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Interactive comment on "Carbon export in the naturally iron-fertilized Kerguelen area of the Southern Ocean based on the ^{234}Th approach" *by* F. Planchon et al.

Anonymous Referee #2

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This manuscript is a description of 234Th-derived carbon export in the region of the annual bloom observed near the Kerguelen Plateau. The work was part of the KEOPS2 project (2011), which followed up on the original work of the KEOPS project (2005). A major goal of KEOPS2 was to observe the conditions of the bloom early in the season, so as to offer comparison to KEOPS observations that were made later in the season. The general sampling strategy is to compare carbon export in a productive bloom region against a control region of low productivity non-bloom region.

The authors state the aims of this study at the end of the introduction and at the start of the discussion:

"Upper-ocean 234Th and carbon export obtained in HNLC and Fe-enriched waters were used to assess the impact of natural fertilization on the vertical transfer of carbon."

"The principal aim of this study was to estimate how natural Fe fertilization affects carbon export at high productivity sites over and off plateau during the early stages of the bloom."

The results presented show that export in the bloom region was variable in magnitude but generally higher than the reference non-bloom station. Greatest export was measured at the E stations located south of the permanent meander of the polar front. Variability in the ThE ratio was also observed with low ThE ratios at high productivity sites (A3 and F-L) suggesting that the accumulation of biomass was not mirrored with high export, and high ThE ratios at the low productivity site (R). Temporal variability in the ThE ratio was seen at repeat occupations of station E. This variability is not surprising and is another good example of the decoupling of production and export that either results from real ecosystem dynamics or methodological miss-matches in the measurements (24h production measurements vs $\approx$1 month 234Th export proxy). Therefore the authors should use the ThE ratios with caution when drawing conclusions and should clearly highlight the methodological limitations and possible ways of validating the ThE ratios such as using integrated new production.

On balance, the manuscript is well written and contains a high quality set of 234Th-derived export measurements in the Southern Ocean that deserve publication. Unfortunately, the manuscript falls short of addressing the aims of demonstrating how Fe fertilization affects carbon export and its vertical transfer. However, the data presented does build a solid foundation for future work to address these aims. In order to show how Fe fertilization affects and carbon export there needs to be an assessment of both carbon export and Fe supply. The former is contained within the manuscript, whereas the latter is not. The only reference to Fe data is a single cited value of Queroue et al., 2014, which is not in the references. Therefore the authors need to be mindful of how the aims and conclusion are stated so as to be reflective of the results presented (e.g.

page 15998, lines 2-4; page 16007, lines 22-24; page 16015, line 19; page 16017, line 11).

With regards to assessing the impact of the vertical transfer of carbon I see little discussion on this aim, unless the authors are using this term interchangeably with the ThE ratio. However, there is a good opportunity to assess the vertical transfer of carbon if an assessment of carbon export through the different depth horizons is made (100, 150 and 200 m). A similar approach of Ref 1 could be used to do this and it would make a good addition to the manuscript.

Overall, I recommend this manuscript for publication after minor revisions have been made after considering the comments above and the detailed comments below.

General comments

The authors use a myriad of terms to describe their fluxes and exports for 234Th and carbon that make the text hard to read in parts and could easily confuse a reader not completely familiar with the subject area (234Th export, 234Th flux, 234Th export flux, carbon export, particle export, POC export, POC flux, POC export flux, POC export production, export production, carbon export production). The text will benefit greatly by using a set of succinct standardized terms that are defined early on and used consistently throughout the manuscript.

The rationale and reasons for using the various fixed integration depths should be described. Recent work (Ref 2) has shown that a variable integration depth based on fluorescence may be a more appropriate way to integrate 234Th.

The manuscript would benefit by removing most of the details relating to the transects, including the transect data in Table 1 and Fig 2. This part of the manuscript comes across as a side-story that doesn't significantly contribute to the discussion on carbon export. If the authors wish to publish the transect data it could be placed supplementary material.

Detailed comments

Abstract:

The abstract is in excess of 600 words and is too long. The abstract needs to be considerably shortened.

Introduction:

The introduction provides a thorough background of the subject area but requires the addition of Ref 3 (page 15996, line 6).

Material and method:

This section is well written and contains a good amount of detail.

The transects are not shown on Fig 1. The reference station R does not show the station name referred to in the text (R-2) whereas as all the other stations are shown in this way on Fig 1.

2.2 (page 16000, line 8-9) Are filters for total 234Th samples also covered in Mylar and Al foil when mounted in the Riso sample mounts? This was specified for particulate 234Th samples but not for total 234Th samples.

2.3 (page 16001): Consideration was given to the impact of vertical transport of 234Th when assessing the suitability of models to calculate the 234Th budget. However, no consideration was given to horizontal fluxes of 234Th and should be addressed. To address this, the authors may consider the residence time of water passing through the study area or consider horizontal mixing rates, the necessary information may be found in Refs 4 & 5 or in a manuscript of the KEOPS2 special issue.

Results:

The description of the results follows a systematic approach and addresses each distinct sampling region in turn.

3.1 (page 16004, line15) This statement requires a reference, Ref 6 is a good option or some of the earlier 234Th modelling work cited therein.

Discussion:

4.1 (page 16009, line 1) It is unclear to what the value of 11.2 mmol m-2 d-1 is referring to (export or production), please clarify.

4.2 (page 16011, lines 3-4) The CROZEX values require a reference to the Morris et al (2007) CROZEX paper already cited in the manuscript.

4.3 (page 16012, line 9) The value of 5.5 mmol m-2 d-1 requires a reference to its origin.

4.4 (page 16013, line 26) I disagree with the statement that describes export as "decreased progressively", export decreases and then increases.

4.4 (page 16014, line 16) As above, I disagree with the statement on that describes the C:Th ratio as "decreasing progressively", the C:Th ratio decreases and then increases.

4.4 (page 16014, line 28) Where the authors refer to the "export depth" are they referring to depth at which 234Th reaches equilibrium with 238U? The use of the term "Export depth" here is ambiguous.

4.4 (page 16015, line 19) Please revise this statement to better reflect the results of the work reported. See my earlier comments.

References:

1. Buesseler et al (2007) Science, 316, 567-570

2. Owens et al (2015) Deep-Sea Research II in press, doi:10.1016/j.dsr2.2014.11.010

3. Morris & Charette (2013) Deep-Sea Research II, 90, 147-157

4. Park et al (2008) Deep-Sea Research II, 55, 582-593

5. van Beek (2008) Deep-Sea Research II, 55, 622-637

6. Rutgers van der Loeff et al (1997) Deep-Sea Research II, 44, 457-478

Interactive comment on Biogeosciences Discuss., 11, 15991, 2014.