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Discussions

Interactive comment on "Isotopic fractionation of carbon during uptake by phytoplankton across the South Atlantic subtropical convergence" *by* Robyn E. Tuerena et al.

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Response to reviewer 2. We thank the reviewer for their time in completing this review, we believe that their input will help greatly improve the manuscript. Here we include responses to all of the comments: (1) Reviewer's comment (2) Author's comment (3) Suggested change to manuscript

(1) This is an interesting paper looking at the variability in carbon isotope (and fractionation) of particulate organic matter (with CO2aq) in relation to phytoplankton cell size. The authors sampled subantarctic and subtropical regimes with contrasting environments and community structures to investigate mechanisms for isotopic fractionation in

d13CPOC resulting from carbon uptake and biological production in the upper ocean. The authors suggest that cell size is an important factor. Using estimates of cell size (via HPLC analyses) and calculated CO2aq, the authors suggest that smaller cells will respond less to increased CO2aq than the larger cells south of the SSTC and the wider Southern Ocean.

Query: when looking at investigating future epsilon-p did the authors consider the combined effect of increased CO2 and increased temperature in the two environments?

(2) We refer to our response to reviewer 1, which describes the expected changes to temperature as well as CO2 increases (the temperature increases would have a much lesser effect than CO2 increases and a decrease in cell size).

'Although an increase in temperature in the Figure 9 shows an increase in δ13CPOC and a decrease in ep, this will have very little effect compared to the predicted changes in carbon availability and cell size. To give an example:

A 2degC change in SST from 14 to 16degC would increase δ13CPOC from -23.9‰ to - 23.3‰ which is the predicted change over 200yrs (IPCC). Over this time period atmospheric CO2 would increase from pre-industrial to 500ppm which would decrease δ13CPOC to -26‰ (at 14degC) and -25.5‰ (at 16degC). Decreasing cell radius from 10um to 8um would decrease δ13CPOC further to -27‰ (14degC) and -26.5‰ (16degC).

Therefore a 2degC increase in SST with the expected rise in atmospheric CO2 would decrease δ13CPOC from -23.9‰ to -25.5‰ and would decrease further if the average cell size decreased.'

In the revised version, we will include a statement to address the effects of both CO2 and temperature.

(1) General point about Figures, it is very hard to deduce where measurements were taken in the profiles and also which interpolations were used to create the profiles.

(2) We have edited Figures 1 and 4 to have more visible points in the profiles (larger point size). The interpolation for these figures has been made using ODV and the weighted average gridding (x, y spacing determined by profile spacing). Information about this has now been included into the captions.

(1) Initial thoughts while starting to read the manuscripts were: 'but what about species composition'? This really only gets dealt with in the discussion. It would be good to see this upfront, including a small discussion about cell size on its own (so possibly discussing culture studies) actually supports what the authors conclude.

(2) We will provide a paragraph in the manuscript introduction regarding species composition and we will refer to Figures 4 and 5 in Browning et al., 2014, which include the contribution of major accessory pigments to total accessory pigments.

(1) Introduction: Second sentence: missing a bit; anthropogenic CO2 input to the atmosphere causes enhanced greenhouse gasses, which causes the oceans to warm up. It is not a direct effect.

(2) Sentence changed to:

(3) Anthropogenic carbon inputs and the increase of greenhouse gases in the atmosphere are causing ocean warming (Cheng et al., 2019), changes to upper ocean stratification (Bopp et al., 2001; Capotondi et al., 2012) and altered distributions of nutrients and carbon (Khatiwala et al., 2013; Quay et al., 2003; Gruber et al., 2019).

(1) Methods: A bit strange to see details of where the inorganic carbon isotopes where analysed, but none of the other analyses.

(2) We agree with the reviewer and have removed 'University of Cambridge' from the manuscript. Sentence now reads: (3) Samples were measured using a Thermo MAT253 stable isotope mass spectrometer.

(1) Results: 3.1 first para. In reference to Figure 1, what does MC stand for?

(2) Sentence changed to: (3) The three subtropical water masses (Agulhas Current (AC), South Atlantic Central Water (SACW) and Brazil Current (BC)) can be readily identified with warmer temperatures and higher salinities, the influence of the Malvinas Current (MC) separates the core of the SACW and BC (Figure 1).

(1) Figure 1 does not show a correlation between various variables, just cross sections.

(2) Sentence has been edited to read:

(3) Across the zonal transect, higher δ13CCO2 is associated with lower [CO2(aq)] and warmer temperatures of the subtropical water masses (Figure 1).

(1) 3.2 Para 3 'There is no significant correlation between d13CPOC and CO2aq or d13CCO2 (Fig 2)' where? Subtropical samples?

(2) Sentence has been edited to read:

(3) There are no significant correlations between δ13CPOC and [CO2(aq)] or δ13CCO2 in the subtropical or subantarctic water masses (Figure 2, $p>0.05$).

(1) Para 4 Statement: Picoplankton were dominant in the subtropical environments. NO. This figure suggests that fmicro and fnano are dominant in all environments.

(2) We thank the reviewer for highlighting this error in our wording and have changed the sentence accordingly:

(3) Picophytoplankton were more abundant in the subtropical environments in comparison to the SASW, contributing between 30-40% of the pigment biomass at the core of these water masses (Figure 4).

(1) The authors claim there is a significant positive correlation between average community cell radius and d13CPOC, with n=30. There are 47 data points in Figure 6a; in Figure 6b 4 are attributed to being coastal sites. What happened to the missing 13 data points?

(2) There is less data in Figure 6b as we did not have corresponding cell size data for all of the d13C-POC data points, to inform the reader, this information has been added to the figure caption.

(1) Page 7: with to first sentence and reference to Figure 5: what is the average error and is the suggested difference supported by statistics?

(2) In general there is no significant difference between the two water masses when you take the definitions of >14 and <14C for subtropical and subantarctic (south and north of the SSTC), as there is the convergence and mixing of water masses in this region. The large errors associated with the average cell radii can arise from the variation at the DCM of the subtropical water masses (larger size cells) and the variability from the mixing of water masses and thus different nutrient requirements. If we use only the cores of each of the surface water masses and discount the variability at the DCM, then there is a significant difference (Subtropical >20C 6.5 $\pm$0.8, n17, Subantarctic<18C 10.4 $\pm$2.3 n31). Because of this ambiguity, we change the wording accordingly:

(3) Estimated average cell radii were generally smaller at the core of the subtropical water masses compared to the SASW (Figure 5) (depth range <40m, subtropical >20C 6.5um $\pm$0.8, n17, subantarctic<18C 10.4um $\pm$2.3 n31).

(1) Discussion: add some references when discussing the used of stable isotopes of organic matter as a primary means for examining food web structure and variability. Plus also to line 32-33 (nitrogen isotopes).

(2) This is a valuable comment and extra references will be added to the revised version of the manuscript.

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