Interactive comment on "Early season mesopelagic carbon remineralization and transfer efficiency in the naturally iron-fertilized Kerguelen area" by S. H. M. Jacquet et al.

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Dr Jacquet and co-workers report an interesting study variability of the mesopelagic barite in excess along a broad N-S transect in the Kerguelen area, from which they deduce the zonal variability of the POC export. They also performed this study within a meander east of the Kerguelen plateau, transect allowing them to follow the temporal evolution of these oceanic parameters. They eventually compare some of their results (when possible) to earlier data obtained at the same location but at fall, which provides an insight on the seasonal variability of the Baxs distribution, POC export (EP) and their remineralization rate estimate, that they compare to primary production (PP and EP being published in companion papers of the same issue). The set of data is of good quality, the complexity of the area made the interpretation challenging, difficulty which is honorably overcame by the authors. This work deserves to be published in Biogeosciences, but not without some improvements proposed below.

General Comments

Reviewer: The whole paper is based on the use of Baxs as proxy of the POC remineralization, proxy that was well described by many preceding works of the same authors and oth- ers. Indeed, the Baxs mesopelagic maxima is ubiquist; Bishop, Dehairs and others demonstrated that micro-crystals of barite precipitates in biological microenvironments (fecal pellets, aggregates. . .) , and that the release of these micro-crystals yielding the observed maximum corresponds to the disintegration of this biological material, con- comitant to the maximum consumption of oxygen, the latter being related to POC oxi- dation. However, this reasoning and the empirical relationship allowing relating Baxs to POC remineralization is based on one dimensional approach. The Kerguelen plateau is particularly dynamic, and several preceding works discuss (and even propose a modelling, for the Pa/Th distribution, Venchiarutti et al, 2008) the importance of the advection on the fate of Trace Elements and isotopes on the plateau and around. I am concerned by the fact that the impact of advection and internal tides is never dis- cussed in this work. For example, the maximum of Baxs at the reference station is considered only as a remnant signal from a preceding bloom, occurring in late winter. Other works are observing maxima of LSi, particulate Fe, Mn and Al (van de Merwe, Lasbleiz et al) that could be advected from the Leclaire Rise, located 75 km north west of R-2. . .knowing that re-suspended sediments are also enriched in Baxs (as shown in this work at stations A3 for ex) why is the hypothesis of such horizontal transport not discussed here? On the plateau, what is the importance of horizontal versus vertical transport? This should be more deeply considered in the present manuscript.

Reply:
First, to estimate POC remineralization rates we used an algorithm relating Baxs contents to the rate of oxygen consumption that was deduced via a 1-D advection diffusion model applied on highly resolved, precises dissolved O2 profiles along 6°W in the Southern Ocean (Shopova et al., 1995, Dehairs et al., 1997). During the KEOPS 1 cruise, by comparing mesopelagic oxygen consumption rate obtained using the Winkler method and this obtain using Baxs contents and the above-mentioned algorithm, the correlation was significative (R^2=0,90, $p<0.05$). We concluded in the validity of the algorithm in the Kerguelen area. This correlation and discussion about oxygen consumption rate have been added in the ms.
Then, Baxs peak at the K2 reference station is surprising in that in " HNLC / no bloom / low productivity / low export" conditions we observe a signal that we attributed to a previous/ winter production and export event. Nitrate contents and isotopic enrichment also relate an imprint of winter uptake (Dehairs et al., this issue), and low Si:C and Si:N ratios potentially reflect a previous diatoms development (Lableiz et al., this issue), which is consistent with high dissolution rates of BSi in surface (Closset et al., this issue). Both results suggest the occurrence of a winter production and

remineralization event. In Bowie et al., Quéroué et al. and van der Merve et al., (both this issue), authors report that lateral transport of lithogenic matter from the Leclaire Rise (a large seamount located west of station R) would explain local maximum at 500 m depth and deeper, in particulate and dissolved trace metals. This is also corroborated in Lasbleiz et al. (this issue) with LSi data exhibiting a maximum at R station at 500m reflecting particulate lithogenic input. However, the Baxs maximum at K2 is relatively shallower (maximum at 300 m). Also, the size fractions of particles above and below 500 m depths are different at this station. We don't think that the upper 500 m Baxs signal (and maximum at 300 m) could be related to major Ba advection. We can however not exclude the impact of advection on the whole Baxs profile, even if salient Ba peak are not present deeper 500 m. Also, the Baxs was calculated as the difference between total Ba and lithogenic Ba using Al as the lithogenic reference element. During KEOPS2, at most of sites and depths the biogenic Baxs represented >95% of total Ba. At K2, the lithogenic Ba reached up to 20% solely in the upper 80 m.
Concerning station A3 on the Plateau, the lithogenic contribution is relatively important, mainly below 400 m where we observe important Ba and Al peaks. Particles size spectra clearly indicated at A3 sediment resuspension. We mentioned in the ms. that for profiles at station on the plateau, bottom waters with evidence of lithogenic input were not taken into account when calculation DWAv Baxs values. As also reported for station R-2, the lithogenic part at A3 on the Ba signal was minor (expect near the bottom due to sediment resuspension). Concerning the importance of lateral advection on the plateau in setting the Baxs signal, we added a discussion in the ms. (we referred to the work of Venchiarutti et al., 2008 and to Baxs profiles obtained on the plateau during KEOPS 1).

Sentences have been added in paragraphs first mentioned to as 4.1 and 4.2. These paragraphs moved to the results section.

Detailed comments

Reviewer: In the abstract, it should be explicitly written that the "mesopelagic POC remineralisa- tion" reported here is deduced from Baxs proxy: this would be more precise
Reply: Done

Reviewer: -In the introduction and section 3.2, no reference is made to E. Sternberg work, who also demonstrated (with F Morel) that Baxs in the surface water is "scavenged Ba" but not immediately crystallized as barite, and brought some clues on the seasonal "rhythm" of the barite formation by studying a "short time series" in the Mediterranean Sea. This could be added.
Reply: Three references related to the works of E. Sternberg (2005, 2007 and 2008) have been added in the introduction and in section 3.1.

Reviewer:-At the end of the introduction, I found question 1) not clearly written, please explicit better what was this first motivation.
Reply: Question has been reformulated, and explanations have been added in the introduction and section 2.1.

Reviewer:-Sampling and analyses: neither the blanks, nor the reproducibility are given, should be added.
Reply: Details have been added in section 2.2.

Reviewer:--In the result section, the surface maxima observed at E1 and the pic at 100 m at E4-E are not described. Could be done.
Reply: The surface Baxs signal at E1 and E4 has been described (paragraph 3.1)

Reviewer:-Paragraph 4.1: the first sentence is not clear as it is written: the link between "low productivity, low export and highest DWAV is not direct, which appears to be the case at the first reading of the sentence: rephrase.
Reply: the sentence has been revised.

Reviewer:- End of the same paragraph: about the hypothesis of "recurrent winter production" that might explain the R-2 maximum. . .was such phenomena visible and already observed with the satellites?
Reply: We checked Chla satellite image from the Giovani online Visualization and Analysis system (NASA GES DISC). It appears that for different years, the R-2 and KERFIX area could indeed be subject to enhanced productivity during early spring periods, but it is not salient for winter period. The sentence has been revised in the ms.

Reviewer:- Discussion, station in the meander (4.3): I appreciated the evolution of the different ratios considered here, that allows following an interesting temporal evolution of the biogeochemical dynamic in this "recirculation". Fig 5b and the related discussion would be easier to follow if the authors could add an inset to the Fig3, inset showing the full depth profile of Baxs at the stations TNS-6 and E-1 where bathypelagic processes are suspected.
Reply: Fig3h has been added showing the full depth profile of Baxs at TNS6 and E-1 vs. E4-E. Fig3h is referred in the ms in section 3.1 and 4.2.3.

Reviewer:-Table 1: in the date of sampling, the precision "2011" is perhaps not useful
Reply: "2011" has been removed from the dates of sampling.

Reviewer:--Figures: None of the figure proposes a circulation scheme, that could be helpful (in connection with my general comment)
Reply: The two branches of the Fawn trough Current have been added in Fig1a. Sentences have been added in section 2.1.

Reviewer:-In the caption of fig 4: the authors could add "POC, deduced from the Baxs maxima"
Reply: Done