

## ***Interactive comment on “The importance of an estuarine salinity gradient on soil organic carbon stocks of tidal marshes” by Marijn Van de Broek et al.***

### **Anonymous Referee #1**

Received and published: 30 August 2016

General comments: The paper is well-written and generally well structured. It addresses an important gap in the field of carbon cycling, namely of measurements in brackish and freshwater marshes. The authors address various aspects clearly and draw attention to the problems associated with different sampling depths. In addition, they indicate what a future sea level rise may entail for the carbon storage dynamics within the Scheldt estuary.

There are some aspects which need clarification and one main concern of mine is that samples were collected in different seasons. Depth profiles were collected in November whilst aboveground biomass was not collected until August. No mention of this is made in the discussion and I certainly believe that this needs to be addressed and

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justified.

I also miss more discussion on the effect the very different types of vegetation may have on the carbon dynamics of the different marshes. This certainly influences stable isotope signatures and carbon mineralization rates. More comments are found in the specific comments regarding this.

Specific comments: P3 L3f: Why did the authors limit themselves to the incorporation of in situ produced belowground biomass? Aboveground biomass also produces substantial amounts of litter and can also be buried.

P4 L18-20: the use of PSU/practical salinity unit is discouraged, nowadays salinity as written here would be unitless i.e. the authors should write: “. . . salt or polyhaline zone (salinity >18), brackish or mesohaline zone (salinity 5–18) and freshwater/oligohaline zone (salinity 0–5). . .”

P5 L4: How were these samples stored during their transport i.e. were the 0.03 sections thus homogenized?

P5 section 2.2: why were depth profiles collected in November 2014 and aboveground biomass not until the end of August? How do the authors justify using data from such different seasons?!

P5 Section 2.3: just make one paragraph for easier reading and change title to “Soil and biomass analysis”

P5 L18: What do the authors mean with split? This also needs clarification because now it sounds like only one of the five replicates was analysed. Is this the case, or are you describing what was done to each one of the five replicates? Please clarify.

P5 L25ff: The authors sectioned the cores into 0.03 m sections, so, when they say one sample every 0.09m, do they mean it is the sample at 0.06-0.09, or 0.09-0.12 and so forth? The same question applies to when they say every 0.18 m. Maybe rather say “. . . For the other two replicate profiles every third sample was analysed (i.e. 0.06-0.09,

0.15-0.18, . . . , 0.69-0.72m) to a depth of 0.72m. Thereafter, a sample was analysed every 0.18 m.”

P5 L29: what linear interpolation technique was used to do this?

P6 L6: Was only a check for normality done? Please also mention (and I hope the authors did!) that homogeneity of variance was also checked.

Please also specify what statistical programme was used to run the analysis. What techniques were used for the posthoc analyses as I presume some were done since you mention differences in Figure 4? And please specify which level of probability was used (e.g. “with a level of significance of  $p < 0.05$ ”).

P6 section 3.1: - also include here that detailed results for the grain size (not texture) are in the supplementary information

Section 3.2: - Figure S1 is not maximum annual biomass but as is noted in the figure caption as total biomass. This is a difference so please clarify. - Even if the below-ground data was not statistically analysed and no clear patterns are observed, I would have liked to see some comments on what we see i.e. that at the fresh low biomass is clearly very high, that for most sites we see very low values. - An explanation is needed here for figure 4 and the letters apparently showing differences. These need to be explained.

P.7 section 3.4: - Depth profiles of cumulative OC stock per 0.01 m layer are shown. . . Where does this 0.01 m sectioning come from? The authors make no mention of this in the methods. There you can only find 0.03 m sections or 0.1 and 0.2 m sections. Please clarify what I have missed. - Please be more consistent with the terminology. Within this one paragraph the authors begin by using SOC but then use only OC later on.

P7 L 11f:  $^{13}\text{C}$  signal of standing vegetation is closely related to the  $\delta^{13}\text{C}$  signal of SOC in the topsoil layer. How is this conclusion reached? I presume with standing

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vegetation you mean the aboveground biomass? I would not agree with this from what I see in figure 6.

P7 L18: “However, the differences reported in previous studies are almost always much smaller than the differences we find. This may to some extent be related to differences in environmental conditions, but differences in sampling procedures also matter.” I agree that the authors want to address the problem of inconsistent sampling depth but I do not think that you can dismiss all the other reasons why there are such differences with this one sentence. The estuaries listed in Table 4 are all very different in terms of their geology, morphology, inputs, outputs, etc. and I would like to see some more discussion of this. One of the aims of this paper was to determine OC stocks along a salinity gradient of a temperate estuary and its main controls and I think this has to be addressed more thoroughly. Since the authors do actually discuss some of these factors in section 4.3, I would suggest that section 4.3 follows directly to 4.2 (or is combined) because the authors here try and further explain the observed patterns in SOC stocks which is a more natural progression from what is initiated in section 4.1. I would also bring the issue of different sampling depths then as a separate header and not as the first paragraph of the discussion. This is an aspect but not the most important one.

In relation to this it is unclear in line 20 whether the authors refer to differences from this study or from the other studies. This needs to be clarified.

Section 4.3.2: I miss a more thorough discussion on the fact that you have very different vegetation types. I presume no  $\delta^{13}\text{C}$  values are known for the different plants themselves? I also struggle with the fact that biomass was only measured in August, whilst all other measurements were taken in November. The influence of weather and climate conditions and subsequently river flow on affecting stable isotope signatures should not be underestimated (e.g. Zetsche et al. 2011, [dx.doi.org/10.1016/j.csr.2011.02.006](https://doi.org/10.1016/j.csr.2011.02.006)).

I would suggest the authors also look at a recent similar study by Hansen et al. 2016

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(DOI 10.1007/s11368-016-1500-8) and see how their results of the importance of salinity can be reconciled in this study also for section 4.3.1.

P8 L7f: There is no relationship. Did you analyse this statistically? If so please provide test results here, or at least indicate (data not shown).

P8 L19f: Elymus is considered an invasive species. Do you think it is invading here and will remain as the dominant vegetation type here? How will this affect influence SOC stocks in the future as conditions favour this plant?

FIGURES: Personally I would prefer it if the authors used the blue colours always for the saltmarshes (since closest to the blue ocean) and the green colour for the freshwater marshes (closest to land) in the figures. This is more intuitive to the reader.

Figure 1: Please increase the font size of the country names in the inset. FYI: A black and white version of the map will not depict the light grey areas.

Figure 2: Brackish water marsh not just Brackish marsh

Figure 3: All species names should be italicized. Figure caption: At several marshes the former tidal sandflat was reached, whilst at two other locations the marsh sediments extended below the maximum sampling depth of 1.4 m. The vegetation history is based on Temmerman et al. (2003) and information from the  $\delta^{13}\text{C}$  profiles of this study, in combination with information from Boschker et al. (1999) and Middelburg et al. (1997). Mix denotes a mixed vegetation which included the following species: . . . . A '?' indicates that no clear identification was possible.

It is not possible to say only shallow marshes because the sandflat is also reached at the high saltmarsh and I presume only freshwater and brackish water high went beyond 1.4 m? Also specify what mix stands for. The figure has to be understandable on its own.

Figure 4: the inset is very distracting. Please remove. Instead you can insert a break on the y-scale to allow the details to be seen more easily for the belowground biomass.

Adjust the figure caption i.e. remove “(the inset...biomass)”. Also add the y-axis legend i.e. Biomass production (g dry weight m<sup>-2</sup> yr<sup>-1</sup>). Replicas should be replicates. The letters to indicate significant differences are confusing. It has to be explained in the figure caption what the different letters stand for. No mention of these are made in the main text which also has to be addressed!

Figure 5: Error bars for specific depths represent the standard deviation.

Figure 6: aboveground (circles)... Error bars represent the standard deviation.

Figure 7: write out OC once as organic carbon in the figure caption.

TABLES: Comments like A, B, C etc. should be added as footnotes. They are footnotes and should not be in the main caption text.

Table 1: please change around C and D (better to have A, B, C in the same line and then D at the bottom for the mixed vegetation. Please also italicize all species names in the footnote D (previously footnote C). Regarding footnote C (previously D): What is texture? It is not texture but grain size that was measured in this study. Why is this called maximum marsh sediment depth? I would rather simply write “Maximum sampling depth”. The tidal sandflat that is reached most likely is deeper but probably caused problems with the sampling device? Sand is not easy to sample.

Table 2: Keep footnotes C and D and make them A and B. Add to figure caption: “Bulk density values are averages for the upper meter of soil, whilst soil pH and electrical conductivity were measured in the topsoil only.

Table 3: Increase the space between the line termed saltwater and the next line for ‘up to 0.6 m depth’ to make this clearer for the reader. Figure caption: Total organic carbon (OC) stock (kg... deviations calculated for the full vertical sampling profiles (depths used for the calculations are given in brackets), and the upper 0.6 m.

Table 4: make this into a horizontal table and thus more readable. Perhaps place the location then as a separate column next to the estuary name.

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Supplemental data: I would welcome that the excel sheets provided in the supplemental data are at least referred to in the paper.

Figure S1: see my comments on Figure 4. Please also remove the inset here.

Figure S2: why is there now mention of a depth interval of 0.01m? This is never mentioned previously in this study, only slicing at 0.03 m and 0.1 +0.2 m intervals is ever mentioned. Please explain.

Table S3: Please italicize all species names. Replace Oosterschelde with Eastern Scheldt and Westerschelde with Western Scheldt.

Table S2: Figure caption: Average values ( $\pm$ SD) for aboveground, belowground (maximum root depth is given in brackets (m)) and total biomass, biomass production, organic carbon and nitrogen concentration (%), C:N ratio as well as the  $\delta^{13}\text{C}$  signal (‰ for vegetation at the study sites. Remove footnote A, footnote B: write here in full as a footnote the species. In table: Adjust either DW or dry weight, now have both. Also write species names in full. If you miss space you can shorten Freshwater to Fresh, etc. and add to caption “. . .at the study sites (freshwater, brackish water and saltwater marshes).”

Technical corrections: P2 L14: downstream of the maximum. . .

P3 L2: replace extratropical with temperate. Extratropical is not normally used in this context.

P3 L7: equilibrium with the local

P3 L8: remove ‘in particular’

P3 L16-17: remove spacing and merge into one paragraph.

P3 L22: tidal marshes, for which no data is available, is the

P3 L23-24: remove separation into paragraphs. These three reasons are all one aspect

and should be together in one paragraph.

P3 L25: ... (Craft, 2007). A sharp increase in salinity...

P3 L29: ...2010). In addition, the OC input in tidal marsh...

P3 L32: data not date

P4 L5: remove space and form one paragraph.

P4 L8: ...stocks in tidal marsh soils. The aims...

P5 L6f: ...0.5m depth, and then in 0.2 increments down to the maximum depth of 1.4m.

P5 L17 and L23: replace weighted with weighed. Samples were placed on a scale, hence they were weighed. Weighted is used in a different context.

P5 L19: ...using the Elemental Analyser...

P5 section 2.4: remove line spacing and form one paragraph.

P5 L26: ...analysed to a depth of 0.72m. Below this depth, samples were analysed every 0.18 m.

P6 L5: remove "is"

P6 L17: willow trees were

P6 L18: what is meant by woody parts, this is not a correct term!

P6 L19: deduced from other studies

P6 L23: showed and decreased i.e. past tense.

P6 L26: do not write just in the top of the profile, be more specific, e.g. "...OC concentration in the upper 0.2 m." Or whichever depth it is...

P7 L2: to the low marshes

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P7 L11: this is the first time a 'C4 Spartina site' is mentioned, please refer to this differently to make it clearer for the reader.

P8 L3: observations

P8 L3: remove spacing and merge into one paragraph

P8 L13: deeper down along the profile, both variables

P8 L21: from the decomposition... likely, as shifts in ... decomposition are generally in the order of...

P8 L25: On the high saltmarsh... with depth also occurs.

P8 L26: ... characterised by a mixture of...

P8 L28: ...marsh growth *Spartina anglica* was also present at this ...

P9 L 22: remove spacing and merge into one paragraph

P9 L23: that determines

P10 L31: remove spacing, merge into one paragraph

Section 5: merge all into one paragraph.

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