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Biogeosciences Discussions

Interactive comment on "Coupling of surface pCO_2 and dissolved oxygen in the northern South China Sea: impacts of contrasting coastal processes" *by* W. Zhai et al.

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Response to Review #2 (by David Hydes)

In our paper we examined the relationship between CO_2 partial pressure (pCO_2) and dissolved oxygen (DO) based on a cruise conducted in July 2004 to the northern South China Sea, spanning from estuarine plume, coastal upwelling and deep basin areas. Distinct relationships between pCO_2 and DO saturation were identified in different regimes. This study reveals that a combination of high-resolution CO_2 and O_2 measurements may provide valuable information regarding net metabolic status in marine ecosystems under different physical and biogeochemical conditions. We have demon-

strated a simple procedure to evaluate the community metabolic status based on these surface pCO_2 and DO measurements, which may have applicability in other coastal systems with a large gradient of changes in their physical and biogeochemical conditions.

The reviewer suggested us to make more attempt to put our dataset into the context of the annual cycle of change in the region. We should point that our focuses are on different relationships between pCO_2 and DO, and also on the possible biogeochemical processes they implied. In the "study area and survey transects", we have presented sufficient background information about the carbon cycling characteristics in the annual and global contexts.

During this study, we selected four shelf-crossing transects, so as to investigate contrasting processes from estuary / nearshore to the shelf and finally to the deep basin. The idea to present the results in this study is to extract the general features of the pCO_2 - DO relationships in the context of contrasting processes. The latter was then led to the discussion, where we adopted a simple approach to use such contrasting relationship to diagnose different processes. In the modified MS, we have added more discussion on the possible impact of air-sea gas exchanges on the pCO_2 - DO relationship.

The reviewer questioned our usage of a fixed bubble effect of 2.5% supersaturated DO. We do appreciate that the reviewer pointed out this important issue, and agree that the bubble effect on surface DO may vary depending on factors such as breaking surface waves. Our observed surface DO was mostly in the range of 103% -107% (Fig. 2f) at Transect S, the trend of which was consistent with the chl-a (from <0.1 to 0.2 μg L^{-1}, Fig. 1) although the area is generally very low in biological production. As such, we justified that the 2.5% supersaturation we adopted from Broecker and Peng (1982) and Stigebrandt (1991) should be reasonable to be applied to the study area. However, this supersaturation might be subject to variations given the regional heterogeneity in terms of surface wave field. Thus, using a fixed supersaturation rate to characterize the

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bubble effect may have resulted in uncertainties. For example, under the condition of a same DO concentration of close to air-equilibrium (200 μmol kg^{-1}), one site having the bubble effect of 2.5% DO super-saturation and another with the bubble effect of 5.0% DO super-saturation, the calculated excess O_2 would show a difference of 5 μmol kg^{-1}. Unfortunately, there is no way that we could make the correction for individual data point. Therefore, we have made clear notes of this potential bias in the revised MS both in the method section where the excess O_2 was defined and the caption of Fig. 5 (in the original MS), where results of excess O_2 were presented. However, we must also point out that such uncertainties (<5 μmol kg^{-1}) should be minor, given the fact that the ranges of DO spatial variations were as high as 80 μmol kg^{-1} in nearshore areas (Fig. 5a in the original MS) and 50 μmol kg^{-1} in the PRE (Fig. 5c in the original MS). Most importantly, such uncertainties would not affect the approach we are using to examine the community metabolic status based on surface pCO_2 and DO measurements, nor the general conclusion of this study.

We are also aware of the limited period and space coverage of sampling. Both in the introduction and conclusion, we have stated in the revised MS that this study has such limitation, and pointed out that this study has provided an example that that a combination of high-resolution CO_2 and O_2 measurements may provide valuable information relating to metabolic status in marine ecosystems.

As for the specific comments and questions:

For the abstract, per the reviewer's suggestion, we have added information of the latitudes and longitudes of the area under study. Fluxes were not estimated in this work.

The nearshore waters of the northern SCS are not well studied on the topic of carbon cycle. We have summarized the current understanding of coastal upwelling, river plume, river plume induced bloom and its effects on carbonate system in the "study area and transects".

The reviewer criticized that the use of the single word metabolism is confusing, which

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have been taken care of in the revised MS.

In the area map, the reviewer asked us to mark the 70-m contour used in the review of the data. These lines that distinguish the nearshore dataset from offshore dataset in Fig. 2 had been marked in the area map (Fig. 1) using the "+" mark. They only happened around the 70-m isobath. In the modified MS, we have deleted the emphasis on 70-m isobath. The reviewer also suggested us to show the extent of the Pearl River plume, the region of upwelling and the direction of currents though the area. We had marked the typical upwelling regions in summer as shadowed areas. Major currents in the region under study have been added in the modified MS according to the reviewer's suggestion. However, the Pearl River plume varies very much in different years and months. Note that we have also added data maps of surface T, S, pCO_2 and DO in the revised MS, according to the reviewer's suggestion.

References:

Broecker, W.S. and Peng, T.H.: Tracers in the sea, Eldigio Press, Palisades, New York, 690pp, 1982.

Stigebrandt, A.: Computations of oxygen fluxes through the sea surface and the net production of organic matter with application to the Baltic and adjacent seas, Limnol. Oceanogr., 36, 444-454, 1991.

Interactive comment on Biogeosciences Discuss., 6, 6249, 2009.