

Title: Coupling of surface pCO₂ and dissolved oxygen in the northern South China Sea: Impacts of contrasting coastal processes

Author(s): Weidong Zhai et al.

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By Fiz F. Pérez

Overall comment:

This paper presents new observations of the sea surface pCO₂ and O₂ obtained in the South China Sea during a 17-days summer cruise. The authors describe the different pCO₂ and O₂ ratios with respect to different open ocean and coastal dynamic systems (upwelling, river plume). The presented results may have applicability in many coastal systems with large physical and biogeochemical gradients. This study represents a very interesting example of how to evaluate the metabolic status of communities and other coastal processes according to coastal pCO₂ and O₂ relationships. The results are very valuable information that adds to coastal pCO₂ international data synthesis and global carbon budget computations. Although there are no innovative procedures in the interpretation of the variability of pCO₂-O₂ relationships for this kind of studies, the quality of the observations and their description are worth to be spread amongst the scientific community.

The Revelle factor is described as one of the most important factors that control pCO₂ and account for the pCO₂ and O₂ relationships. Although air-sea gas exchanges are also considered, their relative importance is somewhat lessened compared to photosynthesis-respiration ratios based on the argument that primary production is rather low in most of the study area.

Specific comments:

Page 6254, Lines 5-6: *"According to Broecker and Peng (1982) and Stigebrandt (1991), we used the 2.5% super-saturation as the effective DO saturation level considering the bubble effect"*

It is not clear whether this consideration should be made in coastal waters where subduction of water masses is not a prominent process. In fact, excess O₂ seems to be slightly negative, by about 5 μmol·L⁻¹. The authors should further discuss what are the implications of their assumption in the results and the associated uncertainties.

Page 6257, lines 20-24: The slope computed using equation 2 is about 1.45 μatm/μmol O₂ or 339 μatm/%OD. This value should be given in the paper here, not only in later paragraphs (page 6259). In any case, this value is twice the one given by the slope given in figure 4 (green line). If this computation is correct, the difference should be explained.

In addition, estimation of the uncertainties should be provided and discussed.

Page 6259. Excess number of decimal places / expression of accuracy for $\Delta\text{CO}_2^*=1.18$. In any case, the uncertainty for this estimate should be provided. In other words, this same $\text{CO}_2:\text{O}_2$ ratio could be generated from river-sea mixing, not only from photosynthesis / CO_2 outgassing. It seems as if the CO_2 and O_2 exchanges maintained a stable slope over time whenever the CO_2 gradients are large enough to balance the O_2 air-sea flux.

Epigraph 4.2 Influence of air-sea exchange on pCO_2 -DO relationships in offshore regions.

This section addresses the importance of air-sea gas exchanges in order to account for the pCO_2 - O_2 ratios found offshore and in the river plume. The steep slopes stem from the combined effect of photosynthetic activity and the high rates of CO_2 exchange. The authors correctly state that this is modulated by a combination of metabolic and physical processes during the long-distance mixing with offshore waters. However, no explanation is given to try to justify the high slope of -1465 μatm obtained. This slope is 10 times higher than the theoretical slope estimated using the average air-sea gas changes of O_2 and CO_2 . These values suggest that there exists a $\text{pCO}_2:\text{O}_2$ ratio that stabilizes air-sea gas exchanges after the long-distance mixing, equilibrating the losses of CO_2 and O_2 and maintaining the ratio in coastal and offshore environments. In offshore conditions, the authors acknowledge the low productivity and long displacements of surface water masses. However, this can also occur in the river plume where residence times are lower but the CO_2 and O_2 gradients are very high.

In addition several segments in transects E and C (Fig 5a) have high slopes that could be due to air-sea gas change effects or to mixing between surface water masses affected at varying extents by air-sea CO_2 exchanges and photosynthetic activity.

Technical comments:

Fig. 2. It should be explained why 70 m depth is used as the reference for continental shelf instead of 100 m, which is the line plotted in Fig 1.

Fig. 5. Correct 'exchange' by 'exchange'