We would like to thank the editor and reviewers for their comments, feedback, and recommendations on how to improve our manuscript. We have edited the manuscript incorporating the feedback from the reviewers. We have reduced the number of tables and figures in the main body of the manuscript, and recalculated the CH_4 budget incorporating it now in the NECB as recommended by reviewer 3. We have also incorporated the minor changes and recommendations from reviewers 3 and 4. In the text below you can find the comments from reviewers in *Italics* followed by our response written in plain text. Line numbers in our response refer to the manuscript with track changes.

Referee 3.

General comments:

What remains unresolved for me is the streamlining of the main results. The manuscript is now very long, yet more text and graphs were included in the last revision instead of being reduced. For example, is the PCA information necessary, or could it be removed?

The manuscript has been edited following the reviewer's recommendations. Figures and tables that were not essential for the main body of the manuscript were removed, combined with other tables or moved to the appendix. Three tables and one figure were removed from the main body of the manuscript following the recommendations of the reviewer. A detailed explanation of how figures and tables were removed, edited or relocated can be found in the text below which answers specific recommendations from the reviewer. The PCA figure was edited to keep only the PC1 vs PC2 plot which contributes to the discussion of the relations between porewater nutrients and the heterogeneity at the study site.

You have many figures (eight) and tables (six) in the main part of the manuscript (not including the appendix). Are they all necessary for explaining the results, or could some be moved to the appendix or supplementary materials, or even removed if they don't add any additional information? For example, I recommend moving Figure 7 and Tables 4 and 6 to the appendix. In addition, I recommend combining Tables 2 and 3, as mentioned in detail below. In addition, I recommend adapting Figure 2. The most interesting part is Panel B, so I would increase its size and reduce the size of Panel A, for example by putting them next to each other with a width ratio of 1:2. Currently, panel A is larger than panel B, which shifts the focus in the wrong direction.
I recommend removing Table 1 because it is the result of a previous study and does not provide valuable insights that cannot be explained in one to two sentences

The main body of the manuscript has now three tables and seven figures. We have followed the specific reviewer's recommendations in the following way: Figure 7 and table 4 were moved to the appendix, additionally, table 4 was combined with table A3. Table 6 was removed. Text in lines 456 to 459 includes what was described in the former table 6. Tables 2 and 3 were combined as recommended by reviewer. Figure 2 was edited as recommended. Text was edited in lines 136 to 138 regarding Table 1. Although peat physicochemical characteristics were collected as part of the referenced study, the study by Nielsen et al.

(2023b) does not specifically describe the peat characteristics of the four blocks included in our study. Therefore, we consider it relevant to include this information in Table 1 as it provides specific block information. We consider that the figures and tables kept in this version of the manuscript contribute to explain the findings presented in this manuscript.

The differences in carbon emissions among the four blocks can be explained by peatland heterogeneity in hydrology and water chemistry (perhaps as a result of peat mineralization?). With the current experimental design, spatial heterogeneity has a greater influence on carbon emissions than different land use intensities. In my opinion, the explanations and limitations are not clearly stated in the abstract and conclusion yet.

The abstract and conclusion has been edited to include the possible explanations to why heterogeneity had a greater effect than management in the study's results (lines 29-31 and 695-698)

Why was linear interpolation used to account for annual CH_4 fluxes instead of a model like the one used for CO_2 fluxes? The preliminary study (Nielsen et al., 2024) even used a temperature-dependent CH_4 model to calculate annual CH_4 fluxes. As you mentioned, higher temporal resolution of environmental parameters improved the models and changed the annual fluxes significantly.

Thank you for pointing this out. In order to improve our estimation of annual CH_4 budgets, a model based on Karki et al. (2014), which uses water table depth, soil temperature, and RVI is now being used instead of the linear interpolation to calculate the annual CH_4 emissions. Information on the model used can be seen now in lines 275-279

Since the subheading is called "Annual Carbon Balances" in the Results chapter, I don't understand why CO_2 and CH_4 fluxes are treated separately. Furthermore, Tables 2 and 3 have different layouts; one is sorted by block, and the other is sorted by treatment, which I find confusing. I recommend merging the two tables. Additionally, one table uses SE, while the other uses SD. Be more concise throughout the manuscript and arrange the tables consistently to make it easier for the reader to recognize patterns, differences, etc.

We agree with the reviewer and have deleted the former Table 3 and included a column in Table 2 with the CH_4 emissions. The whole manuscript was revised to only use SE instead of SD.

Why are methane fluxes not considered in the net ecosystem carbon balance throughout the manuscript, even though CH_4 flux data are available? However, the CH_4 is suddenly considered in the NECB in two sentences (one in the abstract and one in the discussion). This makes it confusing.

We have now added the CH_4 contribution to obtain the NECB as can be seen in table 2. This NECB is now used throughout the manuscript. The CH_4 contribution to the C budget at the study site was low, therefore, our study focused on CO_2 mitigation. Despite this, we have

included CH_4 emissions in our study because CH_4 contribution to GHG emissions is expected to increase as rewetting progresses making data on CH_4 emissions at early rewetting valuable information for future studies.

Then, there is the issue of the units of CO_2 and CH_4 fluxes. Why aren't the same kind of units used for both carbon fluxes? Annual CO_2 fluxes are in C units, and annual CH_4 fluxes are in CH_4 units. Why aren't the same units used as in the preliminary study (Nielsen et al., 2024)? I recommend expressing the annual fluxes in CO_2 equivalent because this makes them more comparable to other GHG emissions from paludiculture or other agricultural uses, with or without rewetting. Alternatively, use C units for both C fluxes, not just CO_2 fluxes.

Answer: We have edited the manuscript to use CH_4-C as the unit for CH_4 emissions throughout the manuscript, and incorporated it into the NECB as can be seen in table 2. Since the focus of the manuscript is in the C balance we have kept the C units throughout the manuscript, however, since we refer to the global warming potential of the CH_4 contribution in the discussion and abstract, we have also included the GWP in CO2e as a column in table 2.

Why weren't nighttime measurements carried out at least a few times in addition to daytime chamber measurements? Would that have improved your results?

We agree with the reviewer that nighttime measurements could have improved our results showing potential interaction of the temperature with other variables (light, plant physiology etc.) on CO_2 and CH_4 fluxes. However, we did not have resources in terms of personnel to perform these measurements. Current studies being conducted with automatic chambers at the study site will contribute to improve our data availability and understanding in this regard.

For me, it is unclear how the rewetting procedure was performed in the study area. This is important for readers to understand the study area and results better. Do I understand correctly that the ditches or drainage pipes were never closed, but maintenance was stopped? Does the area still lose water (and carbon) laterally? In the discussion chapter, however, you suddenly wrote, "after blocking the drainage ditches." Are the ditches blocked manually or not? I am confused. I recommend adding a sentence about this in the study area description to clarify.

The study site has been going through passive rewetting since 2018, the year in which maintenance of the drainage ditches stopped, this gradually raised the annual mean water table depth in the following years as can be seen in Figure 2. Since ditches were not blocked by the time the study was conducted, the site was still losing water and possibly C laterally also. On August 2022 dams were built, initiating further gradual blocking of the drainage ditches which has been progressing to the present. However, events after spring 2022 are irrelevant for the current study and thus were not included in the manuscript. Text was edited in the discussion section (lines 497-498) the words “blocking of” have been changed to “not maintaining”. Thank you for pointing out this error.

Specific comments:

Title: On the one hand, I prefer the new title to the previous one, but I would like it to be more specific in terms of its type of paludiculture. On the other hand, I cannot find the term 'heterogeneity' or a description of it in the abstract. So, is it not important enough to be in the title, or does the heterogeneity of the WTD between sites, for example, explain the different emissions rather than the treatment, in which case I highly recommend including it in the abstract as well?

Title was edited to include the type of paludiculture that was studied. Additionally, abstract was edited in line 29 in order to mention the heterogeneity of the study site.

L17: Why did you choose to use the colloquial name of the crop instead of the scientific name in the abstract? In addition, the abbreviation of the plant name is not used again in the abstract.

Text was edited in line 18 to include the scientific name and remove the abbreviation.

L40: I would refrain from using the term 'carbon footprint' in the abstract, as it is mainly used for products rather than ecosystems or agricultural areas. I would rather stick to terms such as 'carbon sink' or 'carbon source', or 'carbon uptake' or 'carbon release'.

“footprint” was removed.

L54: The abbreviation 'N' is not explained.

“nitrogen” was included (line 63).

L81: I would use 'ways' instead of 'pathways'.
Word was changed to “ways” (line 89)

L137: All used abbreviations should be explained in the figure captions, as these should be understandable without reading the text. The y-axis names should also be consistent.

The water table depth abbreviation was explained and y axis names were edited in Figure 2 to be consistent.

L148 ff: It would be good to make it clearer in this subchapter that your experimental design was the same as in the previous study (Nielsen et al., 2024), since you continued the chamber measurements at the same sites, but only used a portable gas analyzer instead of gas sampling for GC.

A sentence was included to that effect (lines 162-163)

L163: It would be good to add that every block has at least one (?) WTD measurement and probably the same for the Ts. It was not clear to me where the WTD was measured until I saw

the figure for the WTD in the results chapter showing that every block had at least one measurement.

Each plot had both a water table and soil temperature logger, since each block has three plots, there were three sets of loggers per block. Sentences were added at lines 172 and 177 to clarify this.

L199: The abbreviation 'nrmse' is not explained.

Abbreviation has now been explained. Line 209.

L273: Here, you used the term 'electrocoductivity', but in most tables in the manuscript, you named it 'electrical conductivity'. Be more consistent.

Term was changed to electrical conductivity throughout the manuscript.

L315: Five-cut or 5-cut treatment: Be consistent in how you name your treatments.

Text was changed to 5-cut. Whole manuscript was checked for consistency on the name of treatments.

L370: The abbreviation NSE is not explained.

Abbreviation has been explained

L371: The abbreviation is now written in capital letters (NRMSE); in the method chapter, it was written in lowercase. Be consistent.

Abbreviation has been changed to capital letters throughout the manuscript.

L463: I would recommend using the term 'water parameter' in the table header instead of 'W.C. parameter', as otherwise new abbreviations are introduced that would need to be explained in the table captions. Alternatively, remove the entire table as recommended above.

Table was removed. Results shown in the removed table are included as a text in lines (456 to 459)

L482: You used the same comparison (NECB results with Koch et al., 2023) as in the first sentence of the chapter, but the differences are different now. Please correct the duplicate comparisons and remove the incorrect sentence.

Duplicated sentence was deleted.

L497: It would be good to name the CH_4 emission ranges of these citations.

A range of CH_4 emissions was included for the referenced citations (line 510).

L499: Until now, you have used the NECB without considering the CH_4 emissions, but have suddenly included them. I found this very confusing. I would still recommend using the NECB with CH_4 emissions throughout the manuscript. Otherwise, please stick to one approach/definition and do not change it within the manuscript.

NECB is now calculated including the CH_4 contribution. The entire manuscript was revised for consistency regarding the use of the term NECB.

L500: Please explain the abbreviation GWP and cite the reference for the GWP of 27 for CH_4.

The abbreviation was explained and a reference included (line 512).

L574: A space is missing between 'as' and 'higher'.

A space was included.

L667: I think the unit for N_2O emissions should be CO_2 equivalent instead of CO_2-C, and 'ha-1' and 'a-1' are also missing.

Reviewer is correct. Units have been changed.

L684 ff: This sentence is more than four lines long. I would recommend splitting it into a few shorter sentences to make it easier to read.

Text was edited and split for readability (Line 703)

Tables A1 and A2: 'Ago' probably means 'August', but to make that clearer, I would recommend using the abbreviation 'Aug' instead.

Change accepted.

Figure A2: In the 1:1 plots, it would be helpful to include metrics showing how comparable the measured and modelled values are. Were all values from the four blocks used together? As the data at Zenodo is not yet publicly available and there is no data description. It is unclear which data will be made available, and it cannot be reviewed.

Table 4 (now table A2) has detailed metrics (R^2, NRMSE, NSE, and AICc; for all blocks and treatments) of the measured VS modelled R_{eco} comparison. These statistics are shown for all R_{eco} models, including model 4. Reviewer is correct, figure A2 includes the values from the four blocks at each treatment. We pooled them together in order to minimize the number of

1:1 figures. A sentence was added in line 717 to explain which data will be available in Zenodo after the embargo period.

Referee 4

Line 40: Rewetting->rewetted

Change accepted.

Line 316: lowest->least negative

Change accepted.

Line 321: add one decimal to 4 for concistency

Change accepted, a decimal was added to both numbers.

Line 328: Consider changing the verb "seen" to "found" because then there would be a clearer difference between "looking" and "measuring" things.

Change accepted.

Line 402: replace "field model" with "a model including all data" or similar.

Change accepted, wording was edited in Figure, caption and throughout the manuscript.

Line 444: use the term electrical conductivity for consistency

Change accepted. Term was changed throughout the manuscript.

Line 447: "adding nutrients" sounds like fertilization, better use wording like "adding nutrient concentrations in the model"

Change accepted. Text was edited accordingly.

Line 558: remove the extra point

The extra point in line 579 was removed.

Line 574: ashigher->as higher

Change accepted

Line 677: The sentence starting here is a bit "straight to the point". Maybe rephrase e.g.: The

climate impact of a rewetted site also depends on the fate of the biomass, which could reduce GHG emissions elsewhere if used to replace fossil materials or creating a carbon storage.

Text was rephrased as recommended (lines 690 to 692).