Response to Reviewer Comments for Manuscript

Carbon dioxide release driven by organic carbon in minerogenic salt marshes

egusphere-2025-4621

We would like to thank the reviewer for their thoughtful comments and feedback. We revised the manuscript thoroughly and the changes are provided here: comments by the editor and reviewer in normal front, the reply of the authors (author comments) in *italic* front, and the revised/ added text in green.

Reviewer comment 1

This manuscript presents a comprehensive in situ investigation of organic carbon (OC) turnover and CO_2 release in minerogenic salt marsh sediments of the Wadden Sea. By integrating porewater and solid-phase geochemistry, microbial functional analyses, and an OC manipulation experiment, the authors address an important and timely question: whether OC decomposition in salt marshes is primarily limited by electron acceptor availability or by OC availability and composition.

The study is methodologically sound, data-rich, and clearly written. The focus on European minerogenic marshes is particularly valuable given the predominance of organogenic systems in the literature. The main conclusion, that OC composition and availability dominate over electron acceptor availability in controlling CO_2 release, is compelling, but in several places overstated and would benefit from more nuanced framing.

Overall recommendation: Major revision.

Author comments: *Thank you for the positive feedback and the comments to improve the study.*

Reviewer comment 2

Abstract: Lines 22–26

The Abstract concludes that microbial CO_2 release was not limited by electron acceptor availability, based on sulfate presence and absence of CH_4. This conclusion is strong relative to the evidence presented.

Suggestion to rephrase to indicate the relative importance rather than absolute:

"Electron acceptor availability was unlikely to be the primary limiting factor under the conditions studied".

Author comments: *The reviewer brings up an important and valid point. We conclude based on different lines of evidence that TEA likely did not limit OC decomposition, which we will explain in more detail as responses to the other comments below. We appreciate the suggestion to rephrase the statement in the abstract to emphasize relative importance rather than an absolute conclusion.*

Revised/ added text:

Line 22 and below: Overall, we found that the microbially mediated CO_2 release was likely limited by OC availability and composition, and electron acceptor availability was unlikely to be the primary limiting factor, as evidenced by the presence of aqueous sulfate (SO_4^{2-}) at all tested depths and the lack of CH_4.

Introduction

Reviewer comment 3

Line 29 rephrase to "at the interface between land and the open sea"

Author comments: *Rephrased.*

Revised/ added text:

Line 29: Vegetated coastal wetlands, located at the interface between land and the open sea,…

Reviewer comment 4

The Introduction is well written and provides a thorough background but does not clearly state the hypotheses for the study.

It is also unclear whether differences between pioneer marsh and intertidal flat were hypothesized a priori.

Suggestions: Explicitly state hypotheses at the end of the Introduction and clarify whether spatial contrasts are expected mechanistically or are primarily comparative.

Author comments: *We thank the reviewer for this important suggestion. We now explicitly state our hypotheses at the end of the introduction and shortly clarify the differences between both zones (pioneer marsh and intertidal flat). A more detailed description of these two zones is given in the Material and Methods (line 86-95).*

Revised/ added text:

Line 75 and below: Building on those results, we conducted an in situ manipulation experiment investigating the impact of two contrasting OC sources (acetate, humic acid) on GHG emissions. We hypothesized that (i) the high energy and sediment inputs in minerogenic salt

marshes result in low TOC supply and high TEA availability. We further hypothesize that (ii) this leads to the likely limitation of electron donor and not acceptor on OC decomposition and (iii) the composition of OC plays a more important role than the concentration in CO_2 release from a minerogenic salt marsh. These hypotheses were tested in two successional zones of a salt marsh, a pioneer marsh with sparse pioneer vegetation and a non-vegetated intertidal flat.

Methods:

Reviewer comment 5

The experimental section and the OC manipulation experiment is well designed and described in details. But the ecological relevance of the injected OC concentrations requires a bit clarification. Also explicitly state that the experiment targets short-term process responses, not long-term carbon budgets.

Author comments: *We thank the reviewer for raising this important point. We agree that the ecological relevance of this experiment should be clarified. We have therefore added an explanation how both labile and complex OC addition reflects realistic scenarios in the Materials and Methods (line 137 and below). Furthermore, we explicitly mention that our experiment was a short-term OC addition experiment in the Materials and Methods (line 172). We agree that OC inputs of natural events (e.g., eutrophication or root exudation) have a lower OC input compared to concentrations used in this experiment and last longer than 48 h (e.g., root exudation over a growing period). The high concentrations over a short incubation time (48 h) were intentionally chosen to test in a mechanistic, process-oriented framework, if OC addition can stimulate microbially mediated CO_2 release from minerogenic salt marshes. Our goal was not to simulate OC supply at natural levels but rather to analyze the system response to increased labile and complex OC availability. High OC concentrations were chosen to minimize the effect of dilution and physical flushing due to tidal exchange which potentially obscure the biogeochemical response. We acknowledge that there might be differences in the carbon cycle response between short-term, high concentration OC inputs and sustained, low OC inputs. To address this limitation and avoid over-extrapolation, we added a paragraph in the discussion addressing short-term, high concentration OC inputs to natural OC supply (line 601 and below). Moreover, we will discuss the extent to which our findings can be transferred to long-term C cycling in minerogenic salt marshes.*

Revised/ added text:

Line 137 and below: Studying both labile and complex OC additions is ecologically relevant as salt marshes receive OC from multiple sources (Temmink et al., 2022). Eutrophication of coastal waters and/or root exudates can supply readily degradable OC to salt marshes, while increased organic matter load in rivers can deliver more complex OC compounds to salt marshes. The applied OC compounds in our study, therefore, represent environmental

scenarios and allows us to investigate how these OC sources influence GHG release under realistic conditions.

Line 172: The applied approach allowed us to assess short-term OC process response in minerogenic salt marshes, rather than long-term responses.

Line 601 and below: Furthermore, it is important to note that OC concentration used in this experiment are higher than those expected for naturally occurring OC inputs, such as root exudates, which are typically released at lower concentrations with a continuous input. Thus, upscaling the enhanced CO_2 fluxes measured in our study might result in overestimation of CO_2 release from minerogenic salt marshes. Our findings rather reveal, on a process level, that the addition of labile OC stimulates microbially mediated CO_2 release. Enhanced CO_2 release from the acetate amended plots was measured at nearly all sampling time points (1.5, 24, and 48 h) without a clear trend, while the concentration of the inert tracer showed a slight decrease over the same period (Fig. S3) – indicating dilution and flushing of the injected OC. This suggest that the elevated CO_2 release was driven by enhanced availability of labile OC independently of its concentration. These findings allow us to generalize that the system is likely limited by labile OC availability, regardless of the concentration; however, further work should quantify how the magnitude of CO_2 promotion corresponds to OC concentration, particularly under low, naturally sustained OC input rates. In conclusion, we can reliably predict the direction of increased OC inputs to minerogenic salt marshes, but further studies are needed to predict the long-term magnitude of changes in the carbon cycle in these ecosystems.

Results:

Reviewer comment 6

Several statements in the Results section interpret mechanisms rather than reporting observations.

My suggestion restricts the results to direction and magnitude of change, statistical significance and variability observed, and move the mechanistic interpretation to the Discussion section.

Author comments: *We thank the reviewer for this comment and carefully revised the results section to ensure its focus on results (magnitude, statistical significance, and variability observed). Specifically, we shortened explanatory text (line 266-267), moved explanations to the Material and Methods section (line 382-385 moved to line 224) or deleted it (line 406-408 as already states in Material and Methods). We removed interpretations (line 395-396 and line 478-479) or shortened them (line 487-490) and, if not already stated, moved them to the corresponding discussion section. We did not identify additional statements in the results that we believe are mechanistic interpretations. Furthermore, we decided to keep introductory*

sentences at the beginning of some paragraphs to remind the reader of the purpose of the measurement. We think that these sentences provide necessary contextual information without interpreting the results mechanically, e.g., in line 261-262 "Porewater and solid phase measurements from the push and microsensor cores analysis show availability of electron acceptors (O_2, Fe(III), and SO_4^{2-}) over depth in both the pioneer marsh and intertidal flat (Fig. 2)." And in line 294-295 "Bromide was used in the in situ experiment as an inert tracer to test the washing out of the injection solution from the experimental plot over the sampling time of one injection cycle (48 h).".

Revised/ added text:

Line 266-267: ~~We measured concentrations of Fe(II) as an indicator of Fe(III) reduction.~~ Aqueous Fe(II) (as an indicator of Fe(III) reduction) showed a decreasing tend in both zones, with…

Line 382-385 moved to line 224: We are aware that the weaker acid extraction extracted Fe(II) from carbonates and sulfides in addition to iron (oxyhydro)oxides. We therefore used this approach to determine the crystallinity of iron minerals and call it poorly (extracted by 0.5 M HCl) and higher (extracted by 6 M HCl) crystalline iron minerals (and not (oxyhydr)oxides).

Line 395-396 removed: ~~Overall, a decreasing trend from higher contents in the upper 5 cm to lower contents in the deeper layer (5-10 cm) was notable for all treatments and crystallinities.~~

Line 406-408 removed: The impact of the added OC on the bacterial community was analysed by qPCR. ~~to quantify the total bacterial abundance (bacterial 16S rRNA gene copy numbers), the abundances of Geobacter spp. as an indicator for Fe(III) reduction, and the dsrA gene as an indicator for sulfate-reducing bacteria (SRB) in the pioneer marsh.~~

Line 478-479 removed: ~~Overall, an increase for all treatments and the control in the AVS content with depth was measured.~~

Line 487-490 shortened: No significant increase in the RNA-based copy numbers of *dsrA* genes in both depths (Fig. S12c) were observed; however, we detected slightly higher RNA-based dsrA gene copies in the acetate treatments (0.33 ± 0.06 log2FC) compared to the control in the upper layer.

Reviewer comment 7

Lines 285–286; 345

The absence of detectable CH_4 is an important result. Report the CH_4 detection limit and also clarify whether CH_4 was assessed both in porewater and as surface fluxes.

Author comments: *Thank you for the comment regarding the CH_4 detection limit. We will revise the manuscript to include the detection limit and clarify whether it refers to porewater or fluxes.*

Revised/ added text:

Line 24: … at al depth and the lack of detectable CH_4.

Line 285-286: In both the pioneer marsh and intertidal flat, no CH_4 release, neither as fluxes nor in the porewater up to a depth of 50 cm, was detected (detection limit: 0.28 and 0.53 ppm respectively; Table S3).

Line 345: In all treatments and the control, no CH_4 release as a flux was detected (lower than detection limit (0.28 ppm); Table S3).

Line 451: Methane was not detected in the effluxes of any treatment in the intertidal flat plots (lower than detection limit (0.28 ppm); Table S3).

SI: Detection limit of CH_4 (Table S3):

Table S3. Detection limit of CH_4 for the porewater samples (2022) and for the fluxes (2023). *Headspace gas of chambers was not exchanged before measurement. Thus, ambient air was present in the samples as well (concentration ambient air 4.2665 ± 0.2835 ppm). No linear response of CH_4 was observed and changes within the incubation time in some cases were below detection limit.

	Detection limit	Range of measured samples
CH_4 flux (2023)	0.28 ppm	3.78 – 7.72 ppm *
CH_4 porewater (2022)	0.53 ppm	n.a. (all below detection limit)

Reviewer comment 8

Lines 294-307

The bromide tracer convincingly demonstrates limited physical washout, but the definition of residual fraction is not immediately clear. Provide a simple equation defining residual fraction in methods or results rather than Supplement.

Line 305–307: Simplify wording of residual fraction definition.

Author comments: *Thank you for the feedback regarding the term "residual fraction". We are aware that this is not a common term, so providing a simple equation defining it may help the reader. We avoided using the term recovery fraction because our measurements reflect the concentration (Br^- or DOC) remaining in the experimental plots, not the total recovered. To avoid confusion, we will add a clear definition in the results and provide an equation.*

Revised/ added text:

Line 305 and below: Here, residual fraction is defined as the ratio between the Br^- concentration measured in the porewater 48 h post injection and the expected total Br^-

concentration in an experimental cylinder (Equation 1). The expected total Br^- concentration includes both the native Br^- and the added Br^- during the experiment (expected Br^-) after accounting for dilution in the sediment. Details on the calculation of the Br^- residual fraction are provided in Supplement, S1.4.

Equation 1 (simplified equation; details in S1.4)

$$\frac{Br^-_{concentration\ at\ the\ end\ of\ an\ injection\ cycle}}{Br^-_{expected}} = residual\ fraction$$

Line 308-310: The residual fraction of DOC is defined in the same way as for Br^-, representing the proportion of measured DOC after 48 h to the expected DOC (native DOC + added acetate/humic acid) and was calculated in the same way as for Br^- (Equation 1 and S1.4).

Discussion:

Reviewer comment 9

The Discussion repeatedly concludes that electron acceptor availability did not limit OC decomposition (Lines 494–538; 545–548).

The authors move from:

“Fe(II) is present / increases

To

“Electron acceptor availability did not limit OC decomposition”

The paragraph (Lines 514–527) is well written and appropriate. However, elevated Fe(II) may indicate enhanced reduction rates rather than absence of limitation. So elevated Fe(II) tells that iron reduction is happening faster now. It does not prove that iron was never limiting or constraining the system. The authors conclude that electron acceptors are not limiting (strong statement) and OC alone controls decomposition (very strong statement).

Authors need to be cautious about this and rephrase and moderate the interpretation throughout the manuscript to emphasize that OC availability and composition dominated process rates under the conditions studied, rather than concluding that electron acceptor availability was generally non-limiting.

Author comments: *The reviewer brings up an important and valid point. It is true that our conclusion in only based on concentrations and did not directly test that Fe(III) or SO_4^{2-} was limiting or constraining the system using turnover rates.*

We first address the point about iron reduction: we agree that the porewater Fe(II) concentrations we observed with depth (lines 514-527) do not necessarily mean that Fe(III) is

not limiting, but rather that there is some Fe(III) reduction occurring. We chose not to make changes specifically at this point in the text since we address the general point about the TEA limitation below.

Based on different lines of evidence, we concluded that TEAs likely did not limit OC decomposition: First, SO_4^{2-} remained high throughout the sampled depth and the sulfate:chloride ratio stayed stable (only a slight decrease was observed in the intertidal flat). This indicates no strong SO_4^{2-} depletion with depth. We considered whether the lack of observed decrease was due to continuous resupply of SO_4^{2-} with infiltrating tidal water. However, the fine particle size of the sediment suggests that tidal water does not percolate completely through the sediment, even over multiple tidal cycles. Thus, we should have been able to observe SO_4^{2-} consumption due to microbial reduction if occurring.

Second, the OC addition experiment showed a clear response due to the addition of labile OC (acetate). We agree that these results cannot exclude potential shifts in TEA respiration pathways; however, the rapid increase of CO_2 release after addition of acetate (in some injection cycles already 1.5h after addition) combined with no depletion of SO_4^{2-} or observed changes in TEA availability suggest that microorganisms capable of utilizing acetate were already present in the sediment, and is consistent with electron donor limitation rather than electron acceptor limitation.

Third, porewater and solid-phase respiration end products e.g., Fe(II) and/or sulfide levels give evidence that Fe(III) and SO_4^{2-} reduction was occurring. This suggests that these electron acceptors were available and utilized. Furthermore, the high SO_4^{2-} concentrations may suppress methane (CH_4) formation. The absence of CH_4 therefore indicates that electron acceptors were not depleted as a thermodynamically more favorable electron acceptor was still available.

In summary, we suggest that there are indications of an electron donor limitation. We agree that the absence of rate measurement introduces uncertainty and we will add a paragraph in the conclusion (line 659 and below) describing that our data do not fully exclude TEA depletion but are consistent for OC limitation, in addition to softening the conclusions.

Revised/ added text:

Line 536-538: Collectively, due to the occurrence of Fe(III) reduction (especially in the upper sediment layers) and the availability of SO_4^{2-} throughout the sediment, we assume that electron acceptor availability likely did not limit microbial OC decomposition in our study.

Line 545-547: Based on the availability of electron acceptors (e.g., SO_4^{2-}) at all depths and the lack of CH_4, we hypothesize that at our field site and other comparable coastal sites, OC is likely the constraint on microbially mediated CO_2 release and that electron acceptors are likely not a limiting factor.

Line 659 and below: … in terrestrial wetlands. We caution here that we did not directly measure TEA reduction rates. Future studies should investigate turnover rates, potentially

utilizing isotopes to confirm this finding. Overall, our results indicate that the OC composition, rather than the concentration alone, controlled CO_2 release in both succession zones. This suggests that OC composition likely plays a limiting role in microbially mediated CO_2 release from minerogenic salt marshes. The higher CO_2 release observed in the …

Reviewer comment 10

Statistical reporting and methods are briefly described, but replication and model structure are not fully transparent. State sample sizes per treatment zone, and injection cycle, also specify whether error bars represent SD or SE.

Author comments: *We thank the reviewer for this comment. We expanded the statistical description in the main manuscript (line 246 and below). Details on model structure are given in the SI (response variable was CO_2, fixed effect was treatment and time after injection, random effect was treatment replicates). Additionally, we added the sample size per treatment and injection cycle in the figure captions (Figure 2-8). The figure caption also now specifies whether the error bars are standard error or standard deviation. Due to the missing samples values for the CO_2 release in the intertidal flat resulting from nonlinear CO_2 release during the incubation time of gas sampling, we decided to not apply statistical comparisons and thus rephrased it accordingly (line 446-451) and will remove Table S12.*

In the figure caption of Figure 2, the order was slightly changed, and the corresponding sub-panel number (a-e) was added. For Figure 3, details on samples size for each treatment and injection cycle were added. For the figure caption of Figure 4, the line "Markers represent triplicates: mean ± standard error." (line 229-330) was replaced with a more detailed explanation in line 333, similar to figure caption of Figure 7 (line 445). For all other figure captions, details about injection cycle and treatment were added. We tried to add sufficient information to provide clarity while avoiding confusion for the reader. Thus, the general sample size is reported, although some single data points include fewer observation (e.g., outliner). Additional information to figures and statistical information tables has also been added in the Supporting Information (SI).

Revised/ added text:

Line 246 and below: For statistical analysis RStudio (R version R-4.4.3) was used. The significance level for all tests was set at $p < 0.05$. Normal distribution of the data and homogeneity of variances were tested by Shapiro-Wilk test and Levene test, respectively. Correlations between parameters was tested with the relevant tests (Pearson's correlation test or Spearman's rank correlation test depending on the normality of the data). Statistical differences between two groups were tested with a t-test and for more than two groups with a one-way Analysis of Variance (ANOVA) or Kruskal-Wallis rank sum test. For differences in the CO_2 release, a linear mixed model was applied. More details on the chosen tests and model are given in Supplement, S1.7. We reported the p-value in the text; further relevant statistical

test results and parameters are shown in the corresponding sections in the SI. The variability of the geochemistry analysis is represented by the standard deviation of triplicates/duplicates. For the in situ experiment, the variability is reflected in the standard error of triplicates. For duplicate analyses, variability reflects the range of the two samples.

Line 446-451: Figure 7a presents the CO_2 release from the intertidal flat over three injection cycles 1.5, 24, and 48 h post injection. Acetate treated plots released the highest CO_2 in all three injection cycles compared to the humic acid and the control plots. Similar to the pioneer marsh, no strong differences were observed between humic acid treated plots and the control plots. Consistently, the maximum cumulative CO_2 emissions were observed in the acetate treated plots (Fig. 7b). Due to nonlinearity of CO_2 release over the incubation time of gas sampling, some data points are missing; therefore, statistical comparison of CO_2 release between treatments and the control were not possible. Nevertheless, plots amended with acetate consistently showed higher CO_2 releases across all injection cycles.

Figure captions:

Figure 2
Line 257 and below: Figure 2: … (e) Total organic carbon (TOC) in the sediment. For (b-d), push cores were taken in triplicates in both zones to a depth of 25 cm in 2023. Duplicate push cores for (e) the TOC were sampled in 2022. For all sub-figures, markers denote mean ± standard deviation (due to limited sample mass, some depth values only show mean and the range of two samples, or only a single value). All cores were sampled during low tide.

Figure 3
Line 322 and below: Figure 3: … Markers represent the mean of the triplicates, with error bars indicating the corresponding standard error for treatments and control in both zones for DOC and Br^- across all injection cycles.

Figure 4
Line 329-330 replaced by additional details in line 333 and below: Figure 4a/b: … For (a/b), markers represent mean ± standard error of triplicates for all treatments and the control across injection cycles. For the 1st and 3rd injection cycle for the acetate treatment, the 1.5 h values were based on duplicate measurements.

Figure 5
Line 366: Figure 5a: … Triplicates for each treatment and control for each injection cycle were collected and mean ± standard error is shown.

Line 371 and below: Figure 5b: …For each treatment and control, each spatial triplicate (n = 3) was analyzed in triplicate (total n = 9) for each depth (0-5 and 5-10 cm); results are presented as mean ± standard error.

Figure 6

Line 433-434: Figure 6: …Sample sizes include triplicates of each treatment and control at both depths, represented as mean ± standard error (exception of duplicate measurements for 16s RNA-based humic substances (5-10 cm) and 16s RNA-based control (0-5 cm)).

Figure 7:
Line 445 and below: Figure 7: …For (a/b), markers represent the mean ± standard error of triplicates for all treatments and the control across injection cycles, except where missing values for CO_2 release occurred due to nonlinear CO_2 release during the gas sampling incubation time. (a) duplicate measurements are reflected for the 1st injection cycle for the control (1.5 and 24 h), for the 2nd injection cycle for the acetate treatment and control (48 h), and the 3rd injection cycle for the acetate treatment and control (1.5, 24, and 48 h). Single measurement values are shown for the control in the 1st (48 h) and 2nd (1.5 h) injection cycle. For (b) cumulative CO_2 emissions the acetate treatment shows duplicate measurements for the 2nd and 3rd injection and for the control, only single values are reflected.

Figure 8:
Line 468: Figure 8: … Each spatial triplicate (n=3) was analyzed in triplicates (total n = 9) for each treatment and the control at both depths; results are presented as mean ± standard error.

Figures in Supporting information:

Figure S2: …(c) Total organic carbon (TOC) in the sediment. For (a/b), push cores were taken in triplicates in both zones to a depth of 25 cm in 2023. Duplicate push cores for (c) the TOC were sampled in 2022. For sub-figures (a/b), markers denote mean ± standard deviation (due to limited sample mass, some depth values only show mean and the range of two samples, or only a single value).

Figure S3: …Markers represent the mean ± range of duplicates for each time point and treatment/control for each succession zone (too small to be visible).

Figure S4: …Data are shown as mean ± standard error of triplicates for each treatment/control and injection cycle.

Figure S5: … (a/b) Data are shown as mean ± standard error of triplicates for each treatment/control and injection cycle.

Figure S6: … (a) Data are shown as mean ± standard error of triplicates for each treatment/control and injection cycle. … (b) Each spatial triplicate (n = 3) was analyzed in duplicates (total n = 6) for each treatment/control and both depths; results are presented as mean ± standard error.

Figure S7: … Samples size compress triplicates of each treatment and both depths; represented as mean ± standard error (exception of duplicate measurements for 16s RNA-based humic substances (5-10 cm) and 16s RNA-based control (0-5 cm)).

Figure S8: … Data are shown as mean ± standard error of triplicates for each treatment/control and injection cycle.

Figure S9: … Data are shown as mean ± standard error of triplicates for each treatment/control and injection cycle.

Figure S10: … (a) Triplicates for each treatment and control for each injection cycle were collected and mean ± standard error is shown… (b) Each spatial triplicate (n = 3) was analyzed in triplicates (total n = 9) for both depths; results are presented as mean ± standard error.

Figure S11: … Markers show mean ± standard error of triplicates for each treatment/control and injection cycle.

Figure S12: …Sample sizes include triplicates, represented as mean ± standard error for each treatment/control and both depths.

Figure S13: … Samples size compress triplicates, represented as mean ± standard error for each treatment/ control and both depths.

Add samples size to statistical details given in the Supporting information:

Table S4: … Pioneer marsh samples size including values across all injection cycles for DOC comparison: acetate: n = 12 and humic acid n: = 11, and for Br^- comparison: acetate: n = 12, humic acid: n = 10, and control: n = 10. Sample size for the intertidal flat (across all injection cycles) for Br^- comparison: acetate: n = 8, humic acid: n = 9, and control: n = 9.

Table S5: … Samples size for each time point and each treatment and control for each injection cycle was 3 (n = 3) with exception for the acetate (1.5 h) in the 1st and 3rd injection cycle.

Table S6: … Samples size acetate (n = 34), humic acid (n = 36), and control (n = 36).

Table S7: … Sample size includes values across all injection cycles for acetate, humic acid, and control (each n = 12).

Table S8: … Data are presented as mean ± standard error of triplicates (n = 3) for each treatment and the control at both depths.

Table S9: … Sample size includes triplicate measurements (n = 3) for each injection cycle for acetate, humic acid, and control, resulting in a total samples size of n = 12 per treatment/control.

Table S10: … Samples size for each treatment and the control contained spatial triplicates (n = 3), which were analyzed in triplicates (total n = 9) for each depth (0-5 and 5-10). Exceptions: 6 M HCl extraction at 0-5 cm, control: two spatial triplicates (n = 3) were only analyzed in duplicates (n = 8), same as for one spatial acetate replicate (n = 8) at 5-10 cm.

Table S11: …Sample sizes include triplicates (n = 3) of each treatment/control and depth.

Table S13: … Each spatial triplicate (n = 3) was analyzed in triplicates (total n = 9) for each treatment and the control for both depths. Exceptions for acetate (0-5 and 5-10 cm): one spatial triplicate was only analyzed in duplicates (total n = 8) for both depths.

Table S14: … Each spatial triplicate (n = 3) was analyzed for each treatment/control and both depths.

Conclusion:

Reviewer comment 11

The Conclusions are strong but occasionally extend beyond the scope of the experiment.

Emphasize that findings reflect short-term OC inputs and reduce a bit to sharpen the conclusion.

Author comments: *We thank the reviewer for this valid comment. We agree that the original conclusion was too strong as the limitation of electron acceptor was not tested with rates and short-term OC inputs was not mentioned. We have revised the conclusion accordingly, clarified its limitation and acknowledged that this should be tested in further studies. Additionally, we state that our results are short-term OC inputs responses. The revised/added text (line 659 and below) are already mentioned above in response to the reviewer comment that "electron acceptor availability did not limit OC decomposition".*

Revised/ added text:

Line 659 and below: … in terrestrial wetlands. We caution here that we did not directly measure TEA reduction rates. Future studies should investigate turnover rates, potentially utilizing isotopes to confirm this finding. Overall, our results indicate that the OC composition, rather than the concentration alone, controlled CO_2 release in both succession zones. This suggests that OC composition likely plays a limiting role in microbially mediated CO_2 release from minerogenic salt marshes. The higher CO_2 release observed in the …

Line 670: The results of this in situ study contribute to our understanding of short-term carbon dynamics in minerogenic temperate salt marshes.

Line 677-679: Further, the in situ experiment simulated a potential increase of short-term in OC input to the ecosystem, reflecting scenarios associated with climate change such as inundation of previously unflooded areas due to sea level rise and storm surges or eutrophication.

Line 681-683: Our study thus provides valuable insight into the consequences of such short-term scenarios for GHG release and highlights that the input of labile OC (e.g., primary production during eutrophication, root exudates) into the sediment of a minerogenic salt marsh results in higher CO_2 releases.

Minor Comments:

Reviewer comment 12

Line 31–36: Global carbon burial statistics could be shortened.

Author comments: *We decided to leave the section as it is, as we believe it is important to emphasize the role of vegetated coastal areas in global carbon cycles in order to motivate the need for studies on OC dynamics.*

Reviewer comment 13

Line 305–307: Simplify wording of residual fraction definition.

Author comments: *Thanks for this relevant comment. We simplified the definition and provided a simple equation (see response above).*

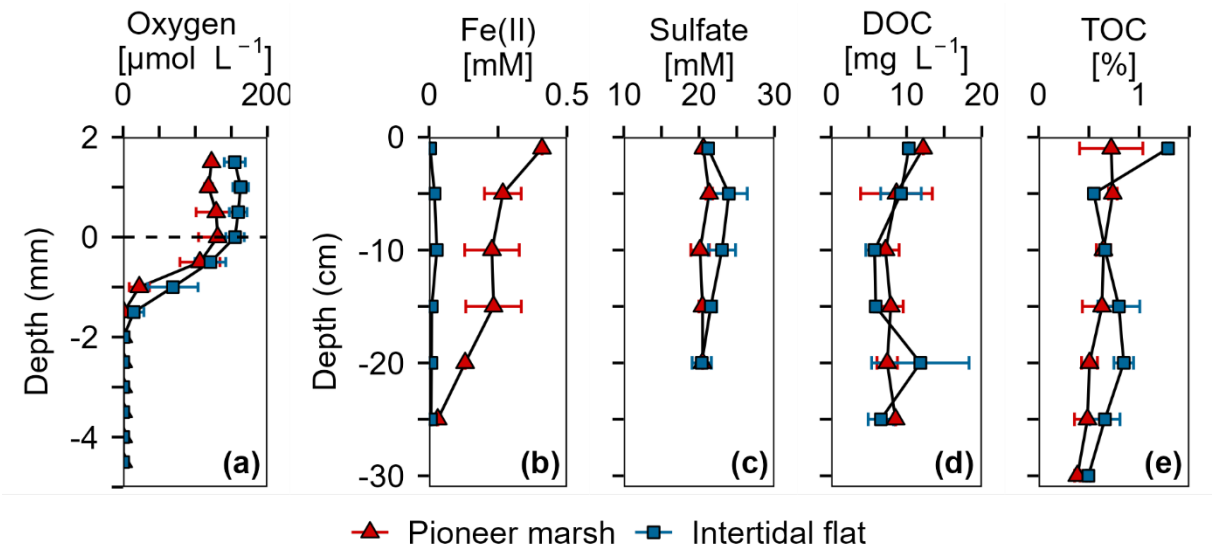
Reviewer comment 14

Ensure consistent color coding for treatments across all figures.

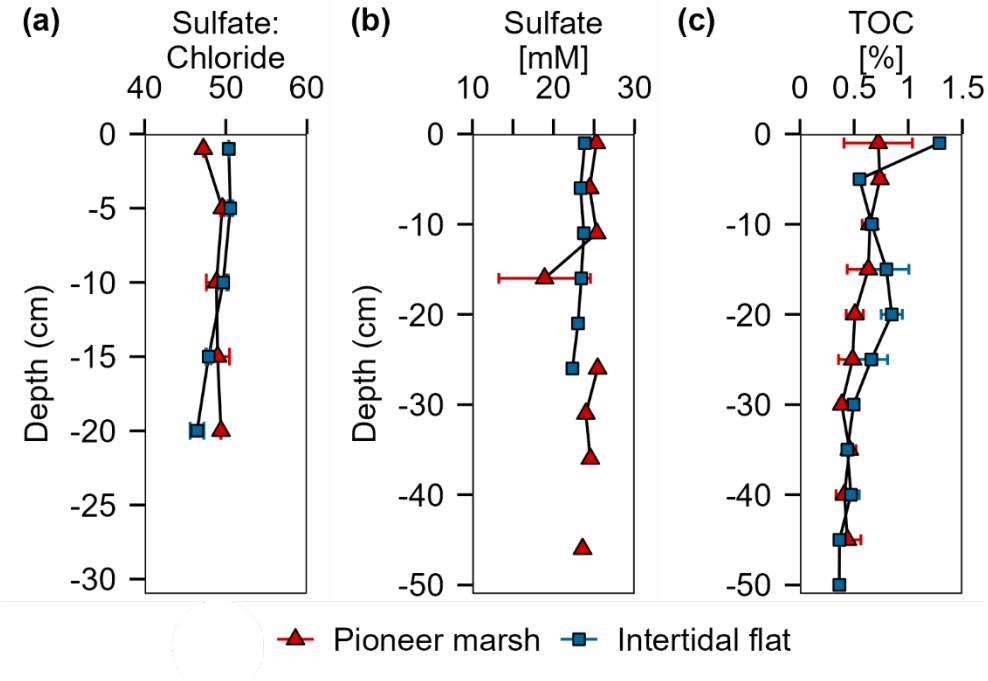
Author comments: *Thank you for this comment. We carefully checked the color coding across all figures and found no inconsistencies among treatments. However, in Figure 2 (geochemical analysis), the intertidal flat was presented in the same gray color as the control in the in situ experimental figures. To improve visual differentiation, we changed the color of the intertidal flat from grey to blue in Figure 2 and in Figure S2 (in the SI).*

Revised/ added text:

Line 252-253: Figure 2. Overview of porewater and sediment biogeochemistry in terms of electron acceptors (O_2, Fe(III), SO_4^{2-}) and electron donor (DOC, TOC) from in situ push cores in the pioneer marsh (red triangles) and intertidal flat (blue squares).



SI: Figure S2. Porewater and sediment biogeochemistry in terms of electron acceptor (SO_4^{2-}) and donor (organic carbon) from in situ push cores in the pioneer marsh (red triangles) and intertidal flat (blue squares).



Reviewer comment 15

Line 381: Avoid reflexive phrasing such as “we are aware that”.

Author comments: *Thanks, we replaced it with “We acknowledge”*

Line 382-383: We acknowledge that the weaker acid extraction extracted Fe(II) from carbonates and sulfides in addition to iron (oxyhydro)oxides.

Recommendation:

Reviewer comment 16

This manuscript is a **strong and valuable contribution** to coastal biogeochemistry specially to carbon cycling in minerogenic salt marshes. With moderated claims regarding electron acceptor limitation, clearer hypothesis framing, and improved separation of Results and Discussion, it should be suitable for publication.

Author comments: *We thank the reviewer for this positive feedback! We have responded to each comment and made corresponding changes, and the manuscript has been improved accordingly.*

References

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