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Interactive comment on "Functional trait responses to sediment deposition reduce macrofauna-mediated ecosystem functioning in an estuarine mudflat" *by* Sebastiaan Mestdagh et al.

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We wish to thank Anonymous Referee #1 for his thorough and useful comments. We have now revised our manuscript in accordance with the comments raised by the referee. We believe that this revision has substantially improved the quality of the manuscript. Please find below how we have addressed each comment, point by point.

- Referee's comments: 1. Page 3, line 22: I understand that a deposit of fine, cohesive sediment will decrease the supply of dissolved oxygen to the deposit-underlying

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sediment and so decrease the decomposition of organic matter in this sediment with oxygen as electron acceptor. If so, the contribution of anaerobic pathways to the overall decomposition will increase and the upwards diffusing reduced soluble end-products of this decomposition will likely be oxidised with oxygen at the oxic–anoxic boundary somewhere inside the deposit or in the deposit overlying seawater. That is, the re-oxidation of reduced substances (line 24) is not inhibited but simply relocated. Of course, this would not apply for reduced solid phases, but this perhaps needs to be clarified.

2. Page 4, line 5: In my book, bioturbation includes the displacement of particles and the irrigation of burrows. In line 5, it reads 'bioturbation or bio-irrigation', so I assume that the authors do not consider burrow irrigation as a form of bioturbation. Perhaps this needs to be clarified as well.

3. Page 4, line 27. The authors state that their control (T0) did not receive a layer of pre-treated sediment. In line 30, however, they explain that the control did receive a 0.5 cm frozen mud cake, which consisted of pre-treated sediment and luminophores. How did this layer affect the mud–seawater solute exchange and the behaviour of macroinfauna? I feel the authors should discuss this.

4. Page 5, line 3. The deposit was free of organic matter, so its oxygen demand must have been low increasing the penetration of oxygen into the layer. How do the authors know that this deposit 'prohibited (passive) exchange of dissolved oxygen between the sampled community and the water column'? Did you measure the penetration of oxygen into the freshly deposited layers with microelectrodes and did you find the oxic-anoxic boundary somewhere inside the layer? If so, how did the four different deposits (0.5, 1, 2, 5 mm) perform in regard to this penetration?

5. Page 5, line 33. Here, BMU is defined as 'biological-mediated oxygen uptake'. I found this misleading because biological mediated oxygen consumption is also included in estimates of DOU, that is, the consumption by bacterial processes, micro-

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and meio- fauna. I believe that this contribution to the overall sediment oxygen consumption should be termed 'macrofauna mediated oxygen uptake'.

6. Page 8. Please consider moving numbers in parentheses to a table; this would improve the readability of your text.

7. Page 8, line 37. 'biotic-mediated oxygen consumption'. See comment above and please use terms consistently.

8. Page 9, lines 14–28. I recommend moving this section to the introduction, so the discussion starts with your results.

9. Page 9, line 31. Please show the oxygen penetration data in the Results section.

10. Page 23, line 6. 'benthic-mediated oxygen uptake (BMU)'. See comment above and please use terms consistently.

- Authors' response:

1. Indeed, this is correct and we have therefore rephrased this part to clarify better how a physical barrier alters the contribution of anaerobic pathways.

2. Kristensen et al. (2012) proposed to use bioturbation as an umbrella term, incorporating both burrow ventilation and particle reworking. Indeed, burrow ventilation is a mechanism evolved by infauna to enable a constant supply of fresh nutrients and oxygen by pumping overlying water into their burrows, and as a transport process clearly associated with bioturbation. However, since we aimed at disentangling the mechanisms of deposition-induced alteration of SCOC (burrow ventilation, macrofauna respiration or particle mixing into oxic layers) we preferred to distinguish between bioturbation (i.e. particle reworking) and bio-irrigation (i.e. burrow ventilation). We incorporated this rationale in the manuscript.

3. Our objective to disentangle the different mechanisms of altered oxygen consumption necessitated the application of a luminophore-spiked mud cake on all treatments

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(including the control sediments). Without such thin cake on the control, the importance of particle mixing and disturbance of the sediment matrix at the sediment-water interface for deposition-altered functioning would have been impossible to investigate. Moreover, though luminophores are in essence inert particles, the absence of such a luminophore mud cake on the natural sediment in the control could potentially have introduced bias between treatments due to species specific responses to e.g. small modifications in physico-chemistry of the sediment matrix, hence creating an experimental artefact. The high survival and appearance of clear bioturbation signs at the sediment surface, already the day after application of the mud cake in the control (photos are included in Supplementary material Annex 2), indicate that the application of the thin deposit evoked fast migration to the sediment-water interface in the control. However, we do not believe that this thin deposition and subsequent fast disturbance related to benthos migration significantly altered functioning at the longer term, i.e. at the end of the experiment 14 days after addition of the mud cakes. This hypothesis is supported by the high survival but lower bioturbation and bio-irrigation in the control as compared to the T1 treatment. Collectively, this suggests a fast recovery of the sediment-water solute exchange following the deposition of the thin mud cake in the control. Indeed the measured oxygen penetration depth and SCOC in the control are comparable in magnitude to the diffusive and sediment community oxygen fluxes measured in the same habitat and season in previous studies (Van Colen et al. 2012; see manuscript for full reference). We have added this rationale in the revised manuscript.

4. The oxygen penetration depth varied from shallower in the control to deeper below the sediment-water interface in the more extreme deposits (that were largely depleted in organic matter as compared to the control). However, oxygen penetration depth remained restricted to the deposited layer for all treatments. Thus, oxygen did not diffuse below the deposited layers into the natural community. The vertical profiles of oxygen penetration are submitted as supplementary material to the manuscript, to which we now refer in the text (Page 5, line 3; Page 9, line 32; See comment 3).

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5. We agree that the terminology we used was potentially confusing and have therefore followed the suggestion by this referee to change this term to 'macrofauna-mediated oxygen uptake' in the revised version of the manuscript.

6. We have accepted this comment. We now refer to the new Tables 2 and 4 in the revised manuscript which contain the densities of the macrofauna and the results of the statistical test.

7. This inconsistency apparently remained unnoticed by me and the co-authors, and we have now corrected this throughout the revised manuscript.

8. We have adopted this comment.

9. See also reply to comment 4. Oxygen penetration depths are now provided as supplementary material to the manuscript.

10. Complied with this comment; see also reply to comment 7.

- Authors' changes in the manuscript:

Page 3, line 22: "Firstly, the formation of a physical barrier increases the contribution of anaerobic pathways to the overall decomposition and relocates the re-oxidation of reduced solutes upwards (Colden and Lipcius 2015; Hohaia et al. 2014). Under these circumstances, reduced solid phases would only oxidise when sediment reworking or irrigation of large burrows by macrofauna brings them to the oxic layer."

Page 3, line 27: "Though both processes are interrelated and sometimes grouped under the umbrella term 'bioturbation' (Kristensen et al., 2012), we opted to use them as separate concepts, in order to clearly distinguish between particle reworking and solute transfer. Bioturbation and bio-irrigation can be significantly altered under. . ."

Page 4, line 31: ". . . on top of the natural sediment surface. The addition of this mud cake ensured the quantification of particle mixing in these treatments and avoided potential bias between treatments due to species specific responses to the physico-

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chemical environment created by the mud cake. The addition of a luminophore mud cake on top of the sediment surface in the control treatment did not profoundly affect the natural oxygen fluxes or oxygen penetration depth. Our measured values were comparable in magnitude to those of previous studies in the same habitat and season (Van Colen et al. 2012; Annex 1), and clear bioturbation signs on the sediment surface soon after deposition indicate fast migration to the sediment-water interface (Annex 2)."

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2017-417/bg-2017-417-AC1-supplement.pdf

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