

Interactive comment on “Patterns of carbon processing at the seafloor: the role of faunal and microbial communities in moderating carbon flows” by C. Woulds et al.

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Reviewer 1 Major Comments:

We would like to thank the reviewer for their thorough review, and for their overall positive opinion.

Reviewer: Carbon processing categorization The discussion 4.5. based on many uncertainty and speculations, and need to remove from the manuscript. The authors proposed the categorization of C processing using data in this study and references. However, there is no mention on how and why authors selected specific time scale of the incubation duration. In Woulds et al. (2009), there were circle graphs of carbon fate

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for both 2 days and 5 days. However, in this paper, only one of them (I guess so) are shown. It is expected that the respired C increases with time (as mentioned in the line 563) while macrofaunal and bacterial ¹³C-label will be respired and decreased. Further, the faunal uptake and bacterial uptake also showed different patterns with time between taxa: for instance, macrofauna responded quicker than foraminifera (Witte et al. 2003, Nature), bacterial assimilation decreased after 1 or 2 days (Middelburg et al. 2000) whereas foraminiferal uptake showed increasing pattern during similar time scale (Moodley et al. 2000). It is thus obvious that the time scale selection is the most important factor to properly categorize the carbon processing. In this manuscript, data from different time scales (hours to 23 days) were combined without description what time scale of incubation was selected in the categorization from several different incubation periods (e.g. Moodley et al. 2002, Witte et al. 2003a, b, Bhuring et al. 2006). Also, there is no discussion on the effect of time scale (except line 563, which mentioned as to explain the irregular pattern of the categorization). I therefore recommend to remove discussion 4.5 from the manuscript and just discuss Loch Etive was macrofauna dominated C processing and Ythan sand flat was bacteria dominated. The manuscript itself can withstand as research paper without the chapter 4.5.

Answer: The reviewer is correct that in the medium and longer term the experiment duration will have an effect on biological C processing pattern, with respiration becoming more important with time (and in the end we might expect C which was incorporated into biomass to be respired as well, such is the nature of a pulse chase experiment). Our manuscript concerns the short-term biological processing of organic carbon, and therefore these longer term fates are not directly relevant to the categorisation. The wording of section 4.5 will be adapted to clarify this. The reviewer is also correct that smaller variations in the relative importance of different pathways tend to be observed within the short term, however this does not lead to problems for our categorisation. The experiments presented in figure 5 range from 6 h to 23 days, with the majority falling in the 1-7 days range (i.e. the single 23 day experiment was the only one longer than 7 days). Therefore the only one which cannot truly be said to represent 'short-

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term' biological C processing is the 23 day experiment (Porcupine Abyssal Plain, Witte et al., 2003b), and this will be excluded. In a few cases experiments were conducted over multiple durations at the same sites. In the case of 5 sites across the Pakistan margin the difference in duration between 2 and 5 days never caused a shift in the category of short term biological C processing (Woulds et al., 2009). Similarly in the Sognefjord the C processing pattern remained in the same category in experiments lasting both 1.5 and 3 days (Witte et al., 2003a). In the German Bight, experiments lasting 0.5 to 1.5 days always showed a bacterial uptake dominated pattern, and bacterial uptake remained equally important as respiration after 5.5 days (Bhuring et al., 2006). Therefore, while we accept that experiment duration does play a role in determining the finer detail of the pattern of biological C processing observed in an experiment, it does not determine the category of C processing pattern within the range of experiment durations included here (and is certainly not the 'most important factor' as the reviewer suggests). The Porcupine Abyssal Plain is the only example of a site where different short-term experiment durations led to different biological C processing categories (Witte et al., 2003b). At this site, where we would expect to see 'respiration dominated' biological C processing, the shortest experiment (60 h) actually showed 'active faunal uptake', with macrofaunal uptake accounting for 26% of biological C processing. All longer experiments showed 'respiration dominated' biological C processing. This site will be removed from the standard categorisation and will instead be discussed alongside the other exceptions. Therefore we feel that the variation in experiment duration between the results does not cause sufficient changes to C processing patterns to invalidate the categorisation, and that therefore section 4.5 and figure 5 should be retained. We will add clarification, and discussion on the effect of experiment duration, and will add a column to table 1 showing experiment duration, so that all details are clearly available.

Reviewer: Differences in light condition. The authors performed the ^{13}C -labeled phytodetritus experiments with and without light (with light: Loch Etive, without light: Ythan sand flat). The authors validate the different conditions because natural environments

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are dark and light conditions, respectively. However, I believe that the incubation with light makes complicated pathways. Without light, the ^{13}C -phytodetritus is incorporated into heterotrophic microbes or eukaryotes, and either assimilated into their biomass or respired as $^{13}\text{CO}_2$. With light, however, the respired $^{13}\text{CO}_2$ can be assimilated into photoautotrophic microbial biomass via photosynthesis. This leads underestimation of respired carbon and overestimation of bacterial assimilation. Without light, chemolithoautotrophic microbes can also cause same process, but the contribution must be smaller than photosynthesis. How much proportion of CO_2 was labeled with ^{13}C ? If the ^{13}C concentrations in CO_2 is almost negligible (few %), then the bacterial assimilation via photosynthesis may also be negligible. This can be calculated from the DIC-d ^{13}C data of the study. Or, if there are literature which investigated bacterial community at this area, then the authors may validate that photoautotrophic bacteria was minor.

Answer: Once again the reviewer is correct that the different light conditions led to a difference in the C flow pathways that were possible in the two experiments. However the different light levels were necessary in order to correctly re-create natural conditions. The labelling level of DIC in the Ythan experiment remained very low throughout (never $1.33 \times$ atom % ^{13}C), therefore the underestimation of respiration due to use of respired DIC by photoautotrophs is negligible, as the reviewer suggests.

Reviewer: Uptake calculation The authors calculated the Carbon uptake by sample with the equation (3), line 253. However, the At% phytodetritus must be subtracted by At% background. I understand that the extent of ^{13}C -label in this study (25% and 34%) are high and the re-calculated values using subtracted value may change only 2 or 3 % (considering 25 become 23.9 and 34 become 32.9). However, the it is necessary to indicate appropriate values as much as possible.

Answer: We do not agree that it is necessary to subtract the natural occurrence of ^{13}C from the labelling level of the phytodetritus when calculating C uptake into the different C pools. It is true that phytodetritus grown without any artificial ^{13}C enrichment would

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indeed have contained a natural amount of ^{13}C , but this does not change the fact that the phytodetritus actually added to our experiments had the labelling levels as measured and reported. Both the 'naturally' present and artificially enriched fractions of the ^{13}C in the phytodetritus serve as tracer, and the only thing that has to be subtracted out is naturally occurring ^{13}C in the sediment system to which the tracer was added.

Specific comments: Minor comments will all be attended to by re-wording, clarification, correction, or addition of detail.

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