generally inappropriate for H2O with the LI-7200RS due to the dependence of lag time on relative humidity. Did you check if the lag windows were appropriate? The automatic timelag optimisation is a better approach for non-passive gases with closed path instruments in EddyPro. The impact on your results is probably not large since you didn't make extensive use of LE outside of the EBC, but it is used in other corrections such as the WPL. See Sabbatini et al. DOI: 10.1515/intag-2017-0043.

Response: We thank the reviewer for highlighting this point. We agree that the effect on CO_2 fluxes is likely small. In the revised version we will provide relevant references in the Methods section to clarify this point. In our case, water vapour fluxes which would most be affected by the maximisation technique, were only used in the WPL correction of the CH_4 fluxes, since CO_2 fluxes were measured with a closed-path analyzer. However, we do not anticipate that the lag determination would affect the CH_4 fluxes substantially given that measured fluxes were already small and close to the measurement uncertainty. The WPL correction would improve any overestimation rather than increasing the uncorrected fluxes.

L169-170: the correct reference for the high-pass filtering effects is Moncrieff et al. (2004), the year is wrong, see DOI: 10.1007/1-4020-2265-4_2

Response: We will use the correct references.

L170: I assume the spectroscopic correction was also applied for CH4 with the LI-7700, see McDermitt et al. 2011 DOI:10.1007/s00340-010-4307-0. Again, the LI-7700 measures gas concentrations (well molar densities actually) of CH4 and not fluxes.

Response: Spectroscopic corrections were indeed applied during flux processing in EddyPro. We will add:
"CH_4 concentrations measured with the open-path analyser were corrected for density fluctuations using the WPL correction (Webb et al., 1980) and spectroscopic effects (McDermitt et al., 2011)."

L175: did you filter the LI-7700 using signal strength? If so what threshold?

Response: We filtered the CO_2 flux data based on a signal strength of 80% and the LI-7700 based on a signal strength of 10% (McDermitt et al., 2011). We will add this information in the methods description.

L179: After the absolute limits removal, the remaining spikes…

Response: This will be corrected.

L182: The RStudio version is not important, rather the version of R is if you want to include something.

Response: We will add the correct R version instead of the RStudio version.

L184: What was the determined threshold? How many quantiles were extracted in addition to the determined threshold, just 0.05 and 0.95? Or e.g. 40 quantiles spaced evenly as in OneFlux?

Response: We will add the final determined annual u*-threshold values which were 0.11, 0.17 and 0.14. We will also clarify that we used 37 evenly spaced quantiles between 0.05 and 0.95 in spaces of 0.025.

L203: I assume these other uncertainties were also added in quadrature? Was the uncertainty due to u* threshold computed as the variance of the different gapfilled totals for each u* quantile threshold?

Response: We did add the other uncertainties in quadrature as well. To make this clear we will change the wording to:
"Uncertainty for the final half hourly fluxes was computed by adding the uncertainties arising from the random measurement errors (Finkelstein & Sims, 2001), the uncertainty arising from the choice of u*-threshold (Pastorello et al., 2020), and the inherent gap filling model uncertainties (Vekuri et al., 2025) in quadrature."

To determine the uncertainty regarding the u*-threshold we used the 95% confidence interval of the gapfilled totals across all u*-quantile thresholds.

L208: NEE introduced but not defined. Did you add the single point storage estimate to get NEE or is just the CO2 flux? I assume there was no profile since the tower was low at 2.77 m.

Response: We will add the definition of NEE here as the net ecosystem CO_2 exchange.

There was no profile measurements as the EC instruments were installed at 2.77 m. Storage fluxes are low (abs. median of 0.06 µmol m^{-2} s^{-1} compared to an abs. median CO_2 flux of

1.23 µmol m^{-2} s^{-1}), and were not included in the NEE calculation. In the revised version we will add the storage flux to the CO_2 flux to calculate NEE.

L211: convention is to use G as the soil/ground heat flux, as you did in Figure S3.

Response: We will use "G" for soil heat flux throughout the manuscript.

L231: all available observations – only observed and not gapfilled?

Response: The anomalies are calculated on the daily scale from all data, measured and gapfilled. In the subsequent driver analysis (Section 2.6) we imposed a threshold which filters out any days that have more than 75% of gapfilled data, which will be changed to 50% in the revised version. As we are using a daily timescale only a small fraction of days have no gapfilled data. Removing all days with any gapfilled data would result in large data loss as well as a skewed filtering. Gapfilled data that is created close to measured data is generally more robust than gapfilled data in long gaps of several days or weeks (Vekuri et al., 2025). As mentioned above in a previous comment, we will further add supplementary information on the impact of gapfilled data showing results when a 50% threshold is applied.
We will make this point clear by writing:

"Daily anomalies were calculated as the deviation of each daily data point from the mean of the daily data within a ±3 day-of-year window across all three years. "

Further, we will add:
"Few days have no data gaps in them, often due to filtering out low turbulence conditions at night (u*-filtering). Therefore, when working on the daily timescale, some gapfilled data needs to be included to reduce excessive data loss and avoid skewed filtering (skewed towards nighttime when turbulence is lower). In order to minimize the effect of gapfilled data on the driver analysis we used a threshold to include only days with less than 50% gapfilled data."

L250: Q10 was earlier with subscript 10 in L105

Response: Throughout the revised version, we will consistently use Q_{10}.

L253: All Reco is modelled using the temperature relationship determined from NEE night, not just Reco day if you used the REddyProc implementation. You can see that in your response functions in Figure 9

Response: We will rephrase as:
"NEE_{night} is used instead of the partitioned Reco because Reco is already modelled."

L261: Sentence starts lower case and missing 'to', should it be "To determine the light response of the ecosystem fluxes , …"?

Response: We thank the reviewer for catching this, the missing "to" will be added.

L264: why is night time defined as < 10 W m-2 but daytime is > 50 W m-2?

Response: This is indeed a mismatch between the post-processing pipeline and the data analysis pipeline and will be corrected. We will consistently use a 10 W/m² threshold to determine day/nighttime conditions

L266: µMol -> µmol, fix here and other usage

Response: We will fix this typo throughout the manuscript.

Results

L290: be consistent with the number of digits for reporting R^2. Instead of writing “it was” be more specific, e.g. the R^2 was

Response: We will report with a consistent number of digits and correct the wording as suggested.

L295: between 11.0 and 11.6ºC

Response: Will be corrected.

L296: W m-2 instead of kW m-2

Response: This unit error will be corrected.

L297: total rainfall (Fig, 2b), respectively,

Response: We will adjust the wording as suggested.

Figure 2: figure resolution needs to be increased

Response: We will increase the resolution of the final figures to at least 300 DPI.

Figure 3: nice Figure. Daily P might look better as a barplot rather than line

Response: We will change daily P to a barplot.

L324: The year 2025 was by far the driest…

Response: We agree that this wording is more fluent and will incorporate it.

L330: What is the average closure of FLUXNET2015?

Response: The average closure is currently in the Methods section (line 215). We will move it from there into the Results.

L336: "The ensemble neural networks filled the gaps with an average R2 across all u*-scenarios of 0.85±0.03, uncertainty in the R2 expressed as the 95% confidence interval across all models.”

This should be rephrased. You cannot know the R2 of the gaps since you don’t have the data (unless you are talking about artificial gaps, but I don’t recall you introducing them). Rather, is this the average score of the validation sets? Reporting the RMSE and bias would also be useful.

Response: We agree with the reviewer. To provide a robust estimate of the performance of the gapfilling model we will add an iterated temporal-split validation with temporal blocks of different sizes being held out during training to give reliable validation metrics for different gap lengths. Further we will additionally report the RMSE and the bias in addition to only the R^2.

L339: this is a high proportion of data points filtered out for CH4. Was it because the data quality/signal strength was too low often? Note that if the fluxes are regularly below the

detection limit you should not use the stationarity flag of CH4 (included in the Mauder and Foken test), rather you should apply the CO2 stationarity flag. See Nemitz et al. 2018: Filtering and gap-filling section on page 536. DOI: 10.1515/intag-2017-0042.

In any case, given the low fluxes the overall impact on your study will be low.

Interesting that you didn't see regular CH4 fluxes given the water levels could be elevated at times with warmer temperatures, but also considering the presence of drainage ditches. Particularly the summer of 2023 there was a wetter period, but you did not have measurements then.

Response: We thank the reviewer for pointing this out. In fact there was an error in the calculation. The correct percentage of filtered out data is 56% which is closer to typically expected filtered out amounts of data.

L340-341: mmol m-2 s-1 -> nmol m-2 s-1, otherwise those are large fluxes of CH4!

Response: We will check any mention of CH_4 fluxes throughout the manuscript and correct the units to nmol m^{-2} s^{-1}.

L349: "reducing all correlations controlled for to maximum remaining Pearson correlation coefficient of 0.13" please rephrase

Response: We will rephrase this statement to:
"The employed filtering methods successfully isolated the effects of TA and VPD. The remaining correlations of fluxes with the controlled variables did not exceed a Pearson correlation coefficient of 0.13 (Fig. S4)."

L368-369: CO2, 2 should be in subscript

Response: We will fix subscript errors throughout the manuscript.

Table 1: how did you put CH4 into units of g CO2-C eq. m^{-2} yr^{-1}? If a GWP value was used, state which and what timeframe in the figure caption. Be consistent with the number of decimal places for each value in the table. Your Reco and GPP totals add up to NEE for 2024 and 2025, but there is small difference for 2023.

Response: For the conversion to CO_2-C equivalents we used the GWP100 factor of 25. We will clarify the conversion of CH_4 fluxes into CO_2-C equivalents in the Methods (Section 2.3) where the flux processing is described. Further, in the revised version we will use the value of 27.9 instead of 25, as is advised for biogenic methane emissions in the AR6 of the IPCC (Smith et al., 2021).

We will make sure to report values with a consistent number of digits.

We will check the exact flux sums for NEE, GPP and Reco for each year and season and provide the exact matching sums in the revised version.

Section 3.5: It's interesting that the climate anomalies didn't explain much of the flux in EGS, however there was clear diverging behaviour/conditions as shown by parameters in Figure 8 – particularly in 2024.

Response: We will add this observation in the Discussion in Chapter 4.3 where the variations in P_{max}, α and Q_{10} in the early growing season are discussed.

Fig 7: Z_WTD had positive effects on Reco and GPP but a mixed response on NEE, why? (Okay, I see a reason in discussion later).

L411: Interesting that lower WTs enhanced Reco but VPD decreased it. Which growing season for the VPD impact, both EGS and LGS (seems that only EGS from the figure)?

Response: Indeed, Reco is only suppressed during the EGS and not in the LGS, which is also visible in Fig. 9 e. We will change the wording in line 412 to:
"Conversely, positive VPD anomalies suppressed Reco during the EGS."

L419: missing full stop at end of sentence.

Response: We will add the missing full stop.

Fig 7: black orders -> borders.

Response: Will be corrected.

Figure 9: VPD units should be in hPa? Add regression goodness of fit the plots as well? Would be good to use consistent y-ranges for the plots and extend Reco and GPP to 0. Ranges may be consistent but the Reco right side plot is missing the 5 tick.

Response: The unit for VPD will be changed to hPa. We will add the regression goodness of fit (R^2)to the plot and make the y-ranges consistent and correct.

Discussion

L461: include the uncertainty interval of these totals, units should be g C m-2 a-1

Response: We will add the uncertainty ranges and correct the unit.

L474:476: be more specific about the budgets of the other studies, do you mean GPP and Reco are both similarly within that range?

Response: The presented other flux sums encompass both GPP and Reco, which we will be explicit about. We will rephrase as: "where annual sums of GPP and Reco typically range between 600 and 800 gC m^{-2} (Humphreys et al., 2014; Hurkuck et al., 2016)."

L490: Neither of those studies included Molina caerulea, though they did write about the effect of pressurised flow systems of vascular plants and CH4 emissions. You could also add a citation that showed the effect of M. caerulea, e.g. Leroy et al. 2017 DOI:10.1016/j.soilbio.2017.01.005

Response: We thank the author for pointing us towards that specific reference and will add it to support our text.

L475: Is the higher nutrient availability, as indicted by your elevated N and lower CN, also a reason for the higher productivity compared to the semi-natural sites and enabled the dense shrub cover?

Response: That is possible, however a direct attribution of nutrient compositions and vegetation productivity is not possible based on our data. We will make sure this point is clarified in the Discussion.

L490: do you know anything about the water / peat chemistry? Could there be other terminal electron acceptors that suppress CH4 emissions here?

Response: In Amtsvenn, the peat below 30 cm depth contains low concentrations of inorganic alternative terminal electron acceptors (Lemmens et al., 2026), yet ombrotrophic peat typically contains redox active organic moieties, contributing considerable electron accepting capacities (Guth et al., 2023). Thus a suppression of methane formation by alternative electron acceptors during the warm summer period may occur. Although nitrogen and phosphorus concentrations are elevated in the upper 10–15 cm of the peat, peak water levels only rarely reach these layers. Moreover, when they do, low temperatures are likely to co-limit methane production. We will incorporate this information into the referenced paragraph (line 490).

L496: this should be self-evident since Reco is defined by the relationship with TA

Response: While the increase of Reco with TA is self-evident, the stronger relative increase of Reco than of GPP with rising TA is not necessarily prevalent at all times, as shown in the TA response of GPP and Reco split up by early and late growing season (Figure 9 b and c).

L501: I'm not sure I agree with your phrasing about the contrasting role. WTD does or should control emissions across sites since it limits the oxygen intrusion into peat and as a result limits decomposition, and it forms a nice relationship at the seasonal/annual scale with net emissions typically. I think to find a short-term effect it will be tricky with NEE if you don't examine day/night separately – as you note with the effect of Reco/GPP and WTD cancelling out. And hence why you find a better relationship in the NGS.

Response: This is an important point, also raised by reviewer #3. We acknowledge the differences in spatial and temporal scale of the inferences made by the referenced scales and will rephrase this as follows:
"While WT is widely accepted as the primary driver of CO_2 emissions on the annual timescale and across sites (Evans et al., 2021; Ma et al., 2022; Tiemeyer et al., 2020), anomalies in WTD had little influence on changes in daily NEE (Fig. 7)."

L573: To the best of our knowledge, there…

Response: The missing comma will be added.

Supplement

Figure S2: ET isn't in the figure?

Response: ET will be removed from the caption.

Figure S3: fix the date range(2023–202)

Response: This will be changed to (2023-2025).

Figure S4: no (a) and (b) labels in figure

Response: The (a) and (b) labels will be added to the figure.

References

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