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## ***Interactive comment on “Late summer particulate organic carbon export and twilight zone remineralisation in the Atlantic sector of the Southern Ocean” by F. Planchon et al.***

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### General comments

The manuscript of Planchon et al. reports and discusses data of export fluxes and mesopelagic remineralization fluxes (based on  $^{234}\text{Th}$  and Baxs proxies) from a latitudinal transect in the Southern Ocean. The data set is of great quality and interest. The manuscript is very clear and understandable, scientifically sounded and of potential large audience. A great originality of the manuscript is to present and discuss both export and mesopelagic remineralization fluxes leading to the possibility of assessing deep export fluxes in contrasted zones of the Southern Ocean.

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The manuscript could stand as it is (with minor revision). However, I think it can be highly improved in order to rend it more attractive and then to increase its audience. Indeed, the manuscript fails in emphasizing the most interesting messages contained in the data set. This is both because it is too wordy with many detailed of low interest and because the discussion is too much focused on technical issues and not enough focused on deep science. I suggest the manuscript to be 1) shortened and cleaned from superficial information and 2) refocused on C fluxes (production, surface export mesopelagic remineralization, mesopelagic export) and their ratios (export efficiency, sequestration efficiency), and on their controls.

Detailed main comments

Reorganizing the discussion

I suggest the following sections and sub-sections for the discussion:

1. From  $^{234}\text{Th}$  activity to POC export fluxes
  - 1.a neglecting the physics (see my last 'main comment' below)
  - 1.b steady versus non-steady state fluxes (present section 4.1 but one third in size)
  - 1.c POC/ $^{234}\text{Th}$  ratio (present section 4.2 but again one third in size)
2. Surface fluxes (ca. present section 4.3)
3. Mesopelagic POC remineralization (ca. present section 4.4 without the last paragraph)
4. Flux attenuation in the context of seasonal maturity of the system

Section 1 has the advantage to gather all 'technical issues'.

Section 2: in addition to compare EP100 to NP, the comparison with primary production (PP) would be of high interest. As PP was not measured on board, it could be estimated from total N-uptake and C/N ratio (as authors did for estimating NP from nitrate uptake).

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Since the phytoplankton composition was not the same along the ocean section, the C/N ratio used for this conversion may differ from the north to the south (what C/N ratio was used to estimate NP?).

Section 4 would focus on the comparison of PP, EP100 and EP600 at the different stations (or preferentially in latitudinal regions of similar characteristics). Martin's curve may be fitted to the data and its constant 'b' discussed in the context of the biogeochemical and biological functioning of the studied areas (see for instance Buesseler et al., 2007, Science). Seasonal maturity may be of importance in this discussion

#### Shortening the manuscript

There are many occurrences in the ms where the text can be shortened. It would usually help removing unnecessary, well known and/or superficial information and point out useful information. Below are detailed suggestions. Please check and shorten the text throughout the manuscript. This also stands for some figures and tables.

Section 2.2: the method is deeply described in Pike et al (2005). Thus, there is no need to detail it has much as it is. I suggest reducing the second paragraph (page 7, lines 6-18) to few lines (but keeping the third paragraph as it is since you modified this part of the method).

Sections 2.3 and 2.6: these sections can also be shortened since the calculations have been detailed in many previous articles.

Results: this section is very very long. Results are almost exhaustively described and cited. This is not needed. In many occurrence part of the text can be shortened into one or very few sentences. Some examples: page 16, lines 6-22; page 17, lines 6-13 and lines 14-29; page 18, lines 10-17 and lines 20-24; page 19, lines 9-17. Also page 18, lines 29-31, and page 19, lines 1-4: delete these sentences from section Results since it is discussion.

Section 3.3: particulate  $^{234}\text{Th}$  and POC data are only slightly used in the discussion.

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To me, this section and Fig 5 are not needed. I suggest removing them from the ms. Particulate data may be shown as a table in appendix.

Section 4.1: first paragraph: do not repeat the values. Page 21, lines 27-31: delete the text and refer to Fig. 7 and/or Table 1.

Table 2: This table is not needed. Remove it from the ms or place it as an appendix.

Uncertainty and bias associated with assumptions

234Th models: advective and diffusive fluxes are neglected and it is assumed (NSS model) that the two visits sampled a single water mass. This should be at least partly discussed. I'm not really sure that BGD and ANTXXIV really match (please add the longitudes of the stations in Table 1). For instance you can check the salinity of the pairs of visits. I think the attempt of calculating NSS fluxes by using the results from both cruises is a great idea but the potential bias linked to the assumption have to be discuss. Also you can use usual vertical diffusion coefficients (for the Southern Ocean) to calculate potential 234Th vertical diffusion and check if the 234Th export fluxes you have estimated would significantly change (or not).

Uncertainties associated to the NSS fluxes look quite low (table 1). Calculations should be checked.

Other comments

Introduction

Clearly state the aims or objectives of the manuscript.

Section 4.3

Page 23, lines 31-33 and page 23, lines 1-4: it does not mirror plankton abundance but particle abundance. This paragraph does not stand since there is always a strong correlation between POC and particulate 234Th because 234Th adsorb on particles. Delete or deeply reword this paragraph.

**BGD**

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Page 24, lines 19-22: is this negative relationship significant? Cite the p-value.

#### Section 4.4

Page 26, first paragraph: another difference is the time integration. Time scale of  $^{234}\text{Th}$  proxy is ca. one month (for SS fluxes) whereas time scale of Baxs proxy may extend to few months. This should be taken into account in the discussion.

Technical corrections and other details

Page 4, lines 11-13: a ref is needed

Page 4, line 14: replace “under sampled” with “undersampled”

Page 4, lines 25-28: ref needed.

Page 5, line 12: replace “meso pelagic” with “mesopelagic”.

Page 5, line 26: also cite Waples et al 2006.

Page 7, line 8: replace “which” with “that”.

Page 7, line 23: replace “ro” with “to”.

Page 8, line 15 “n=14”: looks contradictory with page 7, lines 1-5; please be consistent or more clear.

Page 10, line 1: what filters (QMA filters?)?

Page 13, line 27: I guess you refer to Table 1.

Page 15, line 21: “annuls” may be better than “cancels”?

Page 18, line 28:  $>70\mu\text{m}$  or  $>50\mu\text{m}$  as indicated on Fig 8.

Page 18, lines 28-29, sentence “Th matching [...] is less clear”: you may insert “even if the latitudinal trend is similar” at the end of the sentence.

Page 20, line 29: replace “3” with “4”.

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Page 25, line 21: replace “height” with “depth”.

Page 26, line 2: also refer to the papers of Cardinal et al. (and others from the same teams)

Tables: indicate in the captions what “STZ”, “PFZ”, etc. stands for.

Table 3, column “NSS model”, first line: add a digit to the numbers.

Figures: check the numbering of Fig 8 to 12 (text + figs and order of citing in the text).

Figure 1: locate the ANTXXIV stations on this fig. Caption: this is not a cruise track.

Figure 2: Please use the same scales for all panels; this will help the reader to compare stations. Add a vertical line to locate the MLD. Indicate what hatched and dotted areas stand for. I suggest the hatched area to be extended also for 234Th deficit.

Figure 3: indicate in the caption what vertical lines stand for (I guess fronts). Please locate the MLD as a line. Panel a: why this section does not extent down to 1000m? It should.

Figure 5: not really needed. I suggest replacing it by a table in appendix.

Figure 7: no needed since the data are reported in Table 3. There is no need to show the data from other cruises since they are cited in the text (and the fig. is not exhaustive).

Figure 9: This fig. is not illustrative: only the numbers are informative. A figure like Fig. 8 should be preferred.

Fig. 12: again, I find this figure not very informative. I suggest a figure of panels (one panel per station or zone). Each panel reports fluxes versus depth. Fluxes are NP (or primary production; see above), EP100 and EP600.

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