RC2: 'Comment on egusphere-2025-335', Anonymous Referee #2, 17 Mar 2025

We sincerely thank the Referee#2 for his/her work and the time he/she spent in reviewing our manuscript. We have considered all your remarks to improve the methodology, the precision, the limitations and the implications of our research study.

Title: Aquatic metabolism influences temporal variations of water carbon and atmospheric carbon dioxide fluxes in a temperate salt marsh by Mayen et al.

General Comments:

This manuscript presents valuable insights into the metabolic dynamics of a temperate salt marsh ecosystem, with a focus on temporal variations in DIC and CO_2 fluxes. The study is thorough in its approach and provides meaningful data across seasonal and tidal cycles. However, addressing the points below—especially those related to external influences, methodological clarity, and data interpretation—will improve the manuscript's clarity and impact.

We are grateful to Referee#2 for his/her positive feedbacks on our manuscript. Referee#2 highlighted the importance of our findings on the temporal variations of water carbon concentrations and atmospheric CO_2 fluxes in a temperate salt marsh using *in situ* carbon original samplings (seasonal 24-h cycles) and innovative methods (water pCO_2 probe and atmospheric Eddy Covariance). We believe our innovative results provide a better understanding of metabolic processes controlling water pCO_2, DIC and atmospheric CO_2 fluxes in salt marshes where diurnal/tidal data are still scarce. We considered all rightly-suggested Referee's recommendations (see below) and we hope that this revision will allow a final publication in the Biogeosciences journal. The manuscript has thereby been substantially revised, especially the external input influences on the study results, the methodology and the limitations of the study.

Contextualization with broader literature:

While the study provides localized data on carbon dynamics, its relevance to broader regional or global trends is not fully explored. Including references to similar studies or integrating global estimates would help contextualize the findings and enhance the manuscript's scientific significance.

We followed the recommendation of the Referee#2. In the revised MS, we added other similar studies to contextualize our findings and enhance the manuscript's scientific significance. A new table was specifically added in the revised MS to regroup similar articles studying inorganic carbon dynamics and water-air CO_2 emissions in temperate salt marsh systems (see table 5). In the revised MS, we compared our results with the literature (Table 5) to contextualize our findings.

Table 5. Seasonal/annual comparison of water inorganic carbon dynamics (pCO_2 in ppmv, DIC and TA in μmol kg^{-1}), total aquatic metabolism (NEP_{tot} in mmol m^{-2} h^{-1}) and water-air CO_2 fluxes (FCO_2 in mmol m^{-2} h^{-1}) between the Bossys perdus salt marsh (this study, France) and other similar temperate salt marsh systems in the literature. Median values were done in bold and range values were done in brackets (min – max).

Reference		Winter	Spring	Summer	Fall	Annual
This study	Water pCO_2 (ppmv)	**525** (321 – 1461)	**221** (106 – 416)	**158** (89 – 597)	**411** (311 – 541)	**382** (89 – 1461)
	DIC (μmol kg^{-1})	**2799** (2354 – 3963)	**2173** (2053 – 2530)	**2056** (1587 – 2175)	**2584** (2206 – 2762)	**2238** (1587 – 3963)
	TA (μmol kg^{-1})	**3076** (2508 – 4016)	**2757** (2379 – 2947)	**2385** (2228 – 2812)	**2804** (2351 – 3047)	**2617** (2228 – 4016)
	NEP_{tot} (mmol m^{-2} h^{-1})	**-2.35** (-7.72 – 3.02)	**-15.80** (-16.61 – -14.98)	**-16.43** (-19.36 – -13.50)	**-5.45** (-7.81 – -3.08)	**-10.01** (-19.36 – 3.02)
	Water-air FCO_2 (mmol m^{-2} h^{-1})	**0.24** (0.05 – 0.46)	**-0.25** (-0.52 – -0.03)	**0.28** (0.05 – 0.53)	**0.36** (0.03 – 0.62)	**0.15** (-0.52 – 0.62)
Wang et al. (2018)	Water pCO_2 (ppmv)	n.a. (500 – 4000)	n.a.	n.a. (1600 – 12000)	n.a.	n.a. (500 – 12000)
	DIC (μmol kg^{-1})	n.a. (1500 – 2500)	n.a.	n.a. (2250 – 4300)	n.a.	n.a. (1500 – 4300)
	$NEP_{aquatic}$ (mmol m^{-2} h^{-1})	-0.83	n.a.	-2.50	n.a.	-1.60
	Water-air FCO_2 (mmol m^{-2} h^{-1})	0.60	n.a.	3.90	n.a.	2.05
Reithmaier et al. (2023)	DIC (μmol kg^{-1})	**2158** (1610 – 3080)	**1941** (1452 – 7895)	**2052** (1450 – 4200)	**2210** (1367 – 3740)	**2065** (1367 – 7895)
	TA (μmol kg^{-1})	**2262** (1634 – 3296)	**1977** (1376 – 8045)	**2083** (1578 – 4191)	**2269** (1330 – 3765)	**2104** (1330 – 8040)
Song et al. (2023)	Water-air FCO_2 (mmol m^{-2} h^{-1})	n.a.	n.a.	**1.03**	**0.20**	n.a.
Gong et al. (2023)	Water-air FCO_2 (mmol m^{-2} h^{-1})	n.a.	**0.53**	**0.65**	**1.10**	**0.76**
Alongi (2020)	Water-air FCO_2 (mmol m^{-2} h^{-1})	n.a.	n.a.	n.a.	n.a.	**1.49**

Discussion of study limitations:

The manuscript would benefit from addressing potential limitations, particularly the absence of direct measurements of anaerobic respiration. Since both aerobic and anaerobic respiration pathways are key drivers of DIC and TA generation, a discussion on the lack of direct data and its implications would improve the transparency and robustness of the study.

Referee#2 is right, anaerobic respiration processes as other benthic processes/fluxes were not measured over our marsh site, which constituted a limitation in our study. In our case, the importance of anaerobic respiration in the marsh carbon cycle was revealed by the large and simultaneously DIC and TA increases measured from high to low tide, especially over the winter 24-h cycle (Fig. 6 and Fig. S1 in the Supplements). Indeed, in intertidal systems, the strong relationship between nTA and nDIC suggested a major contribution of anaerobic respiration in water inorganic carbon dynamics (Borges et al., 2003; Koné et Borges, 2008, Nakamura et al., 2024). In most intertidal systems, such as salt marshes and mangroves, intense anaerobic respiration processes occur in sediments inducing the highest 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). Moreover, during our winter 24-h cycle, the strong nutrient increases (DIP and NH_4^+) from high to low tide could confirm microbial respiration of organic matter in marsh sediments and, in turn, lateral exports of DIC from porewaters to channel waters by tidal pumping as observed in other tidal systems (Cabral et al., 2024; Deborde et al., 2008; Santos et al., 2019). However, direct measurements of anaerobic respiration pathways in marsh sediments, such as sulfate reduction, denitrification and DNRA (dissimilatory nitrate reduction to ammonium), would have provided valuable information to conclude about the main biological drivers of DIC and TA increases during low tide periods in particular. We modified the manuscript accordingly to highlight this limitation in our study (see below).

Section 4.3. Marsh aquatic respiration as DIC source (this sentence was modified in the revised MS)

p28, L673-675: "*Direct measurements of anaerobic processes at the benthic interface, such as sulfate reduction and DNRA, should be assessed to confirm the significance of these metabolic processes in the winter DIC production.*"

Section 5. Conclusions and limitations (this sentence was added in the revised MS)

p30 L752-754: "*Direct measurements of heterotrophic respiration in marsh sediments could clearly highlight the contribution of autochthonous metabolic processes at the benthic interface in the channel DIC production in comparison with allochthonous processes/inputs*"

Influence of external inputs and confounding factors:

The potential influence of riverine and anthropogenic inputs—especially given the proximity to upstream dykes and salt ponds—is not thoroughly discussed. River inputs can introduce organic and inorganic materials, impacting gas concentrations and leading to supersaturation conditions for O_2 and pCO_2. As noted in Line 515, transient tidal phases cause considerable pCO_2 variability due to lateral exchanges. More explicit discussion on these confounding factors is necessary to support the conclusion that observed variations are predominantly driven by marsh primary production.

We thank Referee#2 for this comment. At our studied site, allochthonous inputs can significantly impact water pCO_2 dynamics measured in the sampling channel along with autochthonous processes as mentioned in our submitted MS. At high tide, the salt marsh is immersed by coastal waters imported from the continental shelf, this latter being under influence of riverine inputs to the East depending on seasons (Mayen et al., 2023); whereas at low tide, the salt marsh is emerged into the atmosphere and remaining water in the channel is drained from upstream salt ponds. In the revised MS, we more discussed the potential influence of downstream and upstream end-members in the marsh carbon cycle (water carbon dynamics and associated CO_2 fluxes).

Firstly, during high tide both the day and the night, imported coastal waters were generally oversaturated in CO_2 with respect to the atmosphere inducing atmospheric CO_2 emissions during the marsh immersion, except in spring (Table 2). Indeed, Mayen et al. (2023) and Coignot et al. (in prep.) showed that the coastal end-member (i.e. the continental shelf) behaved as a CO_2 source throughout the year, especially in winter during the highest river water flows from the Aiguillon Bay (Fig. 1). Thus, at high tide, coastal waters imported to the studied marsh could degas the excess of anthropogenic-derived CO_2 into the atmosphere during the marsh immersion (see section 4.1 in the revised MS). At the same time, the riverine and anthropogenic nutrient inputs by coastal waters from the continental shelf could supply the anaerobic respiration processes in the marsh sediments and, in turn, induced the large exports of dissolved CO_2 in channel waters (large oversaturation). In fact, over the winter 24-h cycle, the large NO_3^- decrease (sink) from high to low tide was significantly related to the large NH_4^+ increase (source). This relationship could highlight a dissimilatory nitrate reduction to ammonium (DNRA) in sediments which is an intense respiration process producing DIC and TA in water (see section 4.3 in the revised MS).

On the contrary, the upstream salt ponds connected with the studied salt marsh through a lock during low tide periods only could strongly influence the water carbon dynamics measured in the sampling channel. Indeed, from spring, the intense primary production of floating macroalgae and phytoplankton bloom in the upstream salt ponds can influence the water inorganic carbon inducing large water CO_2 undersaturations at low tide in channel waters. Mayen et al. (2023) confirmed that the fast-growing macroalgae recorded in the upstream salt ponds induced and maintained large water CO_2 undersaturation at both day and night during warm and bright periods, inducing low diurnal variations of water pCO_2. Thus, in our case, the catchment area constituted of artificial salt ponds and associated anthropogenic dykes strongly influence water pCO_2 dynamics in the studied salt marsh (see section 4.2 in the revised MS).

Role of emergent vegetation:

Section 4.2 focuses heavily on planktonic primary production, yet emergent vegetation such as Spartina maritima likely plays a significant role in carbon cycling. Data in Tables 2 and 3 suggest that marsh plant metabolism (NEEmarsh) has a greater influence than planktonic NEP. The manuscript should provide a more detailed discussion on how emergent plants contribute to DOC production and GPP.

During low tide, phytoplankton and benthic microalgae recorded in the sampling channel could strongly control water carbon dynamics inducing large water CO_2 undersaturation and large DOC production as measured in spring, summer and fall. At the same time, the intense autotrophy of emerged plants strongly controlled NEE promoting a marsh atmospheric carbon sink during daytime immersion (Mayen et al., 2024). The metabolism of emerged plants can also contribute to a DOC production through above-ground and belowground litter loss and root exudations.

In the section 4.2, we firstly highlighted the role of planktonic communities in the CO_2-depleted and DOC-concentrated water exportations from high to low tide. Indeed, a large part of inorganic carbon was fixed by primary producer photosynthesis (negative correlation between Chla and water pCO_2; Table 3) including mainly phytoplankton, benthic microalgae and macroalgae, processed by metabolic processes and then exported from/to channel waters as organic carbon (negative correlation between DOC and water pCO_2; Table 3). In the second time, we discussed the potential contribution of the emerged plants, especially in spring and summer, in the large DOC production measured in the channel waters. Indeed, the large GPP_{marsh} rate estimated by Eddy Covariance at low tide day indicate an intense autotrophy of emerged plants (Fig. 2) and confirmed by Mayen et al. (2024). Thus, these latter could produce large amounts of DOC in the marsh sediments, which are exported to the surface water of the channel by tidal pumping at low tide. In a temperate salt marsh, Schiebel et al. (2018) confirmed strong DOC production by plant biomass following by a leaching of DOC to surface water by tidal pumping. Thus, in some cases, it is difficult to distinguish the relative contribution of allochthonous and autochthonous metabolic processes to water carbon dynamics recorded in the channel as both process origins are involved. Over our 24-h cycles, the daily carbon balances of marsh plant metabolism (NEE_{marsh}) and the planktonic metabolism (NEP_{pk}) indicated a minor contribution of planktonic communities and a major one of emerged plants to marsh atmospheric carbon balances at the ecosystem and daily scales (Table 4). We have now modified section 4.2 and section 4.4 to provide a more detailed discussion on how emergent plants contribute to DOC production and GPP as follow:

Section 4.2. Marsh primary producer metabolism influence on water pCO_2 and DOC (this paragraph was completed in the revised MS)

p26, L612-L626: "*Finally, at our salt marsh, the strong primary production of emerged plants, especially in spring and summer (high daytime GPP_{marsh} rates over C3-summer; Fig. 2) and confirmed by Mayen et al. (2024), could also induce DOC production through above-ground and belowground litter loss and root exudations (Kristensen and Alongi, 2006; Schiebel et al., 2018), then exported to surface waters by tidal pumping (Santos et al., 2019) inducing the highest DOC concentrations measured at low tide (Fig. 7).* Most of the DOC leached from marsh plants, like S. maritima, is labile and biodegradable through bacterial activity, especially polysaccharides. *However, because of its long residence time, lignin-derived DOC is a potentially important source of recalcitrant humic substances in marsh-influenced waters (Arnaud et al., 2024; Moran and Hodson, 1990; Wang et al., 2014). Thus, over our spring and summer 24-h cycles, the CO_2-depleted and DOC-concentrated water exportations from high to low tide could highlight the major role of autochthonous/allochthonous marsh primary production within all compartments (terrestrial and aquatic) in the coastal carbon cycle. However, in some cases, it is difficult to distinguish the relative contribution of allochthonous and autochthonous metabolic processes to water carbon dynamics recorded in the channel as both process origins are involved (Fig. 8). Contrary to our study, Santos at al. (2021) indicated large DIC and DOC outwelling from salt marshes over all seasons; it could indicate lower aquatic heterotrophy and higher aquatic autotrophy at our studied marsh, especially in spring and summer, allowing simultaneously large CO_2 uptake and DOC production."*

Section 4.4. Influence of aquatic and benthic metabolisms on NEE

p28, L690-697: "For an integrative study of the planktonic community contribution to marsh CO_2 uptake including both high and low tide periods, daily C balances were computed from planktonic aquatic metabolism (NEP_{pk}) and net ecosystem CO_2 exchanges (NEE) within the EC footprint (Table 4). Over our 24-h cycles, planktonic metabolism was net autotrophic in winter and spring due to higher daytime CO_2 uptake than night-time CO_2 source in waters, whereas it was net heterotrophic in summer and fall due to lower daytime CO_2 uptake than night-time CO_2 source (Fig. 5-a). Simultaneously, NEE measurements indicated an intense autotrophy of the whole salt marsh from winter to summer (Mayen et al., 2024) allowing a large atmospheric C uptake with a major contribution from marsh plants (NEE_{marsh}) and a minor one from planktonic communities (NEP_{pk}) (Table 4)."

Clarity through visual aids:

A conceptual figure illustrating the pathways of TA, DIC, and DOC generation—and their respective effects on pCO_2—would help clarify the interactions and enhance the reader's understanding of the discussed processes.

In the revised MS, we added a conceptual figure (see figure 8) as suggested by Referee#2 to illustrate TA, DIC and DIC generation in the studied salt marsh and their contribution on water pCO_2 in the channel.

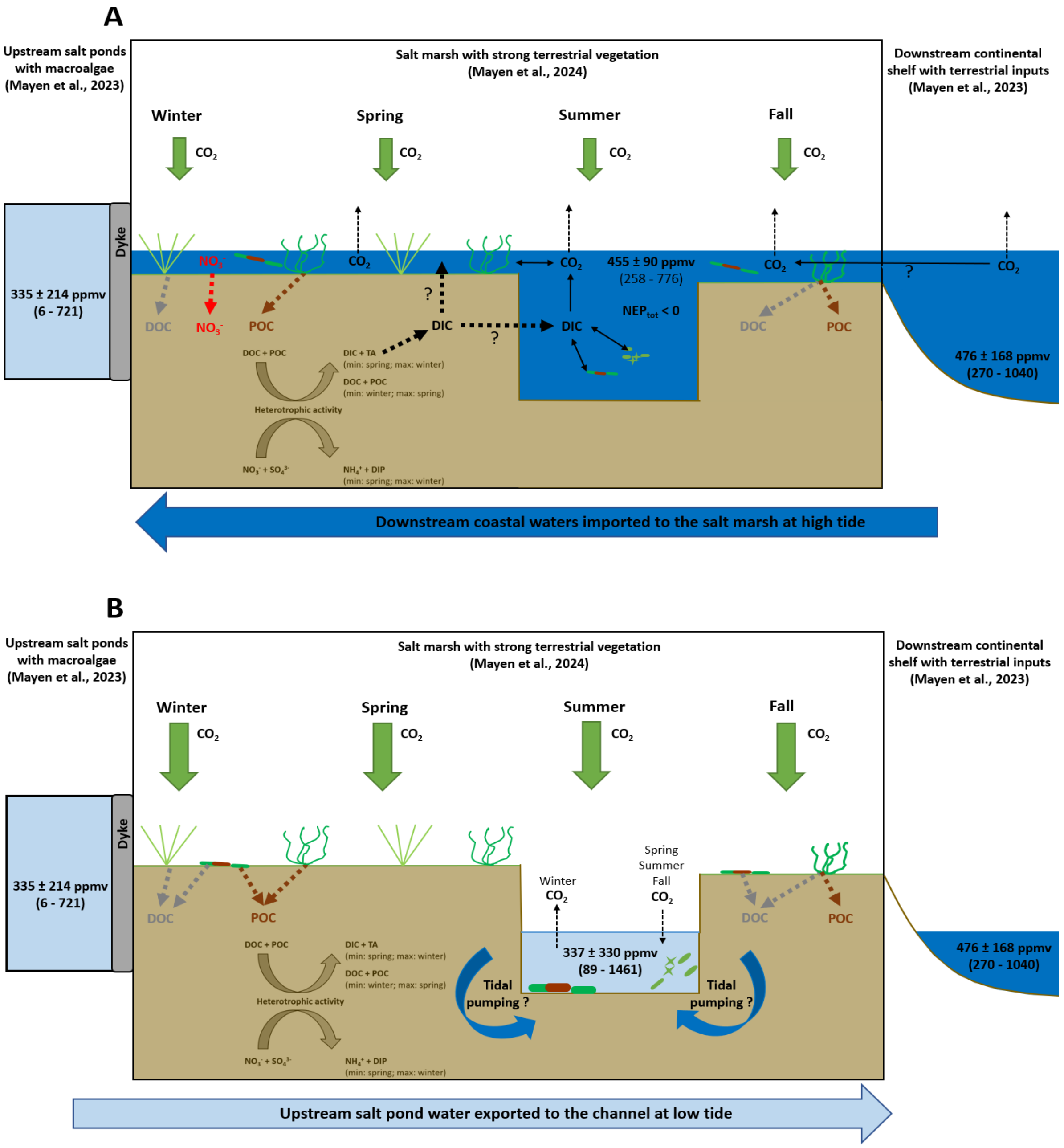

Fig. 8. Water carbon dynamics and atmospheric CO_2 fluxes at the Bossys perdus salt marsh over our 24-h cycles at two contrasted tidal periods: (A) high (flooding) tide (marsh immersion by downstream coastal waters) and (B) low (ebbing) tide (marsh emersion and channel water come from the marsh-drainage process by tidal forcing and the waterflow **from the upstream salt ponds). Green arrows represent net atmospheric CO_2 sink measured at the ecosystem scale by eddy covariance. Negative NEP_{tot} in the water column at high tide corresponds to aquatic heterotrophy (net carbon source for water).**

Specific Comments:

L95: Provide sediment type information at the study sites, which is relevant for interpreting diagenetic processes. This can be added to the Methods or Results section.

In the revised MS, we completed the description of the study site to add information concerning the marsh sediment composition (see below). At top, sediments are dominated by a sandy substrate whereas at bottom, sediments were composed by muds.

Section 2.1. Study sites (these sentences were added in the revised MS)

p4, L109-L112: "*Two different substrata can be found in the soil of the salt marsh with sand-dominated sediments at bottom and mud-dominated sediments at top (transition depth at 33 cm). In the muddy section, dry bulk density and organic carbon content were 0.8 ± 0.1 g cm*$^{-3}$ *and 1.78 ± 0.19%, respectively (Amann et al., 2024).*"

L160: Standardize the y-axis scaling for CO_2 in Fig. 2 to ensure comparability across plots.

The figure 2 was modified and we standardized the y-axis scaling for water pCO_2 (between 0 and 1600 ppmv) to ensure comparability across the plots.

L178–179: Clarify whether the listed plant species percentages are based on biomass, coverage, or another metric. Also, indicate whether vegetation composition varies seasonally, and how this might impact CO_2 fluxes.

As suggested by Referee#2, we completed the revised MS in the Eddy Covariance section and we indicated that the plant percentages inside the studied footprint are based on a habitat coverage survey fully described in Mayen et al. (2024). A land-use map was created from geo-referenced IGN BD orthogonal images with a resolution of 20 cm (2019) using ArcGIS 10.2 (ESRI). The spatial analysis tool of ArcGIS 10.2 was used to perform an unsupervised classification of the BD orthogonal images. We checked the resulting map by selecting 20 random locations within the footprint of the studied salt marsh and compared their land use on the ground and on the map (Mayen et al., 2024). Also, we added supplementary information concerning seasonal life cycle of the marsh plants and their potential impact on atmospheric CO_2 fluxes (see below). *H. portulacoides* and *S. vera* are evergreen plants throughout the year whereas, the growing season for *S. maritima* was shorter (only in spring and summer).

Section 2.3.2. Atmospheric Eddy Covariance and footprint (these sentences were added in the revised MS)

p6, L181-L186: "*A habitat covering map showed that the studied footprint was occupied mainly by halophytic plants including Halimione portulacoides (37%), Spartina maritima (22%) and Suaeda vera (7%) whereas, mudflats and channels occupied 34% of the footprint area (Mayen et al., 2024). H. portulacoides and S. vera are evergreen plants throughout the year whereas, the growing season for S. maritima was shorter (from spring to late summer). During winter and fall, S. maritima persists only in the form of rhizomes and its low metabolism could induce lower marsh CO2 uptake rate (Mayen et al., 2024).*"

L194–195: The reported uncertainties are appreciated. Specify whether they were determined through replicate analyses, CRM comparisons, or another quality control method.

In our study, the uncertainties of nutrient measurements were obtained from certified reference material (CRM) comparisons. The revised MS was completed in the method section (see below).

Section 2.4.1. Discrete parameters (this sentence was added in the revised MS)

p8, L212-213 "Measurement uncertainties were 4% for DSi and 8% for NO_3^-_NO_2^-, NH_4^+ and DIP *and were obtained from certified reference material comparisons within interlaboratory studies (the Dutch Accreditation Council, ISO 17043:2010*)."

L245: It is noted that water samples were collected for DIC analysis, yet DIC concentrations were calculated rather than directly measured. Clarify this apparent inconsistency.

For each hourly water sample, DIC was analysed using a TOC meter in laboratory (Shimadzu TOC-$_{\text{LCPH/CPN}}^{\text{TM}}$) after water acidification to convert all DIC into CO_2. However, this method can have large uncertainties since water samples were filtered directly in the field and large CO_2 amounts could evade into the atmosphere, especially during the water CO_2 oversaturation periods in winter, inducing potentially underestimated DIC values. Thus, in this study, we decided to calculate DIC concentrations from the measured total alkalinity (TA) and water pCO_2 using the CO_2 system calculation program CO_2SYS (Lewis and Wallace, 1998) as fully described in the 2.5 section of the submitted MS. Other studies in shallow coastal systems estimated DIC from the pair TA-pCO_2 (Sippo et al., 2016; Cotovicz Jr. et al., 2021; Koné et Borges, 2007). In the revised MS, we modified the method section to clarify this apparent inconsistency.

L270: The formula presented appears incorrect. (TA1 - TA2) should be multiplied by a factor of 0.5, and DIC and TA should be referred to as NDIC and NTA.

In this study, we calculated the net ecosystem production of the water column (NEP_{tot}, eq. 2) as follows:

$$NEP_{tot} = ((nDIC_1 – nDIC_2)\rho d) / \Delta t – ((nTA_1 – nTA_2)\rho d) / \Delta t – FCO_2$$

where $nDIC_1$ and $nDIC_2$ are DIC concentrations (mmol kg^{-1}) normalized to salinity between two samplings, nTA_1 and nTA_2 are TA concentrations (mmol kg^{-1}) normalized to salinity between two samplings, ρ is the water density (kg m^{-3}), d is the water depth (m), Δt is the time interval (h) between the two discrete samplings and FCO_2 is the water-air CO_2 flux (mmol m^{-2} h^{-1}). We used the method proposed by Cotovicz et al. (2021) in which (nTA1 – nTA2) was not multiplied by 0.5. We modified the revised MS to indicate that DIC concentrations and TA concentrations between two samplings were normalized to salinity (see above). However, we propose not to change this formula and to keep the results in the submitted MS (see Table 2).

Cotovicz, L. C., Knoppers, B. A., Régis, C. R., Tremmel, D., Costa-Santos, S., and Abril, G.: Eutrophication overcoming carbonate precipitation in a tropical hypersaline coastal lagoon acting as a CO_2 sink (Araruama Lagoon, SE Brazil), Biogeochemistry, 156, 231–254, https://doi.org/10.1007/s10533-021-00842-3, 2021.

L530: The manuscript discusses seasonal shifts in metabolic status, but the role of light (PAR) across seasons and tidal phases is underexplored. If PAR data were collected, integrating it into the analysis would enhance the interpretation.

Over our sampling 24-h cycles, atmospheric PAR was continuously measured by the Eddy Covariance system and the seasonal variations of PAR were fully described in the 3.1. section (meteorological and environmental settings). We showed that C2-spring and C3-summer were the brightest periods with no significant variation in daytime PAR values (Mann-Whitney test, $p = 0.10$). Over C2-spring and C3-summer, the medians of daytime PAR values were 1236 and 1135 µmol m^{-2} s^{-1}, respectively. Thus, we concluded that the seasonal shift in planktonic metabolic status from spring to summer was rather related to an increase in air temperature and a change in abundance and diversity of planktonic communities than a PAR variation (see below and see Fig. 4).

Section 4.2. Marsh primary producer metabolism influence on water pCO_2 and DOC

p24, L579-L583: “During daytime low tide, the highest planktonic CO_2 uptake ($NEP_{pk} > 0$) was recorded in spring (high PAR and temperate Tw) through a significant autotrophic activity of pennate diatoms and nanophytoplankton, whereas the decrease in planktonic CO_2 uptake towards summer (high PAR and Tw) was concomitant to higher temperatures, leading to increased community respiration, and more generally, dominant heterotrophic processes.”

L540: The use of POC stable isotope ratios is mentioned; briefly explain the methodology and analysis in the Methods section.

We followed the recommendation of Referee#2 and briefly explain the methodology and analysis of POC stable isotope ratio in the material and method section (see below).

Section 2.4.1. Discrete parameters (this sentence was added in the revised MS)

p8, L228-L229: "*The analysis of POC stable isotope ratios (δ^{13}C-POC) was performed using an Elemental Analyser Isotope Ratio Mass Spectrometer (EA-IRMS: Thermo Flash HT/EA and Delta V Advantage) following Razanamahandry et al. (2024).*"

L675: The statement "Over the seasonal 24-h cycles, water pCO_2 was mainly controlled by biological activity..." is not supported by the data. Fig. 2 indicates that pCO_2 variation corresponds closely with Hw, suggesting tidal forcing as the main driver. This should be addressed.

Referee#2 is right, tidal forcing is a major controlling factor of marsh water carbonate chemistry (Fig. 6), especially water pCO_2. In the figure 2, we can see that water pCO_2 variations were strongly related to water height measured in the sampling channel. During transient tidal phases, lateral exchanges with adjacent down- and upstream waters instantaneously produced intense channel water pCO_2 variations, leading to increases during flood tides (i.e. channel filling) mainly due to buffered coastal waters imported from the shelf, except in winter at night, and decreases during ebb tides (i.e. channel emptying), mainly due to CO_2-depleted marsh waters exported from the marsh system. The revised MS was modified accordingly (see below).

Section 4.1. Temporal variations of water pCO_2 in salt marshes (these sentences were modified in the revised MS)

p22, L528-L539: "*During high tide both at day and night, imported coastal waters were oversaturated in CO_2 inducing atmospheric emissions during marsh immersion (except in spring; Table 2). Indeed, Mayen et al. (2023) confirmed that the coastal end-member behaved as a CO_2 source, especially in winter during the highest river water flows from the Aiguillon Bay. Thus, coastal waters advected to the studied salt marsh could degas the excess of anthropogenic-derived CO_2 into the atmosphere (Fig. 8). In the salt marsh, strong water pCO_2 variations were recorded from high to low tide due to more intense biological activity (production and respiration) at low tide in channel waters influenced by the marsh than at high tide in more buffered coastal waters as shown elsewhere by Wang et al. (2018).* In winter at low tide, the net marsh autotrophy during the day induced a small channel water pCO_2 decrease, whereas the net marsh heterotrophy during the night induced a large channel water pCO_2 increase. In contrast, during spring and summer, the intense autotrophy in channel waters induced the lowest pCO_2 values both at day and night (Fig. 2). *Thus, during transient tidal phases, lateral exchanges with adjacent down- and upstream waters instantaneously produced* *intense channel water pCO_2 variations, leading to 1) increases during flood tides (i.e. channel filling) in response to CO_2-oversaturated coastal waters imported from the shelf, and 2) decreases during ebb tides (i.e. channel emptying) in response to CO_2-depleted marsh waters exported from salt ponds (Mayen et al., 2023), along with autochthonous carbon processes (production/respiration) involved at both tidal periods.* These tidal water pCO_2 variations over our 24-h cycles were observed and confirmed during the longer in situ measurement periods up to 5 days per season *encompassing our 24-h sampling measurements. These intense tidal variations confirmed that water mixing processes occurring in the channel induced large changes in carbonate chemistry mainly related to contrasted coastal and marsh endmembers (Fig. 8).”*

Section 4.3. Marsh aquatic respiration as DIC source (theses sentences were modified in the revised MS)

p27, L641-646: “*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). 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 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).”

Section 5. Conclusions and limitations (these sentences were modified in the revised MS)

p29-30, L732-741: “*Over the seasonal 24-h cycles, water pCO_2 dynamics was partly controlled by the tidal forcing inducing intense variations in the channel during transient tidal phases due to contrasted end-members (coastal water CO_2 oversaturation versus marsh water CO_2 undersaturation).* In general, at high tide, water column CO_2 oversaturation due to heterotrophic metabolism was able to significantly reduce atmospheric CO_2 uptake measured at the ecosystem scale (NEE) during the highest immersion levels only. From high to low tide, the salt marsh acted as a source of DIC, TA and NH_4^+, especially in winter, related to intense anaerobic respiration processes in waters and sediments inducing a significant increase in water pCO_2. On the contrary, in spring and summer, intense autochthonous and allochthonous primary production, including phytoplankton, benthic microalgae and macroalgae, induced the lowest water pCO_2 in the channel both at day and night, coupled with high DOC production. *The spring/summer phytoplanktonic bloom in channel waters and the associated aquatic autotrophy led to CO_2-depleted water exportations downstream.”*

Figures and Tables:

Fig. 2: In winter, high salinity occurs during high Hw, whereas in spring and fall, high salinity coincides with low Hw. Additionally, no clear relationship between salinity and Hw is observed in fall. These seasonal differences warrant further discussion.

At our studied salt marsh, no clear relationship between salinity and water height was observed between the seasons (Fig. 2), contrary to the river-dominated coastal systems (Wang et al., 2018; Polsenaere et al., 2023). In our case, the winter/fall low tide periods correspond to the lowest salinity values whereas the spring/summer low tide periods correspond to the highest salinity values (Fig. 2). This seasonal difference in channel water salinity at low tide was related to dilution and evaporation occurring in the upstream salt ponds due to seasonal changes in meteorological conditions and associated upstream dyke marsh water managements. Over C1-winter and C4-fall, salt water in these upstream ponds was diluted by the rain decreasing salinity whereas over the hottest periods (C2-spring and C3-summer), evaporation processes occur in the salt ponds inducing large salinity increases, especially during neap tide periods. These winter/fall dilution and spring/summer evaporation processes in the upstream salt ponds were fully described by Mayen et al. (2023). We completed the revised MS to added this explanation in the discussion section (see below).

These upstream artificial ponds are supplied with salt waters from the estuary during high tide through a lock management practice to promote biodiversity protection. The water residence time in these artificial ponds varied from a few hours to fifteen days according to the management practices before being discharged to the downstream estuary through the Bossys perdus channel during low tide. Thus, according to the weather, the pond geomorphology, the complex circulation of salt waters and management practices, there is no correlation between water heights and salinity values at low tide in the sampling channel.

Section 4.3. Marsh aquatic respiration as DIC source (these sentences were modified in the revised MS)

p26, L629-L635: “*Large tidal variations of DIC and TA were recorded along the salinity gradient (Fig. 6) confirming a strong control of water mixing processes occurring in the channel on the carbonate chemistry (Reithmaier et al., 2023). 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 (Fig. 2). More precisely, in the upstream salt ponds supplying the studied marsh channel during low tide, large seasonal variations of salinity can occur 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 hot (Mayen et al., 2023).*”

Moreover, pCO_2 does not exhibit significant diurnal variation during low Hw periods, which diverges from typical diurnal patterns. This anomaly requires explanation.

Referee#2 is right, low diurnal variations in channel water pCO_2 was recorded during low tide periods. In winter at low tide, the weak autochthonous/allochthonous aquatic autotrophy during the day induced a small channel water pCO_2 decrease, whereas the intense autochthonous/allochthonous aquatic heterotrophy during the night induced a large channel water pCO_2 increase. On the contrary, in spring and summer, large water CO_2 undersaturations were induced and maintained in the channel both during the day and the night mainly due to the intense autotrophy of the allochthonous macroalgae and autochthonous benthic microalgae (Mayen et al., 2023). Thus, in some cases, it is difficult to distinguish the relative contribution of allochthonous and autochthonous metabolic processes to water carbon dynamics recorded in the channel as both process origins are involved. To illustrate, over the C2-spring and C3-summer, water pCO_2 decreased of 100 and 140 ppmv, respectively, during the low tide day and increased of 30 and 50 ppmv, respectively, during the low tide night. These low diurnal variations of channel water pCO_2 were explained in the section 4.2 of the revised MS (see below).

At the daily scale, planktonic communities could play a major role in the water inorganic carbon dynamics in spring only when the highest planktonic autotrophy ($NEP_{pk} = 0.25$ g C m^{-2} d^{-1}) was associated with the lowest water pCO_2 values (239 ± 105 ppmv), especially at low tide (Fig. 5). On the contrary, the winter planktonic autotrophy ($NEP_{pk} = 0.11$ g C m^{-2} d^{-1}) corresponded to the highest water pCO_2 values (669 ± 327 ppmv) due to a more intense autochthonous respiration at the benthic interface. In the same way, the summer planktonic heterotrophy ($NEP_{pk} = -0.06$ g C m^{-2} d^{-1}) simultaneously measured with the water CO_2 undersaturation (271 ± 182 ppmv) could indicate that the autochthonous planktonic respiration in the salt marsh was counterbalanced by the intense allochthonous macroalgae primary production in the upstream ponds.

Section 4.2. Marsh primary producer metabolism influence water pCO_2 and DOC (these sentences were completed in the revised MS)

p26, L602-L611: "In spring and summer at low tide, the strong daytime increases (up to 190%) and night-time decreases (down to 10%) of DO in channel waters (Fig. 2) could indicate an intense biological activity of *allochthonous* aquatic macroalgae and/or *autochthonous* benthic microalgae which have higher rates of production and respiration than phytoplankton per unit area (Borum and Sand-Jensen, 1996; Hill et al., 2015). The fast-growing macroalgae recorded in the upstream salt ponds induced and maintained large water CO_2 undersaturation at both day and night, especially during warm and bright periods, *inducing low diurnal variations of water* pCO_2 (Mayen et al., 2023). Thus, these *allochthonous* macroalgae could also largely contributed to the large CO_2 uptake and DOC production recorded in the sampling channel that receives all upstream salt pond waters at low and ebb tides (Fig. 8). Previous studies have reported that macroalgae primary production favours tidal DOC exportations, a part of which can be sequestered in marine sediments (Hill et al., 2015; Krause-Jensen and Duarte, 2016; Raven, 2018)."

Table 1: The highest Chl a concentration is reported in fall, which contradicts the data shown in Fig. 4. Clarify this inconsistency.

In the submitted MS, a representation error of Chl*a* concentration was made in the figure 4. At each diurnal/tidal phase (LT/Day, HT/Day, LT/Night and HT/Night), the Chl*a* concentration value reported in green corresponded to one sample only, associated to sampled planktonic community. In the revised MS, we modified the figure 4 and the Chl*a* concentrations reported in green correspond to the Chl*a* median value for each diurnal/tidal phase. The caption of the figure 4 was also modified.

Fig. 4: Chl a concentrations are high in fall, but both microphytoplankton and pico-nanophytoplankton abundances are low. This discrepancy should be addressed in the discussion.

Referee#2 reported a valuable comment. Over C4-fall at low tide, the highest Chl*a* concentrations were recorded while, at the same time, the microphytoplankton and pico-nanophytoplankton abundances were low. This discrepancy could be related to the presence of benthic microalgal mats (microphytobenthos) resuspended in the channel over C4-fall inducing high phytoplankton biomasses (high Chl*a* concentrations) and low phytoplankton abundances in surface waters. Indeed, over C4-fall at low tide, the diatom community sampled in channel waters was constituted of 71% of marine benthic diatoms (39% of *Nitzschia longissima* and 32% of *Pleurosigma* + *Gyrosigma*). This information has already been mentioned and discussed in section 4.2. (see below).

Section 4.2. Marsh primary producer metabolism influence water pCO_2 and DOC

p24, L570-578: "During the 24-h cycles, the large phytoplankton abundance increases from high to low tide, especially in spring and summer (Fig. 4), indicated a development of planktonic communities in the salt marsh under nutrient-rich conditions and low water levels. At low tide (except in winter), POC:PON ratios were close to the Redfield value (Redfield, 1958) suggesting living phytoplanktonic biomass in channel waters. Moreover, phytoplankton was highlighted as the dominant C source at low tide using POC stable isotope ratios ($\delta^{13}C$ of -18.3 ± 1.0‰, -17.4 ± 0.4‰ and -20.6 ± 0.9‰ in spring, summer and fall, respectively; unpublished data) according to Gearing et al. (1984). In the sampled planktonic communities, high abundances of pennate diatoms indicated the presence of resuspended benthic microalgal mats (microphytobenthos: MPB) whose strong metabolism could promote the lowest water pCO_2 measured in the channel (Fig. 2) as observed elsewhere (Polsenaere et al., 2022)."

Fig. 5a and Table 2: NEPpK > 0 is shown during Ht/Night in spring; however, NEPpK cannot logically be positive during nighttime. An explanation for this abnormal result is necessary.

We thank Referee#2 for this abnormal result. In the submitted MS, a sign error was made in the spring planktonic metabolism at the HT/Night in the figure 5a et the table 2. Referee#2 is right, $NEP_{pk} > 0$ (i.e. autotrophy of planktonic communities) is not possible during the night (no light, PAR < 10 µmol m^{-2} s^{-1}). In the revised MS, the correction was made in the figure 5a et in the Table 2. We checked all other calculations of metabolism rates and no error was found.

Fig. 6: TA and DIC show a negative correlation with salinity in winter and fall, but a positive correlation in spring and summer. The reason for this seasonal shift needs to be discussed.

Over the sampling 24-h cycles, DIC and TA were significantly related to salinity but the slope of this relationship was negative in winter/fall and positive in spring/summer, as the Referee#2 rightly noted (Fig. 6-A). Indeed, over C1-winter and C4-fall, channel waters at low tide had the lowest salinity values and the highest DIC and TA concentrations (negative slopes) whereas C2-spring and C3-summer, channel waters had both the highest salinity values and the highest DIC and TA concentrations (positive slopes). This shift was related to a seasonal change in the channel salinity, especially in water exported from the upstream salt ponds, due to dilution and evaporation processes (Mayen et al., 2023). We completed the revised MS to added this explanation in the discussion section (see below).

Section 4.3. Marsh aquatic respiration as DIC source (these sentences were added in the revised MS)

p26, L629-L635: "*Large tidal variations of DIC and TA were recorded along the salinity gradient (Fig. 6) confirming a strong control of water mixing processes occurring in the channel on the carbonate chemistry (Reithmaier et al., 2023). 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 (Fig. 2). More precisely, in the upstream salt ponds supplying the studied marsh channel during low tide, large seasonal variations of salinity can occur 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 hot (Mayen et al., 2023).*"