RC1: 'Comment on egusphere-2025-335', Anonymous Referee #1, 14 Mar 2025

We sincerely thank the Referee#1 for his/her review and for the time he/she spent on our submitted manuscript. We have considered all your remarks to improve the methodology, the precision, the limitations and the implications of our research.

Dear Authors,

This study entitled "Aquatic metabolism influences temporal variations of water carbon and atmospheric carbon dioxide fluxes in a temperate salt marsh" has several distinct strengths. Firstly, the author systematically observed changes across four seasons—spring, summer, autumn, and winter—and further examined diurnal variations within each season over 24-hour cycles, successfully capturing seasonal and daily fluctuations in carbon dioxide fluxes. Additionally, the author employed multiple measurement methods, including changes in atmospheric CO_2, water partial pressure of CO_2, nutrients, planktons, and biological parameters. However, further clarification of the study's scope, limitations, and implications will substantially enhance the research's logical coherence and completeness. My major comments are as follows.

We are grateful to Referee#1 for his/her positive feedbacks on our study. Referee#1 highlighted the importance of our findings to better understand the marsh carbon cycle investigating the fine temporal variations in water carbon concentrations and atmospheric CO_2 exchanges in a temperate salt marsh located between upstream artificial salt ponds and downstream continental shelf waters. Referee#1 also appreciated the multiple measurement methods employed in our study highlighting the influence of aquatic metabolism on water carbon and associated CO_2 fluxes. In the literature, very few studies have looked for the aquatic metabolism contribution on salt marsh carbon dynamics, using *in situ* carbon original samplings (seasonal 24-h cycles) and innovative methods (water pCO_2 probe and atmospheric Eddy Covariance). In blue carbon systems, like salt marshes, the strong heterogeneity of horizontal and vertical carbon fluxes caused by seasonal, diurnal and tidal rhythms requires simultaneous integrative measurements of net ecosystem CO_2 exchanges (NEE) and organic and inorganic carbon in tidal waters to better evaluate all marsh carbon processes and fluxes at the various temporal and spatial scales. Moreover, it is important to study more precisely the whole marsh metabolism integrating terrestrial and aquatic compartments at the different spatio-temporal scales and pinpointing their respective contributions to net ecosystem CO_2 exchanges (sink/source) to better take into account salt marshes in regional and global carbon balances. We believe our new results provide a better understanding of biotic and abiotic factors controlling water pCO_2 and atmospheric CO_2 fluxes in salt marshes where diurnal/tidal data are scarce to include these coastal systems in global carbon budgets and predict future marsh carbon sinks.

In consequence, we substantially modified the manuscript in accordance with the Referee's recommendations (see below) to improve the study's scope, limitations, and implications of our study and we hope our manuscript's revision will allow its publication in the Biogeosciences journal. We proposed a conceptual model 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). Moreover, a new table was added in the revised MS to regroup similar articles studying inorganic carbon dynamics and water-air CO_2 emissions in temperate salt marsh systems to contextualize our findings and enhance the manuscript's scientific significance (see table 5 in the revised MS).

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**

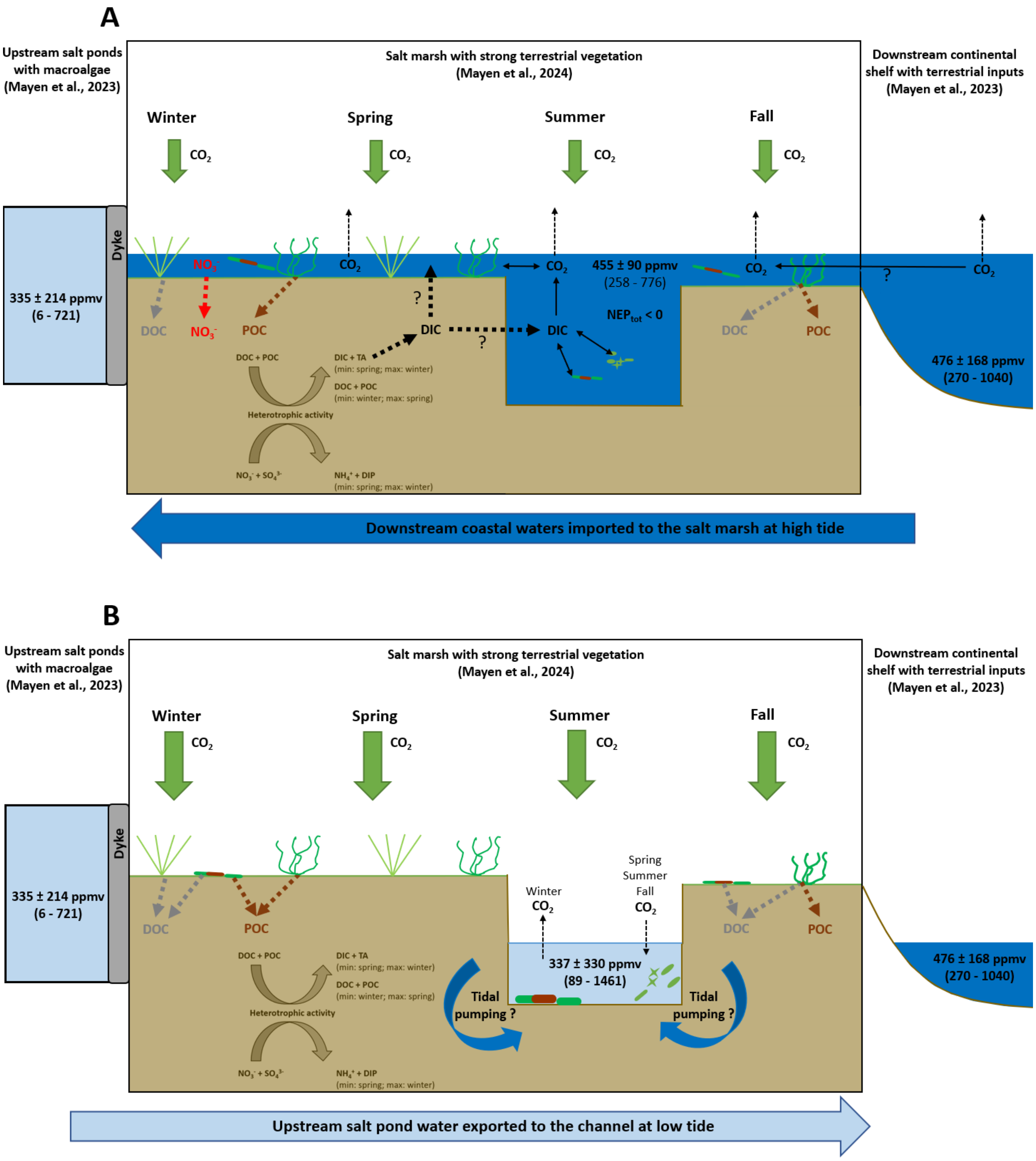

Fig. 8. Water carbon dynamics and atmospheric CO_2 fluxes at the Bossys perdus salt marsh over our 24-h cycles at two contrasted tidal periods: (A) high (flooding) tide (marsh immersion by downstream coastal waters) and (B) low (ebbing) tide (marsh emersion and channel water come from the marsh-drainage 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).

1; The author emphasizes the study of "ecosystem carbon dioxide exchange" in the introduction, but the main discussion of the paper actually focuses on the water interface.

In the introduction section, we detailed the marsh carbon cycle focusing on the ecosystem carbon dioxide sinks and the major carbon fates. We described metabolic processes occurring in salt marshes inducing large exports of DIC and TA by the tide at the sediment-water interface and large CO_2 emissions at the water-air interface (see section 2.1, p2, L52-62). In the discussion section, we highlighted intense tidal variations in water pCO_2 due to strong water mixing processes in the salt marsh (upstream marsh and downstream coastal endmembers). During low tide, intense anaerobic respiration in winter induced the highest increases in DIC and water pCO_2 in the channel at night whereas in spring/summer, intense aquatic primary production induced CO_2-depleted and DOC-concentration channel waters. Finally, the contribution of aquatic metabolism on NEE fluxes were investigated in an integrative way within the Eddy Covariance footprint during 24-h periods. In our revised manuscript, we think that the introduction and discussion sections were consistent to answer the objectives of the study.

The authors also used "air-water CO_2 exchange" later for the measurement in the water. Further, NEE and air-water gas exchange actually measured at different locations. The authors can use a conceptual model to organize the role of each in this study area and also indicate the physical or theoretical boundaries and limitations of this study.

Over each 24-h cycle, net ecosystem CO_2 exchanges (NEE) were continuously measured every 10 minutes by atmospheric Eddy Covariance (EC). In intertidal systems, like salt marshes, the major advantage of the EC method is to measure NEE fluxes at the ecosystem scale, coming from all habitats inside the footprint, at short timescales and at both the sediment-air and water-air interfaces (i.e. low and high tides, respectively) (Mayen et al., 2024). Inside the EC footprint, water-air CO_2 fluxes were estimated at each high tide from *in situ* water pCO_2 and gas transfer velocity parametrisation. Thus, water-air CO_2 fluxes estimated from water pCO_2 could be compared with NEE fluxes measured simultaneously by EC to go further on the contribution of aquatic metabolism on uptake/emission fluxes at the ecosystem scale (Table 2). We followed the fair recommendation of the Referee#1 and proposed a conceptual model to organize and better 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 above and see the revised MS in figure 8).

Upon closer inspection of the methods and results, the study shows unclear definitions regarding its spatial scope and scale. The author claims to have conducted "vertical and horizontal surveys," yet in practice, the vertical survey is essentially limited to the air-water interface. The so-called horizontal survey is restricted to observations from a single point, where the author assumes tidal movements bringing upstream and downstream waters into the sampling area over a 24-hour period suffice as horizontal analysis. This approach, however, is highly limited since single-point sampling cannot represent the actual spatial variations throughout the salt marsh region. What is the role of this study site on this whole area, including the evaporation ponds all over the island?

Referee#1 is right and he/she has highlighted an important limit of our study. Here, vertical carbon fluxes were not limited to diffusive CO_2 fluxes at the water-air interface since, at the same time, we continuously measured net ecosystem CO_2 exchanges (NEE) inside the footprint (both at high and low tides) by the atmospheric eddy covariance (see above). At a single point in the main channel following the water mixing between upstream salt ponds and downstream continental shelf (Fig. 1), we measured the temporal dynamics of water carbon and nutrient concentrations at the diurnal/tidal scales through continuously water samplings over 24-hours (Fig. S1 in the Supplements). Very few studies performed seasonal 24-h cycles in blue carbon systems, such as salt marshes, to sample all water carbon forms from high to low tide including all intermediate tidal situations both the day and the night. In our study, horizontal carbon flux measurements (tidal DIC, DOC and POC outwelling in g C day^{-1}) along with carbon sequestration data should be added to our approach to better constrain the carbon budget of the studied salt marsh system over other regional/global carbon cycles. 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.

In consequence, we modified the revised MS specifying all these aspects and indicating only water sampling at a single point in the main channel was made to study water carbon dynamics in the salt marsh. Along with the new conceptual scheme, a new table was also added in the revised MS to regroup other similar articles studying inorganic carbon dynamics and water-air CO_2 emissions in temperate salt marsh systems to contextualize our findings and enhance the manuscript's scientific significance (see table 5 in the revised MS and see above). In addition, we modified the introduction, section 2.2, and the conclusion to show clear definitions regarding the spatial scope and scale of the study (see below).

Section 1. Introduction (this paragraph was modified in the revised MS)

p3, L87-L97: "At a temperate salt marsh, this present study focuses on aquatic metabolism influence on water carbon dynamics and net ecosystem CO_2 exchanges at small timescales (diurnal and tidal) during the four seasons. The main aims of this paper are (1) to highlight biotic and abiotic controlling factors on water carbon variations, in particular water pCO_2, (2) to study the metabolic status of planktonic communities in the marsh as CO_2 sink or source and (3) to identify the contribution of water pCO_2 signatures and planktonic/water column metabolism on NEE. *To this purpose, we performed four seasonal 24-hour cycles (continuous samplings for 24 hours) measuring relevant water biogeochemical parameters (pCO_2, organic and inorganic carbon and nutrients), planktonic metabolism and water-air CO_2 fluxes at a single point in the main channel of the salt marsh connected to upstream salt ponds and* *downstream continental shelf. The novelty of this study was to look for marsh aquatic metabolism contribution on water carbon dynamics and water-air CO_2 fluxes, using in situ carbon original samplings through 24-h cycles at each season simultaneously with large scale and continuous atmospheric CO_2 exchange measurements (NEE by Eddy Covariance).”*

Section 2.2. Sampling strategy and field samplings (this paragraph was modified in the revised MS)

p5, L134-L142: “*At a single point in the main channel of the salt marsh* (Fig. 1-b), four seasonal 24-h cycles were performed from March to December 2021 (Fig. 2). For each 24-h cycle, our sampling strategy consisted of simultaneously measuring water biogeochemical parameters, planktonic metabolism and water-air CO_2 fluxes at diurnal (daytime and night-time) and tidal (*from high to low tides and all tidal phases in between*) scales through discrete samplings and continuous real-time measurements. At this station, samplings of sub-surface waters were performed continuously every one or two hours over the four 24-h cycles (n = 13 over C1-winter, n = 15 over C2-spring and C3-summer and n = 16 over C4-fall) encompassing a large variation in water heights (Hw): from the channel bottom at low tide (Hw = 0.5 m) to the full marsh immersion at high tide (Hw > 2.5 m) with all tidal intermediate situations in between (Fig. 2 and Fig. S1). *When repeated across seasons, it allows to sample the full tidal range, and hence the heterogeneity of the tidal height, residence time and water mixing.”*

Section 5. Conclusions and limitations (this paragraph was modified in the revised MS)

p30, L747-757: “In this study, the same diurnal/tidal synchronism (low and high tides at the same period of the day) was adopted during each 24-h cycle. However, due to the strong intraseasonal variability of meteorological (temperature, light, humidity, wind) and tidal (water level and immersion time) parameters, production and respiration rates in the marsh could strongly change from day to day and influenced the marsh carbon cycle differently. *Thus, several 24-hour cycles per season with different thermic and tidal conditions would allow to better take into account all temporal variabilities and to truly extrapolate at the seasonal scale our results on carbon dynamics in salt marshes. 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. Moreover, subsequent to water mixing processes occurring in the sampling channel, lateral carbon exports from the salt marsh along with carbon sequestration rates should be measured (DIC, DOC and POC outwelling) to better constrain the carbon budget of this coastal intertidal wetland among other regional and global carbon cycles.”*

Consequently, the observed data might disproportionately reflect sedimentary and anoxic environmental influences from the upper or lower stream rather than the actual diurnal variations caused by photosynthesis and planktonic activity. Can this single selection inadvertently led the author to interpret tidal-driven signals as representative of the entire salt marsh ecosystem?

Over our 24-h cycles, observed data in the sampling channel at the diurnal/tidal scales reflected the water mixing processes between coastal and marsh endmembers but also the autochthonous/allochthonous metabolic processes. In winter, the low aquatic autotrophy during the day induced a small channel water pCO_2 decrease, whereas the intense aquatic heterotrophy during the night induced a large channel water pCO_2 increase. Over the winter 24-h cycle, the strong nDIC and nTA increases from high to low tide, especially at night, could relate to intense autochthonous heterotrophic respiration in the marsh sediments inducing the highest water pCO_2 values in the channel waters (Fig. 6). On the contrary, in spring and summer, lower tidal variations of DIC and TA were measured. The lowest nDIC and nTA were recorded at low tide associated with the lowest water pCO_2 values and the highest DOC concentrations indicating intense autochthonous and allochthonous primary production (phytoplankton, benthic microalgae and macroalgae). In the planktonic communities sampled at low tide, high abundances of pennate diatoms in spring and summer indicated the presence of autochthonous benthic microalgal mats resuspended in channel waters whose strong metabolism could promote the lowest water pCO_2. Moreover, the large autotrophy of the allochthonous macroalgae recorded in the upstream salt ponds 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. 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. This difficulty was more discussed in the revised MS.

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 water CO_2 undersaturation (271 ± 182 ppmv) could indicate that the autochthonous planktonic respiration in the studied salt marsh was counterbalanced by the intense allochthonous macroalgae primary production in the upstream ponds.

Contrary to global findings on the marsh carbon cycle (large DIC and DOC outwelling; Santos et al., 2021), our study highlighted CO_2-depleted and DOC-concentrated water exportations from high to low tide in spring and summer confirming the major role of autochthonous/allochthonous primary production within all marsh compartments (terrestrial and aquatic) in the coastal carbon cycle. 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.

Santos, I. R., Burdige, D. J., Jennerjahn, T. C., Bouillon, S., Cabral, A., Serrano, O., Wernberg, T., Filbee-Dexter, K., Guimond, J. A., and Tamborski, J. J.: The renaissance of Odum's outwelling hypothesis in "Blue Carbon" science, Estuarine, Coastal and Shelf Science, 255, 107361, https://doi.org/10.1016/j.ecss.2021.107361, 2021.

To address these issues, the author should clearly define the limitations of the study, explicitly describing the representativeness of the sampling points within the salt marsh area. It is crucial to specify under which spatial conditions the observed results are applicable, distinguishing clearly between areas with longer or shorter water flow paths, and between flowing or stagnant water bodies.

Over our 24-h cycles, surface water was continuously sampled every hour of two hours at a single point in the studied salt marsh inside the EC footprint from the channel bottom at low tide (Hw = 0.5 m) to the full marsh immersion at high tide (Hw > 2.5 m) with all tidal intermediate situations in between (see above responses and revised section 2.2.). At high tide, 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). The Breton Sound continental shelf exchanges salt waters with the Atlantic Ocean to the west at each semi-diurnal tidal cycle and receives continental inputs through the Aiguillon Bay discharges to the east depending on hydrodynamic and meteorological conditions. The residence times of coastal waters in the Breton Sound continental shelf are generally above 85 days (Polsenaere et al., 2017). 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. 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 is difficult to distinguish the relative contribution of allochthonous and autochthonous metabolic processes to water carbon dynamics recorded in the channel. To better understand the representativeness of the sampling points within the salt marsh area, we completed the revised MS, especially in the section study site (see below), and we added a conceptual scheme to clearly distinguish water samplings at low tide and at high tide (see figure 8). Moreover, a new table was added in the revised MS to regroup similar articles studying inorganic carbon dynamics and water-air CO_2 emissions in temperate salt marsh systems to contextualize our findings and enhance the manuscript's scientific significance (see table 5).

Polsenaere, P., Soletchnik, P., Le Moine, O., Gohin, F., Robert, S., Pépin, J. F., ... & Goulletquer, P. (2017). Potential environmental drivers of a regional blue mussel mass mortality event (winter of 2014, Breton Sound, France). *Journal of Sea Research*, *123*, 39-50.

Section 2.1. Study sites (this paragraph was modified in the revised MS)

p3-4, L101-121: "The Bossys perdus salt marsh is a vegetated intertidal wetland (52.5 ha) located along the French Atlantic coast on Ré Island (Fig. 1-a). The salt marsh is located within the Fier d'Ars tidal estuary which receives coastal waters from the Breton Sound continental shelf during high tide periods (Fig. 1-a). This intercommunication enables (1) the immersion of the estuarine intertidal zone (including the studied salt marsh) and (2) the water supply for artificial salt marshes (i.e. salt ponds) upstream of the dyke. Water residence times in the salt ponds vary from a few hours to a fortnight depending on seasonal management practice. Generally, macroalgae blooms (*Ulva spp*.) colonize salt ponds from April to October each year (Mayen et al., 2023). *After an intensive land-use (salt harvesting and oyster farming), the Bossys perdus salt marsh is now protected within a National Natural Reserve to restore its natural hydrodynamics and vegetation while conserving the site's specific typology due to past human activities (channel networks, humps and dykes; Fig. 1-b) (Mayen et al., 2024). 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).* The salt marsh is subject to semi-diurnal tides originating on the continental shelf allowing its immersion through channels differently in space, time and frequency depending on tidal periods. At high tide (HT), imported coastal waters gradually fill the sampling channel (Fig. 1-b) and immerse the salt marsh at variable water heights depending on tidal amplitudes and meteorological conditions. *Due to the site's specific typology, lowest marsh levels (mudflats and S. maritima) were quickly immersed (south), whereas the whole marsh immersion (all muds and plants) only occurred 0.75 h later at the highest water heights (Mayen et al., 2024). At low tide (LT), the channel empties and the salt marsh is emerged and exposed to the atmosphere. During this time, water remaining at the bottom of the channel come from (i) the Bossys perdus marsh-drainage process by tidal pumping and (ii) the waterflow from the upstream salt ponds to the downstream estuary (Fig. 1-b) at low water height situations (0.50 m maximum depth; see Fig. S1 in Mayen et al., 2024) fluctuating seasonally according to meteorological conditions and pond managements (Mayen et al., 2023).''*

Section 5. Conclusions and limitations (this paragraph was modified in the revised MS)

p30, L747-757: "In this study, the same diurnal/tidal synchronism (low and high tides at the same period of the day) was adopted during each 24-h cycle. However, due to the strong intraseasonal variability of meteorological (temperature, light, humidity, wind) and tidal (water level and immersion time) parameters, production and respiration rates in the marsh could strongly change from day to day and influenced the marsh carbon cycle differently. *Thus, several 24-hour cycles per season with different thermic and tidal conditions would allow to better take into account all temporal variabilities and to truly extrapolate at the seasonal scale our results on carbon dynamics in salt marshes. 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. Moreover, subsequent to water mixing processes occurring in the sampling channel, lateral carbon exports from the salt marsh along with carbon sequestration rates should be measured (DIC, DOC and POC outwelling) to better constrain the carbon budget of this coastal intertidal wetland among other regional and global carbon cycles.''*

Furthermore, the author should further explore how air-water CO_2 fluxes are influenced by temperature and wind speed variations under different seasonal and diurnal conditions, and clearly state which factor has the more significant impact.

In marsh and coastal end-members, Mayen et al. (2023) highlighted the predominance of air-water CO_2 gradients in the control of flux directions either as a sink or a source. Indeed, in the present study, during all high tide periods (except in spring), sampled coastal waters were oversaturated in CO_2 compared to the atmosphere (water pCO_2 > air pCO_2) producing atmospheric CO_2 degassing. However, at the seasonal scale, turbulence processes measured at the air-water interface also played an important role in CO_2 flux variability and magnitude (see below). For instance, at high tide night between winter and summer, wind speed variability and associated k_{660} gas transfer velocity produced significant water-air CO_2 emission variations although no significant air-water CO_2 gradients were measured (i.e. higher CO_2 emissions and k_{660} values over C3-HT/Night than over C1-HT/Night whereas water pCO_2 values were similar; see below). Moreover, the methodological calculations and associated differences chosen for the exchange coefficient parameterizations may produce even more contrasts in the estimated air-water FCO_2 (see Polsenaere et al., 2022 and Mayen et al., 2023).

	Tw (°C)	NEP_{tot} (mmol m^{-2} h^{-1})	pCO_2 (ppmv)	k_{660} (m s^{-1})	FCO_2 (mmol m^{-2} h^{-1})
C1-winter-HT/Night	9.8 ± 0.4	-7.53	546 ± 51	7.39 ± 0.51	0.38 ± 0.05
C3-summer-HT/Night	20.3 ± 0.2	-19.04	546 ± 49	9.64 ± 0.22	0.48 ± 0.07

2. The role of mixing. Moreover, since the study site is located at the river-sea interface, the dynamics of water mixing should be investigated in greater detail.

The Bossys perdus salt marsh is located within the Fier d'Ars tidal estuary at the interface between the upstream artificial salt ponds and the downstream Breton Sound continental shelf (see above responses) that were studied before from a carbon influenced-typology/management point of view (Mayen et al., 2023). At high tide, coastal waters imported from the estuary and the shelf by the tide can completely fill the sampling channel and immerse the salt marsh through variable water heights depending on tidal amplitudes and meteorological conditions. In contrast, at low tide, the marsh vegetation at the benthic interface is emerged into the atmosphere without any coastal waters and during this time, the channel allows drainage of upstream artificial salt ponds waters to the Fier d'Ars tidal estuary (Mayen et al., 2024).

The author should discuss how water mixing processes affect the study results, thereby enhancing the regional significance of the research.

We thank Referee#1 for this major comment about the role of water mixing in the study results. In the revised MS, we more investigated the water mixing processes occurring in the salt marsh and their influence in carbon dynamics (see below). During transient tidal phases, we showed that the mixing between two contrasted water masses (marsh-influenced endmember and shelf-influenced endmember) can significantly affect water pCO_2 dynamics in the sampling channel. During flooding tides (i.e. channel filling), water pCO_2 generally increased in response to CO_2-oversaturated coastal waters imported from the continental shelf whereas during ebbing tides (i.e. channel emptying), large water pCO_2 decreases could partly be recorded due to CO_2-depleted marsh waters exported from salt ponds, along with autochthonous carbon processes (production/respiration) involved at both tidal periods in channel waters (Fig. 2). In upstream artificial salt ponds with higher water residence times, a strong biological control on water pCO_2 was seen, inducing water CO_2 undersaturation in spring and summer due to intense aquatic autotrophy (135 ± 165 and 242 ± 116 ppmv, respectively) and water CO_2 oversaturation in fall due to heterotrophy (622 ± 57 ppmv; Mayen et al. 2023). On the contrary, in downstream estuarine waters, a strong seasonal compensation of thermal and non-thermal effects occurred throughout the year producing low seasonal water pCO_2 variations (from 441 ± 21 ppmv in winter to 385 ± 60 ppmv in summer; Mayen et al. 2023). Thus, CO_2 source/sink status of the sampling channel can instantaneously change during the water mixing between two contrasted endmembers.

Moreover, the strong DIC and TA variations in the channel during salinity changes also indicated a major influence of water mixing processes in marsh carbonate chemistry (Fig. 6). Over the four sampling 24-h cycles (n = 59), mean TA:DIC ratios were 1.15 ± 0.11 in surface waters confirming mixing between marsh waters and seawater following Reithmaier et al. (2023). In coastal systems, water mixing processes strongly controlled inorganic carbon dynamics, especially in tidal salt marsh (Wang et al., 2016), in seagrass tidal bay (Polsenaere et al., 2023) and in mangrove (Cabral et al., 2024). We completed the revised MS in the section 4.1. and 4.3 accordingly to discuss how water mixing processes can affect water pCO_2 and DIC variations (see below).

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

p22, L533-L541: "*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 (these sentences were added in the revised MS)

p26, L629-630: "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).*"

p27, L641-L655: "*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). In winter, during low biological 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 highest POC-δ^{13}C values measured in winter at low tide (-14.6 ± 0.9‰; unpublished data) could confirm the presence of terrestrial C4 plants in channel waters, like *S. maritima* (Amann et al., 2024). This could constitute an energy source for microbial activity in sediments 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) due to a strong winter tidal forcing. *During this period, DIC increased faster than TA until reaching very close concentrations (Table 1). This could indicate that most of carbonate ions (CO_3^{2-}) in channel waters were converted into bicarbonate ions (HCO_3^-) by the large addition of CO_2 and H^+ from marsh respiration processes, such that carbonate species in the exported channel waters mostly consisted of HCO_3^- and dissolved CO_2."*

Moreover, we discussed the potential influence of riverine and anthropogenic inputs from the continental shelf in the marsh carbon cycle. The Breton Sound continental shelf exchanges salt waters with the Atlantic Ocean to the west at each semi-diurnal tidal cycle and receives continental inputs through the Aiguillon Bay discharges to the east depending on hydrodynamic and meteorological conditions (Mayen et al., 2023). During high tide in winter, the large terrestrial inputs of NO_3^- + NO_2^- in coastal waters from the Aiguillon Bay (Fig. 1) could supply the anaerobic processes in the marsh sediments and induced the large export of dissolved CO_2 in channel waters during low tide. More precisely, over the winter 24-h cycle, we simultaneously recorded a large NO_3^- + NO_2^- decrease (sink) and a large NH_4^+ increase (source) from high to low tide and could highlight a dissimilatory nitrate reduction to ammonium (DNRA) in marsh sediments which is an intense respiration process producing DIC and TA (Giblin et al., 2013; Hopkinson and Giblin, 2008). These terrestrial inputs could constitute an energy source for heterotrophic activity in marsh sediments inducing, in turn, the largest increase of DIC and pCO_2 measured at low tide (up to 3963 µmol kg^{-1} and 1461 ppmv, respectively; Fig. 6) due to a strong winter tidal forcing. However, direct measurements of anaerobic processes especially at the benthic interface, should be realized to confirm the significance of these metabolic processes in the winter DIC production. We completed the revised MS in the section 4.3. to discuss how terrestrial inputs affect the study results (see below).

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

p27-28, L665-675: "However, nutrient variations over our 24-h cycles could highlight other anaerobic processes, particularly at benthic interface, involving DIC and TA production in channel waters. *In winter at high tide, we recorded the highest concentrations of NO_3^-_NO_2^- in coastal waters derived from riverine and anthropogenic inputs (Belin et al., 2021).* Over this 24-h cycle, the large NO_3^-_NO_2^- decrease (sink) from high to low tide was significantly related to the large NH_4^+ increase (source) ($R^2 = 0.90$, $p < 0.001$). This strong relationship could highlight a dissimilatory nitrate reduction to ammonium (DNRA) in sediments which is known to be an important metabolic process in salt marshes producing DIC and TA (Giblin et al., 2013; Hopkinson and Giblin, 2008). In low winter autotrophy conditions, NO_3^-_NO_2^- was not consumed by primary producers and could diffuse through sediments during immersion (Boynton et al., 2018) where it could be reduced in NH_4^+ by DNRA (Koop-Jakobsen and Giblin, 2010) before diffusing to channel waters through tidal pumping (Zheng et al., 2016). *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."*

3. A few sentences can be modified to improve the reading.

Line, 675-676. The authors may change the sequence of presentations for the season. For example, "inducing water CO2 undersaturation in spring/summer and water CO_2 oversaturation in fall/winter." This may be applied to the entire article.

The conclusion section was revised to highlight the tidal forcing importance in the water pCO_2 variation (see below).

Section 5. Conclusions and limitations (this paragraph was modified in the revised MS)

p29, L732-734: "*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)."*

Line, 682-684. This sentence is hard to read and can be spectacular. The Reviewer suggests splitting this sentence into two sentences and clarifying each sentence. Similar sentences can be found in the abstract, making this sentence difficult to interpret.

Both in the abstract and the conclusion of the revised MS, we modified the text concerning the contribution of planktonic communities in the marsh carbon cycle to improve the clarifying and the reading. We split the information into two sentences as suggested by Referee#1. We highlighted that phytoplankton communities can affect the pCO_2 variations in the channel waters during the low tide periods due to intense aquatic metabolism but planktonic metabolism did not control the marsh atmospheric carbon uptake at the ecosystem scale in the integrative way measured by eddy covariance.

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

p29, L740-743: "*The spring/summer phytoplanktonic bloom in channel waters and the associated aquatic autotrophy led to CO_2-depleted water exportations downstream. However, at the daily scale, planktonic metabolism did not play a significant role in marsh atmospheric carbon balance measured by Eddy Covariance at the ecosystem scale (within the footprint).*"

4. Uncertainties induced by k is unclear, Line 257. The authors should justify the reason to use this k in one or two sentences.

We completed the revised MS and we justified the use of the *k*-wind parametrization of Van Dam et al. (2019). Currently, there is no consensus on the *k* value parameterization in shallow coastal systems, such as salt marshes, mainly because *k* depends on several drivers acting at the same time: wind, current, water depth, friction at the bottom, heating and cooling. In this study, we have used the *k* parameterization of Van Dam et al. (2019) as a function of wind speed, that was determined from concomitant pCO_2 and FCO_2 eddy covariance data in an estuarine system with characteristics very similar with our study site: similar water/air temperature ranges, similar tidal amplitude (0.50 < depth < 2.80 m), similar depth (average depth: 1 m) and similar wind speed range ($0.93 < U_{10} < 6.79$ m s^{-1} and average U_{10}: 3.85 m s^{-1}). Moreover, other studies in salt marsh systems also used this model for *k* calculation (Song et al., 2023).

Section 2.5.1. Water-air CO_2 fluxes (this paragraph modified in the revised MS)

p9-10, L277-287: "Water pCO_2 (ppmv) were measured by the C-sense^{TM} probe, while air pCO_2 (ppm) were measured by the EC station at a height of 3.15 m. $FCO_2 > 0$ (i.e. water pCO_2 > air pCO_2) indicates a CO_2 source from water to atmosphere and $FCO_2 < 0$ (i.e. water pCO_2 < air pCO_2) indicates an atmosphere CO_2 sink by the water column. *We used the k-wind parametrization of Van Dam et al. (2019), which is a coefficient specific to shallow and microtidal estuaries but can be adapted to salt marsh systems (Song et al., 2023). Currently, there is no consensus on the k value parameterization in shallow coastal systems, such as salt marshes, mainly because k depends on several drivers acting at the same time: wind, current,* *water depth, friction at the bottom, heating and cooling. In this study, we used the k parameterization of Van Dam et al. (2019) as a function of wind speed, that was determined from concomitant pCO_2 and FCO_2 eddy covariance data in an estuarine system with characteristics very similar with our study site. The gas transfer coefficient, normalized to a Schmidt number of 600 (k_{600}) obtained from Van Dam et al. (2019), were converted to the CO_2 transfer velocity according to in situ temperature and salinity (k or k_{660}) following Jähne et al. (1987).''*

5. Implication: Most importantly, it is suggested that the author explicitly articulate the global or regional implications of this research clearly in the final sentence of the abstract to underscore its significance. Since this study employs both atmospheric and aquatic CO_2 measurement methods, the author should consider comparing and discussing the differences and relationships between these two measurement methods, potentially providing predictions or assessments regarding regional variations. Establishing a clear conceptual model based on such comprehensive and systematic observations would greatly enhance the research's academic value and influence.

We followed the recommendation of the Referee#1 and we completed the abstract in the revised MS to highlight the regional implication of this study in the coastal carbon cycle (see below). Also, we established a clear conceptual model based on our findings to greatly enhance the research's academic value and influence.

Abstract (these sentences were added in the revised MS)

p1-2: *''This study suggests that the horizontal exchanges of coastal waters with the salt marsh significantly participate to measured water carbon dynamics and associated channel water CO_2 sink/source status, through strong biological activity in the salt marsh (production and respiration). At the daily scale, plant and phytoplankton metabolisms played a major and a minor role, respectively, to the marsh atmospheric CO_2 sink measured at the ecosystem scale (NEE), even during low immersion where emerged plants located on the highest marsh levels can maintain net CO_2 uptake despite aquatic heterotrophy and shelf-contributed CO_2 emissions.''*

Minor comments:

Regarding presentation, it is recommended that the author rectify the inconsistent font sizes in the figures. For example, the term "pCO_2" is excessively large while other text is too small, causing readability issues. All text should be consistently sized and easily readable. Additionally, the labeling of "pCO_2" should remain uniform throughout the paper.

In the revised MS, we modified the font sizes in all figures as suggested by Referee#1 so that the text is of a uniform size and easily readable.