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Comment

## ***Interactive comment on* “The influence of hypercapnia and macrofauna on sediment nutrient flux – will ocean acidification affect nutrient exchange?” by H. L. Wood et al.**

**H. Wood**

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Reply to referee #3

The authors wish to thank the reviewer for their comments, which we have addressed below.

Referee: Except for ammonium, a net sediment uptake of the nutrients was observed many times (Fig. 1-3), meaning that the inlet water must have contained nutrients. Without knowing these concentrations it is difficult to fully discuss the observed net sediment-water fluxes.

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The inlet water for every core examined was measured and for an integral part of the nutrient flux calculations, as outlined in the equation shown on P.2393 L.5 and denoted by  $C_i$ - the concentration of nutrient x in the inlet water (P.2393 l.6-7). The above mentioned equation calculates the nutrient flux as a balance of nutrient concentration in core water compared to inlet water, with consideration of flow rate, and core size, and has been utilised in several nutrient flux publications. The authors are confident that this method of calculation enables the full discussion of net sediment-water fluxes.

Referee: The weak impact of the animals was surprising when compared to other studies. Could it be due to starvation, as this suspension feeder was served nothing but filtered sea water for more than 40 days?

While *Amphiura filiformis* is passive suspension feeder it can switch to deposit feeding, collecting food from within the sediment (Ockelmann & Muus, 1978). The animals were adequately spaced in even the highest *A. filiformis* density, and as such the authors do not consider that the study individuals were starved. This belief is further supported by previous work on this species, when the metabolism of individuals kept under the same conditions were measured after 40 days and found to increase. Additionally these earlier individuals also regenerated arms in this time period- which would not fit with the theory that the animals were weak with starvation.

Referee: The complete change of the sediment from a nitrate sink to a nitrate source at the lowest pH (Fig. 2) was the most significant and also a most unexpected result, as nitrification should be the more acid sensitive process (p. 2402, l. 10). To explain that, the authors introduce microphytobentos (MPB) in Discussion as some possibly more sensitive organisms, which at the higher pH values might have masked nitrification by their nitrate assimilation (p. 2400, l. 3-6). In Materials & Methods and in Results, however, there is no indication of any presence and activity of MPB in this experiment!

As is also picked up by the other reviewers the discussion identifies MPB as playing an important role in our results, however, as we state in our response to reviewer 1, we

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have not measured this. We reiterate that while we believe this to be the most probable ‘missing link’ in the explanation of our results, the response of the reviewers highlights that we have placed this explanation too centrally within our findings to the point where it appears as a conclusion of this experiment- and thus requires evidence. We did not measure MPB levels/activity, and unfortunately are not aware of any definitive publications on sediment from the area of this study. We reiterate that MPB is likely to be the missing link from the flux equations that we carried out however we will readdress and restructure the discussion so that this is highlighted as a possible explanation requiring further investigation. We do not feel that this detracts from the important and primary findings of this manuscript, namely the quantification of the role *Amphiura filiformis* plays in sediment nutrient flux, and how this may be impacted by ocean acidification.

Referee: Other much less significant and consistent trends found in the data set - and lacks of expected trends - are discussed in a similar way (p. 2396 – p. 2404).

In this comment the reviewer has highlighted the page numbers of the entire discussion with the broad stroke statement that ‘less significant and consistent trends’ have been discussed in ‘similar ways’. Given the vagueness of this, we presume the reviewer means without the investigation of these factors- as in the earlier referral to microphytobenthos. If so then we strongly disagree with this statement. All trends referred to in the discussion are statistically significant, therefore the phrase ‘less significant’ is meaningless and such judgement can only be made on assessment on the potential biological and ecological implications of these results; which is what we have done.

Furthermore ‘lacks of expected trends’ makes the assumption that trends were expected. We would like to point out that there is painfully little research into the impacts of ocean acidification on sediment-water nutrient fluxes (the only publication known to the authors is Widdicombe & Needham, 2007). These nutrient fluxes are an important process with implications through all trophic levels. We need empirical experimental data to inform and develop ‘expected trends’. It seems short sighted to not consider experimental results just because no expectations have yet been formulated. The pur-

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pose of this manuscript is to characterise the effect of *Amphiura filiformis* on sediment nutrient fluxes, and observe how this is affected by ocean acidification. We believe we have done this and while the conclusions of the work raise more questions than provide answers, this merely highlights the need for further research in this field. We would also make the point that going into a study with an a priori expectation of what the results should be, could inadvertently affect the experimental process itself. Therefore, we would consider it good experimental practice to make no assumptions as to the results or conclusions your study will generate.

Referee: There are simply all too many unmeasured processes at hand which can generate or consume nutrients, and thereby provide an assortment of explanations to the observed net fluxes. The conclusions of the study are therefore weakly supported by the presented data. To reach solid conclusions about the importance of ocean acidification to sediment biogeochemistry it is probably required making experiments which both simulate realistic, complex conditions and monitor single processes and key community members.

As previously mentioned, this manuscript does not purport to characterise sediment biogeochemistry, rather the influence of hypercapnia and macrofauna (namely *Amphiura filiformis*) on sediment fluxes. While we acknowledge a good understanding of nutrient fluxes and the associated processes is a necessity to do this, the focus of this study is on the changes to nutrient fluxes resulting from hypercapnia and *A. filiformis* and their interaction

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**BGD**

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