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Interactive comment on "A multiproxy approach to understanding the "enhanced" flux of organic matter through the oxygen deficient waters of the Arabian Sea" *by* R. G. Keil et al.

Anonymous Referee #1

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General comments

This study is incredibly ambitious but one that is needed to hopefully entice further studies on why so much organic material is transferred to the deep ocean in oxygen minimum zones. There are quite a few published studies that find this phenomenon but do not investigate what the cause is, so this is a really important piece of work. Most of the comments made are aimed to guide the reader more easily through the study.

1) In the methods it becomes apparent that not all the hypothesized methods (M1-M6) had been directly measured/analysed as part of this study. I would bring this to attention earlier in the abstract and/or introduction so as not to disappoint the reader

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later. However each hypothesized method is valid and interesting, well supported in the introduction and should remain included to stimulate further studies.

2) It's slightly ambitious to have zooplankton and sinking speed methods framed in the same way as methods that were actually measured and analysed. These should be minimized in the introduction and results and just concentrated on in the discussion, as important factors that likely contribute to the low attenuation of flux in OMZs.

3) M4 (mineral protection) and M6 (sinking speeds) should be grouped together as M6 is based solely on the ballast hypothesis. For example M4 = mineral protection that (M4a) reduces remineralisation and (M4b) increases sinking speeds of particles.

4) As with all particle flux studies there are always caveats with the sampling methods but none have been mentioned here. In the methods I would include a brief statement on why you chose to use the nets and what are the pros/cons and any biases associated with using them.

5) No statistical tests have been used to say if any results were significantly higher or lower at station 3 than station 1 and 2. Does this mean the results aren't significantly different or statistical tests couldn't be done?

6) Finally at the end of each of the discussion sections of the different methods, a concluding sentence on whether the data was able to/did prove the hypotheses is needed. This is particularly required at the end of section 4.2, which included a lot of information on different processes and methods and many of the outcomes appeared to be conflicting.

Specific comments

P17053 Lines 11-12: Martin's b describes the rate of attenuation, not the amount of flux. Less decay of material does not necessarily equal less or more flux as the magnitude or amount of flux is not what is being compared. This sentence needs rewording to clarify it's a steeper attenuation of flux or a lower rate of remineralisation that is found

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at OMZs.

P17054 – 17055 Link in the introduction to a new method at the beginning of each paragraph as it currently reads a bit staccato.

P17054 lines 23-24 'When they migrate into the ODZ, they (M3a) deliver dissolved nutrients supporting chemoautotrophy' needs a reference.

P17055 lines 4-6 Also cite Le Moigne et al. (2012) on sinking particles and ballasting.

P17056 lines 24-25 – What was the maximum depth the smaller nets were used for 'shallow' sampling?

P17057 line 6 – What was the depth range the nets were raised through line 14 – Show the equation for the mass flux calculation. line 16 – Specify if it's particulate/dissolved organic carbon and total nitrogen being analyzed.

P17059 lines 13-30 – Explain why particles from just 80 m at station 3 were used in the incubation studies? How did you change the O2 concentrations in the bag to get 4 different concentrations from 0.7-40 μM?

P17060 line 20 – Can you say how much faster (%) sinking particles were remineralised at station 3 compared to the other two stations?

P17062 lines 5-7 – Describe the results of DIC production in incubations bag more fully. lines 22-27 – Put this in the introduction to introduce Martin's b fully to the reader as the 'b' coefficient is a strong part of the results.

P17063 line 9 – Briefly, what reasons were given in these studies to the different 'b' values found at OMZ and oxygenated sites?

P17065 line 5 – What size (m) is a 'typical OMZ'? Reference?

P17066 line 2 – Needs a reference for 'Histones are found only in eukaryote nuclei, not in bacteria or archaea'. line 2 – Are diatoms a dominant part of the phytoplankton in

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this region? Are they exported? Why did you choose to target at diatom histone? lines 19-20 – Are the Csurf:Cbulk at station 3 statistically higher than at other 2 stations?

P17069 line 22 – This seems a big assumption given section 4.2 on chemoautotrophy resulted in conflicting results for the presence of it and Fuchsman et al (2011 & 2012) was cited stating anammox is most likely a water column process. So the addition of ammonium in the water column by zooplankton is not likely to result in the addition of material to particles.

P17070 lines 9-10 – Could the explanation be that zooplankton migrate to surface, oxygenated waters at night to feed and defecate. Therefore when they are shallower than their OMZ aggregation depth, where there is more O2, they can feed on aggregates and their own faecal pellets. When they migrate back to the OMZ they don't feed meaning any faecal pellets that sink into low O2 waters, escape being eaten/remineralised and therefore sink to the deep. In oxygenated waters they don't escape being eaten as deep zooplankton undergoing diel vertical migration have enough O2 to support eating. lines 20-27 – Does the reduction in DIC accumulation rates solely imply reduced remineralisation? Further, the following lines (P17071, lines 1-5) suggest that dust is not the reason for less remineralisation in the OMZ as no aluminium was detected in any sample. Finally the O2 concentrations (40 and 100 uM) are much higher than observed in the core OMZ so don't represent an oxic and OMZ.

P17073 line 8 – The paper by Le Moigne et al 2012 doesn't state that ballasted particles sink faster. It suggests they are transferred to depth more efficiently (low Martin's b, as in the OMZ). However this could be due to mineral protection as this current study suggests. What determines sinking rates of particles is very complex. Other factors are likely to be important such as density of the sea water, degradation rate, size, type of particle e.t.c. As suggested in the general comments I would combine this with M4.

P17074 – Chemoautotrophy (anammox) is a large part of the OMZ model, however as mentioned this process was not confirmed in this study.

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Figure 1 – Write the station numbers (1-3) above the first plot so the readers don't have to work it out themselves.

Reference Le Moigne et al On the proportion of ballast versus non-ballast associated carbon export in the surface ocean, 2012, GRL.

Interactive comment on Biogeosciences Discuss., 12, 17051, 2015.