

## ***Interactive comment on “The most oligotrophic subtropical zones of the global ocean: similarities and differences in terms of chlorophyll and yellow substance” by A. Morel et al.***

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As the main questions by the Referee #1 and the Referee # 2 are similar and converging, the following answers are thus for both of them.

They both also recommended technical corrections and editions (text and figures), which were all accounted for without any particular difficulty. We thank them for their scrutiny and help in this matter.

About the matter itself, additional discussions were suggested by Referees to improve our paper, including the consideration of new references, in particular regarding the main questions mentioned above (detailed answers below). These references have  
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been carefully considered (plus some others also) and added in the reference list (11 additional references compared with the initial version); the analysis of the results has been extended along the lines suggested by both Referees.

The revised version of our paper includes all the recommended corrections and suggested discussions; we thus believe that we have complied with the Referee's requirements, and for the benefit of the paper.

### **Detailed Answers:**

An important question was:

“ the reader cannot reproduce or follow the statistical method for gyre delimitation. . . . Perhaps the authors could make the Fougnie paper available via their ftp site” (Referee #1)

“It would be useful to have the Fougnie method explained in more detail since the citation refers to an Ocean Optics abstract” (Ref. #2)

Answer: i) the corresponding paragraph has been expounded, and it is believed that it is now self-sufficient;

ii) in addition, the Fougnie et al., 2002 paper is made directly available as a pdf, appended to the reference itself (with ctr+1click) in the list of references.

Actually, this pdf is also available on our ftp site.

The modified (and expended) paragraph is now as follows:

Six quadrangular domains within the five major anticyclonic gyre systems of the three oceans (McClain et al., 2004) were considered. These zones (except the Hawaiian zone –see comments below-) were selected to coincide with the most oligotrophic cores of each gyres in the northern and southern hemispheres (Fig. 1, and Table 1 provide their locations and limits). The central parts of the gyres were delimited some-

what arbitrarily by considering the monthly [Chl] composites encompassing firstly the whole gyre systems, and then by progressively reducing (down to  $\sim 1-3 \cdot 10^6 \text{ km}^2$ ) the area under consideration, in order to isolate the cores of each system. The core is assumed to be typified by minimal [Chl] concentrations, compared to the values of the entire gyre in the same month, and, if possible, it must be spatially sufficiently homogeneous. Simple statistical tools guide this process, by examining the evolution of the [Chl] means and standard deviations, while progressively shrinking the boundaries of the quadrangular zones. The standard deviations, describe the inter-pixel variability, and the coefficients of variation (sd/mean in %) provide thus a quantification of the spatial heterogeneity within each zone. These coefficients are comprised for the six zones between 35 and 64% in terms of [Chl], or 25 and 45% in terms of  $a_y$ ; the lowest figures are for the Sargasso Sea, and the highest ones for the Easter Island zone, that is also the widest zone. This method is similar to that described in Fougne et al., (2002) (pdf available).

Another set of germane questions:

“ ..The paper could benefit from further insights into the unique aspect of the North Pacific gyre with its decoupled Chl and CDOM processes..” (Ref #2)

“..the discussion would be made more interesting with the insertion of additional hypotheses (physical, biological) for why the pelagic N-Pacific differs so strikingly from the rest of the subtropical zones...” (Ref #1)

“..Fig.5 suggests that the Mariana region exhibits MLD seasonality on par with that of the North Atlantic, but much less seasonality in optical properties is observed in M than in S.” (Ref #1)

Answer: the corresponding section has been deeply recast and now includes information (and appropriate new references) on the importance of the upper layer with less saline waters within the warm pool region, and the insulating properties of the barrier layer. Some physical considerations are also added regarding the North Equatorial

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current, south of Hawaii, and the possibility that much of the variability is generated by eddy activity and lateral advection. This section now reads as follows:

“ For the second group (M and H), the situation and temporal evolution markedly differ from those observed within the first group; in particular in M, as well as in H, the regularity of the seasonal cycling (for [Chl] and CDOM) is to a great extent perturbed. In both zones, the supply of nutrients and unbleached CDOM to the upper layer seems to be hampered, with the consequence that the seasonality in the signals is largely smoothed out. In H, the MLD is almost constant during the year (around 60 m, see Fig. 5); vertical mixing events are thus limited, and erratic strong [Chl] peaks, which occur in mid-summer, are not related to such improbable events. In M, from about 40m in summer, the MLD reaches 80 m in January (as in the Sargasso Sea). Maybe, in North-West Pacific, this depth is insufficient to reach the nutricline, or the nutrient reservoir would be partly depleted (e.g., Palter et al., 2005). Also due to heavy rainfall in this zone, the existence of strong haloclines could impede active convection, and the near-surface salinity-stratified layers are insulated from the thermocline itself by the presence of relatively thick barrier layers (Maes et al., 2006; Sato et al., 2004).

As for CDOM, the common trait of the M and H zones is a rather flat annual mean (Fig. 3). In M, both  $a_y$  and  $\Phi$  are low all the year round within the less saline well-lit surface waters of the warm pool. A seasonal CDOM cycling, however, is clearly detected in M along the 10 years record (Fig. 2). A weak maximum is observed in winter (January) and a systematic minimum occur in summer ( from April to September) when the solar bleaching is particularly effective. It is worth noting that, for unclear reason, the weak  $a_y$  and [Chl] maxima are in opposite phase (Fig. 2 and 3). On the contrary, south of Hawaii, the main CDOM maxima, in June-July, coincide with the [Chl] pulses. More generally, the rather erratic  $a_y$  fluctuations in H (Fig. 2) roughly parallel those of [Chl], suggesting that the common cause would be some lateral advective processes inside the turbulent eastern branch of the North Equatorial current (Wyrtki and Kilonsky, 1984).”

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