Author Response to Referee comments to BG Manuscript egusphere-2023-2784

Spatial patterns of Organic Matter content in the surface soil of the salt marshes of the Venice Lagoon (Italy)

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Reply to Referee #1

Legend:

Referee Comment

Author Response

Modified manuscript text

The authors set out to understand spatial patterns on soil organic matter content in salt marshes around Venice Lagoon. The topic itself is interesting and timely and of high relevance for the readers of biogeosciences. Although the authors put a lot of effort in collecting and analyzing samples, in my opinion the data analysis and interpretation does not go far enough in understanding the uncovered spatial patterns.

We thank the Reviewer for his/her overall positive comment on our manuscript and for his/her insightful suggestions that contributed to improving the quality and the clarity of our manuscript. In particular, following the Reviewer's comment we deepened the data analysis and the interpretation of the spatial organic matter patterns. Furthermore, we added a Supplement file with additional content aimed at clarifying the less clear aspects of the data analysis and interpretation.

Main comments:

- It seems increasing distance from the channel edge does not always mean increase in SOC, why, what could be the underlying causes? This is missing in the current version.

  We thank the Reviewer for this helpful comment. Consistently with previous findings (e.g. Chen et al., 2016; Leonard et al., 2002; Roner et al., 2016) and despite considerable variability, our analysis suggests a significant correlation between OM content in surface soils and the distance from the marsh edge, with organic content generally increasing toward the inner marsh. This evidence is supported by the results of the Kendall's tau test on all the available data (p-value < 0.001). If we consider the pattern along each transect, seven out of ten transects show increasing OM with the distance from the marsh edge (CA, PA, SF, SE, CV, CO, VB). In the initial version of the manuscript, we focused the discussion on the average trend of OM and SOC with respect to the distance from the marsh margin. However, following the Reviewer's comment, we added a more detailed discussion on the OM variability along the various transects, particularly when the considered trend deviates from the average one. As a result, we have included the following paragraphs in the Discussion section:

  > "Considering all available data along transects allows us to capture global trends and average out variabilities related to local conditions. However, analysing site-specific trends can offer an interesting perspective on driver locally affecting OM dynamics. Overall, seven out of ten analysed transects show an increasing trend of OM with the distance from the marsh edge (CA, PA, SF, SE, CV, CO, VB). At the SA, MI and FO study sites the trend in OM content deviates from the average behaviour and this can be attributed to the effects of local variability. At the SA site, observed OM content is very low (Figure 3n), and its distribution pattern may be masked by the intrinsic variability of the measurements. At the MI site, *Phragmites australis* grows on the marsh edge, providing a contribution of OM that outcompetes that provided by the halophytic vegetation of the inner marsh (Figure S1 in the

Supplement). At the FO site, we observed abundant beach-cast seagrass wracks on the marsh edge, which are likely transported from the extensive seagrass meadows located on the tidal flats adjacent to the FO area (Figure 1f). These wracks may serve as an additional source of OM, locally influencing OM trend with the distance from the marsh margin."

- I suggest to characterize the selected sites in being driven by different processes, e.g. driven by sedimentation through the tide, driven by sedimentation through waves, and then to analyze specific subgroups together, to gain an in-depth understanding of the encountered patterns

We thank the Reviewer for this suggestion. In response to the Reviewer's suggestion, in the description of the sites we have better clarified that CA and CO are bordered by tidal flats and are exposed to energetic wind-waves, whereas all the other sites are bordered by tidal channels and therefore show a tide-dominated sedimentation. Nevertheless, these characteristics do not seem to influence the overall trend of organic matter content along the transects.

We modified the text as follows:

Section 2.1 "The study sites are located in 10 salt marshes of the Venice Lagoon, at variable distances from the inlets (Figure 1). Considered marsh edges typically face a channel, with the exception of CA and CO, that face tidal flats. [...]

The CA marsh, whose main edge faces a shallow tidal flat exposed to Scirocco wind, hosts halophytic species dominated by *Limonium narbonense,* associated with *Sarcocornia fruticosa, Spartina maritima, Salicornia veneta,* and scarce *Suaeda maritima, Triglochin maritima* and *Juncus gerardii.* [...]

The Conche (CO) salt marsh fringes the mainland and faces the wide subtidal flat that occupies the central-southern Venice Lagoon, being exposed to Bora wind. CO hosts halophytic species dominated by *Sarcocornia fruticosa*, *Suaeda maritima, Inula crithmoides,* and *Halimione portulacoides."*

Section 2.2 "The selected sites are distributed across the Venice Lagoon in order to represent the different environmental conditions typical of the system (Figure 1). ~~In most cases,~~ Transects typically start on the marsh edge facing a channel~~,~~ and therefore show a tide-dominated sedimentation.~~with the exception of~~ In contrast, CA and CO~~, that~~ transects face tidal flats and are exposed to energetic wind-waves."

- Vegetation biomass data: either the authors show that the used literature-data-approach is valid, e.g. with some field sites comparisons, or I suggest removing all the vegetation biomass sections

We appreciate the Reviewer's suggestion regarding the limitations of our biomass estimation approach. Despite our efforts to provide a biomass estimation that is reliable for drawing general conclusions, we acknowledge that our estimates can be improved and do not account for intraspecific biomass variability. Furthermore, we recognize that the relative conclusions drawn from the biomass estimation are not central to the manuscript's results. As a result, we have decided to remove the biomass estimation, along with the corresponding figure and lines in the Material and methods, Results, and Discussion sections. However, we added a Supplement file to the manuscript, where we included a table with literature data on vegetation species biomass, as follows. We believe that this information, which has been enhanced and clearly explained, will support some of the general conclusions related to vegetation characteristics and their influence on soil organic matter.

Species	Aboveground biomass (g m^{-2})	Belowground biomass (g m^{-2})	Source	Notes
Inula crithmoides	366		1	Study for agricultural purposes, Lebanon.
Aster tripolium	545		2	Vegetation data from the Venice lagoon.
Limonium narbonense	276.3		3	Max live plant biomass as dry weight. Vegetation data from the Venice lagoon.
Salicornia veneta	657.7		3	Max live plant biomass as dry weight. Vegetation data from the Venice lagoon.
Sarcocornia fruticosa	1296.7	4314	3, 4	Max live plant biomass as dry weight. Vegetation data from the Venice lagoon.
Spartina maritima	370.7		3	Max live plant biomass as dry weight. Vegetation data from the Venice lagoon.
Halimione portulacoides	1540.7		3	Max live plant biomass as dry weight. Vegetation data from the Venice lagoon.
Suaeda maritima	135.42		5	Max live plant biomass as dry weight. Vegetation data from the Venice lagoon.
Pucinellia palustris	372.7		3	Max live plant biomass as dry weight. Vegetation data from the Venice lagoon.
Juncus maritimus	601.3		3	Max live plant biomass as dry weight. Vegetation data from the Venice lagoon.
Phragmites australis	900	5600	2, 4	Max live plant biomass as dry weight. Vegetation data from the Venice lagoon.

Table S 1. Literature data on vegetation biomass (dry weight g m^{-2}) for species found in our study area, primarily focusing on aboveground biomass from studies conducted within or possibly near the Venice Lagoon. Belowground biomass is included where available.1 = Zurayk and Baalbaki (1996); 2 = Ingegnoli and Giglio (2004); 3 = Scarton (2006); 4 = Scarton et al. (2002); 5 = Das et al. (2015).

- What is the variability in OM over the depth of the core, is it possible to constrain the OM variability at a give site?

In this study, our aim is to analyse OM content in surface soils, investigating its spatial variability both at the marsh and the system scale, as well as the drivers that influence the carbon sequestration and storage capacity of salt marshes. For this reason, we focused on the soil layer directly influenced by current vegetation along with other relevant environmental variables, considering sediments up to a depth of 20 cm. Indeed, according to Trumbore (2009), in most vegetated ecosystems the majority of underground plant biomass and microbial activity exists within the top 20 cm of soils. For sure, an analysis of the same variables also over depth would offer an interesting perspective, but it is clearly beyond the scope of this paper. However, to meet the Reviewer's suggestions, we have incorporated standard deviations for LOI in Figures 2 and 3, thus providing a clearer representation of the variability within the analysed layers. We thank the Reviewer for this suggestion.

Detailed comments:

Abstract

Line15: is organic matter only deposited or can it also originate from autochthonous production?

As specified in the text, soil organic matter comprises the in situ production of belowground root tissue integrated into the sediments, along with autochthonous or allochthonous organic materials that accumulate on the marsh surface. The conciseness of the abstract does not allow us to explain in detail this concept at this point. However, to enhance the clarity of the statement and avoid any possible confusion we have substituted "deposition" with "contribution" and the new sentence now reads:

> "Being controlled by the interplay between hydrodynamics, geomorphology and vegetation, the contribution of both organic matter (OM) and inorganic sediments drives salt marsh vertical accretion."

Line 19: what are the authors referring to when, stating in surface salt marsh soils, are they only considering surface samples or are did they also analysis samples throughout different depths?

We are not sure we have fully understood the question, which we try to address in the following. As mentioned later in the text, soil samples were taken every 5 cm up to the depth of 20 cm (0, 5, 10, 15, 20 cm). Also in this case, the conciseness of the abstract does not allow us to explain it in detail at this point. However, to enhance the clarity of the statement we modified the text as follows:

> "This study aims at inspecting spatial patterns of OM in surface salt marsh soils (top 20 cm), providing further insights into the physical and biological factors driving OM dynamics, affecting salt marsh survival and carbon sink potential. Our results reveal two scales of variations in ~~sedimentary~~ SOM content in salt marsh soils."

Line 20-25,.. how was sedimentary OM distinguished from autochthonous OM?

In this study, we did not distinguish between autochthonous (in situ produced) and allochthonous (not locally produced) organic materials. We removed "both autochthonous and allochthonous" to enhance clarity in the statement. The new sentence now reads:

> "~~Variations in inorganic and organic inputs, both autochthonous and allochthonous, sediment grain size, and preservation conditions may explain t~~The observed variations in SOM are explained by the combination of inorganic and organic input, preservation conditions and sediment grain size."

Line 25: what do the authors mean with "carbon sink environments"?

The dynamics that render salt marsh environments carbon sinks, whose significance is increasingly acknowledged, are thoroughly elucidated in the Introduction. However, due to the brevity of the abstract, we were unable to elaborate on this concept extensively in that section. To meet the Reviewer concern and to increase its clarity, we have incorporated an explicit definition of "carbon sink" in the Introduction as follows:

> "The organic material that helps building marsh elevation is likely a combination of in situ production of belowground root tissue inserted into the sediments (Craft et al., 1993; Day et al., 1999) and autochthonous or allochthonous organic materials that are deposited over the surface in association with mineral sediment particles (Nyman et al., 2006; Mudd et al., 2009; Ewers Lewis et al., 2019; Mueller et al., 2019). Furthermore, tidal flooding inhibits microbial aerobic activity and slows down decomposition, fostering C accumulation in marsh soils (Keuskamp et al., 2013; Mueller et al., 2018; Kirwan et al., 2014; Morris et al., 2016). Thanks to these dynamics, the C captured through plant photosynthesis is buried and preserved as soil organic carbon (SOC) and may be locked away from the atmosphere over centennial to millennial time scales (Perillo et al., 2009; Duarte et al., 2005). This process allows salt marsh environments to act as carbon sinks, serving as natural or artificial reservoirs that accumulate and store carbon-containing compounds, thereby helping to offset the effects of greenhouse gas emissions on the Earth's climate (Watson et al., 2000). The C sink function of vegetated coastal ecosystems, including salt marshes, mangrove forests and seagrass meadows, has been increasingly recognised in recent years and the term "blue carbon" was coined to indicate the C sequestered in these ecosystems, with a potential role in climate change mitigation (Chmura et al., 2003; Duarte et al., 2005; McLeod et al., 2011; Macreadie et al., 2019; Nellemann et al., 2009)."

Line 33: do the authors mean in micro to macro tidal regimes, ?

Yes, we modified the text as follows. Thank you for catching this.

> "~~both~~ from microtidal ~~and~~ to macrotidal regimes".

Line 50: Please rephrase "vertical accretion is driven by the deposition of OM", yes OM can be deposited from the water column (e.g. POC) but OM in the sediment bed can also orginiate from plant production (above and below ground)

We thank the Reviewer for suggesting to improve the clarity of the text. We replaced "deposition" with "contribution" to improve the clarity of the statement:

" Vertical accretion in tidal marshes is driven by the ~~deposition~~ contribution of both Organic Matter (OM) and inorganic sediments (Mudd et al., 2009; Fagherazzi et al., 2012; Nyman et al., 2006; Neubauer, 2008)."

The organic contributions we refer to are further explained in the following lines:

"The organic material that helps building marsh elevation is likely a combination of in situ production of belowground root tissue inserted into the sediments (Craft et al., 1993; Day et al., 1999) and autochthonous or allochthonous organic materials that are deposited over the surface ~~in association with mineral sediment particles~~ (Nyman et al., 2006; Mudd et al., 2009; Ewers Lewis et al., 2019; Mueller et al., 2019)".

Line 54 : "Halophytic plants, spatially organized in characteristic patches", I suggest to replace patches by zones, since the cited literature suggests the authors are referring to mid and high-marshes which in general are characterized by closed vegetation cover.

Here, we are referring, in general, to the zonation of vegetation in marsh environments. Although elevation and hydroperiod are commonly considered the strongest drivers of vegetation zonation, salt-marsh plant assemblages and diversity may differ in different coastal zones. Silvestri et al. (2005) describe "The spatial distribution of halophytic vegetation over salt marshes" as "organized in characteristic patches", whereas Marani et al. (2013) say that "Marshes display impressive biogeomorphic features, such as zonation, a mosaic of extensive vegetation patches of rather uniform composition, exhibiting sharp transitions in the presence of extremely small topographic gradients". We believe that the sentence "Halophytic plants, spatially organized in characteristic patches" provides a general description of salt-marsh plant distribution and spatial organization, including what is generally observed in the Venice lagoon and other salt marsh systems worldwide (e.g. Moffett et al., *Ecosystems*, 2010; Pennings and Callaway, *Ecology*, 1992). Salt marshes in the Venice lagoon are often characterized by networks of small creeks, and the inner areas of the marsh are lower than the edges. Main vegetation zones are distinguished in the inner and lower areas, on higher soils along the edges of creeks and channels, and in the intermediate areas (Silvestri et al., 2005).

Line 57, please rephrase, what do the authors mean by tidal marsh volume?

We thank the Reviewer for this comment. We modified the text to improve the clarity of the statement:

"OM contribution to ~~tidal~~ marsh ~~volume and~~ surface vertical accretion can be much greater than that of ~~mineral material~~ sediment deposition".

Line 59, I suggest to add autochthonously produced aboveground plant material which after dying of gets decomposed at the salt marsh surface.

This is what we mean mentioning autochthonous organic materials that are deposited over the surface. To better clarify our description we added the following:

"Surface litter produced during the annual cycles of plant growth and decay settles on the ground and is trapped within the inorganic sediments deposited. A variable proportion of the salt-marsh SOM (Drexler et al., 2020; Middelburg et al., 1997; Mueller et al., 2019) has an allochthonous source, deriving from suspended particulate organic matter, often adsorbed on mineral matter, as well as estuarine and marine phytoplankton, microphytobenthos and non-local macrophytes litter carried to the marsh surface by waves and tides."

Line 62: carbon stored in the soil, as SOC is not necessarily originating from C captured from the atmosphere, please refer to the studies of van den Broek et al.

We agree that the carbon stored in the soil as SOC may not solely originate from carbon captured from the atmosphere in situ. Indeed, we refer to allochthonous organic materials as one of the sources of SOC. Nevertheless, our assertion is that the described accumulation of OM in salt marsh soil facilitates the burial and preservation of the C captured through in situ plant photosynthesis (as well as carbon from other sources). Our work aims to improve current understanding of organic matter dynamics, and the contribution of allochthonous organic matter to the overall organic content is further discussed in paragraph 4.2.

To emphasize this aspect, we added the following sentence to the brief literature review discussed in the subsequent lines, at the end of the Introduction:

"In addition, Van de Broek et al., 2018, show that SOC from allochthonous sources may be a main component of SOC stock preserved in marsh sediments, and this finding could significantly impact organic carbon sequestration assessments."

Line 82: are the authors referring to soil organic content

Yes, we modified the text, thank you.

Line 89; Please rephrase the sentence added here, although I agree with the core message, it is nevertheless difficult to understand: "Considerable variability in sediment organic content has also been observed at different scales across vegetation types (Ewers Lewis et al., 2020; Saintilan et al., 2013), which determine above and belowground biomass production both quantitatively and qualitatively, in terms of decay resistance (Scarton et al., 2002; Stagg et al., 2018). "

Thank you, we modified the text as follows:

"The vegetation type was also observed to significantly affect soil organic content at different scales (Ewers Lewis et al., 2020; Saintilan et al., 2013). Above and belowground production greatly varies across and within plant species, both in terms of quantity and quality, the latter determining different degrees of decay resistance (Scarton et al., 2002; Stagg et al., 2018)."

Line 90: why did the authors not also analyze soil organic carbon stocks? why did the authors only analyze the top 20 cm?

The aim of this paper is to characterize the spatial variability of organic matter in the current state of the Venice lagoon. Therefore, to avoid considering lower layers, which may not be representative of the current morphologies and environmental conditions, and to consider only the layers directly impacted by the current vegetation, we considered only the top 20 cm. Indeed, according to Trumbore (2009), in most vegetated ecosystems the majority of underground plant biomass and microbial activity exists within the top 20 cm of soils. Nevertheless, the soil carbon stock can be calculated also in the top 20 cm of soil. As suggested by the Reviewer, we included this information in the Introduction as follows:

"Here we aim at inspecting spatial patterns of OM in salt marsh soils, providing further insights into the physical and biological factors driving OM dynamics, affecting salt marsh survival and C sink potential. Toward these goals, we analysed soil organic content <u>and SOC stock</u> for the surface soil layer (0–20 cm) in 10 salt marshes of the Venice Lagoon from 60 sediment cores, together with different variables including soil, morphological and vegetation characteristics. <u>The choice to analyse surface marsh soil for assessing spatial patterns of soil organic content is driven by the need to capture the layer most directly influenced by current environmental variables</u>."

The choice of considering the 20 cm soil layer is further explained in the Material and methods section (at the end of paragraph 2.2).

Line 105ff: Since it might be relevant for understanding the SOC data, could that authors give some background information/estimates on the age of the sampled salt marshes?

As suggested by the Reviewer, we included this information in section 2.1:

"The marsh areas under study were already mapped by Sebastiano Alberti in 1611, and considering an overall accretion rate of about 2.0-3.0 mm yr^{-1}, the study deposits were probably accumulated over the past century (Tommasini et al., 2019)."

Line 135ff: Could the authors provide information of the salinity of the water, i.e. is the entire lagoon brackish or are their freshwater to saltwater gradients at some sampled marshes?

More detailed data about salinity of the water at different sites are shown in the Results section (Figure 6a). Study sites were characterized by different mean water salinity ranging between 24.3 and 32.4 ‰. Following the Reviewer's suggestion, we also added descriptive information on salinity when describing the study site in section 2.1:

> "In addition, historical river diversions have significantly reduced freshwater inputs into the lagoon, thereby impacting water salinity and vegetation characteristics. Freshwater inputs currently flow in the lagoon through twelve main tributaries distributed along the landward boundary of the lagoon, with a mean annual contribution of about 35 m^3 s^{-1} and a peak discharge of 344 m^3 s^{-1} (Zuliani et al., 2005). Spatial and temporal variability of salinity in the Venice Lagoon is additionally influenced by groundwater inputs (Gieskes et al., 2013). Estimates of the volume of underground freshwaters entering the lagoon floor vary widely, from 15% of total freshwater flow to more than 100% (Zirino et al., 2014). Salinity levels in the Venice Lagoon today vary from approximately 20 PSU at the northeastern mainland edge to about 34–35 PSU at the three inlets (Zirino et al., 2014)."

Line 152: how was the aboveground biomass estimated? Was the stem-density per species assess, ? Are the literature references from the same are, hydroperiod, how comparable are the literature values to the site-specific conditions?

As addressed in the response to the third main comment, we acknowledge the Reviewer's suggestions regarding the limitations of our biomass estimation approach. Despite our efforts to provide a biomass estimation that is reliable for drawing general conclusions, we recognise that our estimates can be improved and do not account for intraspecific biomass variability. Furthermore, we recognize that the relative conclusions drawn from the biomass estimation are not central to the manuscript's results. As a result, we have decided to remove the biomass estimation, along with the corresponding figure and lines in the Material and methods, Results, and Discussion sections. However, we added a Supplement file to the manuscript, where we included a table with literature data on vegetation species biomass. We believe that this information, which has been enhanced and clearly explained, will support some of the general conclusions related to vegetation characteristics and their influence on soil organic matter.

Line 154: what do the authors mean by sample community?

By sample community we mean the vegetation community sampled within each 1x1 m quadrat. To clarify this aspect, we modified the sentence as follows:

> "Shannon diversity index was used to measure the diversity of species in each ~~sample community~~ 1 x 1 m quadrat."

Line 155: was only 1 core taken per location? I know it is always easy to ask for more samples, but knowing the local variability would help in interpreting the significance of spatial patterns? Maybe there are previous studies which constrained that already ?

We opted to collect six cores per marsh along 30-m-long transects in 10 different marshes. The choice of a transect design aligns with our intent to explore variability at the marsh scale based on hypothesized main drivers, with variations expected to be more pronounced along the margin-to-inner-marsh gradient. We considered 30-m-long transects to sample always within the same marsh and avoid morphological features that may significantly alter the processes at hand (e.g. inner creeks, ponds, etc.). Previous studies in our study area (Roner et al., 2016) showed that the variability within the transect was reasonably captured by this number of cores per transect. For this reason, we took 6 cores per transect, as a good trade-off solution between representativeness and effort for sampling and analysing. Following the Reviewer's suggestion, we added the following section in a Supplement file presenting the results of a preliminary investigation that we conducted on organic matter (OM) variability at the marsh scale. This involved coring in three replicates at San Felice marsh.

1. Preliminary investigation on organic matter variability at the marsh scale – replicates at SF_0 transect

We conducted coring in three replicates at San Felice marsh to observe variability in organic content among the replicates. Along three 30-m-long parallel transects, spaced one meter apart, we collected a total of 18 cores, extending from the marsh edge to the inner area. The spacing between cores within each transect was consistent with the methodology used in the study (0, 2.5, 5, 10, 20, 30 m). Our observations revealed that organic matter (OM) variability along the transects was double that observed between replicates, with the average standard deviation along transects relative to the mean value being about 30%, compared to about 15% between replicates.

Transect	mean	std	%
SF_0_1	0.084	0.039	46.61
SF_0_2	0.057	0.015	26.84
SF_0_3	0.065	0.016	24.81

Table S 2. Preliminary investigation on organic matter variability at the marsh scale – replicates at SF_0 transect. Variability along the transect.

Distance from the edge (m)	mean	std	%
0	0.039	0.004	10.74
2.5	0.056	0.011	20.24
5	0.062	0.007	11.77
10	0.109	0.038	34.91
20	0.084	0.014	16.47
30	0.062	0.001	2.34

Table S 3. Preliminary investigation on organic matter variability at the marsh scale – replicates at SF_0 transect. Variability between replicates at the same distance from the edge.

Line 165: here we see SOC stocks were calculated, please also indicate this at the end of the introduction.
Line 170: the reason for focusing on the top 20 cm, should also be communicated earlier on in the introduction.

We agree with the Reviewer and decided to modify the text as follows:

"Here we aim at inspecting spatial patterns of OM in salt marsh soils, providing further insights into the physical and biological factors driving OM dynamics, affecting salt marsh survival and C sink potential. Toward these goals, we analysed soil organic content and SOC stock for the surface soil layer (0–20 cm) in 10 salt marshes of the Venice Lagoon from 60 sediment cores, together with different variables including soil, morphological and vegetation characteristics. The choice to analyse surface marsh soil for assessing spatial patterns of soil organic content is driven by the need to capture the layer most directly influenced by current environmental variables."

Line 188: please do not start a sentence with "the figure shows", i.e. making the figure the focus of attention, rather describe what the figures shows(the results) and refer to the figure at the end of the sentence, please rephrase,

We modified the text as suggested by the Reviewer. The new text reads as follows:

"We analysed the distribution of the surface sediment variables analysed, namely OM content, DBD, grain size distribution, and the vegetation cover along the surface elevation profile of study transects, in the northern (Figure 2) and southern (Figure 3) lagoon."

Figure2: I am not sure that showing DBD and LOI adds value, I suggest to rescale the LOI axes especially for h,k and n to see whether there are spatial gradients visible? Why did the authors chose to present the mean values, how do the different layers look like ? if the mean values are chosen I suggest to add a standard deviation over the 20cm to be able to set the different layer in context with each other. could some general description of how LOI and DBD changes over depth be added in the appendix?
Line 205: here also a description of OM/LOI over depth should be added, additionally the mean values reported should be supplemented by a standard deviation.

We thank the Reviewer for his/her comments that contributed to improving the clarity of the figures. In response to the suggestions provided, we have made several modifications to Figures 2 and 3. Firstly, we have incorporated standard deviations for LOI, DBD, and D50 values, providing a clearer representation of the variability within the analysed layers. Additionally, we have rescaled the LOI axes to maximize detail while considering the standard deviations, maintaining consistent scales across all transects to facilitate comparisons. Furthermore, we have added a linear regression line for LOI values to visually highlight their trends along the transects.

DBD values were included in the figure, as they are essential for calculating soil carbon density, a crucial factor in blue carbon assessments.

As addressed in response to the fourth main comment, an analysis of LOI and DBD is clearly beyond the scope of this paper.

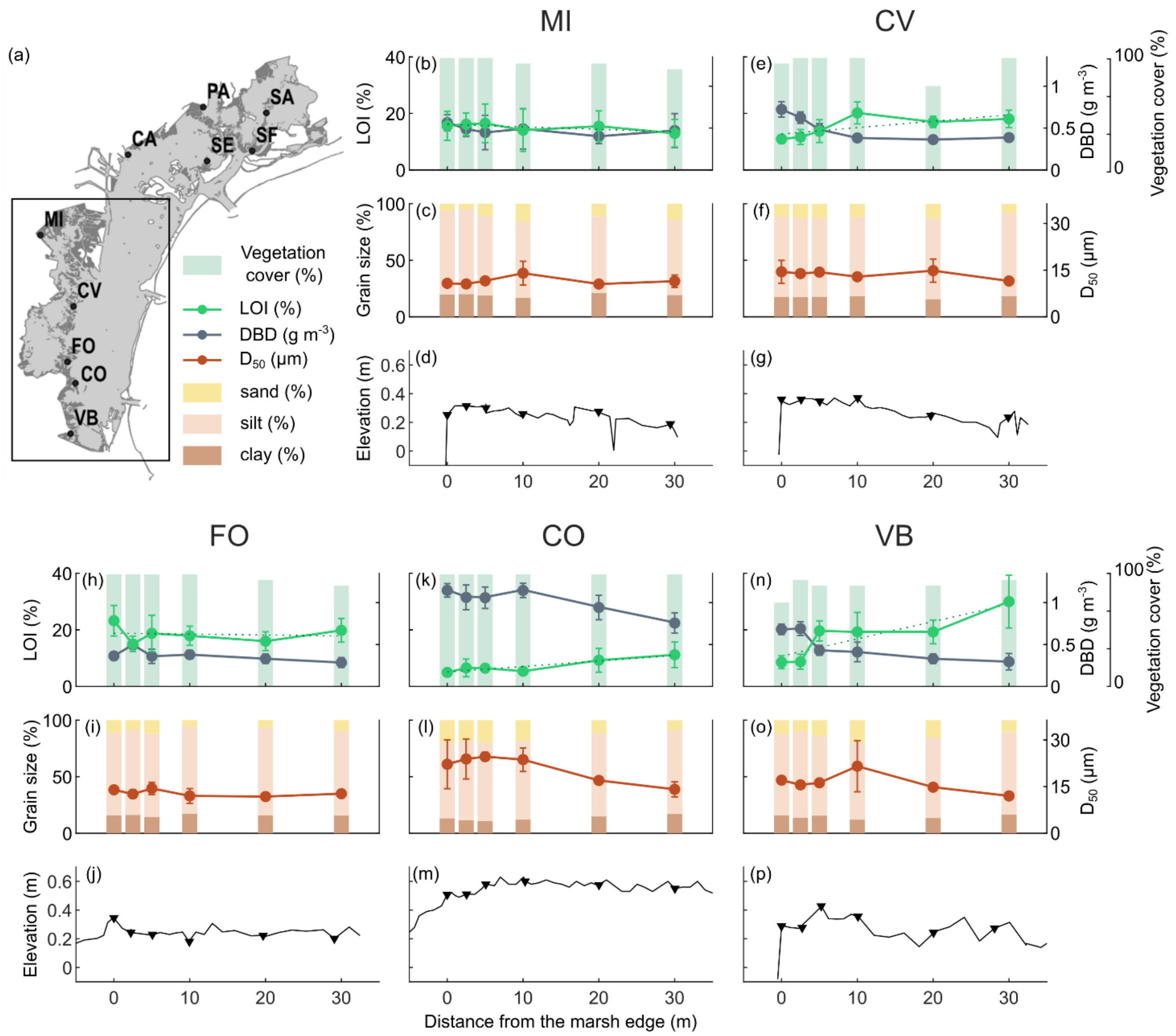

Figure 1. Distribution of surface sediment variables analysed and surface elevation profile along the transects in northern lagoon: organic matter content (LOI % - mean value and standard deviation in top 20 cm), Dry Bulk Density (g cm^{-3} - mean value and standard deviation in top 20 cm), vegetation cover (%), grain size distribution (D_{50} µm and sand-silt-clay percentage - mean value and standard deviation in top 5 cm) and surface elevation (m a.MSL). The dashed line represents the linear regression between the percent organic matter values.

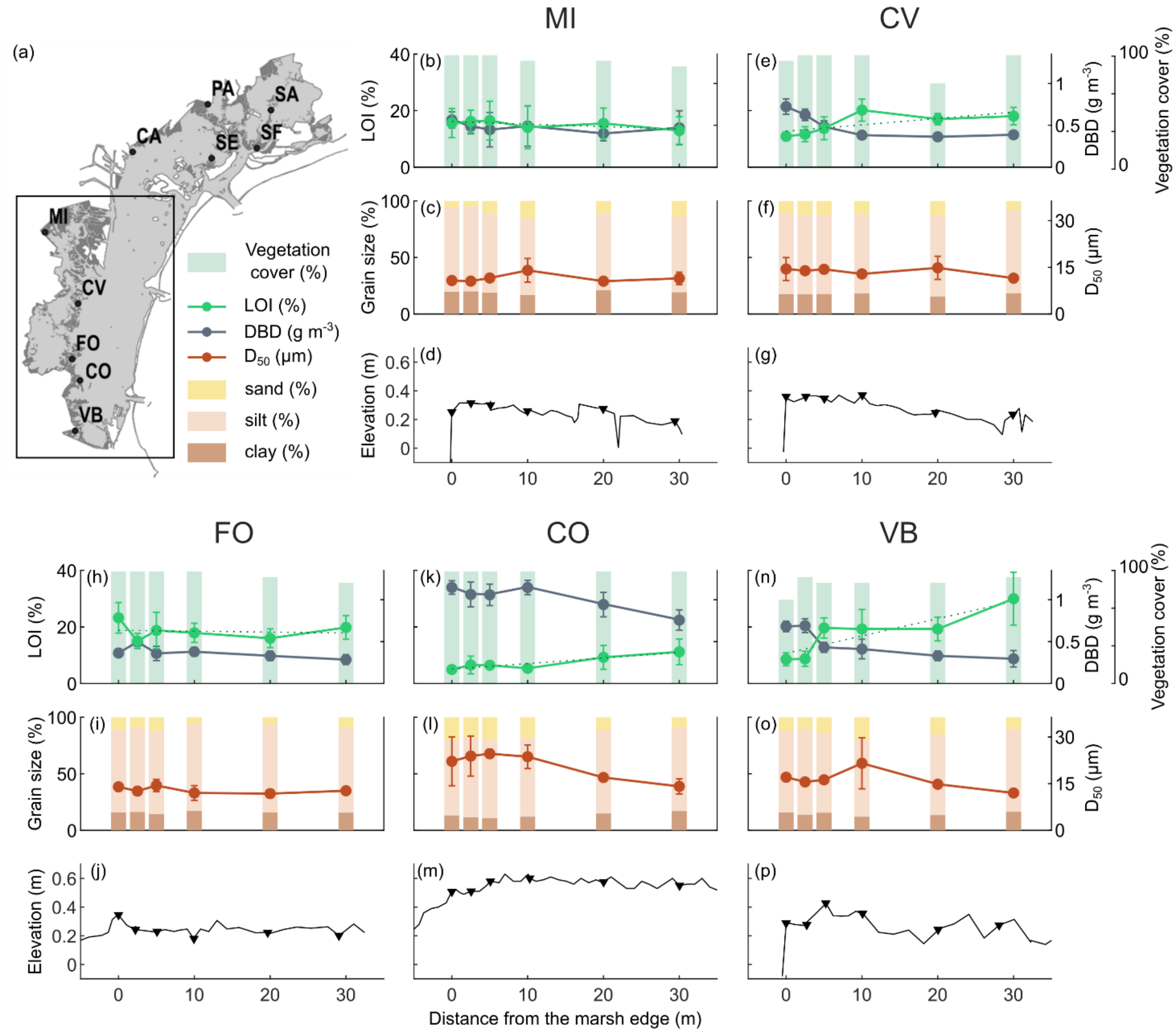

Figure 2. Distribution of surface sediment variables analysed and surface elevation profile along the transects in southern lagoon: organic matter content (LOI % - mean value and standard deviation in top 20 cm), Dry Bulk Density (g cm^{-3} - mean value and standard deviation in top 20 cm), vegetation cover (%), grain size distribution (D_{50} µm and sand-silt-clay percentage - mean value and standard deviation in top 5 cm) and surface elevation (m a.MSL). The dashed line represents the linear regression between the percent organic matter values.

Line 210: I suggest rephrasing in a more or less clear increase, in my opinion some do not show an increase at all, I think adding standard deviations might help with the interpretation.

Ok, we modified the text as follows:

"Trends of OM content along the transects suggest an increase toward the inner marsh in most of the study sites (e.g. CA, PA, SF, SE, CV, CO, VB)."

In addition, as addressed in response to the first main comment, we added a more detailed discussion on the OM variability along the various transects, particularly when the considered trend deviates from the average one. Furthermore, as mentioned in the previous response, we have incorporated standard deviations and added a linear regression line for LOI values in Figures 2 and 3 to emphasize the trends OM along the transects.

Line 225: I am not convinced this is a fair comparison, i.e. simply lumping all the data. As visible in fig.2 a positive trend could be interpreted in maybe PA,SF,SE,SA and in fig.3 CV, CO,VB, which is the majority of the sites. However there are also clear sites showing that there is no increase in LOI with distance from the channel. I suggest to focus how the difference between sites can be explained. See comments above, to interpret this patterns it is important to know how SOC was changing over depth and whether the spatial variability can be estimated.

The aim of the paper is to consider the spatial variability of organic matter both at the marsh and at the system scale. For this reason, we presented and discussed the results both within the single transect and globally at the basin scale. While recognizing that site-specific peculiarities may be captured only by analysing the results at the transect scale, we believe that global trend can provide a more synthetic, yet not less valuable view of the process. Indeed, the overall trend across different marshes allows us to identify broader patterns, that may be masked by local variability. Concerning the feasibility of the comparison, we may note that we considered 10 marshes distributed across the lagoon (i.e. representative of the system) and in each marsh we took the same number of cores. Therefore, each study area is equally represented in our dataset. In addition, following the Reviewer's suggestion, as addressed in response to the first main comment, we added a more detailed discussion on the OM variability along the various transects, particularly when the considered trend deviates from the average one.

Line 240: See previous comment, it is unclear to me whether the estimated above-ground biomass is related to reality. Since previous studies, e.g. Kirwan et al, has shown the biomass production is highly dependent on local conditions and external drivers such as inundation period. It is moreover unclear how this estimate was achieved ? Fig.5a if the estimate of aboveground biomass cannot be better constrained I suggest to remove it from the manuscript !

As addressed in the response to the third main comment, we acknowledge the Reviewer's suggestions regarding the limitations of our biomass estimation approach. Despite our efforts to provide a biomass estimation that is reliable for drawing general conclusions, we recognise that our estimates can be improved and do not account for intraspecific biomass variability. Furthermore, we recognize that the relative conclusions drawn from the biomass estimation are not central to the manuscript's results. Therefore, we have decided to remove the biomass estimation, along with the corresponding figure and lines in the Material and methods, Results, and Discussion sections.

Fig.5c, is it difficult to see but it seems that for some species there are only 1-2 data points, which in my opinion would make the shown box-plots highly uncertain and potentially misleading. I would prefer to show the points (data) and potentially a horizontal line per plant signifying the average.

In response to the suggestions provided, we modified the figure by substituting the box plots with mean and standard deviation markers in revised Figure 5c. We thank the Reviewer for this comment.

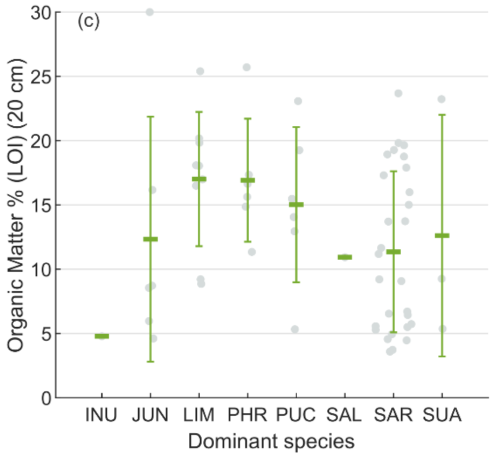

Fig.6 what do we learn from this plot? what data is shown here? Are the authors comparing LOI, Carbon stock, SCB and D50 of all location irrespective of distance to channel? Assuming that the relationship in Fig.4 is correct and LOI is increasing with distance from channel (which I am not convinced of to be true for all sites) is it a good idea to compare averages of different parameters between sites? The authors could for instance compare samples close to the channel to samples in the interior, which could give more insights on whether OM import or local production differ between sites?

Line 260-270, same comment as for Fig.6

Our approach combined both analyses at the marsh scale, by examining individual transects, and at the lagoon scale, by considering various marshes. Figure 6 displays surface sediment variables at various study sites. Since the same sampling scheme was employed at each site, comparing them enables us to examine the drivers influencing OM dynamics at the lagoon scale.

In response to the suggestions, including those from Reviewer 2, we have modified the Discussion section to enhance its clarity and quality. The new text reads as follows:

The sources of OM content in salt marsh soils are influenced both by local and non-local processes. Firstly, OM is the result of in-situ production of belowground (root, rhizome and tuber tissue) (Craft et al., 1993; Rybczyk et al., 2002) and aboveground biomass, thus directly depending on the local primary production. OM content is also affected by the accumulation of organic material produced in other sites (Nyman et al., 2006, Mudd et al., 2009, Ewer Lewis 2019, Mueller 2019), which are transported and eventually is deposited on the marsh surface by hydrodynamic processes (i.e. tides and waves)

acting at larger spatial scales . Both autochthonous and allochthonous organic materials, once part of marsh soil, are also affected by decomposition resulting from local topographic, sedimentological and environmental conditions (Chen et al., 2016). Due to the intricate interaction of these local and non-local dynamics, two main spatial scales in OM variations can be identified: the marsh scale (meters to tens of meters) and the system scale (ranging from kilometers, encompassing the entire lagoon or estuary). In the following discussion, we will first examine evidence of OM variations in our results at the marsh scale by considering trends along the transects. Subsequently, we will shift our focus to the system scale by comparing results among study sites.

At the marsh scale, our results show that OM content in surface soils displays a significant trend with the distance from the marsh edge, with OM content generally increasing towards the inner marsh (Figure 4a), consistently with previous findings (e.g. Chen et al., 2016; Leonard et al., 2002; Roner et al., 2016). This overall trend in OM with distance from the edge is influenced by various processes acting at the marsh scale, among which the interaction between sediment delivery and local topography plays a preeminent role. Suspended material is primarily delivered onto the marsh platform through inundation by overbank flow along tidal channels (Bayliss-Smith et al., 1979) and by apical flow at creek heads (Torres and Styles, 2007). As soon as the flow reaches the vegetated marsh platform, current velocities and turbulent energy rapidly decrease (D'Alpaos et al., 2007; Mudd et al., 2010), thus promoting the deposition of more abundant sediments during the flooding initial phase in close proximity of the marsh edge (Christiansen et al., 2000; Roner et al., 2016). As a result of the larger deposition close to the edge, inner marsh generally present slightly lower elevation than that of the marsh margin (Figures 2 and 3). Lower elevations promote the persistence of an anaerobic environment, which slows down OM decomposition by reducing microbial respiration (Halupa and Howes, 1995; Kirwan et al., 2013; Puppin et al., 2023a; Roner et al., 2016).

Progressive energy dissipation over the vegetated marsh platform also promotes selective material settling. Coarser, denser inorganic sediment is mainly deposited near the marsh edge, while the inner marsh receives a higher proportion of finer sediments, as supported by the observed grain size distribution along the transect (Figure 4c), and less dense organic material (Leonard et al., 2002; Miller et al., 2022). In addition to the already larger proportion of organic material settling in the inner marsh, the supply of finer inorganic sediment (Figure 4c) may also promote conditions favourable for OM preservation. This can occur due to the reduced oxygen exchange resulting from the lower porosity and drainage capacity of finer sediments, as well as their greater potential for protecting C from decay through organic-mineral interactions and the formation of micro- or macro-aggregates (Kelleway et al., 2016).

Considering all available data along transects allows us to capture global trends and average out variabilities related to local conditions. However, analysing site-specific trends can offer an interesting perspective on driver locally affecting OM dynamics. Overall, seven out of ten analysed transects show an increasing trend of OM with the distance from the marsh edge (CA, PA, SF, SE, CV, CO, VB). At the SA, MI and FO study sites the trend in OM content deviates from the average behaviour and this can be

attributed to the effects of local variability. At the SA site, observed OM content is very low (Figure 3n), and its distribution pattern may be masked by the intrinsic variability of the measurements. At the MI site, *Phragmites australis* grows on the marsh edge, providing a contribution of OM that outcompetes that provided by the halophytic vegetation of the inner marsh (Figure S1 in the Supplement). At the FO site, we observed abundant beach-cast seagrass wracks on the marsh edge, which are likely transported from the extensive seagrass meadows located on the tidal flats adjacent to the FO area (Figure 1f). These wracks may serve as an additional source of OM, locally influencing OM trend with the distance from the marsh margin.
Conversely, in some transects where the organic matter trend aligns with the average increasing trend with distance from the marsh margin, we observed particular cases in the behaviour of grain size and topographic variables, which occasionally deviate from the average trend. For example, at the inner end of the SE transect, we can observe an unexpected, slight increase both in sediment grain size (Figure 2l) and in topographic elevation (Figure 2m). This may be related to the presence of a tidal flat at the inner border of the SE marsh (Figure 1j), which can represent an additional source of sediment supply. Two notable exceptions in terms of marsh topography are also represented by the CA and CO marshes, which face a tidal flat (Figure 1b,h) and are exposed to energetic wind waves. As a consequence of the influence of wind waves, the elevation profiles exhibit a subtly convex shape, with the disappearance of the raised margin and a slight inward shift (i.e. between 5 and 10 m from the edge) of the maximum elevation along with the locations of higher median grain size values. However, these variations do not appear to affect the overall increasing trend of OM content towards the inner marsh at SE, CA and CO sites.

We observe variations and patterns of OM also at the system scale. The position within the gradient generated by marine and fluvial influence was previously observed to be a key predictor of OM content (e.g. Van de Broek et al., 2016; Ewers Lewis et al., 2020; Kelleway et al., 2016; Macreadie et al., 2017). At the lagoon scale, our results show lower mean OM content in surface soil in areas which are directly affected by marine influence, being closer to the inlets or along the main channels branching from them (CO, SE, SF, SA) (Figure 1 and Figure 6a). Conversely, higher OM contents were observed at sites closer to the mainland, e.g. CA, MI and PA. In agreement with this result, a significant negative relationship was observed between OM content and water salinity. However, it is unlikely that salinity as such directly controls soil organic content, as previous observations suggest an inverse relationship between soil salinity and decomposition (Hemminga et al., 1991; Wang et al., 2019), ,. The effect of salinity on decomposition may have been overcome by the co-occurring effects of other factors acting at different positions within the lagoon, such as vegetation characteristics, hydrodynamic conditions, sediment supply, freshwater inputs. OM increase at less saline sites is likely minimally related to the supply of already stabilized organic suspended particles from terrestrial sources as suggested for other study areas (e.g. Van de Broek et al., 2016; Gorham et al., 2021; Omengo et al., 2016; Van de Broek et al., 2018), because in the Venice Lagoon, after historical river diversions, fluvial supply of organic and inorganic material dramatically decreased. However, residual freshwater

inputs, especially in terms of groundwater, can still locally reduce salinity levels and, consequently, affect vegetation characteristics, with usually increasing macrophyte biomass at lower salinity values (Hansen et al., 2017; Van de Broek et al., 2016).
A relationship between OM and grain size can also be observed at the lagoon scale. Higher values of median grain size were observed at sites closer to the inlet (i.e., SF, SE) or adjacent to first order channel connected to them (SA) (Figure 6d), whereas higher fractions of fine sediments were observed at the lagoon-mainland boundary, near the Dese River mouth (PA) (Figure 1). This pattern is consistent with the general grain-size gradient observed in the Venice Lagoon, reflecting the typical pattern of decreasing hydrodynamic energy conditions from the inlets to the landward shore (Zonta et al., 2018). Considering the landward decreasing grain-size gradient observed within the lagoon, enhanced C preservation capacity of fine sediments (Kelleway et al., 2016) may have a role in the observed organic content pattern. Furthermore, we may hypothesize that at sites where inorganic sediment inputs are greater, where hydrodynamic energy is higher, soil organic fraction is proportionally lower.

Another potentially important factor controlling OM content is vegetation type, as different species exhibit varying biomass production and decomposition resistance (e.g. Van de Broek et al., 2016; Ewers Lewis et al., 2020; H Ford et al., 2019; Saintilan et al., 2013; Yuan et al., 2020).
While our data do not allow for a full statistical analysis of the relationship between OM content and vegetation type, we can derive some interesting qualitative observations. We find no discernible trend in vegetation cover along the transects, nor a significant relationship between OM content and vegetation cover.
Considering the relationship between SOM and dominant species, we observed that higher OM percentages in surface soil are not necessarily associated with dominant species having greater aboveground biomass (as reported in the literature, see Table S4 in the Supplement). We speculate that the lack of a relationship between aboveground biomass and OM may be due to the continuous transport and mixing of locally-produced litter by marsh flooding, weakening the effect of local aboveground biomass production. Moreover, previous studies indicate a major impact from belowground biomass, which inserting into the sediments directly contributes to OM content (Craft et al., 1993; Rybczyk et al., 2002). The highest mean organic contents were observed in the presence of *Limonium narbonense, Phragmites australis* and *Puccinellia palustris* as dominant species (Figure 3c). *Phragmites australis*, characterized by high aboveground biomass and even higher belowground biomass, forms a dense and deep network of leathery stems, roots, and rhizomes (Figure 3e) (Moore et al., 2012; Scarton et al., 2002). *Limonium narbonense,* despite low aboveground biomass (Table S4 in the Supplement), produces massive woody roots (Figure 3b), and *Puccinellia maritima* creates a dense root mat (Brooks et al., 2021). The belowground biomass of these plants may importantly contribute to SOM content quantitatively and qualitatively, as belowground litter decomposition was observed to decline with increasing lignin content (Stagg et al., 2018; Puppin et al., 2023). Interestingly, these species are more abundant in locations associated with higher values of SOM, such as the inner marsh for *Limonium narbonense* and *Puccinellia palustris,* and brackish areas for *Phragmites australis* (Figure 3a and

Figure S1 in the Supplement). However, it was not feasible to directly measure or estimate the relationship between aboveground and belowground biomass and their effect on SOM content in this study.
In addition, soil organic content showed a significant positive correlation with vegetation species diversity (Figure 3d), in agreement with Ford et al. (2019). Ford et al. (2016) found that plant species richness was one of the most important explanatory variables of root biomass and Xu et al. (2020) suggested that species richness may increase biomass productivity due to multiple mechanisms including competition reduction, niche complementarity, selection effects, and biotic and abiotic facilitation.

Overall, the interplay of these dynamics at both marsh and system scales also impacts sediment bulk density. We observed higher soil densities along marsh edges and at sites such as CO, SE, SF, and SA, where organic content is generally lower and coarser sediments predominate (Figure 4b and Figure 6b). This observation aligns with previous research indicating that soil density is influenced by both organic matter content and grain size. Indeed, several studies have reported a significant and negative correlation between SOM and bulk density (e.g. Holmquist et al., 2018; Morris et al., 2016), while sand content has been shown to correlate positively with soil bulk density (Tanveera et al., 2016).
As a consequence of the variability in soil organic content and density both at the marsh and at the system scale, SOC density and C stock show significant variations across and within different salt marshes, enhancing the complexity of blue C assessment. Based on our estimates of mean SOC density in top 20 cm, and considering an expected accretion rate of about 0.3 cm yr^{-1} for salt marshes in equilibrium with Relative Sea Level Rise (RSLR) (Day et al., 1998), the average C accumulation rate for the salt marshes in the Venice Lagoon is estimated to be approximately equal to 69 g C m^{-2} yr^{-1}. Our results are consistent with the mean C accumulation rate in the Australian tidal marshes of 54.52 g C m^{-2} yr^{-1} calculated by Macreadie et al. (2017) from 323 soil cores to the depth of 30 cm all around Australia and using a mean accretion rate of 0.21 cm yr^{-1}. However, we observed that, under the same accretion rate, estimated SOC from our study may result in C accumulation rates varying up to 50% from one place to another because of the two-scale variability highlighted by our measurements. This underscores the need for careful consideration of local variability when assessing blue carbon sequestration and storage potential in wetland environments."

Line 290: I am sorry but I cannot see the coarser sediment on top of levee in fig.2 and fig.3

We thank the Reviewer for this comment. We modified the text to improve its clarity:

"Progressive energy dissipation over the vegetated marsh platform also promotes selective material settling. Coarser, denser inorganic sediment is mainly deposited near the marsh edge, while the inner marsh receives a higher proportion of finer sediments, as supported by the observed grain size distribution along the transect (Figure 4c), and less dense organic material (Leonard et al., 2002; Miller et al., 2022)."

Line 295: Fig.4b “median sediment grain size (D50) on the marsh surface was found to be significantly correlated to the distance from the marsh edge and to surface elevations ” I cannot support this statement, looking at fig.4b there seems to be not a consistent relationship.

This statement is not derived from the visual impression of the plot’s trend but rather from the results of the Kendell’s tau statistical test (p-value < 0.05), which provides a quantitative outcome.

I recommend to not try to establish a general relationship between LOI and distance from channel but rather discuss where this relationship is present and where it is not and why? For instance Line 297, is it discussed that CA and CO are more exposed to winds and waves and therefore might have a different morphology and different spatial patterns in SOC.

Indeed, we are not trying to establish any quantitative relationship between LOI and distance from the marsh edge. We are just evaluating a possible global trend, that may average out local heterogeneities. We observed slightly different morphologies at the CA and CO sites, characterized by the absence of the levee on the marsh margin. However, this does not appear to influence the overall trend of organic matter content along the transects. As addressed in response to the first main comment, following the Reviewer’s comment, we added a more detailed discussion on the OM variability along the various transects, particularly when the considered trend deviates from the average one.

What are assumptions are linked to the expectation that SOC increases with distance from the channel, more organic deposition? more autochthons production?, in my opinion these factors should be further investigated using the existing dataset?

The discussion is located in paragraph 4.

“At the marsh scale, our results show that OM content in surface soils displays a significant trend with the distance from the marsh edge, with OM content generally increasing towards the inner marsh (Figure 4a), consistently with previous findings (e.g. Chen et al., 2016; Leonard et al., 2002; Roner et al., 2016). This overall trend in OM with distance from the edge is influenced by various processes acting at the marsh scale, among which the interaction between sediment delivery and local topography plays a preeminent role. Suspended material is primarily delivered onto the marsh platform through inundation by overbank flow along tidal channels (Bayliss-Smith et al., 1979) and by apical flow at creek heads (Torres and Styles, 2007). As soon as the flow reaches the vegetated marsh platform, current velocities and turbulent energy rapidly decrease (D’Alpaos et al., 2007; Mudd et al., 2010), thus promoting the deposition of more abundant sediments during the flooding initial phase in close proximity of the marsh edge (Christiansen et al., 2000; Roner et al., 2016). As a result of the larger deposition close to the edge, inner marsh generally present slightly lower elevation than that of the marsh margin (Figures 2 and 3). Lower elevations promote the persistence of an

anaerobic environment, which slows down OM decomposition by reducing microbial respiration (Halupa and Howes, 1995; Kirwan et al., 2013; Puppin et al., 2023a; Roner et al., 2016).
Progressive energy dissipation over the vegetated marsh platform also promotes selective material settling. Coarser, denser inorganic sediment is mainly deposited near the marsh edge, while the inner marsh receives a higher proportion of finer sediments, as supported by the observed grain size distribution along the transect (Figure 4c), and less dense organic material (Leonard et al., 2002; Miller et al., 2022). In addition to the already larger proportion of organic material settling in the inner marsh, the supply of finer inorganic sediment (Figure 4c) may also promote conditions favourable for OM preservation. This can occur due to the reduced oxygen exchange resulting from the lower porosity and drainage capacity of finer sediments, as well as their greater potential for protecting C from decay through organic-mineral interactions and the formation of micro- or macro-aggregates (Kelleway et al., 2016)."

Line 300ff: to stress how SOC and morphology changes on the lagoonal scale an additional figure would be necessary, e.g. classifying all sampling locations as distance from the lagoon-mainland boundary, now this paragraph is difficult to very using the data presente.

Figure 1 was designed not only to depict the study site but also to enhance the reader's comprehension of the characteristics of the study sites. The central insert illustrates the locations of the transects within the lagoon and their positions relative to the mainland and inlets. Satellite images were intended to illustrate the features of each transect, showcasing its orientation in relation to surrounding morphologies, such as channels, tidal flats, creeks, and ponds. In response to this reviewer comment, we referenced the above recalled figure in the Discussion.

"For example, at the inner end of the SE transect, we can observe an unexpected, slight increase both in sediment grain size (Figure 2l) and in topographic elevation (Figure 2m). This may be related to the presence of a tidal flat at the inner border of the SE marsh (Figure 1j), which can represent an additional source of sediment supply. Two notable exceptions in terms of marsh topography are also represented by the CA and CO marshes, which face a tidal flat (Figure 1b,h) and are exposed to energetic wind waves. As a consequence of the influence of wind waves, the elevation profiles exhibit a subtly convex shape, with the disappearance of the raised margin and a slight inward shift (i.e. between 5 and 10 m from the edge) of the maximum elevation along with the locations of higher median grain size values. However, these variations do not appear to affect the overall increasing trend of OM content towards the inner marsh at SE, CA and CO sites."

Line 312-317: the described two scales describing variations in OM content are in the current form of the manuscript difficult to find? Since unfortunately no stable isotope markers or have been used or data on autochthonous production at different sites has been compared, it stays unclear why SOC sometimes increase with distance from the channel and why sometimes not. Whether this is linked to incoming OM and transport phenomena remains unclear?

As previously mentioned, in response to these suggestions, including those from Reviewer 2, we modified the Discussion section to enhance its clarity and quality and better highlight OM variability at the marsh and lagoon scale. Unfortunately, we did not have the opportunity to obtain data on stable isotopes or direct measurements of plant biomass. However, we were able to analyse data on morphology, grain size, and vegetation type. These variables allowed us to identify trends in organic matter variability and establish relationships with the available variables at both the marsh and lagoon scales. As addressed in response to the first main comment, we added a more detailed discussion on the OM variability along the various transects, particularly when the considered trend deviates from the average one. As a result, we have included the related paragraphs in the Discussion section.

Maybe the authors could characterized locations in tide or wave dominated areas and use this distinction to understand spatial patterns?

As previously mentioned, we observed a slightly different morphology and grain size distribution at sites facing tidal flats and exposed to energetic wind-waves (CA and CO); however, this appears not to influence the overall trend of organic matter content along the transects.

Line 335: I would argue that no clear results were obtained regarding plant biomass since it was not measured but extracted from literature which is unclear how it relates to the field situation, see criticism above. Also belowground biomass was not estimated !

As addressed in the response to the third main comment, we acknowledge the Reviewer's suggestions regarding the limitations of our biomass estimation approach. Despite our efforts to provide a biomass estimation that is reliable for drawing general conclusions, we recognise that our estimates can be improved and do not account for intraspecific biomass variability. Furthermore, we recognize that the relative conclusions drawn from the biomass estimation are not central to the manuscript's results. Consequently, we have decided to remove the biomass estimation, along with the corresponding figure and lines in the Material and methods, Results, and Discussion sections. However, we added a Supplement file to the manuscript, where we included a table with literature data on vegetation species biomass, as follows. We believe that this information, which has been enhanced and clearly explained, will support some of the general conclusions related to vegetation characteristics and their influence on soil organic matter.

Line 340ff: See comment above, to link OM to vegetation patterns seems very simplistic and does not do justice to what to authors have set out to do. I suggest to compare different channel distances for different vegetation patterns, to try to understand whether vegetation production causes increase of SOC or OM import from SPM.

We thank the Reviewer for his/her insightful suggestion. Prompted by it, we added a figure showing the cumulative species percent cover at each of the distance from the marsh edge sampled. This analysis allowed us to add some observations on vegetation distribution. In addition, we added a figure (Figure S1) in the Supplement, showing species percent cover observed within each 1 x 1 m quadrat at each study transect.

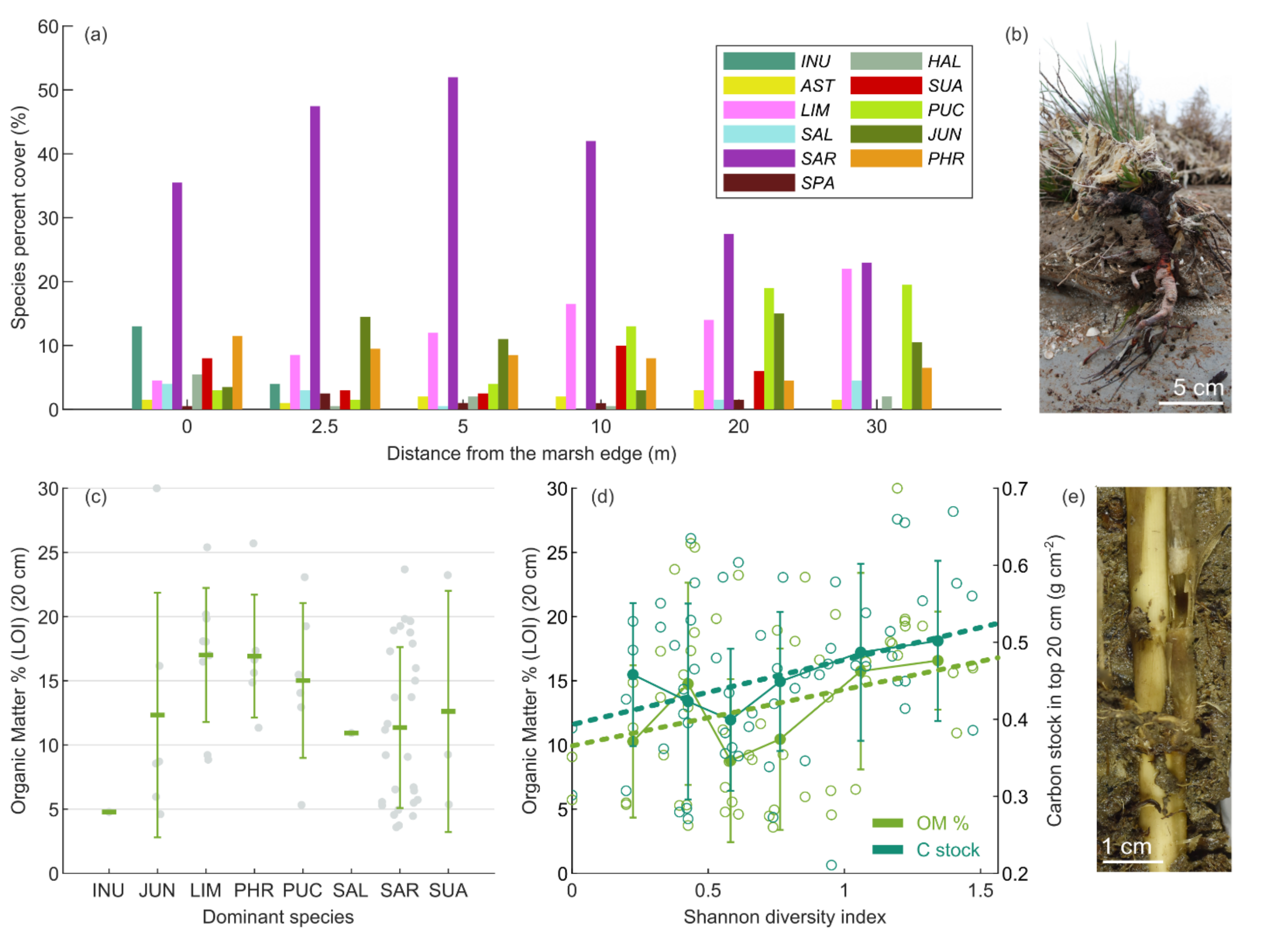

Figure 3. Vegetation distribution and influence on SOM. Species cumulative percent cover at each station along the transect (a) Organic matter content in marsh surface soils (LOI % - mean value in top 20 cm) as a function of dominant species (c) (INU = Inula crithmoides, JUN = Juncus maritimus, LIM = Limonium narbonense, PHR = Phragmites australis, PUC = Puccinellia palustris, SAL = Salicornia veneta, SAR = Sarcocornia fruticosa, SUA = Suaeda maritima). Organic matter content in marsh surface soils (LOI % - mean value in top 20 cm) and OC stock in top 20 cm as a function of Shannon Diversity Index H (d) in 1x1 m plot around core sites. *Limonium narbonense* roots exposed by marsh edge erosion at SE site (b) and *Phragmites australis* roots and stems within PA site soil (e). Panel (c) includes mean values (horizontal-line markers) and standard deviations. Swarm plots show single values (grey closed circles). Panel (d) includes median and standard deviation of binned values. Open circles represent single values and bold lines represent their linear regressions (OM = 9.91 +H4.43, R^2 = 0.0679, p-value = 0.0444; C $stock$ $(20$ $cm)$ = 0.39 +H0.08, R^2 = 0.0982, p-value = 0.0147).

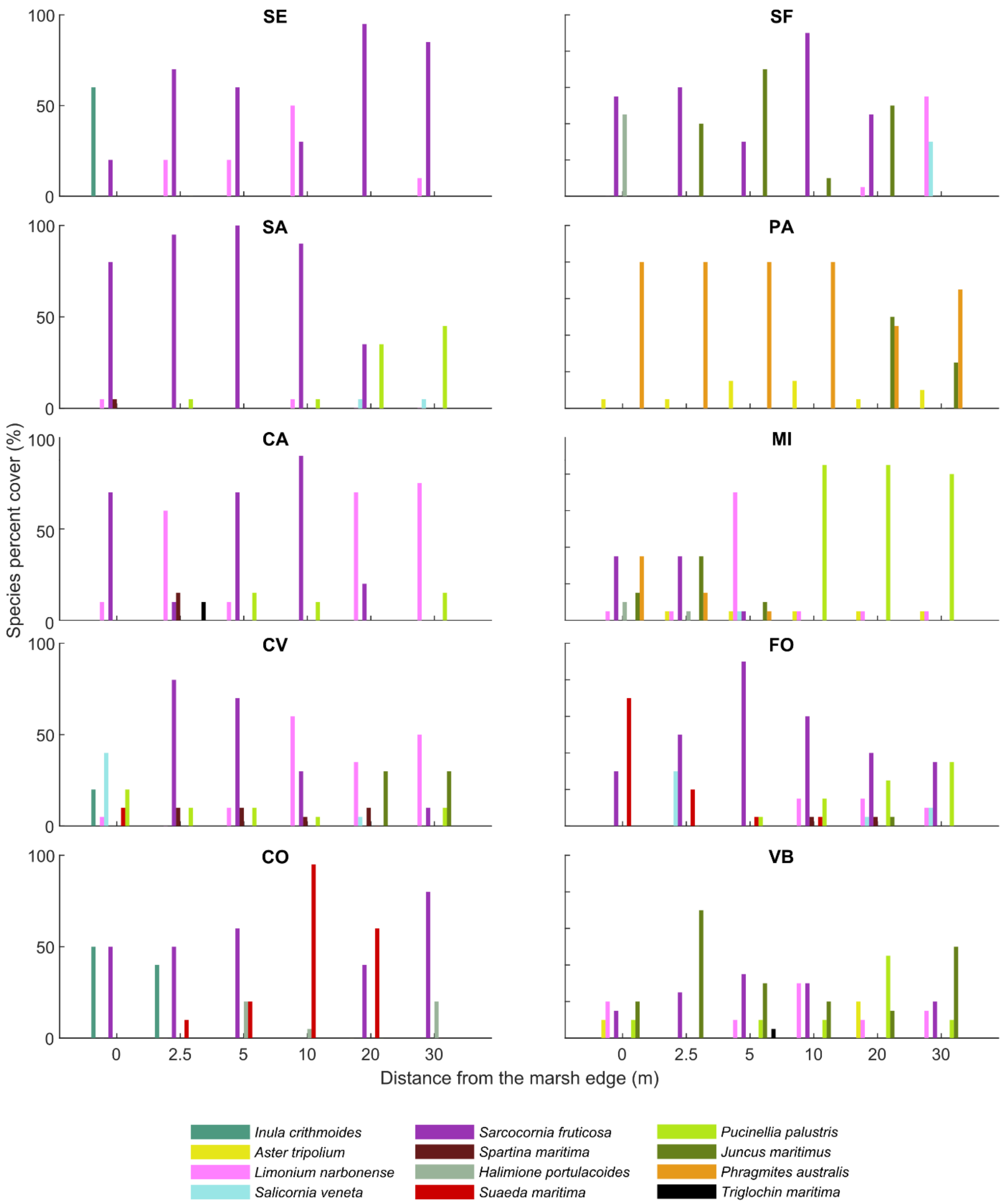

Figure S 1. Species percent cover observed within each 1 x 1 m quadrat surveyed for vegetation characteristics at each study transect.

Section 3.3 of the Results, "Vegetation influence on SOM", now reads:

"The vegetation surveys revealed that *Sarcocornia fruticosa, Limonium narbonense, Pucinellia palustris*, and *Juncus maritimus* are among the most abundant species in terms of percent cover along the analysed transects (Figure 3 a). *Sarcocornia fruticosa* exhibits an increasing trend in cover with distance from the marsh edge, peaking at approximately 5 meters from the edge before declining. Conversely, the cover of *Limonium narbonense* and *Pucinellia palustris* increases towards the inner marsh. The cover of *Juncus maritimus* varies along the transect. At the lagoon scale, *Phragmites australis*, typically found in brackish water environments, was observed only at two sites, PA and MI (Figure S1 in the Supplement). Additionally, *Pucinellia palustris* was more abundant at sites located in the southern part of the lagoon (Figure S1 in the Supplement). We found no relationship between OM content and vegetation cover. When considering the dominant species, OM content of marsh surface soil displayed a wide variability (Figure 3 c). Higher mean organic content was observed in the presence of *Limonium narbonense* (Figure 3 b), *Phragmites australis* (Figure 3 e) and *Puccinellia palustris* as dominant species. Although highly variable, organic content showed a significant positive correlation with vegetation species diversity (Kendall's tau test for Shannon Diversity Index H and OC stock in top 20 cm: $\tau = 0.1931$ p-value = 0.0300; with mean SCD in top 20 cm $\tau = 0.1818$ p-value = 0.0412) (Figure 3 d)."

The discussion on vegetation distribution and influence on SOM was modified as follows:

"Another potentially important factor controlling OM content is vegetation type, as different species exhibit varying biomass production and decomposition resistance (e.g. Van de Broek et al., 2016; Ewers Lewis et al., 2020; H Ford et al., 2019; Saintilan et al., 2013; Yuan et al., 2020).
While our data do not allow for a full statistical analysis of the relationship between OM content and vegetation type, we can derive some interesting qualitative observations. We find no discernible trend in vegetation cover along the transects, nor a significant relationship between OM content and vegetation cover.
Considering the relationship between SOM and dominant species, we observed that higher OM percentages in surface soil are not necessarily associated with dominant species having greater aboveground biomass (as reported in the literature, see Table S4 in the Supplement). We speculate that the lack of a relationship between aboveground biomass and OM may be due to the continuous transport and mixing of locally-produced litter by marsh flooding, weakening the effect of local aboveground biomass production. Moreover, previous studies indicate a major impact from belowground biomass, which inserting into the sediments directly contributes to OM content (Craft et al., 1993; Rybczyk et al., 2002). The highest mean organic contents were observed in the presence of *Limonium narbonense, Phragmites australis* and *Puccinellia palustris* as dominant species (Figure 3c). *Phragmites australis*, characterized by high aboveground biomass and even higher belowground biomass, forms a dense and deep network of leathery stems, roots, and rhizomes (Figure 3e) (Moore et al., 2012; Scarton et al., 2002). *Limonium narbonense,* despite low aboveground biomass (Table S4 in the Supplement), produces massive woody roots (Figure 3b), and *Puccinellia maritima* creates a dense root mat (Brooks et al., 2021). The belowground biomass of these plants may importantly contribute to SOM content quantitatively and qualitatively, as belowground litter decomposition was observed to decline with increasing lignin content (Stagg et al., 2018; Puppin et al., 2023). Interestingly, these species are more abundant in locations associated with higher values of SOM, such as the inner marsh for *Limonium narbonense*

and *Puccinellia palustris,* and brackish areas for *Phragmites australis* (Figure 3a and Figure S1 in the Supplement). However, it was not feasible to directly measure or estimate the relationship between aboveground and belowground biomass and their effect on SOM content in this study.
In addition, soil organic content showed a significant positive correlation with vegetation species diversity (Figure 3d), in agreement with Ford et al. (2019). Ford et al. (2016) found that plant species richness was one of the most important explanatory variables of root biomass and Xu et al. (2020) suggested that species richness may increase biomass productivity due to multiple mechanisms including competition reduction, niche complementarity, selection effects, and biotic and abiotic facilitation."

Line 355ff: see comment above, catchment scale conclusion are not be related to a figure comparing different degrees of fluvial or marine influence

As mentioned previously, Figure 1 was designed not only to depict the study site but also to enhance the reader's comprehension of the characteristics of the study sites. The central insert illustrates the locations of the study sites within the lagoon and their positions relative to the mainland and inlets. Satellite images were intended to illustrate the features of each transect, showcasing its orientation in relation to surrounding morphologies, such as channels, tidal flats, creeks, and ponds. In response to the comment, we referenced the figure in the discussion:

"At the lagoon scale, our results show lower mean OM content in surface soil in areas which are directly affected by marine influence, being closer to the inlets or along the main channels branching from them (CO, SE, SF, SA) (Figure 1 and Figure 6a)."