We thank Reviewer #1 for taking the time to give their thorough feedback and useful comments on our manuscript. The text in red indicates our response and the proposed modifications to the manuscript.

Reviewer #1:

This manuscript explores factors that affect the carbon dioxide emissions of dredge spoils. There are compelling reasons, including the sheer volume of dredge spoils excavated globally, to pursue this question in terms of global carbon cycling and management strategies. The authors performed an incubation of sediment collected from dredge spoils at the Port of Rotterdam, a location where dredging is a frequent undertaking. They proceeded to compare their results with a meta-analysis of almost 400 incubations, which were also used for machine learning to determine the importance of and interaction between oxygen, moisture, and temperature. Briefly, the authors report that temperature does have an important role, but may taper out between 20 and 35 degrees C where an enzymatic optimum is reached. Oxygen played a significant role in increasing carbon emissions. Moisture was also positively correlated with decomposition where wetter sediment yielded higher respiration rates. Together, this information represents a novel perspective in considering dredge spoils as a source of carbon dioxide to the atmosphere. Moreover, their approach provides important factors for other researchers to consider when preparing similar incubations.

We thank the reviewer for their positive recommendation on our manuscript.

Overall, this manuscript is written clearly. The methods are valid and reproducible. The results are not over-interpreted yet demonstrate their importance. The figures are sufficient, but I recommend including additional information in the Supplemental to list the studies used for meta-analysis.

We will list the studies used for meta-analysis at a more obvious place in the Supplemental Information.

My most substantial comment is to elaborate on the two-pool modeling approach: it is unclear how the proportion of the slow pool and fast pool were attributed. As discussed later in the manuscript, dredge spoils oftentimes consist of older, refractory material and contain only slow-pool OM. How is the portion of each pool determined? If dredge spoils usually constitute the slow-pool, is there any downside to continue using the two-pool model?

The two pools were not assigned based on sediment/soil characteristics. They were estimated by fitting incubation respiration time series to a two-pool first-order decay model. The model partitions OM into pools with different turnover rates (Line 180). We will provide a more detailed explanation of the two-pool model in the revised manuscript.

L38: The sentence beginning “This important…” is missing a word/verb. Perhaps “This is important globally because perturbations of…”

L93: “refrigerator” instead of “fridge”.

L154: bring Sierra et al. Outside of parentheses and only cite the year: Following Sierra et al. (2017), the effects…

L273: meta-analysis instead of meta-study?

Corrections will be made in the revised manuscript.

L116: I encourage the authors to tabulate the sources of data for meta-analysis. Fig S2 is helpful, but it would be helpful to see all the publications used.

We will place the list of used studies after Fig S2.

L160: I agree with the two-pool modeling approach. Could you elaborate more about the initial fractions of the fast pool and slow pool. What if dredge spoils are old sediments and contain mostly the slow pool? This is discussed further on L380-381.

See the response earlier. We will clarify the two-pool model and refine the discussion in the revised manuscript.

L284: can you elaborate more on the mechanism driving this? Is it that microbes are not adapted to temperatures higher than this since they rarely experience it? Do enzymes stop working at these temperatures? It is surprising since I have read of (and conducted myself) experiments that use 20 & 30 or 15 & 25 degrees C for incubation temperatures and measure Q10 of ~2.

We agree that Q10 of ~2 between 20 & 30 °C may be observed in some incubation studies. Our interpretation, however, does not imply that enzymes stop functioning above 20 °C. The flattened trend observed in our fitted temperature function (Figure 3b) likely reflects a combination of processes, including enzyme kinetics approaching their optimal operating range as well as temperature-driven changes in microbial biomass and substrate availability (e.g. shifts from temperature-limited to substrate-limited respiration) (Čapek et al., 2019). We will elaborate these potential mechanisms in the revised manuscript.

L309-317: Interesting about sand content. Could the machine learning be sensitive to this since higher sand content might possess lower carbon content which could possibly be more refractory organic matter, even when standardized to C? In other words, higher sand is just a proxy for low concentrations of refractory OM that yield low decomposition rates?

Thank you for this insightful consideration. We agree that sand content could partially act as a proxy for a lower OM concentration and much of it being refractory, which contributes to the observed decreasing trend in Figure 4a. We will incorporate this in the revised discussion.

L438-439: Wait, I thought anaerobic conditions *decreased* GHG emissions?

Anaerobic environments may reduce CO_2 generation but promote CH_4 production, which has a greater global warming potential. This change may increase the overall greenhouse gas impact even when OM degradation rates are lower under anaerobic conditions. To avoid confusion, we will clarify in the revised manuscript that anaerobic conditions may enhance CH_4 production, rather than stating an increase in greenhouse gas emissions in general.

Reference

Čapek, P., Starke, R., Hofmockel, K. S., Bond-Lamberty, B., & Hess, N. (2019). Apparent temperature sensitivity of soil respiration can result from temperature driven changes in microbial biomass. *Soil Biology and Biochemistry*, *135*, 286–293. https://doi.org/10.1016/j.soilbio.2019.05.016