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Interactive comment on "Functional classification of bioturbating macrofauna in marine sediments using time-resolved imaging of particle displacement and multivariate analysis" *by* Stina Lindqvist et al.

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Response from the authors to the interactive comment (RC2) on the manuscript "Functional classification of bioturbating macrofauna in marine sediments using time-resolved imaging of particle displacement and multivariate analysis" (#bg-2016-411) by S. Lindqvist et al. for publication in Biogeosciences.

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We thank the reviewer for the comments provided that helped us further improve the revised version of the manuscript. We have to the best of our ability tried to meet the

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comments by for example further clarifying and presenting (i) the concept of functional groups and the experimental approach in the introduction, (ii) the statistical method applied in materials and methods, and (iii) implications of results from the statistical method in the discussion section. We now hope that our manuscript will be accepted for publication as a regular article in Biogeosciences.

Yours sincerely

Stina Lindqvist /on behalf of all authors

Reviewer#2: . . . One of the general strengths of the manuscript is the approach of measuring the effects of infauna on processes first, then using that data to define groups. The authors however miss some of the justification and prior work in this area, that I believe would help support their overall approach, the approach can be highlighted more clearly here by citing Gerino et al. (2003) and another similar perspective from Waldbusser and Marinelli (2009) with regards to functional groupings based on measured effects on processes versus observations of behavior. Along these same lines, I believe the paper could be more impactful if the authors relied on a broader range of literature that has tried to tackle the functional group issue in soft sediment systems (see papers by Pearson, Jumars, Hutchings, and Pearson dating back to the 1970's and up to the 2000's). Let's not forget the work previously done on this general area, and it would be useful for the authors to perhaps couch their functional grouping in the context of prior work as well. Ultimately will be ever have a common functional grouping scheme? Or is it all context dependent? I would also suggest the overall literature cited could be broadened a bit.

Response: We are pleased that our approach to couple definitions of functional groups with measured data is appreciated by the reviewer. As a response to the detailed comments by reviewer#1 we have clarified that the overall aim of the study was to ". . .quantitatively and qualitatively evaluate functionality of benthic macrofauna according to a wide spectrum of experimentally derived variables for particle transport". In

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order to meet the comment by the reviewer related to the issue of further broaden the general concept of functional groups and highlight additional studies in this field, parts of the introduction were revised and additional references (Pearson (2001) and Waldbusser and Marinelli (2009)) added (p.2 l.6-9 and p.2 l.25-28 in the revised version#2). The references Gerino et al (2003) and Fauchald and Jumars (1979) are already cited (p.2 l.15 and e.g. p.11 l.29 in the original version). However, to emphasize previous efforts and approaches to quantify functional behavior of macrofauna, additional implications from e.g. these studies were added to the sections mentioned above.

Reviewer#2: While I appreciate the statistical approach used, as it seems like an important way to let the data do the talking, I have some apprehension about how the PCA was applied, then interpreted, and possibly how well it can be extrapolated to other studies. I don't feel strongly enough to say it is incorrect, but a bit more information on correlated variables within the entire analysis would be helpful. It seems a bit strange to have variables that seem like they would be conveying the same thing, such as the different depths and a maximum penetration depth. It would strengthen the paper if the authors could provide a little more justification for the variable selection criteria, then also, how the variables that seem to come out of the PCA may fit into a broader understanding of the different impacts of infauna on particle displacement.

Response: Text to further clarify the variables used during the PCA analysis has already been added to the revised version of the manuscript and in the response to comments by reviewer #1. To provide basic information on the PCA and correlations within variables as well as to clarify the interpretation of fig.6, text on the statistical presentation was added to the Materials and methods section (2.5 p.6 l.29-34). Additional information on variables was also added to the results section, p.9 l.24-25.

A paragraph on how the PCA analysis may fit into a broader understanding of particle transport by macrofauna was also added to p.10 l.17-19 in the revised version of the manuscript.

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Co-linear variables in the dataset are normally not a problem for a PCA analysis. Quite in contrast, one of the reasons to apply a PCA is to reduce the number of variables and to transform co-linear or co-varying variables to a set of orthogonal principal components. Additional variables with slightly different selectivity often improve the discriminating capacity and robustness of the model. It is quite common to employ this framework to evaluate new or existing sets of variables, or to select the best variables for a specific purpose.

Reviewer#2: The authors recognize that most of the activity occurs within 48 hours of placing the luminophores on the sediment surface. What I cannot determine is whether that activity is included in the broader analysis, or if it is excluded as it represents a bulk sediment deposition event, which can vastly change behavior (see work by D'Andrea and Wheatcroft and also by Lohrer et al.). So, I would recommend that the authors more fully address this issue, as it seems it could be an important effector of their data, and thus possibly the outcomes of the analysis.

Response: Adding luminophores represents a bulk deposition of inorganic particles coated with fluorescent material. As presented by e.g. the 2D redistribution variable, effects on the tracer distribution from reworking were in general most pronounced within the first couple of days. This does not necessarily mean, however, that intensity of faunal reworking was highest during this time period. As observed in e.g. the variable for daily transport, which quantifies the amount ($\approx$ number) of particles relocated over 24 hours (fig. 5), patterns of particle transport by fauna seemed rather constant with time. The temporal effects of luminophore displacements are not directly evaluated as a factor by the PCA model, although individual variables vary with time. The introduction of experimental variables in multivariate analysis to capture temporal effects during investigations of functionality of fauna was considered outside the scope of the present study.

Reviewer#2: Finally, the figures could be perhaps conveyed in a bit more effective way? I also am unclear about the image of the system presented here. Is that a photograph

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that has had some filter applied to it? Why not just present the actual image? Some journals will not allow images that have been altered. If it is a line drawing, wow, the author could also be a graphic artist!

Response: It is from the comments provided difficult to respond and understand exactly how the reviewer thinks we should revise the figures. No changes made.

The image of the experimental system (Fig. 1) is a photograph. It was modified in Adobe Photoshop and Gimp to make the setup clearer. For example, contrast was increased and blurry areas clarified manually. As was also pointed out in the figure captions, it is a schematic overview and not the original image. No changes made in the manuscript.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/bg-2016-411/bg-2016-411-AC2-supplement.pdf

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