

Interactive comment on “Insignificant enhancement of export flux in the highly productive Subtropical Front, east of New Zealand: a high resolution study of particle export fluxes based on ^{234}Th : ^{238}U disequilibria” by K. Zhou et al.

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Response to L.Miller (Referee)

General comments: This paper presents a nice, thorough little study that provides very useful insight into a pressing question about the extent to which carbon export is decoupled from iron-fertilized primary production. I think the paper requires only minor modification before publication: mainly, some details just need to be clarified to make it easier to compare these results with those of others.

Response: We appreciate the positive comments from the reviewer. Suggested clarifications have been made in our revision.

Detailed comments:

Although overall, the paper is very well written in English that is clear and accurate, in places, some peculiar syntax does sneak into the manuscript, and I encourage the New Zealander co-authors to use a heavier hand in editing the paper.

Response: We have undertaken such a review (by S. Nodder), following the reviewer's suggestion.

I encourage the authors to report their radioactivity values in the proper SI units of mBq, instead of dpm. To aid readers' mental comparison with the literature, the values in dpm can be included in parentheses after the most important and/or significant values, but the use of dpm is anachronistic.

Response: Accepted. We have adopted mBq as our standard unit for radioactivity values.

Make it very clear throughout the paper what salinity scale was used (presumably the practical scale, PSU?). With the recent change in the standard salinity scale, it is extremely important to explicitly state what scale has been used.

Response: We used the practical salinity scale, which does not have any units (see Millero, 1996).

Explain what the uncertainties on the average values reported in the text are and how they were determined. The values given don't agree with the direct standard deviations or standard errors of the averages or with the propagated errors from those on the individual values that went into the averages.

Response: The uncertainties on the average values reported in the text were determined by averaging the propagated errors from those on the individual values. Every single uncertainty on the average values has been double-checked and revised accordingly and a statement has been added to the text as “The uncertainties of the average values in this study were determined by averaging the propagated errors from those on individual values”.

Abstract: Page 9536, line 13: these flux numbers appear to have too many significant figures, which contradict the assertion that the values are essentially the same. Reduce the number of significant figures reported and possibly also include the uncertainty (ies) in the values.

Response: Accepted. We have reduced the significant figures of our ^{234}Th fluxes to two decimals. Also we have included the uncertainties in the values.

–, line 15: specify that it was 'The derived POC flux...' that was not enhanced.

Response: Revised.

Introduction: Adding a hemispherical map of the entire Southern Ocean (including the approximate location of the subtropical front all the way around) to Figure 1 and introducing it in the first paragraph would help readers follow the introduction.

Response: Accepted. We have reduced the significant figures of our ^{234}Th fluxes to two decimal places. Also we have included the uncertainties with these values.

Figure 1: Explicitly identify Chatham Rise on the map.

Response: Accepted.

The red circles are hard to see. It might help to make the station numbers black. They are also difficult to read and should be bigger.

Response: We have removed the red circles as suggested and changed the station numbers into black for high salinity stations, and blue for low salinity stations. All station labels have been enlarged.

The axis and scale labels are too small and difficult to read. (also for Figures 3, 4, 5, 6, and 9)

Response: The axis and scale labels have been modified in Figures 1, 3, 4, 5, 6, and 9.

Methods: Th-234 analysis: Specify what the reported uncertainties on the Th-234 numbers are – are they based only on the counting errors, or do they also include the uncertainties in the tracer recovery analyses, the variability in the filter blanks, etc.?

Response: The errors on the Th-234 numbers are based on the error propagation from the first counts, background counts and recovery analysis. To this end, a statement has been added to the text in the Methods section that states “The errors associated with ^{234}Th activities are propagated results based on the counting errors from the first counts, background measurements and total recovery analyses”.

Other ancillary parameters: Specify what the fluorescence numbers are and in what units they're reported. Even if they're uncalibrated data from the CTD, make that clear and indicate that the numbers are in volts. If they're some sort of unitless ratio, that means they've been normalized to something, and that needs to be explained. Later, on page 9542, the Results section explains that the fluorescence signal was calibrated against chlorophyll, but there's nothing in the methods section explaining how chlorophyll was measured, and it appears to be the raw fluorescence data that are shown in figure 4 – if the fluorescence data were actually calibrated against chlorophyll

measurements, the results would be reported in chlorophyll units. Perhaps the authors don't actually mean 'calibrated' on line 10 of page 9542, but rather just mean to say that the fluorescence signal from the CTD correlated well with the discrete chlorophyll samples.

Response:

- 1) The fluorescence values were uncalibrated data from the CTD and the units are in milliVolts (mV).
- 2) A paragraph on the measurement of Chlorophyll *a* (Chl-*a*) in the Methods Section has been added.
- 3) The reviewer is correct that we actually just said that "fluorescence signal from the CTD correlated well with the discrete chlorophyll samples". To convert the CTD fluorescence into Chl-*a* concentration, a linear relationship between fluorescence and Chl-*a* ($\text{Chl-}a \text{ } (\mu\text{g l}^{-1}) = 0.639 \times \text{Fluorescence}$, $R^2=0.87$, $n=50$) has been applied. The units of Chl-*a* are now in " $\mu\text{g l}^{-1}$ ".

Results: Page 9542, line 7: Saying that the mixed layer depth was 'higher' is ambiguous. Just say that the mixed layer was deeper at the high-salinity stations....

Response: Revised.

–, lines 13-4: The fluorescence signal is not homogeneously distributed within the surface mixed layer at station C15.

Response: Agreed. The text has been changed accordingly to indicate that fluorescence/Chl-*a* was in general higher in the upper mixed layer at all stations than it was below this depth.

–, lines 15-20: This description of the variations in fluorescence is very difficult to understand, with apparently contradictory statements. At the least, this section needs to be reworked to be clearer and simpler, but perhaps this much detail isn't required, since the fluorescence data are shown in the figures (i.e., Figure 6d could be separated out and moved up earlier – which should be done, anyway, since that figure is being used as the basis for the water mass classifications).

Response: We have moved Figure 6d up to Figure 2b, and have indicated in the text that fluorescence/Chl-*a* is elevated in the waters with salinities of $34.5 < S < 34.8$.

–, lines 25-6: '... POC distributions generally followed those of fluorescence...;' also, note that in that sentence 'its' refers back to 'fluorescence,' not 'POC.'

Response: Revised.

Figure 4: It would help follow the story, if the stations were identified as SAW, STF, and STW directly on this figure.

Response: We have grouped the stations into three types of waters, ie. high, mid and low salinity waters on Figure 4. Note that all of the stations are within the Subtropical Front (STF).

Table 1: Include the specific dates for each station.

Response: Revised.

The uncertainties in the U-238 and POC measurements need to be included also.

Response: Uncertainties of 3% and 10% have been ascribed to ^{238}U and POC, respectively, and they have also been included in the calculation of ^{234}Th flux, C/Th ratio, and POC flux.

Be consistent with reporting the data to either 1 or 2 digits in the uncertainties – you have the particulate Th and Th:U ratio with 1 uncertain figure, but the total Th and the fluxes with 2 uncertain figures. Personally, I prefer for data to be reported with 2 uncertain figures, because that allows others to do calculations on the data without accumulating additional errors.

Response: We have used 2 uncertain figures for our radioactive data and the uncertainties.

Page 9543, line 14: Make sure the number of significant figures matches between the values and their uncertainties.

Response: Agreed. See response above.

–, lines 17-8: Only station C11 in figure 4 shows total Th-234 to be homogeneous in the surface mixed layer.

Response: We have changed the text to state that “Th-234 was lowest within the isothermal mixed layer”.

Equation 2: The way the reference is placed in this sentence implies that equation 2 came directly out of the Buesseler et al., 1992 paper, which it didn't. Because the derivation of that equation isn't intuitively obvious, the actual derivation needs to be either referenced or explained in more detail here.

Response: Equation 2 has been replaced with the one from Buesseler et al. (1992).

Figure 7: Give the actual dates for each station sampling in the caption.

Response: Revised.

Table 2: Too many significant figures are reported for the Th flux results.

Response: Reduced into 2 significant figures.

Uncertainties (variabilities) in the POC and fluorescence values are needed.

Response: Uncertainties for fluorescence and POC have been added.

A concentration quantity (as opposed to a flux) at a given depth would not be in units of m^{-2} . I assume that those are actually integrated inventories, in which case, the column labels should be, for example: POC, 0-100 m.

Response: The reviewer was correct that those are depth-integrated inventories. We have changed the table column labels to read “POC, 0-100m”, “Part. ^{234}Th , 0-100m” and “Chl-*a*, 0-100m”.

Footnote 'b' makes no sense – if Th-234 were in equilibrium with U-238, the flux would just be 0. The calculation actually done needs to be explained better.

Response: A better explanation has been given below:

For those stations where $Ez > 100$ m, ^{234}Th was assumed to be in equilibrium with dissolved ^{238}U at the base of the Ez since most of the stations were only sampled within the upper 100 m. ^{234}Th flux was then integrated down to the base of the Ez .

Page 9547, 1st paragraph: Too many significant figures are reported on almost all of those numbers.

Response: Reduced to 2 significant figures.

–, line 25: Table 1, not 2.

Response: Revised.

Discussion:

Page 9549, line 15: Replace first comma with a period.

Response: Comma replaced.

Table 3: Emphasize which P values are significant and which are not.

Response: We have added a column with Significance “Yes or No”.

References:

There are a lot of errors in the references. Only a few of the errors would make it difficult for a human to find the paper, but many would cause a search by a computer to fail.

Response: All the references have been carefully checked and all the errors corrected.

The most prevalent error is in the authors' initials: too many, not enough, or just the wrong ones. It is important that the authors' initials exactly match those used in the specific paper cited, so that citation index searches can find them.

Response: Author's initials in the reference list have been checked carefully and corrected accordingly.

For both Limnology and Oceanography and Aquatic Microbial Ecology, it's useful to include the issue numbers, because of the way the web sites are organized.

Response: Issue numbers have been added for references from journals Limnology and Oceanography and Aquatic Microbial Ecology.

Michiel Rutgers van der Loeff's name is presented wrong in every reference in which he not the first author. That is, it should be, for example, Rutgers van der Loeff, M.M., not Van der Loeff, M.M.R.

Response: Corrected.

Special characters are often left out of peoples' names, but should be included.

Response: Special characters have been checked and corrected.

Volume numbers needed: Buesseler et al., 1992; Kawakami et al.

Response: Volume numbers added for these two references.

Errors in titles: Nodder et al., 1998b; Orsi et al.; Probert et al.

Response: Errors corrected for these references.

Errors in page numbers: Pollard et al.; Redfield et al.; Rutgers van der Loeff, 2002

Response: Page numbers changed for these references

Comiso et al.: title doesn't include hyphens.

Response: Hyphens in this reference title have been removed.

Kara et al. has the wrong title.

Response: Title corrected.

Nodder et al., 1998a: that's Deep-Sea Research I, not II.

Response: Revised

References

Buesseler, K. O., Bacon, M. P., Cochran, J. K., and Livingston, H. D.: Carbon and nitrogen export during the JGOFS North Atlantic bloom experiment estimated from ^{234}Th : ^{238}U disequilibria, *Deep Sea Res.*, 39, 1115-1137, 1992.

Millero, F. J. (Ed.): *Chemical Oceanography*, CRC press, Florida, USA, 1996.