Anonymous Referee #1

Dear Editor,

This article does not address whether this study region acted as a CO2 source or sink to the atmosphere when the water coverage varied between dry and wet conditions. One reason is that there is only a single monitoring station representing each condition, dry and wet. However, another possible reason is a conceptual gap in addressing transitional stages between these two conditions. This issue is also reflected in the conceptual diagram, which makes it difficult for the reader to fully understand how the author interprets the overall uncertainty in the system.

In our study, we measured temporal variations of NEE fluxes using atmospheric Eddy Covariance from high to low tides, including all intermediate tidal phases in between, allowing to distinguish marsh CO_2 sink/source status between wet and dry conditions (Fig. 2) as suggested by Referee#1. Recently, we published a first article in Biogeosciences journal (Mayen et al., 2024) that fully described these NEE flux temporal (tidal, diurnal, seasonal) variations measured by Eddy Covariance (EC) over the year 2020, especially according to tidal conditions. In the present manuscript, we focus on water column carbon process/flux dynamics revealed through our seasonal 24-h cycles carried out in 2021 and its influence on atmospheric CO_2 exchanges (NEE) measured by EC. Strong NEE flux variabilities were recorded showing generally daytime CO_2 uptake and night-time CO_2 emissions associated with more intense NEE fluxes at low tide (marsh emersion) than at high tide (marsh immersion), as also shown in Mayen et al. (2024) at the same marsh site in 2020 we referred at in the present manuscript. Indeed, at low tide, the emerged salt marsh remained a strong daytime CO_2 sink and a low night-time CO_2 source, especially in spring and summer, due to more intense plant metabolism (Fig. 2). Thus, at low tide (dry conditions), the salt marsh behaves as a strong carbon sink at the ecosystem scale (within the footprint) and channel water CO_2 sink/source status was not a major controlling factor in marsh CO_2 exchanges (Fig. 8-A). During high tide, coastal waters immersed the salt marsh (mudflats and plants) and quickly disrupted NEE at the diurnal/tidal scales since water created a physical barrier between the soil and the atmosphere limiting CO_2 diffusion (Fig. 2). Since coastal waters were generally oversaturated in CO_2 compared to the atmosphere, the water column behaved as a CO_2 source toward the atmosphere and strongly reduced the daytime CO_2 sink and night CO_2 source at the ecosystem scale. However, at the daily scale, plant metabolism remains the major contributor to the marsh CO_2 sink measured at the ecosystem scale (NEE), even during low immersion levels where emerged plants located on the highest marsh area can still maintain CO_2 uptake despite aquatic heterotrophy and shelf-contributed CO_2 emissions (Fig. 8-B).

Section 4.4., p29: "During the highest immersion levels of plants (winter and spring), total aquatic metabolism and associated water-air CO_2 fluxes significantly influenced the overall marsh CO_2 exchanges within the footprint. Indeed, during daytime immersion in winter, aquatic heterotrophy ($NEP_{tot} < 0$) and associated water CO_2 oversaturation (atmospheric source) strongly reduced marsh CO_2 uptake measured by EC ($NEE \neq NEE_{marsh}$; Fig. 2) whereas in spring, aquatic autotrophy ($NEP_{tot} > 0$) and associated water CO_2 undersaturation (atmospheric sink) allowed to maintain a weak marsh CO_2 uptake associated with a low GPP_{marsh} from *S. vera* on the highest marsh levels (Fig. 2). On the contrary, during the lowest immersion levels of plants (summer), aquatic heterotrophy ($NEP_{tot} < 0$) and associated water CO_2 oversaturation (atmospheric source) did not significantly influence marsh CO_2 uptake ($NEE = NEE_{marsh}$; Fig.

2) which was mainly controlled by emerged plants (*S. vera*) more represented during this marsh situation. During night-time, tidal immersion completely suppressed marsh CO_2 emissions from ecosystem respiration (plants and sediments) even causing a change in atmospheric CO_2 flux direction from source to sink in winter despite aquatic heterotrophy and water CO_2 oversaturation (Table 2)."

In addition to clearly presenting the data from these two locations, the author needs to recognize that the site is subject to not only temporal variation but also spatial heterogeneity. The limited spatial scope of the two points restricts the overall understanding. Thus, the conceptual diagram should narrow the described spatial domain and more clearly define the interfaces and boundaries, as well as provide a clearer depiction of the system as a whole.

This present study allowed to better understand the influence of marsh aquatic metabolism on water pCO_2 and net ecosystem CO_2 exchanges (NEE) at short timescales (diurnal/tidal rhythms). In intertidal systems like salt marshes, the major advantage of the atmospheric Eddy Covariance method is to measure NEE fluxes at the ecosystem scale from an integrative way, coming from all habitats inside the footprint, at various timescales from hours to years and at both the sediment-air and water-air interfaces (i.e. low and high tides, respectively) (Mayen et al., 2024). Over seasonal 24-h cycles, all carbon forms and nutrients in surface waters were sampled at bi-hourly scale taking into account all marsh tidal phases with different water depths (from 0.50 m at the bottom of the channel at low tide up to 2.50 m at high tide with all intermediate tidal situations in between). These water samplings were performed simultaneously with NEE fluxes inside the Eddy Covariance footprint (Fig. 1-B). To our best knowledge, this is the first time so many parameters are quantified simultaneously inside the same marsh footprint to better study the marsh carbon cycle. However, Referee#1 is right, the single-point sampling in the channel (inside the EC footprint; Fig. 1) might not represent the actual spatial carbon variations throughout the salt marsh region. Indeed, unfortunately it was not possible to do multiple simultaneous sampling points (our sampling point + two upstream/downstream end-members) during the seasonal 24-hour cycles to better constrain the spatial heterogeneity of marsh channel water masses. However, this sampling location at the Bossys perdus salt marsh came after other carbon dynamic studies we carried out at other associated sampling points in this marsh system both at upstream and downstream locations (see Mayen et al., 2023, 2024, published works we referred at in the present manuscript).

At high tide at the Bossys perdus salt marsh, water samples are mainly representative from the downstream coastal-endmember (i.e. the continental shelf). Indeed, we recorded similar salinity and water pCO_2 values between the immersed marsh and the Breton Sound continental shelf (Mayen et al., 2023). On the contrary, at low tide, water sampled at the bottom of the channel is representative of both the waterflow coming from the upstream salt ponds and the Bossys perdus marsh-drainage process by tidal forcing (see Figs. 1 and 8). During this time, salinity and pCO_2 measured in channel waters showed similar trends with the upstream salt ponds (Mayen et al., 2023). However, in some cases, it was not possible to distinguish the relative contribution of allochthonous and autochthonous metabolic processes to water carbon dynamics recorded in the channel as discussed in the present manuscript.

Additionally, the author concludes that multiple samplings per season are necessary, yet this approach was not implemented in the study. It remains unclear how such a conclusion was reached without having conducted the suggested sampling scheme.

Referee#1 is right, we performed one water sampling 24-h cycle per season simultaneously with Eddy Covariance measurements that already represent very intense field work, samplings and analysis (lab and data) afterwards. However, in the limits of our study, we clearly recognized that several 24-hour cycles per season at different marsh locations associated with various meteorological and tidal conditions (neap-tides particularly) would allow to better take into account all temporal and spatial variabilities and to truly extrapolate at the seasonal scale our results on carbon dynamics in salt marshes.

In the conceptual model, those four green arrows can confuse readers' understanding as they do not identify where they are going. The authors can check how Earlier studies organized conceptual models.

In the revised conceptual scheme, the four green arrows have been reorganized to better understand NEE fluxes measured by atmospheric Eddy Covariance at the ecosystem scale encompassing our sampling 24-h cycles (Fig. 8). At low tide, water remained at the bottom of the channel and the salt marsh was fully emerged to the atmosphere. During this time, the intense autotrophy of halophyte plants and benthic microalgae induced a net carbon sink at the ecosystem scale with stronger GPP_{marsh} rates than R_{marsh} rates (see Fig. 8 and see Mayen et al., 2024). At high tide, coastal waters immersed the salt marsh (both mudflats and plants) and quickly disrupted NEE fluxes since water created a physical barrier between the soil and the atmosphere limiting CO_2 diffusion (Fig. 2). Moreover, since coastal waters were generally oversaturated in CO_2 compared to the atmosphere too, the water column behaved as a CO_2 source toward the atmosphere and in this case, the strong R_{marsh} rates from coastal waters reducing the net marsh CO_2 uptake at the ecosystem scale. However, the emerged plants located on the highest marsh levels maintained overall a net marsh carbon sink at the ecosystem scale (Fig. 8).

The air pCO2 should be labeled in the conceptual figure.

We added air pCO_2 in the revised conceptual scheme (Fig. 8). When water pCO_2 were higher than air pCO_2, then water column behaves as CO_2 source toward the atmosphere and inversely.

While this study is only a case study with only one site on the land and another site in the creek, the limitations and uncertainties of these two sites and this study should be identified in the authors' conceptual model.

In the revised conceptual scheme, the limitations and uncertainties were included (Fig. 8), especially about the contribution of (1) porewater advection to the channel by tidal pumping during low and ebbing tides (porewaters enriched in DIC, TA and nutrients in winter and porewaters enriched in DOC and depleted in CO_2 in spring/summer) and in turn (2) benthic DIC effluxes from sediments to water column during high and rising tides. However, Referee#1 is right, direct measurements of benthic processes and fluxes, such as heterotrophic respiration in marsh sediments along with simultaneously sampling stations at different locations along the upstream ponds – salt marsh – downstream shelf, could better constrain the contribution of autochthonous metabolic processes at the benthic interface in the channel DIC production in comparison with allochthonous processes/inputs.

Anonymous Referee #2

General Evaluation

The authors have made a commendable effort in addressing the first-round comments. The revised manuscript demonstrates significant improvements. Overall, the manuscript is now much improved and nearly ready for publication. A few minor editorial adjustments are still recommended to further enhance readability and ensure accuracy.

We are grateful to Referee#2 for his/her positive feedbacks on our revised manuscript. Comments from referees were very useful to improve the MS.

Specific Comments

1. Placement of Table 5

Table 5 provides valuable comparative context with other temperate salt marshes but is currently located in Section 3.6. It should be moved to follow its first mention in Section 4.1 (Discussion) to improve logical flow.

We followed the recommendation of the Referee#2 and we moved the table 5 in the Section 4.1. (Discussion) to improve logical flow and enhance the manuscript's scientific significance and understanding.

2. Equation for NEPtot (Line 270)

While the authors cite Cotovicz et al. (2021) to justify using the full ΔnTA term without the 0.5 correction, a brief note in the main text or a footnote acknowledging this methodological choice would help avoid confusion among readers familiar with standard carbonate system stoichiometry.

Referee#2 is fully right, ΔnTA (i.e. nTA1 - nTA2) must be multiplied by a factor of 0.5 to correct the NEP_{tot} rates for $CaCO_3$ production/dissolution (Longhini et al., 2015). We made a mistake in the first version of the submitted manuscript. In the revised MS, we followed the recommendation of the Referee#2 and we modified the calculation of the NEP_{tot} with 0.5 × (nTA1 - nTA2) (see Tables 2 and 5). Now, our revised NEP_{tot} rates are generally very low indicating strong aquatic heterotrophy during marsh immersion by coastal waters. We sincerely think Referee#2 for his/her major comment.

Longhini, C. M., Souza, M. F. L., and Silva, A. M.: Net ecosystem production, calcification and CO2 fluxes on a reef flat in Northeastern Brazil, Estuarine, Coastal and Shelf Science, 166, 13–23, https://doi.org/10.1016/j.ecss.2014.12.034, 2015.

3. Figure 8 Caption and Labeling

The conceptual diagram is now more informative but remains somewhat dense. Consider simplifying the arrows or separating functional components for greater clarity. The caption should explicitly explain:

- The meaning of the question marks
- The directionality of the dashed arrows
- How TA production is linked to anaerobic processes
- The role of tidal pumping (currently labeled ambiguously)

Additionally, including an arrow or notation showing how DIC/TA influence changes in pCO_2 would help illustrate the carbonate chemistry feedbacks more clearly.

As rightly suggested by Referee#2, the conceptual scheme has been modified and the caption was fully completed to for greater clarity. Recommendations of Referee#2 help clarifying the interactions between the different marsh compartments. This revised conceptual model allowed to better organize and delimit the contribution of terrestrial and aquatic compartments to net ecosystem CO_2 exchanges (sink/source) according to the various measurements done at our study site (see Fig. 8 in the revised MS).

4. Discussion of Sediment Composition

It would be helpful to briefly mention in the Discussion how sediment characteristics (e.g., porosity, organic content) may influence benthic respiration or tidal exchange dynamics.

We completed our revised MS to better understand influence of sedimentary characteristics on benthic respiration and tidal exchange dynamics. At our studied salt marsh, two different substrata can be found in the soil with sand-dominated sediments at bottom and mud-dominated sediments at top (transition depth at 33 cm). At the benthic interface, the impermeable muddy section is generally saturated in porewaters and enriched in plant organic matter promoting heterotrophic processes in upper layers of marsh sediments. During transitional tidal phases, such as ebbing tides, porewaters in mud sediments can be easily exported to surface waters by tidal pumping inducing high DIC, TA and nutrients concentrations in the channel at low tide.

Section 4.3, p27, L671-683: "During low tide (marsh emersion), the largest DIC and TA increases were measured in channel waters, especially in winter, highlighting a strong control of tidal forcing on water carbonate chemistry (Fig. 8-A). In similar salt marsh systems, the same tidal DIC pattern was recorded over all seasons with highest concentrations at low tide and lowest ones at high tide (Table 5). In most intertidal systems, such as salt marshes and mangroves, intense respiration processes occur *in water-saturated muddy sediments inducing* high DIC and TA concentrations in surface waters, especially at low tide through porewater exports driven by the tide (Nakamura et al., 2024; Reithmaier et al., 2023). In winter, during low autotrophic activity of *S. maritima* (Mayen et al., 2024), the highest POC:PON and POC:Chl*a* ratios measured at low tide (Fig. 7) suggested predominant detrital organic matter from decaying vegetation (Savoye et al., 2003). The less-depleted POC-$\delta^{13}C$ measured in winter at low tide (-14.6 ± 0.9‰; unpublished data) confirm the presence of terrestrial C4 plants in channel waters, like *S. maritima* (Amann et al., 2024). *The impermeable muddy sediment section at the benthic interface, saturated in porewaters and enriched in plant-derived organic matter*, constitute an energy source for heterotrophic microbial activity inducing, in turn, the largest increase of DIC and pCO_2 measured at low tide night (up to 3963 µmol kg^{-1} and 1461 ppmv, respectively; Fig. 6-B)."

5. Figures 2 and 6: Salinity–Height and DIC/TA–Salinity Relationships

The added discussion linking seasonal salinity changes to pond management and evaporation/dilution cycles is well-argued. It may be worth emphasizing that this complexity makes salinity a less straightforward tracer of mixing in such systems.

We are agreed with Referee#2 and we completed the section 4.3 of the discussion following his/her recommendation (see below).

Section 4.3., p27, L659-665: "However, the slope of this relationship was negative in C1-winter/C4-fall and positive in C2-spring/C3-summer due to a seasonal shift in channel salinity. More precisely, in the upstream salt ponds supplying the studied marsh channel during low tide, large seasonal variations of salinity exist due to different meteorological conditions and water managements inducing low salinity in winter/fall due to salt water dilution by the rain and high salinity in spring/summer due to salt water evaporation by the heat (Mayen et al., 2023). *Due to this complexity, salinity could be a less straightforward tracer of water mixing processes in such salt marsh systems.*"