Review of egusphere-2025-661 entitled as "Improving Marine Sediment Carbon Stock Estimates: The Role of Dry Bulk Density and Predictor Adjustments" by Chatting et al.

This MS applied a machine learning-based DBD model to adjust DBD data and reevaluate the OC stock in the Irish Sea. They mainly compared two different ways to calculate regional OC stock. One is based on the empirical formula and unadjusted data; the other is to use a RF model in this study to generate the spatial distribution of DBD and OC stock. Their findings highlight potential overestimation of OC stock and the necessity to improve current models. Overall, this MS made a good point. However, I frequently felt it hard to follow when reading this MS, and much effort is need to make this MS easier to read. Major comments are as follows.

My most major comment is about the accuracy of the model. Although the adjusted DBD data align better with in-situ measurements, it is not convincing enough that the OC stock after adjustment is closer to the actual value. It is necessary to be clarified in different ways. Moreover, as shown in the main text, the study area lacks observational DBD data. Thus, it is questionable whether the adjusted DBD within the study area really improved the model performance and the accuracy of estimation. I also wonder the reason for just choosing the Irish Sea as the study area. It's better to emphasize these points in the main text and avoid possible vagueness.

Second, the advantages and applicability of this adjusted DBD model were not clearly illustrated. The prediction of DBD data is dependent on a lot of variables and may be difficult to scale to a larger scope. In contrast, the empirical relations are in very simple form and can be easily extended to other places. It is better to include the possibility of extending the scope of this model in the MS. Moreover, the cost and uncertainties should also be considered.

Finally, is this model robust to outliers? If not, you may need to perform data screening before model training and to see whether the performance is improved.

Line comments

L15: "over geological timescales". More studies of continental shelves are about modern environments. The focus of this MS is also in the upper 10 cm of the sediments and is not associated with geological timescales.

L15-18: "Shelf sediments can also be subject to…". This sentence is not related to the main content of this MS.

L18: Correct to "reduction".

L19: What data gaps? Clarify.

L22: "comparatively few". Compare to what? It would be better to use phrase like "sparsely" and to emphasize current data is not enough for an accurate estimation.

L22-25: “We compared…”. This sentence is too long and can be broke up into two. You can also change the way of narrative. 1) Introduce the previous method and the shortcomings. 2) Compare your new model to the previous one.

L25: Clarify the depth of estimated OC stock.

L28: Correct to “emphasize”.

L30: It may not be necessary to repeatedly mention “policy makers”. First, lower regional OC stock is contradictory to their focus. Second, the long-term variation trend (instead of the stock) and the feedbacks to climate change are more important.

L31: “addressing uncertainties”. This phrase is odd.

L32: Managing the carbon sequestration potential is not directly mentioned in the main text.

L35-36: You may need to cite one or two more references. For example, Hedges and Keil (1995), Burdige (2007), Bianchi et al. (2018).

L37: Hage et al. (2022) is about the OC burial flux in the Upper Cretaceous deltas (~75 Ma). It is far longer than the timescale of millennia.

L42-45: This sentence is too long and is not well joined.

L47-51: This sentence is too long as well. I suggest breaking it to two sentences.

L55: “OC per unit of s area”. Typo? In addition, this sentence is too complex.

L56: How can DBD adjust the OC content? Maybe OC stock. Clarify.

L67-71: I wonder the reason for introducing the application of bias adjustments in climate models. It would be better to present the application of bias adjustments in more related fields.

L77-78: Temperature and salinity are not key factors in this MS.

L87: How to verify the OC stock estimate is improved?

L88: Change to “was developed by”.

L89: dash between “un” and “adjusted”. Keep consistent through the MS.

L100: Correct the refs.

L104-105: Maybe detail how to define the inshore area.

L111: Is 10 cm adopted in most of related studies? It would be better to consider and illustrate the corresponding timescale.

L115: It is better to include the number of observations (e.g., n=50). Is the conversion equation developed

exclusively from surface sediments?

L130-132: Again, why do you only choose the Irish Sea to test the model?

L138-141: It would be better to illustrate the reason of choosing these parameters. Availability or likely influence on OC stocks.

L141: Is the Q-Q mapping method sensitive or tolerate to outliers and extreme distribution? Clarify.

L214-217: This sentence is too long.

L226: Were the standard deviations directly summed up? Need clarification.

L239: It may be confusing to use both OC reservoir and OC stock. You may need to change the phrase.

L245: This section (4.1.1) may be inappropriate in Results part. Maybe better in Methods part.

L289-290: How do you estimate the uncertainty of OC stock?

L302-304: It would be better to point out the overestimation is within the study area. This conclusion can only be drawn after applying this adjusted DBD method to wider scope.

Line 310: Delete comma before “compared to” and add comma before “and”.

Line 320: What is “OC storage dynamics”? You may change it to “OC storage variability”.

Line 328: Add “other” before “coastal sediments”.

Line 329: change to “sand, coarse sediments and mixed sediments”.

Line 329-331: The interlamellar area of clay minerals may be more important for OC adsorption (e.g., Kennedy et al., 2002). Just a note.

Line 334-345: Refs.

Line 346: Space “(2024)” and “estimated”.

Line 350: You can also take a look at the bedrock lithology in the study area. If it is dominated by sedimentary rock, significant petrogenic organic carbon associated with coarse fractions may explain the anomaly.

Line 390: Change to “The data collected was…”.

Line 394: The number of observational DBD data is not enough for drawing conclusions without a doubt.

Line 409: There lacks a direct relation between OC storage estimation and management in the main text. Clarification is needed.

Figure 2: The range of color bar is too broad at present. Most OC data is within 0-2%.

Figure 4: Too many plots in one figure. You can consider putting some plots in the Supplement.

Figure 5 and **Figure 6** can be combined into one figure.

Typo

L55: “OC per unit of s area” to “OC per unit of area”.

L201: “RF’s” to “RF”.

References cited

Bianchi, T. S., Cui, X., Blair, N. E., Burdige, D. J., Eglinton, T. I., and Galy, V.: Centers of organic carbon burial and oxidation at the land-ocean interface, Org. Geochem., 115, 14–25, https://doi.org/10.1016/j.orggeochem.2017.09.008 , 2018.

Burdige, D. J.: Preservation of organic matter in marine sediments: controls, mechanisms, and an imbalance in sediment organic carbon budgets?, Chem. Rev., 107, 467–485, https://doi.org/10.1021/cr050347q , 2007.

Hage, S., Romans, B. W., Peploe, T. G. E., Poyatos-Moré, M., Haeri Ardakani, O., Bell, D., Englert, R. G., Kaempfe-Droguett, S. A., Nesbit, P. R., Sherstan, G., Synnott, D. P., and Hubbard, S. M.: High rates of organic carbon burial in submarine deltas maintained on geological timescales, Nat Geosci, 15, 919–924, https://doi.org/10.1038/s41561-022-01048-4, 2022.

Hedges, J. I. and Keil, R. G.: Sedimentary organic matter preservation: an assessment and speculative synthesis, Mar. Chem., 49, 81–115, https://doi.org/10.1016/0304-4203(95)00008-F , 1995.

Kennedy, M. J., Pevear, D. R., and Hill, R. J.: Mineral surface control of organic carbon in black shales, Science, 295, 657–660, https://doi.org/10.1126/science.1066611 , 2002.