

We would like to thank the reviewers for their continued constructive feedback. Please find below our responses to Reviewer 1. Below we have provided Reviewer 1's comments (in black text) and our responses in red italic text.

Reviewer 1

Only a few technical corrections remain. All line numbers refer to the authors' tracked changes document:

L88 - Add "and" between "sediment properties" and "OC content"

This typo has been corrected

L99 - Typo: "these" instead of "tehese"

This typo has been corrected

L113 - Typo: "water" instead of "otter"

We respectfully disagree with the reviewer here. This is not a typo, "bottom otter trawling" is a type of fishing gear that is widely used in the Irish Sea. We have now clarified this in the text

L120/121 - Consider rephrasing "lack of data" as L123 refers to the area as "data rich"

This sentence has now been re-phrased so as not to sound contradictory. It now reads:

"This is particularly important in the Irish Sea, where although the region is generally data-rich, limited information on the impacts of human activities on marine sedimentary OC stocks has been identified as a barrier to incorporating OC into marine spatial planning frameworks (Allcock et al., 2024; Crowe et al., 2023). Moreover, the availability of broader environmental datasets makes the Irish Sea well suited to test and apply the spatial modelling workflow developed in this study."

L306 - Typo? NNDM is performing well on spatially "dependent", locally autocorrelated data, not "independent"

We respectfully disagree with the reviewer here. This is not a typo. The idea of NNDM is to achieve more realistic estimates of model performance than random cross validation. During NNDM the training/testing folds are split to make sure they are spatially independent. So the model is tested on data that is spatially uncorrelated to training data, which gives a more realistic estimate of model performance. Conversely random cross validation creates training/testing splits that likely contain spatially correlated data in both training and testing datasets. Thus the model is trained and tested on similar data, which artificially inflates model performance metrics and does not give a fair reflection of how the model performs in unknown areas. We have now clarified this in the text.

L318 - Provide a reference for the statement on the "15% interval"

We have now added a relevant citation for this statement.

L400 - Typo: "MSE" instead of "RMSE", as this metric was introduced shortly before and applied to the other cases

This typo has been corrected.

L431 - The "Mudbelt" and "Smalls" areas are referred to slightly differently here compared to L423 and L572; please harmonize

References to the western Irish Sea 'mud belt' and the 'Smalls' have been harmonized throughout the manuscript.

L473 - Typo: grain "density" not "size"

This typo has been corrected.

L543 - Add "that" or "which" before "impact"

This mistake has been corrected.

L555 - Do not delete "to"

This mistake has been corrected.

We thank RC2 for their continued constructive feedback. Please find below the comments from Reviewer 2 and our responses in red italic text.

Reviewer 2

The first round of revisions have substantially improved the quality of the MS. I would support publication after a few minor revisions.

1. Abstract, L18-22. First, the flow of these sentences can be improved. For example "Moreover" is not accurate, maybe another word here. Second, DBD estimates are mostly based on global data but used in regional OC stock estimates. This point should be clearly stated. So these sentences need to be rephrased.

We have rephrased these sentences to be clearer and more explicit with regards to previous DBD estimates. The text now reads:

“Spatial models offer solutions to identifying organic carbon storage hotspots; however, regional predictions of OC often rely on global scale predictors which may have biases on smaller scales, reducing their utility for practical management decisions. In addition, estimates of dry bulk density (DBD), an important factor in calculating OC stock from sediment OC content, are typically derived from an empirical relationship developed in one region and applied elsewhere, rather than from local in situ data, leading considerable uncertainty in regional OC stock estimates.”

2. Introduction. Some expressions are not clear.
 - a. L78 sediment properties OC content.

This was a mistake. We have added the word “and” between sediment properties and OC content.

- b. L88 tehse inputs.

This was a typo. We have now corrected this. It should have read “these inputs”

3. Conclusion. This section is now like implications. Important results and data (about DBD estimates) should be emphasized again in this section.

We have edited the conclusion section of the manuscript to now include important results of the study, particularly with regards to DBD estimates. This section now reads:

“Overall, our findings suggest that marine sedimentary OC stocks could be lower than previously estimated, with implications for marine spatial planning and nature-based climate solutions. A key result of this study is that uncertainties in dry bulk density (DBD) estimates strongly influence OC stock predictions. We show that reliance on previously developed empirical relationships for DBD can introduce substantial error, underscoring the need for regionally relevant data. Improved OC stock estimates, grounded in more accurate DBD values, can support more informed seabed management by identifying areas with higher carbon vulnerability or conservation potential. a conclusion with important implications for seabed management. The findings suggest that adjusting improving model inputs based on in situ data, may help refine reduce uncertainties in model predictions to be more locally relevant. We highlight the critical role that accurate DBD estimates play in determining OC stock. Moving forward, more comprehensive in situ DBD measurements and

refined DBD models are essential for improving the accuracy of OC stock predictions. Alternatively, OC stocks could be calculated directly per sediment core, reducing the number of models needed to estimate OC stocks, thus reducing uncertainty in final estimates. These efforts will be instrumental in developing better strategies for managing marine sedimentary OC stocks.”