**Biogeosciences
Discussions**

Interactive
Comment

Interactive comment on "Contribution of
picoplankton to the total particulate organic
carbon (POC) concentration in the eastern South
Pacific" *by* C. Grob et al.

Anonymous Referee #3

Received and published: 4 June 2007

General Comments

The main goal of this research was to assess the variable contribution of different pi-
coplanktonic groups to POC in the upper ocean of the eastern South Pacific. The
authors have sucessfully combined optical theory and several different types of data
sets (flow cytometry, partice size counters, and beam attenuation) in order to achieve
this goal. They first evaluate picoplanktonic abundances, including contributions by
bacteria, Prochlorococcus, Synechoccus, and picoeukaryotes, and the environmental
variables (e.g., temperature and nutrients) responsible for spatial variability. The au-
thors then decompose the measured beam attenuation into its' component parts, using

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optical theory to calculate picoplanktonic contributions and calculating detrital (or non-vegetal) attenuation by difference. In terms of the authors' stated goals, picoplanktonic contributions to POC were determined via two methods: (1) using a bio-optical approach in which cp is considered equivalent to POC, and (2) from intracellular carbon content based on a relationship with flow cytometric FSC.

This manuscript lends further support to the important role that picophytoeukaryotes play in carbon cycling in the eastern South Pacific (in addition to Grob et al., 2007). Such an understanding could potentially improve global estimates of primary production in large regions of the open ocean, if further work is put into studying this presumably diverse group of picophytoplankton. This paper contributes the novel approach of measuring on fresh samples both flow cytometric FSC and particle size on sorted groups using a particle size counter. Additionally, in terms of methods development, this paper concludes that both total chlorophyll a and cp could equally well be used to trace spatial variability in picophytoplankton in this region, an important conclusion since cp is easier to measure. This manuscript makes an excellent contribution to the literature in terms of both our understanding of surface phytoplanktonic processes in the region, as well as contributing potentially useful new methods. My comments in the following sections are minor to medium in scope and are meant to clarify various aspects of the manuscript.

Specific Comments

Abstract

The abstract is generally a good summary of the manuscript. However, I don't think the last sentence properly differentiates the main conclusions of this paper from your previous work, Grob et al. (2007). In that paper, you also concluded that picoeukaryotes played the dominant role in carbon cycling in this region. However, you have applied several new methods in this work, including use of FLS-determined intracellular carbon and bio-optical methods to come to a similar conclusion. Perhaps you could say

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something like "As suggested by Grob et al. (2007), the new methods presented in this paper lend further support to picoeukaryotes playing the dominant role in carbon cycling in the surface ocean, even under hyper-oligotrophic conditions."

Introduction

At the end of the first paragraph, perhaps you could summarize what is currently known about phytoplankton group-specific production in the open ocean. Also, you might address how a better understanding of these three groups (Pro, Syn, and euks) would translate into better satellite-based estimates of primary production. Are there certain assumptions in satellite-based algorithms that would change, say if we knew that picoeukaryotes were more dominant in certain oceanic regimes?

Methods

In your description of picoplankton analyses, you should clarify what your upper and lower flow cytometric FSC and approximate size limits are. For example, in your Supplementary Materials, you write that the flow cytometer was optimized to observe pico-phytoeukaryotes rather than cyanobacteria, and that little FSC data was available for cyanobacteria samples, such that you had to assume an average FSC signal. In terms of scattering, I'm assuming this means that Pro and Syn populations were usually on your FSC baseline. How might this contribute to errors in your flow cytometric abundances for these two groups? In other words, if they're on the FSC baseline, couldn't you potentially be including some noise in your abundance estimates?

In your supplementary materials, Fig. A, I don't understand what the differences are between the two size distributions in panel (1). Did you correct one size distribution to get the other? If so, how?

Results

Section 3.2 - You say that "Cyanobacteria and bacterioplankton attenuation coefficients, on the other hand, varied only according to their abundances." Doesn't this

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have to be the case based on how you did your analysis? I thought you were generally assuming the same average FSC (and thus size) for cyanobacteria populations, as discussed in your Supplementary Materials.

Section 3.3 - You write that both the bio-optical and intracellular carbon approaches gave approximately the same results for picoeukaryotic attenuation (ceuk). This seems like an important conclusion, since it suggests the same refractive index (1.05) can be used for all cells, and thus it seems important to include the results in a figure in this paper.

I am not convinced that Tchla (r=0.67) and cp (r=0.53) were equally well correlated with the dominant picophytoplankton biomass. The correlation with Tchla looks significantly higher. This seems like an important point that needs more clarification. Perhaps you could also include the significance (p-values) for these correlations, as you did in Figure 3.

On page 1476: With reference to Figure 9, could you speculate as to why the picoeukaryotic contributions from the intracellular carbon approach would always be lower than from the bio-optical approach?

Discussion

The discussion section is generally well written and interesting. My main comment is that I think significantly more thought needs to go into your discussion of the importance of picoeukaryotes in your final paragraphs. Several papers have pointed to the importance of this group of phytoplankton in the open ocean. I believe that you need to present your work in the context of a growing body of knowledge, rather than as a completely new finding. For example, as you know, DuRand and Olson (1996) and Chung et al. (1996) have shown the importance of picoeukaryotes in the equatorial Pacific, and you have previously shown the imporance of picoeukaryotes in this region (Grob et al., 2007). When I do a library literature search, I also see several other papers that have identified the important role of picoeukaryotes in the ocean. As well, there is a

review by Worden et al. (2004) in L&O that would help to further put your results into context, the title is: "Assessing the dynamics and ecology of marine picophytoplankton: The importance of the eukaryotic component." If you better place your results in the context of this growing body of knowledge, then the final paragraphs of your discussion will make a greater impact.

Another question that I have is to what extent in the future can simple assumptions be made about bacteria, Synechococcus, and Prochlorococcus cell sizes. For example, in future studies, would it be enough to just measure the abundances of these groups, and make an assumption about their sizes, such as from Stramski et al. (2001), or is it really necessary to measure their sizes for each new study?

Technical Comments

Abstract

Line 16: Define Tchla before using term

Line 17: Remove "with".

Introduction

p. 1463, Line 27: picoeukaryotic mis-spelled.

Methods

p. 1466, Line 11: Do you mean 5x10ˆ3 events?

p. 1466, Line 13: Should be "with" abundances.

p. 1468, Line 5: Should be "put in".

Results

p. 1471, Figure 4: It seems like it would make more sense to first present salinity and nitrate as sub-panels A & B, before presenting abundances.

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p. 1472: Should be followed "the" Prochlorococcus pattern.

p. 1475, Line 10: Do you really mean Figs. 7b here?

p. 1475, Line 22-23: Should be "despite the differences". Remove "of".

Discussion

p. 1477, Line 11: Do you mean "sensitivity" rather than "sensibility"?

p. 1480, Line 23: Should be "share of this carbon pathway".

Figures

Figure 4: Definitely needs to be higher resolution, so that the colorbar labels are legible.

Figure 6: Add "attenuation" at end of first line. In last line, should be "all scales". I do not see the horizontal error bars that you refer to. Were they left out of the figure, or are they just really small? If small, you should say this.

Figure 8: What are the p-values for these correlations?

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