

Review of the manuscript titled *Particulate barium tracing significant mesopelagic carbon remineralisation in the North Atlantic* by Lemaitre et al. 2017.

Reviewer: Anonymous

General comments

The study traces mesopelagic (100-1000 m) remineralisation of particulate organic carbon (POC) in four different provinces of the North Atlantic using the excess of Barium (Ba_{ex}) as a proxy. This technique has been successfully used to quantify remineralisation in the Southern Ocean, but for the first time applied in the North Atlantic.

The study reveals important regional variations in the magnitude of mesopelagic carbon remineralisation and thus the ability of the North Atlantic to sequester atmospheric CO_2 . Based on the measured Ba_{ex} concentrations, the mesopelagic POC remineralisation is the highest in the sub-polar North Atlantic, while in the temperate North Atlantic more POC sinks below 1000 m depth. This work also shows that in some regions mesopelagic POC remineralisation flux exceeds downward POC flux from the upper ocean, thereby highlighting the significance of the remineralisation for the strength and efficiency of the biological carbon pump.

The authors provide strong supporting arguments and evidence from multiple sources to interpret the major drivers of the observed regional differences in mesopelagic Ba_{ex} inventory and hence POC remineralisation.

- The authors use satellite observations of surface Chl-a concentration over relevant period and areas to demonstrate that intensity and stage of phytoplankton bloom relates to the variability of mesopelagic Ba_{ex} inventory and hence, the magnitude of POC remineralisation.
- By tracking the distribution of the water masses in the sampling region, the authors find that in the subpolar region, the deepening of the mixed layer not only leads to a higher POC supply to depth but also reinforces microbial loop as bacteria have more POC to thrive on. As a result, mesopelagic Ba_{ex} inventory is very high in these regions. The authors also show that at some stations Ba_{ex} peak at depth can be of allochthonous and advected from the regions of high POC remineralisation.
- Finally, the mesopelagic Ba_{ex} inventory was shown to be related to the phytoplankton community structure. Regions dominated by calcifying phytoplankton had smaller Ba_{ex} in the mesopelagic zone (= smaller remineralisation), while diatom-dominated provinces had very large Ba_{ex} between 100-1000 m.

The authors also show that their Ba-derived POC remineralisation fluxes are comparable to the previous records from direct measurements of carbon respiration rates and estimates from sediment trap fluxes. This confirms high quality of the data presented in this study.

The development of the relationship between Ba_{ex} concentrations and oxygen consumption specifically for the North Atlantic expands the application of Ba method for tracing remineralisation and adds significantly to originality and importance of the Lemaitre et al.'s work.

Overall, the manuscript represents a very neat, well-structured, mature piece of work. The sampling and analytical methods implemented are robust, while results, discussion and conclusions are very clearly presented and easy to follow. I recommend the publication of this manuscript in the current

form, although the authors may take up some of my minor suggestion for the final version of the manuscript. Those are listed below:

Lines 87-92: This sentence is too long and therefore confusing. I suggest splitting it into two shorter sentences.

Line 93 and 95: Please state the depth of the upper ocean POC export flux

Line 96: For the transfer efficiency, I suggest to replace 'e.g.' with 'here defined as'; again, please state the depth of upper ocean POC export flux

Lines 228-232: The comparison of the Ba_{ex} inventory at stations 44 and 51 to the GEOSECS Ba_{ex} concentration data would benefit from adding the latter to the respective individual profiles in Figure 5.

Lines 334-336: What are the R^2 and p values for the new relationship between Ba and oxygen consumption with and without station 44? Both R^2 and p values should feature the regression in Figure 8.

Lines 649: Table 3 shows a comparison of Ba_{ex} inventory and related POC remineralisation fluxes in the global ocean. The manuscript will benefit from having MR fluxes plotted on a global map.

Line 705: The legend of Figure 5 should include the reference to the dashed line.

Lines 735-738: The legend of Figure 9 should acknowledge the use of Ocean Data View (Schlitzer et al. 2004).