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Interactive comment on "Downward particle flux and carbon export in the Beaufort Sea, Arctic Ocean; the Malina experiment" *by* J.-C. Miquel et al.

Anonymous Referee #2

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Review of paper "Downward particle flux and carbon export in the Beaufort Sea, Arctic Ocean; the Malina experiment" by Miquel et al.

The MS focus on the downward flux of particles, and their composition during three short time sediment trap studies along the shelf break of the Beaufort Sea, August 2009. The study present interesting data, and the downward particle flux of carbon are of interest and importance to understand the biological carbon pump in this region. So is the mechanisms regulating this export, and the core discussion of this paper focus on the role of zooplankton and their contribution to particle flux through fecal pellets identified from the sediment traps. The results of downward carbon flux are compared with long-time sediment traps studies in the region, to place the present study in a

broader context, and with a discussion of the relative lower flux rates observed from the short time traps.

I find this study of great interest, and especially the comparison with long-time sediment traps results, with identical sediment traps, is of great interest and importance to evaluate results from and comparisons with other studies that most often includes either short or long time studies. This kind of study is rare, but very important. The discussion of zooplankton as flux providers/ modifiers is also important, and there are still not that many studies investigating the fecal pellet composition in sediment traps from Arctic regions that well. The data therefor deserves being published.

There are however some issues I would have liked to see modified, further discussed or commented upon in the text, and recommend the paper for publication with moderate/ major revisions.

Main issues: Language and clarity: The MS is well written, and the figure and tables informative and easy to read. But – I suggest a change for Figure 4- lower panel- It would be more informative if you showed the C/N ratio of the sediment trap material, instead of the PON export. First because the PON flux is never mentioned in the MS, second because the C/N ratio is of interest for interpretation of eventual resuspension impacting the deepest traps, and it takes some more effort to interpret from Table 3.

Title and abstract reflecting content of MS: I suggest the title should be slightly modified to better reflect the strong focus on the role of zooplankton as contributors to flux through fecal pellets in this paper. Both the abstract and the discussion have a emphasis on this rather the overall carbon flux. The abstract is clear and well written, but the last sentence of the abstract, is not discussed in the MS (but could have been to explain the limited role of diatoms, relative to flagellates).

Methods and interpretations appropriate: the methods are appropriate for the aim of this study (given that the aims presented in the introduction is moderated; see comment below). The interpretations are in a few occasions contradicting (see specification

BGD
12, C896–C900, 2015

below), and I miss a comment upon the aspect ratio of the sediment traps, given that the low sedimentation rates obtained. I also have some comments to the fecal pellets quantification, and the discussion on the vertical distribution of fecal pellets versus swimmers found (see specific comments below).

Introduction and aim: well written and nice focusing of story, but the last paragraph presenting the main aim of the study, the authors include aspects like identifying forcing factors of greatest importance to downward particle flux i.e sea ice cover, upwelling events or zooplankton community structure. Only the last factor is discussed in the MS at present. Sea ice cover and upwelling events are not discussed.

Discussion: The discussion focus upon the discrepancy between the long-time and short time sediment traps, and the role of zooplankton (despite more ambitious aims in the introduction, and abstract). This may be a result of shortening of the MS prior to submission (?), but should be coherent with aims and results. It would be useful with some comments on the aspect of seasonality that could explain the minor impact of diatoms (as stated in the abstract), and also that the eventual impact of resuspension for the vertical flux pattern is discussed in light of the C/N ratios provided in the MS. I also miss a more thorough reference to other work regarding the potential producers of fecal pellets, with respect to size. The fecal pellets shown in the pictures (fig 6) are quite large (seen from the scale bar), and should intuitively correspond to large zooplankton, but the authors also suggest small copepods to contribute. Here, the fecal pellet diameter compared to other work could provide more substantial support or arguments in the speculations of origin (see more specific comments with reference to MS below).

Specific comments: p 1251, l 18; an aspect ratio of 2.5 is low compared to recommendation of >3, 5 or 8 dependent on current regime as by JGOF report (1989) to avoid under-trapping of particles. This is not commented upon or discussed, neither in comparison of long- vs short time traps (I am aware they are same type), or in comparison with other studies.

BGD
12, C896–C900, 2015

p 1253, l 10; It would be useful if you provided the actual C-conversion factor to inform the reader, and also provided an argument for why this factor (0.11 mg C mm-3) is chosen, as it is quite high compared to many other C-conversion factors used (Shatova et al. J. Plankton Res. (2012) doi: 10.1093/plankt/fbs053).

p 1256, l 5010 and 20-25: first (line 5-10) you argue that increased flux at depth may be due to resuspension. Further down (line 20-25), C/N ratios from traps ($\sim$7) are discussed and found to indicate presence of phyto-rather than zooplanktonic matter. Table 3 provide that C/N ratio of the deepest traps range 7-7.4 at all stations. This information, together with the fact that you argue for the importance of fecal pellets for vertical flux throughout the discussion chapter, is for me contradicting. It would be informative with a paragraph in the discussion chapter where this aspect is discussed, and maybe also with C/N ranges from the long time traps (if available), to compare the range of variability in this observation with the annual variability. To visualize and support this discussion, figure 4 lower panel, could show C/N ratio instead of PON flux.

p 1257, l 0-10; maybe a paragraph in the discussion could elaborate if the high variability of the long-time traps showed some geographical patterns? They do represent a large area, most likely characterized by different ice and physical conditions, so variability is perhaps not surprising, but these aspects are not commented upon.

p 1258, l 0-12 and 1253 l 5-12; Are all fecal pellets (including fragments) counted, or only intact fecal pellets? From the text it is not clear, but no comments on fragmented pellets are made. Figure 6 b, do however show a fecal pellet fragment that I assume is included, enumerated and converted to carbon. Please specify.

p 1259, l 19-21; this sentence is unclear, and I am not sure what you mean. Please clarify.

p 1262, l 14; should “their” be “the”? reads strange as it is. p 1262, l 15-25; or can fecal pellet fragmentation be more prominent where feeding activities is higher and zooplankton abundances higher (more efficient retention of fecal pellets?) as you also

BGD
12, C896–C900, 2015

discuss based on Honjo et al. 2010 p 1263, line 13. But see also J.T. Turner, Progress in Oceanography 130 (2015) 205–248), Svensen et al. MEPS 516:61-70 (2014) - doi:10.3354/meps10976). p 1263, l 22; from Fig 6 and diameters indicated through the scale bars, I would assume that the fecal pellets origin from quite large zooplankton. Are your discussion of smaller copepods producing elliptical fecal pellets referring to pellets of similar size shown in fig 6c,d (d>100μm), or pellets of different diameter? Yoon et al. 2001 give pteropod fecal pellet diameter of 90μm (elliptical), and Wexels Riser et al. (2008) (Deep-Sea Res II 55: 2320-2329. doi: 10.1016/j.dsr2.2008.05.006) provide diameter of different zooplankton fecal pellets indicating orgin of pellets shown in fig. 6. E.g. 6a could match Calanus hyperboreus (d=94$\pm$), 6b be a euphausiid fecal pellet (d=131$\pm$), and 6d could be from appendicularian (d=257$\pm$). If the authors have information on the fecal pellets of Oncea that could support that this genus produce fecal pellets in the size shown at 6c that would give strength to the discussion of fecal pellet producers.

p 1264; this is a long discussion based on very qualitative observations of fullness, and the discussion of a new producer like Oncea is important or if full appendicularian pellets are able to sink to deeper waters would be more substantial if a better description of Oncea pellet sizes could be provided and matched with sediment trap content. Not only the pellet shape.

Interactive comment on Biogeosciences Discuss., 12, 1247, 2015.

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