Here below authors' response to the comments of referee#1

Ref #1: There is one issue that I would like the authors to discuss in some more detail. In Fig. 4 the errors indicated for the cumulative flux are very small. Errors in the 234Th/238U ratio (Appendix) show that the error in the depletion at every level is appreciable, in spite of the excellent quality of the data. The error in the cumulative disequilibrium inevitably increases with depth, which makes the application of 234Th tracer at large depths prohibitively inaccurate (see eg Harada in Buesseler et al., 2007 fig. 5.1). I would like the authors to comment on this and indicate how the errors were propagated. And ultimately what errors are associated with their estimates of the residual export at 600m.

According to Ref#1, we have revised our uncertainty budget associated to cumulative fluxes of Th and C. Error in the Th flux for each depth layer considered in the integration were propagated as follow to obtain the error in the cumulative Th flux:

$$u_c(P) = \sqrt{\sum_{i=1}^{n} u_i(P)^2}$$

With $u_i(P)$ the error in the Th export flux for the depth layer i; n the total number of depth layer at integration depth; $u_c(P)$ the error in the cumulative flux at integration depth.

The error in the cumulative C flux (EP) was obtained by combining $u_c(P)$ to the error in the C/Th ratio as follow:

$$u_c(EP) = (EP) \times \sqrt{\left(\frac{u_c(P)}{P}\right)^2 + \left(\frac{u(C/Th)}{C/Th}\right)^2}$$

For surface export fluxes of Th (at 100 m and at Mixed Layer Depth), revised uncertainties ranged from 78 to 214 dpm m^{-2} d^{-1} and were similar to initial values (range: 57 to 131 dpm m^{-2} d^{-1}). For mesopelagic Th flux (100-600 m), revised uncertainties (range 439 – 897 dpm m^{-2} d^{-1}) were higher than previously reported (range: 55 - 368 dpm m^{-2} d^{-1}). As a consequence, the combined errors in the residual Th export at 600 m were also increased and the new range was between 460 and 903 dpm m^{-2} d^{-1}. For the residual C export flux at 600 m, the 95 % confidence interval has changed from 0.3-3.6 mmolC $m^{-2}d^{-1}$ to 0.9 to 5.0 mmolC $m^{-2}d^{-1}$. Uncertainties in the cumulative fluxes of Th and C have been taken into account in the revised version.

Detailed comments:

Ref #1: P 3428 line 18 station locations rather than cruise track. Text updated.

Ref #1: P 3430 line 26 When deep waters were used for calibration, the average value was set at 1, and you only have to give the standard deviation. Average value deleted.

Ref #1: P 3432 eq. 3. check sign in exponent of denominator Line 12 and beyond. Equation updated.

Ref #1: formulation 53»1 _m is not clear. Use a clearer expression to describe the fraction between 1 and 53 _m. Expression changed into 1-53 µm.

Ref #1: Line 22 custom-built? Line 22 plexiglass. Does this not cause possible contamination for POC analyses? The plexiglas punch was rigorously cleaned between filter subsampling. POC concentrations measured on 142 mm QMA filter blanks subsampled with plexiglas punch and 25 mm QMA filter blanks were highly comparable (< 1 µmol) suggesting a negligible contamination source.

Ref #1: P 3435 line 8 where; P 3436 line 2 appear; Line 8 Be consistent in the use of ML or MLD. Refer to Table 1 for the source of MLD. Text updated.

Line 9-12. This description of the latitudinal trend of depletion cannot easily be followed. We updated the description:"To the south, from the Polar Front (PF) at 50.4°S (station L6) to the northern part of the Weddell Gyre (WG) at 57.5°S (station S5), the surface depletion of total ^{234}Th stays relatively comparable with a mean ^{234}Th/^{238}U ratio of 0.82±0.03 (n= 6, station L6) and of 0.85±0.04 (n=7, station S5)."

Ref #1: P 3438 line 12. Partly: what else? "Partly" changed into "that may be"

Ref #1: Line 13 check symbol. Symbol corrected

Ref #1: P 3441 line 5 The parallel Polarstern study at the Zero Meridian did not show a clear latitudinal gradient in POC/234Th ratio, but the Drake Passage section did. We added: "and also across the Drake passage for >50 µm particles (Rutgers van der Loeff et al., 2011)."

Ref #1: Line 19 and 3443 line 11: The Polarstern study used 50_m screens, just like BGH. Size fraction used by the Polarstern study (> 53 µm) was corrected.

Ref #1: P 3443 line 17 Our and their ratios for large particles; Line 23 and beyond. The use of the term "attenuation" with negative values and yet qualifications as: low, high highest is very confusing. We changed negative values into positive values in the text in order to be coherent with the term attenuation and the following qualifications.

Ref #1: P 3444 line 24 to top of 3445. This is a rather repetitive formulation of the relationship between Ba and MLD. We shortened the description to avoid repetition.

Ref #1: P 3445 line 5 can be found down to. Text corrected

Lines 18-21 This paragraph describing figure 10 (not 9) can better be moved altogether to the discussion to prevent repetitions. Text moved to the discussion

Ref #1: P 3447 line 5: the preceding cruise. Text updated

Ref #1: P 3447 Section 4.1.1. is really rather long. This section has been shortened.

Ref #1: P 3449 line 15 and beyond: EP100: use subscript 100 EPML define at first occurrence. Text updated

Ref #1: P 3450 Lines 2-3 define the effect of enhanced nutrient recycling (in the North?) on POC export more explicitly. We updated the text to better describe that enhanced nutrient recycling lowered the POC export in the North.

L 21-24. I cannot follow the logic of this sentence. The sentence "Bearing in mind that NP represents the potential export of both dissolved and particulate material, lower POC export estimated using 234Th approach tends to suggest that POC export efficiency is particularly low throughout the BGH transect." changed into "Bearing in mind that NP represents the potential export of both dissolved and particulate material, the ratio of POC export estimated using ^{234}Th to NP can illustrate the POC export efficiency."

Ref #1: P 3451 line 3-4 either "may indicate" or "appears", not both. Line 26 yields a correlation coefficient. Text updated.

Ref #1: P 3452 "a large fraction is mineralized" or "export production is strongly attenuated. Text updated

Ref #1: Line 28: with by ??. We suppressed "by"

Ref #1: P 3453 line 1 Why would zooplankton migration affect total 234Th distribution? Zooplankton migration may affect 234Th distribution via fecal pellets excretion at mesopelagic depths.

Line 11 has been reported before in the Southern Ocean. Text corrected.

Ref #1: Tables

Table 4: Title: consumption rate; respiration rate

Column 5: these values have a very small range, much smaller than the MLD.

The depth range for Baxs integration could have been chosen differently for each station depending on the shape of Baxs profile. However we chose to use systematically the same depth range 125-600m for the following reason : (i) for the upper layer, we did not have always a sufficient sampling resolution to start from the MLD, (ii) for the deepest layer it was very subjective to choose at which depth the Ba-xs should have been integrated since the signal could have been very close to the background value (iii) the choice of 125-600m allowed direct comparison with remineralisation fluxes from 234Th and capture the entire meso-Baxs maximum

Note a: when the flux is integrated over depth why tell that it was depth-weighted?

We changed footnote of table 4: "meso-Baxs refers to the depth weighted average of Baxs content for the considered depth interval"

Figures

Fig. 7: I think it would be clear to add that the first POC/Th ratio estimate was based on the average from the MLD to 300m. Caption of Figure 7 updated.

Fig. 9. Indicate that the export estimates were based on the 234Th data. Figure caption updated.