Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2018-339-AC1, 2018

Biogeosciences
Discussions
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Interactive comment on "Large-scale predictions of saltmarsh carbon stock based on simple observations of plant community and soil type" *by* Hilary Ford et al.

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Received and published: 19 October 2018

Anonymous Referee #1 General comments:

Blue C ecosystems show higher rates of C sequestration than many other ecosystems on the long-term. That is, these systems build up with rising sea level, their soils do not become C saturated (as terrestrial soils) and thus C sequestration in soils can be maintained over centuries or millennia. A central driver of C sequestration in these systems is therefore accretion, which I do not see considered in this manuscript. This needs consideration in the discussion part.

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Discussion paper

Thank you for your comment. We will add a short section in the Discussion on the importance of accretion, although the key focus of this paper remains the prediction of soil organic carbon (SOC) stock from simple observations of plant community and soil type.

A related point is that only top soil (10 cm) C contents were assessed, so only a small fraction. "Carbon stock" is therefore misleading, particularly regarding the often several meters deep soils of high C density typical for blue C ecosystems. Also, several studies demonstrated sharp declines in C density/content with soil depth in tidal wetlands, so that little information about the total C stock can be inferred from the top-soil C content. The focus on top soils needs to be made clear from the beginning of the ms throughout, and the implications of the strongly limited data set (i.e. missing depth assessment) need to be discussed. The relevance despite this limitation needs to be demonstrated.

We thank the reviewer for this comment and acknowledge that we need to make this and the following associated points clearer in the text. The blue carbon literature shows SOC stock in the top layer of soil is generally indicative of SOC stock in deeper soil layers; SOC typically has a long-linear relationship with depth. We will provide evidence of literature demonstrating this principle and will add a section in the Introduction and Discussion to elaborate on this point. We will substantiate the principle further by providing examples of SOC to soil depth profiles from the study sites involved (data source: Kingham 2013 The broad-scale impacts of livestock grazing on saltmarsh carbon stocks. PhD thesis, Bangor University, UK). Kingham (2013) sampled 224 cores from 22 saltmarshes in the study region, differing in soil type, plant community type and grazing intensity. By reanalysing this data set, we will show that sampling to a depth of 10 cm consistently captures 72 $\pm$ 1 % of total soil organic carbon (Figure S1). We thus argue that surface SOC stock can provide a reliable predictor of deeper carbon stores and is therefore a useful indicator of total SOC stock for UK saltmarshes.

I am not sure if the application of the results (i.e the SCSP and the Salt Marsh App) are in the scope of this journal. These two parts of the work might be more appropriate for a Methods journal, but I leave this decision to the Editor.

We believe that the manuscript is strengthened by the inclusion of reference to the Saltmarsh Carbon Stock Predictor (SCSP) and the Salt Marsh App. These tools are practical applications of the principles demonstrated in the paper. They give opportunity for large-scale prediction of blue carbon stores by non-experts either in the field or from existing maps. Reference to SCSP and the App should make the paper more attractive to land managers.

Specific points: 42: add pioneer works, i.e. Chmura et al. 2003

We will add 'Chmura et al. (2003) Global carbon sequestration in tidal, saline wetland soils' to the reference list and cite it in line 42.

77-80: So how deep do these plants root in relation to your sampling depth of 10 cm? How much of the belowground biomass stock can be captured?

Sampling to 10 cm consistently incorporates 60 $\pm$ 1.5 % of total root biomass (Kingham, 2013), this is detailed in a later comment relating to root biomass.

101-103: check sentence

The phrase 'quadrat-scale' is not clearly defined here. We will improve the wording if asked to edit the submitted manuscript by the editor.

132: Craft et al 1991 (Loss on ignition and kjeldahl digestion for estimating organic carbon and total nitrogen in estuarine marsh soils: Calibration with dry combustion) demonstrate that the SOM-SOC relationship depends on soil type and that the use of a simple conversion factor (i.e. 55%) can lead to both strong under- and overestimation of SOC. This needs consideration.

We would argue that for our quick-and-easy estimation of soil carbon stock from vegetation and simplified soil type a simple conversion factor (between soil organic matter % and soil C %) is adequate. Variation is apparent in the literature on conversion rates between soil organic matter (calculated from LOI) and soil C (%) in saltmarsh habitats (Coastal Blue Carbon methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows, the Blue Carbon initiative https://www.cifor.org/library/5095/) with the majority of publications from the US, where soil types and dominant vegetation species are often different. The advantage of the 0.55 conversion is that it is from a UK source.

161: This is R code not English. Please make it understandable for people using other software throughout your methods section.

Apologies, I will re-write this section to make it clearer for people using other software whilst still referencing key R packages as requested by the R community (all software is open-source and created by experts free of charge so citations are requested etiquette). If editor requests it this detail can be moved to a supplement.

178: It is unclear what is new about the SCSP tool in this manuscript that has not been described in Skov 2016?

Skov et al. (2016) is a user manual for the SCSP. While it does give a simple overview of the underpinning principles and principles of the analysis for the tool, it does not go into any depth about the analytical components, nor does it introduce or discuss in any depth the underpinning literature.

308: deep-rooting would lead to a C allocation in the soil profile that you did not capture. It is possible that the C stocks under your different plant communities are not different but you could not capture this with your sampling design Kingham (2013; full reference above) analysis of 224 cores from 22 marshes within the study regions showed that sampling to a depth of 10 cm captured 60 $\pm$ 1.5 % of root biomass (Figure S2). This finding can be included in the manuscript and detailed in an appendix. Shallow root biomass is therefore broadly indicative of deeper root biomass, allowing us to assess differences in root biomass between plant communities using relatively shallow cores.

352: please be more specific: long-term C sequestration (aka C burial) is higher than in forests.

The current statement 'However, on a per area basis, coastal wetlands equate to similar or more efficient carbon sinks than most terrestrial forests (Mcleod et al., 2011; Pan et al., 2011)' could be altered to read: 'However, on a per area basis, coastal wetlands are more efficient carbon sinks than most terrestrial forests (Mcleod et al., 2011; Pan et al., 2011) due to their ability to accrete vertically in response to sea level rise (Chmura et al. 2003)'.

356-58: You did not demonstrate that your data are applicable to other UK marshes outside Wales or even European marshes in general.

This study demonstrates the principle that carbon is predictable from vegetation and soil types common across the UK and North-west Europe. We have data to present within the supplement to show comparability between Wales and saltmarshes in other UK regions (this was not included in the present version), see Figure S3. All estimates are close apart from the 'P. maritima + Sandy soil' category, possibly indicative of heavy livestock-grazing on the marsh where this combination was most common.

360: Spartina is also a dominant genus in many European marshes. We agree with the reviewer. We have been up-front in the manuscript about the lack of representation of European pioneer plant communities including Spartina anglica. We will alter the text at line 360 to reflect this. However, in this instance, we were referring to the fact that American marshes, tend to be dominated by Spartina species that render the soil organogenic, more than minerogenic. This has been shown to impact carbon burial (Davidson et al 2017), and we just wanted to make the reader aware of the different functioning of European and American marshes that might mean our method has to be adapted there.

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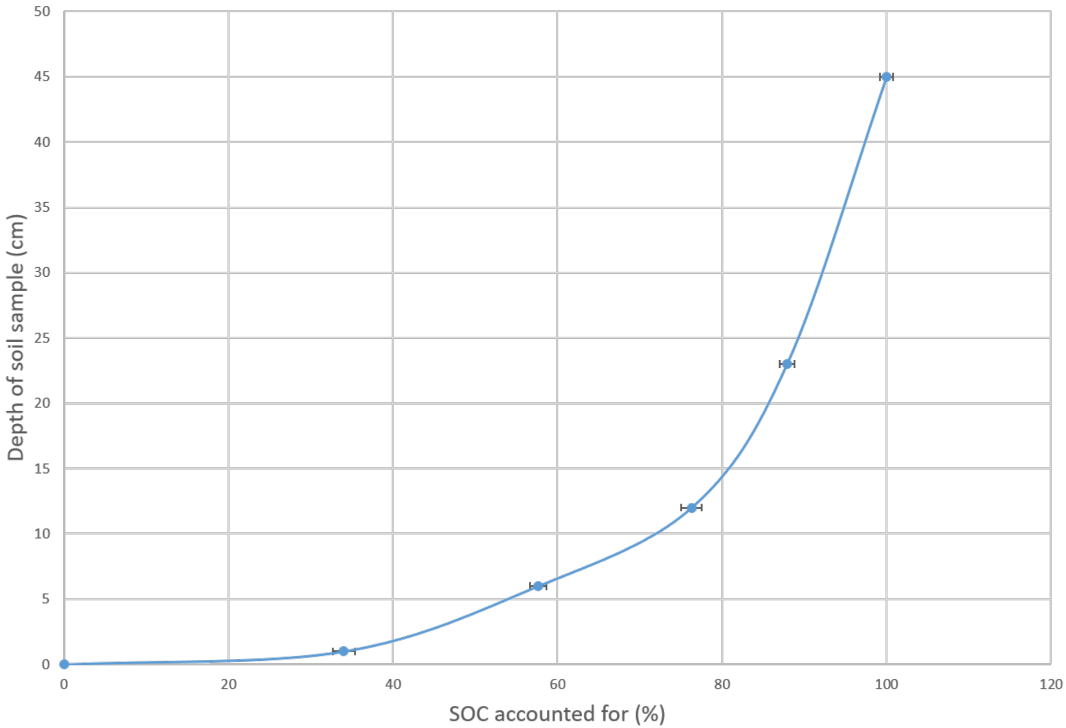

Fig. 1. Figure S1. Soil carbon (%) accounted for by soil depth based on 224 saltmarsh cores from 22 saltmarshes in the study region, differing in soil type, plant community type and grazing intensity.

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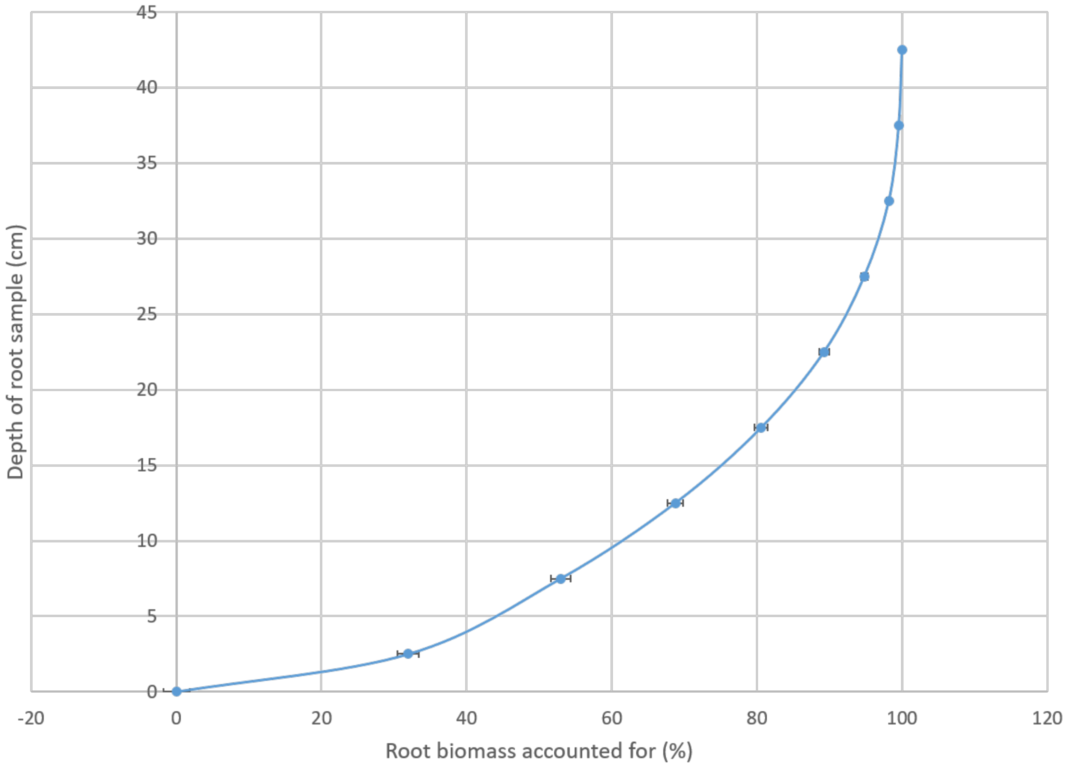

Fig. 2. Figure S2. Root biomass (%) accounted for by soil depth based on 224 saltmarsh cores from 22 saltmarshes in the study region, differing in soil type, plant community type and grazing intensity.

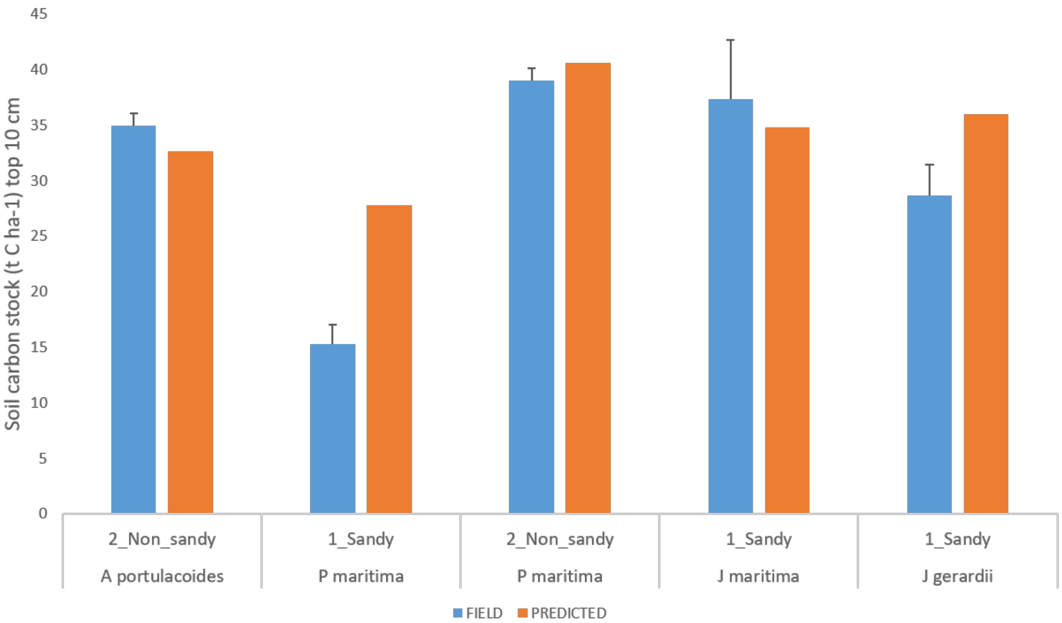

Fig. 3. Figure S3. Field measurements of soil carbon stock (n = 132) using data from three Lancashire and three Essex (UK) saltmarshes compared to predictions from the SCSP tool (Veg_soil_model – 'Vegetation

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