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Biogeosciences Discussions

Interactive comment on "Two High-Nutrient Low-Chlorophyll phytoplankton assemblages: thetropical central Pacific and the offshore Perú-Chile Current" *by* F. Gómez et al.

F. Gómez et al.

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Anonymous Referee #2

General Comments - This manuscript provides a nice contribution to studying the spatial aspect of phytoplankton species composition in relation to nutrients and hydrographic features of two oceanic areas (Tropical HNLC and Temperate HNLC waters). Although this study is similar to ones already reported in the journals for at least the HNLC regions of the South Pacific Ocean (Iriarte & Fryxell, 1995; Kaczmarska & Fryxell 1994; Buck & Chavez 1994; Benitez-Nelson et al 2007), the results from inorganic nutrients and taxonomic data enhance our knowledge of phytoplankton dynamics/structure at the regional scales.

Response: The studies by Iriarte & Fryxell, 1995; Kaczmarska & Fryxell 1994; Buck & Chavez 1994 were restricted to the Equatorial Pacific Ocean. The article “Benitez-Nelson et al. 2007. Mesoscale eddies drive increased silica export in the subtropical Pacific Ocean. Science 312, 1017-1021” is restricted to the North Pacific Ocean. The present study covers the unexplored open South Pacific Ocean between 8°S and 34°S.

- In regard to the manuscript concerning diatoms of the HNLC South Pacific, please remember that we faced complex currents (and so inorganic nutrients) in this zone, in addition to changing El Niño (ENSO) conditions, as well as La Niña. Its make a little bit difficult to compare this study (2004) with studies published 1994-1995 years, because they were actually carried out during 1992 El Niño event at the Equatorial Pacific.

Response: In the submitted manuscript the “El Niño” in only cited in the ‘Discussion 4.1. Page 1544; line 15 “HNLC diatoms such as Planktoniella sol or Rhizosolenia bergonii are commonly reported along the South American coastal waters associated with warm waters especially during the El Niño conditions (Avaria and Muñoz, 1987; Rodriguez et al., 1996). Based on a single survey and with a paucity of information in the literature in offshore waters in the region, the present study does not allow to establish the occurrence of the HNLC-PA in the western PCC as a permanent feature”. In no part of the text we compared the “El Niño” or “La Niña” conditions between 1992 and 2004. The lack of previous studies in the open South Pacific Ocean, beyond the stations close to the Equatorial Pacific, hinders the comparisons.

- Even considering many water masses in the HNLC Pacific regions, I have always wondered at the high diversity of phytoplankton in these regions.

Response: The manuscript described that HNLC-microphytoplankton assemblage was dominated by Pseudo-nitzschia delicatissima-Rhizosolenia bergonii in two geographical distant regions. Unless two water masses were associated with this assemblage:

BGD
4, S1258–S1263, 2007

EGU

one warm water mass in subtropical waters near the Marquesas Islands Archipelago (temperature $>28^{\circ}$C, salinity 35.5) and other water mass in temperate waters of the offshore Perú-Chile Current (temperature $<19^{\circ}$C, salinity <35). The microphytoplankton species found in each HNLC region is reported in the table 2 added after the recommendation of the reviewer.

- Even thought the authors were focused in the two main diatom species (Pseudonitzschia delicatissima and Rhizosolenia bergonii) in the Results and Discussion sections, they did not present a list of phytoplankton taxa at least from the HNLC-PA and PCC (the main objective was focused in phytoplankton assemblages). How many species did they found in the sampled areas (HNLC-PA vs. PCC)?

Response: In the revised version is provided the table 2 that contains a list of all the diatoms, dinoflagellates and large flagellates identified in this study. This allows the comparison of the microphytoplankton composition because both HNLC regions.

- Did the diatoms species showed a distinctive vertical pattern associated to the fluorescence or chlorophyll-a measurements? (In figure 4, relatively high fluorescence values are observed below 50 m in both areas).

Response: As usual, in the more eutrophic areas of this study, Marquesas Is. Archipelago, the offshore Perú-Chile and coastal Chilean upwelling, the chlorophyll a showed a shallower distribution, whereas in the South Pacific Gyre the microphytoplankton is nearly absent in the upper 100m depth. The HNLC microphytoplankton assemblage showed a shallower distribution than those typical diatoms of the deep chlorophyll maximum.

-To my knowledge, quite some of the Pacific diatoms are larger than 20 um cell size, and I might add, heavily silicified. May be, it must be advantageous to sink out of the surface at some life stages. Therefore, the authors should also explore “life stages” as an additional hypothesis (to the antigrazing strategy) for forming clumps species of P. delicatissima species. Small and large but ubiquitous heavily

BGD
4, S1258–S1263, 2007

EGU

silicified diatoms such as Nitzchia bicapitata and Thalassiothrix spp., respectively, have been observed the near-surface water of the Equatorial and south Pacific, suggesting that been “heavy” could be an advantage in terms of their life cycle and physiology.

Response: This manuscript reports Pseudo-nitzschia delicatissima and Rhizosolenia bergonii as the main representatives of the HNLC microphytoplankton assemblage, with a negligible occurrence in other regions such as the South Pacific Gyre. The “normal” diatoms in terms of frustule thickness constitute a minority part of the HNLC-PA. The members of the Nitzchia bicapitata species complex were found along the entire transect, being especially common in the deeper waters (150-250 m depth) in the South Pacific Gyre. Nitzschia bicapitata is not a representative of the HNLC-PA. Thalassiothrix longissima was also found in the eutrophic waters of the Chilean upwelling (Table 2). Other diatom species can be found in the HNLC waters, but they are not representatives of the HNLC-PA. Simply, these species are favored by the eutrophic conditions in the HNLC regions, or in any other eutrophic regions in the open warm Pacific Ocean. In the discussion, page 1545, line 24, was stated “although these species are not exclusive of the HNLC-PA.”

- section 4.1.2 “However, the nutrient limitation is a complex issue and the nutrient ratios are not suitable to infer limitations” pag. 1547, line 3 “This is evidence that silicate is an element limiting the large diatoms in the HNLC region of the South Pacific Ocean”. But Results (Fig. 6) and Discussion sections are based on N:Si ratio. Could the authors explain why they used ratio instead of concentrations to suggest “nutrient limitation” or silicate deficiency?

Response: The nitrate-silicate ratio, as a single factor is not used to suggest the silicate deficiency. Beyond the nitrate-silicate ratio, other two factors are suggested: - The dominance of lightly silicified diatoms, supposed to be favored under Si-limited waters versus other diatoms. - The deficiencies in the frustule formation illustrated in the figures 14-17. Other studies have reported the Si-limitation of the diatoms in the

BGD

4, S1258–S1263, 2007

equatorial upwelling region based on other methods (Leynaert et al., 2001).

Specific comments - pag. 1538, line 16: Where is the data for the Acoustic Doppler Current Profiler (ADCP) that authors mentioned?

Response: The ADCP measurements were reported in the text in order to illustrate the origin and destination of the phytoplankton assemblage associated with the water masses. Results, page 1542, lines 5-7: “The ADCP measurements showed a northwards component between 92°W and 84°W, while the current was weak and often reverse towards the coasts of Chile.” Results, page 1543, lines 16-18: “The ADCP measurements showed an eastwards drift and the surface warm waters run above the entrainment of fresher waters.” This manuscript is a part of an especial issue and the reader will find the complete description of the ADCP current field in: Claustre et al. 2007. Introduction to the special section: bio-optical and biogeochemical conditions in the South East Pacific in late 2004 -the BIOSOPE program, Biogeosci. Discuss.

- the authors classified Pseudo-nitzschia delicatissima as “small pennate diatom”. However, in Figs. 10-11-12 cells are equal or larger than 100 um.

Response: Thank you very much for this comment. The micrographs were taken with software that automatically includes the scale bar of 100 μm according to the magnification. However, the scale of 100 μm was too large and it was reduced by one half in the preparation of the plate. Unfortunately I miswrote 100 μm instead of 50 μm. This has been corrected in the revised version. In order to avoid the confusion in the size of Pseudo-nitzschia delicatissima is reported “30-80 μm in length and only 2-3 μm”.

- What was the operational definition of cell size in this study? Actually, if I understood, the authors counted cells larger than 15 um; this is almost the micro-phytoplankton size class.

BGD
4, S1258–S1263, 2007

EGU

Response: In the abstract and results is reported “The phytoplankton (>15 μm)”…“the microphytoplankton assemblage” The most extended size classification for the phytoplankton (i.e., Sieburth et al. 1978), established the microplankton for cells higher than 20 μm. However, with the Utermöhl method in Lugol-preserved material, the diatoms and dinoflagellates larger 15 μm are well conserved and the sedimentation is efficient (Lugol increases the settling speed). Below 15 μm, the delicate nanoplankton cells are easily destroyed by the fixation and the reduced size implies a low sedimentation rate and consequently the underestimation of the abundance. The limit 20 μm for the microplankton is more theoretical than practical.

- pag. 1541-line 24: “Chl a- nitrate ratio showed”; but in Fig. 5 the legend said Nitrate:chlorophyll-a –

Response: Unfortunately the figure 5 was refereed as Chl a-nitrate in the text instead of nitrate-Chl a. This incoherence has been corrected in the revised version.

- 3.2.2 Phytoplankton, line 10: Nitzschia bicapicata; must change to Nitzschia bicapitata Response: bicapicata has been replaced by bicapitata.

- I strongly suggest to authors present a table with integrated values (over the euphotic layer or the entire water column sampled) from the HNLC-PA, SPG and PCC areas with the following information: Chlorophyll a Nitrate concentrations Orthophosphate Dissolved Silicate Si/N ratio N/P ratio Diatom abundances Dinoflagellates abundances Mixed layer depth 1% light level depth.

Response: The table 1 with these data has been added in the revised version.

Interactive comment on Biogeosciences Discuss., 4, 1535, 2007.