

Interactive comment on “Carbon and nitrogen turnover in the Arctic deep sea: in situ benthic community response to diatom and coccolithophorid phytodetritus” by Ulrike Braeckman et al.

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Braeckman and colleagues present the results of in situ experiment in the Arctic deep sea. Global warming is causing shifts in phytoplankton community composition and functioning, with diatoms being replaced by coccolithophores and other phytoplankton groups. This has consequences for the quantity and quality of organic matter exported and reaching the seafloor. The authors have used ^{13}C and ^{15}N labelled phytodetritus from a diatom and a coccolith to trace the (differential) fate and flows of C and N through the entire food web.

Major strengths of this paper are (1) the focus on Arctic deep-sea sediments (few studies so far), (2) the use of in situ techniques at 2500 m water depth, (3) the whole system, comprehensive approach. The authors did a decent job by tracing not only C, but also N, for following C and N not only through food-web compartments (remaining detritus, bacteria and fauna), but also in overlying water and pore-waters. For instance, they quantified nitrogen transfer from phytodetritus via the sedimentary organic matter and fauna pools to ammonium and nitrate in overlying water and pore waters; thus connecting elemental flow biogeochemistry and microbial transformations with food-web processing. In fact, this is among the most complete tracer recovery studies to date, at par with some recent coastal studies.

However, as clearly communicated by the authors, the level of replication is suboptimal. The study is based on two lander deployment, one lasting 4 days and another one lasting 14 days. Each deployment involved three chambers, one control, one diatom and one coccolith treatment. *Sensu stricto* there is no replication. In a world without logistic and financial constraints one would indeed prefer full replication as is now the standard in most in situ coastal studies and ship-board and laboratory studies. However, I do understand and value their approach given the resources available. The experimental design needs to balance the requirement of full replication for standard statistical inference testing on the one hand, with the need for at least some temporal dynamic information (e.g. there was no a priori knowledge about the optimal experimental duration) and the requirement of in situ experimentation to obtain unbiased transfer rates on the other hand. Overall, the benthic community responses after 4 and 14 days of incubation were rather similar (i.e. the basic findings were replicated and controls were similar) although details (e.g. ratio assimilated vs. respired etc.) differed.

Specific remarks:

- _ Line 37: 2.7-2.8 for clarity
- _ Line 45: years phytoplankton blooms became more mixed

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_ Line 59: delete [OM] because you introduce abbreviation again one line lower.

_ Line 83-89: The authors attribute potential differences in response to diatoms vs. coccolith phytodetritus almost entirely to differences in their skeletons (Si vs CaCO₃) ignoring biochemical composition aspects.

_ Line 118: The TOC of algae can never be 78 or 95%, because 100 % organic matter corresponds to 40-50% C depending on biochemical make up. Please correct.

_ Line 122 & 125: TDN: is this indeed total dissolved nitrogen. But was the inorganic nitrogen not removed by washing three times, so that TDN is more or less DON?

_ Line 186: recovered or added labelled phytodetritus?

_ Line 267: Freeze-dried algae were measured for total ¹³C and ¹⁵N, thus for coccolith inorganic and organic carbon were combined Both types of carbon will very likely be similarly enriched given the identical carbon sources. What is unclear though is how much of the ¹³C-DIC attributed to respiration (and recovered in overlying water and pore-water) is from dissolution of the carbonate. Combining ¹⁵N-DIN and ¹³C-DIC release might be give some hints whether ¹³C from carbonate dissolution matters or not.

_ Line 290-296: I do not see the use of these equations. You present all your data in excess ¹³C atom fractions. Why then are equation 4, 5, etc needed (these are copy-pasted from prior work in which δ values were reported). Line 289-296 can be deleted without loss of information.

_ All through try to avoid using on the other hand if there is no on the one hand (I have counted it 3 or 4 times).

_ Line 364:.. after which the increase levelled off. The increase of ¹³C-DIC...was higher and steady.

_ Line 433: was respired (and recovered in overlying water and pore water).

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_ Section 4.1: Cold, deep-sea systems sometimes show a delayed response, i.e. low activities during the first two-three days (e.g. Andersson et al 2008 in Arabian Sea). This is one of the reason why your experimental design (two incubation durations) makes sense. Culturing phytoplankton in the lab followed by freeze-drying before additions might perhaps have resulted in the addition of DOC to your experiment at the seafloor. This really depends on the very details of your phytodetritus preparation. Differences in response among studies in the literature can be partly explained by this. Resolution requires ^{13}C measurement of the DOC pool and that is a daunting task.

_ Line 525: unclear, too cryptic, I understand but will all readers?

_ Line 536: 0.4-1.5% of total nitrification is similar to 0.3-0.4 contribution to sediment ON pool.

_ Line 570-572: an additional/alternative explanation. OM delivered to the sediment surface is far away from microbes in the subsurface. Animals, through their bioturbation, mix OM down and deliver OM to bacteria that do not move. This is another component of the (inverted) sediment microbial loop.

_ Line 588: sediment OM

_ Line 593: the OM leftovers (POC cannot have a C:N ratio).

_ Line 610-618: another reason for non-closure is that ^{15}N in bacteria and $^{13}\text{C}/^{15}\text{N}$ in archaea have not been measured (although the latter might contribute just a minor amount).

_ Line 641: delete p. 201

_ Line 656: We thank. . . . We further thank Anja. . .

_ References: balanced coverage, but I missed the Boetius et al. 2012 note in Science.

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