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Biogeosciences Discussions
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Interactive comment on "Contributions of the direct supply of belowground seagrass detritus and trapping of suspended organic matter to the sedimentary organic carbon stock in seagrass meadows" *by* Toko Tanaya et al.

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Comment #1: This study aims to assess the mechanisms constraining organic carbon storage at two sites in Japan colonised by seagrass meadows quantifying the different pools of organic carbon that contribute to sediment organic carbon stock in seagrass sediments (and unvegetated sediments). The study demonstrates that seagrass structure and detritus constrain sediment organic carbon stores at the study sites. The manuscript is well written. However, I have some comments that I list in detail below.

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Introduction. Page 3, line 33/Page 4, line 1. It is not clear in this sentence if the authors mean organic carbon or carbonate of calcareous organisms.

Reply #1: We have already clearly explained the meaning in the original manuscript: "OC derived from calcareous organisms" (page 3 line 33 and page 4 line 1).

Comment #2: Introduction. I suggest to re-write the last paragraph of the introduction to highlight the novel aspects of the study.

Reply #2: Concur.

Change #2: We have revised the phrase "the relationship between seagrass and the sedimentary OC stock" to "the pathways of sedimentary OC accumulation in seagrass meadows, especially the direct supply of belowground seagrass detritus" (page 4 line 7), and we added "along a seagrass biomass gradient" at the end of the paragraph (page 4 line 9).

Comment #3: Methods. Study site. The first paragraph could be moved to the introduction.

Reply #3: We do not agree. We did not move the paragraph because the description is too long and detailed to be included in the introduction.

Comment #4: Methods, page 4 last paragraph and Fig. 1. The location of the river mouth of Todoroki River relative to the sampling site is not clearly shown in the figure. This prevents to understand why the terrestrial input in this site is low. Similarly, the location of the small river discharging into the estuary is not clear in the image.

Reply #4: Concur.

Change #4: We have replaced Figure 1 with Figure AC2.

Comment #5: Methods. Page 5. It is not clear the type of organic material included in the fraction OCcsed. If it contained the carbonate from skeletons of corals, foraminifera, and other calcareous organisms it should not be considered in the organic carbon pool.

Reply #5: We have already explained that the carbonate was not included in OCcsed in the original manuscript (page 6 line 24).

Change #5: We have added “OC in the” before “coarse (> 1 mm diameter) sediments” (page 5 line 18) for clarity.

Comment #6: Methods. Page 5. Line 24. “We merged dead plant structures attached to live seagrass bodies into OCbio”. How much did dead plant structures attached to living biomass weight? How much was it in comparison to mass of the seagrass dead compartment? Could this affect the OC results across compartments?

Reply #6: We have already explained in the original manuscript that their mass was usually very small (page 5 line 25).

Comment #7: Methods. Page 5, last paragraph. At each site, samples were collected in vegetated, unvegetated patches within the meadows and bare sediment. However the results in the box plots (Figs. 4 and 5) are presented per site, without indicating if they correspond to vegetated, unvegetated patches or bare sediment. I think it would be relevant to present these results indicating if the sediments were vegetated or not.

Reply #7: Concur.

Change #7: As per your suggestion, we have added a figure showing the differences in total OC stock and its components between vegetated and no-vegetation (unvegetated and bare area) points (Fig. AC1). At both sites, OCbio, OCdead, OCfsed, OCsed, and OCtotal were significantly higher at points with vegetation than at points without vegetation. At points with vegetation, OCbio, OCcsed and OCtotal were significantly higher at the estuarine site than at the back-reef site, whereas OCdead, OCfsed, OCsed were not different between the sites. Therefore, this revision further supports our conclusion described in the original manuscript (page 12 line 24). Figure AC1 replaces Figure 4 in the revised manuscript (page 27) and the figure caption (page 22 lines 12–14) as well as the relevant results (page 9 lines 2–11) and discussion (page 12 line 24) have been

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modified accordingly. We have added an explanation of vegetation in the caption of Figure 5: Figure 5 (a) and (b) show the data of vegetated sampling points and Figure 5 (c) and (d) show the data of vegetated and bare sampling points.

Comment #8: Table 2. In this table the density of dead plant material is 0.00 _ 0.00 g cm-3. I believe that these components did have some dry density but lower than 0.00 g cm-3. I order to be able to provide their dry density, the units could be expressed in mg cm-3.

Reply #8: Concur.

Change #8: We have changed the units of dry density from “g cm–3” to “mg cm–3” to avoid entries of 0.00 (Table AC2).

Comment #9: Discussion. How much was the OC sediment stock at the studied seagrass meadows and at the bare sites? How do the OC stocks in the seagrass sediments found in this study compare with global seagrass OC sed stocks?

Reply #9: Concur. We have added these results and a corresponding explanation.

Change #9: We have removed the sentence (page 10 lines 17–21): “If we assume... (Fourqurean et al., 2012)”. Instead, we compared data of OCbio and OCtotal in the present study with Fourqurean et al. (2012)’s data in the top 0.15-m-thick layer. We have added a new table (Table AC1) and the following sentence: “The averaged OCbio was significantly higher in this study than that in the previous study by Fourqurean et al. (2012) ($W = 1691$, $P = 0.006$), whereas the averaged OCsed was significantly lower in this study than in the previous study at both vegetated and no-vegetation points (vegetation, $W = 6952$, $P < 0.001$; no-vegetation, $W = 225$, $P = 0.039$) (Table AC1). Hence, the contribution of OCbio to OCtotal at our sites was higher than the global average”. We also changed “the highest in globally compiled data” to “higher than in globally compiled data” in the abstract (page 2 line 8).

Comment #10: Discussion. What is the contribution of the different potential OC sources (seagrass, algae, corals, suspended POM and terrestrial POM) to OC in the sediment at both sites (and discriminating between vegetated and bare sediment)? The fraction of the different sources to the compartments of coarse and fine sediment could be estimated using mixing models. These estimates could be incorporated in a revised Fig. 8.

Reply #10: We intentionally did not use the stable isotope mixing model because, in the case examined in the present study, it failed to reliably isolate the contribution of seagrass from those of algae and corals; rather, the strong negative correlations among the inferred values imply that one source is simply being traded off against the other. (see Parnell et al., 2010). We showed that the direct supply of belowground seagrass detritus was a major mechanism of OCsed accumulation at the back-reef site from the contribution of belowground detritus to OCdead and δ13Csed, and from the relationships among δ13Csed, biomass, OCsed and OCdead (pages 11 lines 23–30).

Reference

Parnell, A. C., Inger, R., Bearhop, S., & Jackson, A. L.: Source partitioning using stable isotopes: coping with too much variation, PLOS ONE, 5, e9672, 2010, doi: 10.1371/journal.pone.0009672.

Comment #11: Conclusions. Kennedy et al 2010 and several other papers demonstrate that the contribution of particle trapping and seagrass material to sediment organic carbon widely varies across seagrass meadows, from meadows where allochthonous carbon is the main source to others where the sediment organic carbon pool is dominated by seagrass material. Therefore, there is evidence in the literature that seagrass carbon can be an important source to sediment organic carbon.

Reply #11: Although previous studies showed the provenance of sedimentary OC, they did not show the pathway of sedimentary OC (page 3 lines 28–30). We empirically showed that not only suspended-particle trapping but also the direct supply of belowground seagrass detritus can be a dominant organic carbon accumulation pathway in seagrass sediments.

Minor comments

Comment #12: Minor comments Abstract- line 7. It should say that the stable carbon isotope ratio was measured in OC sources as well as in OCsed.

Reply #12: Concur.

Change #12: We have added "and its potential OC sources" after "(δ13C) of OCsed" (page2 line 7).

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Table AC1. Values of seagrass biomass organic carbon and sedimentary organic carbon mass in globally compiled data (Fourqurean *et al*., 2012) and this study (mean ± SD, *n*).

	Vegetated		No-vegetation	
	Seagrass biomass OC ($gC\ m^{-2}$)	Sedimentary OC ($gC\ L^{-1}$)	Seagrass biomass OC ($gC\ m^{-2}$)	Sedimentary OC ($gC\ L^{-1}$)
	mean ± SD (*n*)	mean ± SD (*n*)	mean ± SD (*n*)	mean ± SD (*n*)
Fourqurean *et al*., 2012	251.4 ± 395.6 (251)	12.32 ± 8.04 (410)	-	8.08 ± 5.90 (43)
This study	283.0 ± 200.8 (21)	5.03 ± 1.32 (21)	-	2.93 ± 0.73 (7)

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Fig. 1. Table AC1

Table AC2: Organic carbon content, $\delta^{13}C$, and dry density of each sediment and dead plant component at the back-reef and estuarine sites.

	Back reef			Estuary		
	Organic carbon		Dry density (mg cm^{-3}) mean ± SD (*n*)	Organic carbon		Dry density (mg cm^{-3}) mean ± SD (*n*)
	%OC (% DW) mean ± SD (*n*)	$\delta^{13}C$ (‰ vs. VPDB) mean ± SD (*n*)		%OC (% DW) mean ± SD (*n*)	$\delta^{13}C$ (‰ vs. VPDB) mean ± SD (*n*)	
Fine sediment	0.37 ± 0.13 (60)	−12.8 ± 0.8 (60)	893 ± 303 (60)	0.42 ± 0.20 (24)	−17.4 ± 3.6 (24)	760 ± 294 (24)
Coarse sediment	0.32 ± 0.13 (20)	−12.8 ± 1.1 (20)	292 ± 152 (20)	0.26 ± 0.08 (8)	−15.9 ± 1.5 (8)	475 ± 142 (8)
Dead leaf	24.80 ± 3.07 (3)	−8.9 ± 0.6 [a] (5)	0.05 ± 0.04 (20)	23.31 ± 3.86 [b] (3)	−9.3 ± 0.2 [a] (5)	0.03 ± 0.04 (8)
Dead sheath and rhizome	21.29 ± 4.07 (3)	−8.9 ± 0.6 [a] (5)	0.55 ± 0.63 (20)	27.52 ± 1.75 [b] (3)	−9.3 ± 0.2 [a] (5)	1.44 ± 1.86 (8)
Dead root	19.25 ± 1.67 (3)	−8.9 ± 0.6 [a] (5)	0.26 ± 0.25 (20)	19.94 ± 5.89 [b] (3)	−9.3 ± 0.2 [a] (5)	0.31 ± 0.35 (8)

[a]Total of sheath and rhizomes, and root.

[b]At one sampling point (FS1) where the dominant species was different, the values were dead leaf, 25.77%; dead sheath and rhizome, 19.05%; and dead root, 19.21%.

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Fig. 2. Table AC2

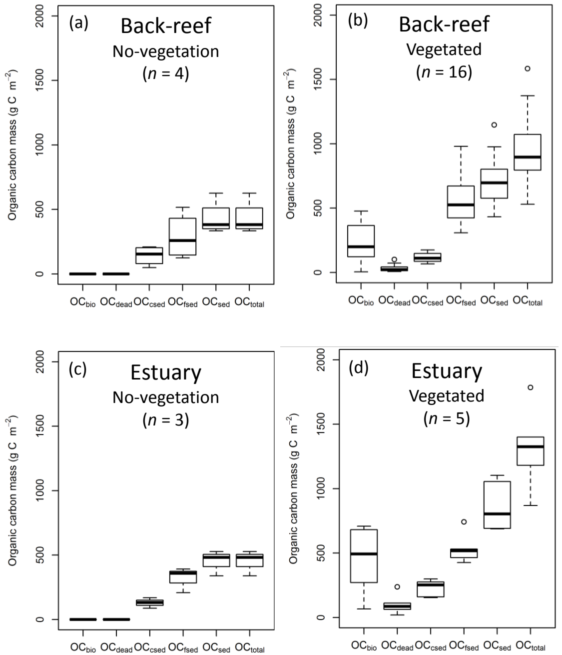

Figure AC1 : OC mass (OC_{bio}, OC_{dead}, OC_{csed}, OC_{fsed}, OC_{sed}, and OC_{total}) at (a) no-vegetation (bare and unvegetated) points at the back-reef site, (b) vegetated points at the back-reef site, (c) no-vegetation points at the estuarine site, and (d) vegetated points at the estuarine site. Boxes show the 25% and 75% quantiles; horizontal bands inside the boxes are median values; whiskers show maximum and minimum values; and the open circles are outliers.

Fig. 3. Figure AC1

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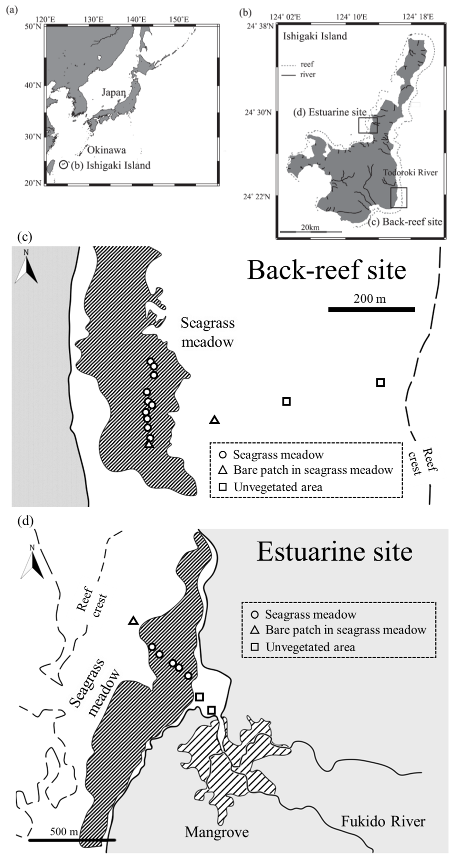

Figure AC2: (a) (b) Study site location on Ishigaki Island, Japan. Sampling points at the (c) back-reef and (d) estuarine sites. At the back-reef site, the circle indicating the southernmost vegetated sampling point actually represents a cluster of six sampling points.

Fig. 4. Figure AC2

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