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Biogeosciences Discussions

Interactive comment on "Nutrient availability and the ultimate control of the biological carbon pump in the Western Tropical South Pacific Ocean" *by* Thierry Moutin et al.

Anonymous Referee #3

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Moutin et al.'s study investigates the regulation of the ocean C, N and P fluxes in the western tropical South Pacific Ocean, a key oligotrophic oceanic region for nitrogen fixation. They combine a large new dataset collected during the OUTPACE campaign (February-April 2015) with climatologies of upper water properties. The OUTPACE cruise followed a 4000 km longitudinal transect going from the Melanesian Archipelago (MA) to Papeete (French Polynesia). Comparing seasonal trends of C, N, and P mass balances for 3 main areas of the WTSP, they find that (1) the MA is a net sink of atmospheric CO2, mainly caused by the soft-tissue biological pump; (2) the MA biological pump results from both high rate of N2 fixation fuelling export production and mesozooplankton diel vertical migration; and (3) MA N2 fixation is essentially controlled by

phosphate availability.

I think the tackled questions and presented results of this study are really interesting and important and deserve publication. There are lots of uncertainties on the role of nitrogen fixers in fuelling ocean production and export in oligotrophic area especially of the Pacific Ocean due to lack of observations. This region is particular important as covering a large area and presenting high rates of N2 fixation. I thus strongly recommend this work for publication. I have however the following main comments that need to be taken into consideration.

Main comments

Paper presentation - At the moment the results and the argument for the role of nitrogen fixation and mesozooplankton vertical migration for the atmospheric CO2 sink of the Melanesian Archipelago region are a bit convoluted. While it is nice to follow the steps of thought of the authors on how they come about to find these links, this is done a step too far: for instance the second half of section 4.3 more or less repeats what is said in section 4.2. I recommend the authors to reorganise the results and discussion to be a lot more concise. This will help following the argument and strengthening the case of the paper. To help make a stronger case for the paper, I wonder also if it would be possible to add a diagram that visualises the main processes occurring in the region (N2 fixation, vertical migration of zooplankton, CO2 uptake . . .).

Effect of zooplankton vertical migration - The current manuscript presents the vertical migration of mesozooplankton as an explanation for the missing sink in the upper C budget at WMA. It would be nice to quantify this process either based on other technique or by simply doing a mass balance (which the authors are shying away).

MA net sink of atmospheric CO2 - It would be good to quantify the net sink in pCO2 and compare it with other estimates and with other regions.

Minor comments

P2, L3: Confusing sentence. In my mind mineral refers to carbonate and silicate which is at odd in association with the soft-tissue pump which refers to organic carbon.

P3, L35: Can you give slightly more information of the climatology of de Boyer-Montegut et al. (2004)? Mainly the type of collected data and coverage.

P6, L39: Say in the Figure 2 caption, what the red lines refer to.

P9, L27: Need to specify that shallow nitracline indicates oligotrophic waters.

P12, L35: Can you add the sum of the MA regions so that we can see that the MA area is a net sink of atmospheric CO2? P12, L40: Little bit misleading as the Table 6 and main text do not use the same unit. Can you add in the text the numbers in mol m-2 d-1 as well?

P18, L40: Can you stipulate here if the source of P changes with climate change, how this might affect N2 fixation, zooplankton migration and CO2 sink?

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