Biogeosciences Discuss., 7, C3396–C3401, 2010
www.biogeosciences-discuss.net/7/C3396/2010/

Biogeosciences Discussions

Interactive comment on "Influence of seasonal monsoons on net primary production and CO_2 in subtropical Hong Kong coastal waters" *by* X. C. Yuan et al.

X. C. Yuan et al.

xcyuan@scsio.ac.cn

Received and published: 20 October 2010

RC: Review of the paper Influence of seasonal monsoons on net primary production and CO2 in subtropical Hong Kong coastal waters by X. C. Yuan, K. D. Yin, W.-J. Cai, A. Y. T. Ho, J. Xu, and P. J. Harrison submitted to Biogeosciences for possible publication. General comments: This work is aimed at providing a description of the factors controlling the seasonal variations of both the air-sea CO2 exchange and primary production in the subtropical coastal waters of Hong Kong. The study is based on field data obtained during the development of seven cruises that temporally cover the shift that in the monsoonal wind regime occurs in the region. According to the results attained, the authors conclude that the trophic status of the system changed from heterotrophic during the winter dry season to autotrophic in the summer wet season, with the area acting generally as a source of CO2 to the atmosphere. Although the study analyses a relatively small area, it apparently contains several contrasting environments in terms of hydrodynamics, their biogeochemical water properties and anthropogenic forcing, which is expected to influence the dynamics of the carbon systems. However, it seems that the contribution of each partial system on the global trend observed is not properly addressed and the underlying mechanisms behind the observed patterns are not entirely explained. Moreover, the methods used to calculate the O2 and pCO2 fluxes seem somehow confusing, which introduces certain doubts about the accuracy of the data. Taking into account these considerations, the conclusions drawn from this study should not be generalized to a larger geographic region or extended to other subtropical coastal areas, as it is implicit in some parts of the manuscript. Therefore, some substantial modifications should be made in the manuscript in order to fulfill the requirements needed to be considered for publication in Biogeosciences.

RC: Specific comments: Methods.- Page 5625, lines 2-3: Differences between data presented in Ho (2007) and Yuan et al. (2010) and those contained in the current work should be stated.

Response: We added a discussion: Data on salinity, temperature, primary production, DO, DIC and pCO2 at stations 1 to 8 were presented in Ho et al. (2008 and 2010) and Yuan et al. (2010a). In this study, these data along with wind, respiration and gaseous air-sea fluxes were grouped into three main regions (the PRE, VH and EW) in seasonal pattern. The average values of all seasonal parameters (e.g. salinity, temperature, primary production and DIC etc.) were calculated by averaging data from April to October for the wet season, and November to March for the dry season.

RC: Page 5626, line 18: As pCO2 was computed from the pH and DIC measurements, the uncertainty associated to the calculations should be provided. Also, it is assumed that the dissociation constants used are those given by Cai and Wang (1998) but a more comprehensive explanation of the procedure would be desirable.

Response: We added a more comprehensive explanation: pCO2 was calculated from measured pH values and DIC concentration for estuarine and coastal waters using the equation (Cai and Wang, 1998): (1) where CT is the DIC value, {H}=10-pH, KH is the solubility constant (Weiss 1974), and K1 and K2 are the constants of carbonic acid (Roy et al., 1993). The 0.01 pH error will result in the uncertainties of $\pm$3% pCO2 (ca. 15 $\pm$ 6 μatm CO2) and $\pm$10% CO2 fluxes (ca. 3 $\pm$ 2 mmol C m-2 d-1), which does not considerably affect our conclusion due to high pCO2 in Hong Kong waters.

RC: Page 5626, line 22: The temperature effect on pCO2 does not seem to be addressed in the study. Hence, either more results are added or equation 1 should be deleted.

Response: We agree and delete it.

RC: Page 5627, line 11: Which is the frequency of the wind speed data? Also, the atmospheric pCO2 value of 370 microatm might not be entirely correct.

Response: It is daily wind speed. We added a discussion about the atmospheric pCO2 : the atmospheric pCO2 has been reported to be in the range of 349 to 372 μatm in inner shelf/coastal areas adjacent to the Pearl River plume (Zhai et al., 2005), and $\sim$358 μatm was reported in offshore waters (Zhai et al., 2009). Since the sampling sites are very close to a mega city, Hong Kong waters are likely subject to land mass influence which may result in higher atmospheric pCO2, especially in the dry season when northeast winds were dominant. High atmospheric pCO2 (349 to 460 μatm, and averaged 405 μatm) was reported in Randers Fjord, Scheldt, and Thames (Borges et al. 2004), where sampling sites were also close to anthropogenic influences. Hence, the average atmospheric pCO2 (405 μatm) is used for the calculation of the air-sea flux of CO2. The variations in atmospheric pCO2 (349 to 460 μatm) would quantitatively result in the estimates of CO2 fluxes varying from -15 to -30 mmol C m-2 d-1, and the direction of CO2 fluxes are the same.

BGD

7, C3396–C3401, 2010

Interactive Comment

RC: Results.- Page 5628, lines 3-4: A considerable part of the results (and the subsequent seasonal patterns of the carbon system properties considered) is explained based on the influence of the freshwater discharge from the Pearl River. However, no data of such a riverine input is provided. I would suggest to add a figure showing the seasonal river discharge to the coastal fringe.

Response: We have mentioned: the annual average Pearl River discharge is 10,524 m3 s-1, with 20% occurring during the dry season in October to March and 80% during the wet season in April-September (Zhao, 1990).

RC: Similarly, although slightly mentioned in the discussion and published in Ho et al., (2008), the seasonal patterns of nutrient distribution would also help to explain the river influence on biological productivity in the area and the concomitant effect on DIC dynamics.

Response: We added nutrient data in Table 1, and present more discussions on nutrients: Previous studies have reported that there was a significant increase in NO3 and SiO4 concentrations (up to 17–56 and 18–40 μM, respectively) due to the freshwater discharge near the Pearl River estuary (PRE) (Ho et al., 2008). NO3 turnover time was $\sim$100 d and transported to deeper coastal/shelf waters with little utilization by phytoplankton based on 15N uptake data (data not shown). However, N/P ratio was high (up to $\sim$100) in the Pearl River estuary, and phosphorus limited phytoplankton growth (Yin, 2002), as well as bacterial respiration and the decomposition of organic matter in the wet season in southern Hong Kong waters (Yuan et al., 2010). Continuous year round discharge of sewage efïňĆuent resulted in high NH4 (7 to 20 μM) and PO4 (and 0.7 to 1.4 μM) in Victoria Harbour (VH) and its vicinity (Ho et al., 2008).

RC: In addition, it would be helpful to mention how the average values of salinity and temperature for both seasons are obtained (same for the rest of variables and parameters considered).

Response: The average values of all seasonal parameters (e.g. salinity, temperature,

BGD

7, C3396–C3401, 2010

primary production and DIC etc.) were calculated by averaging data from May to October for the wet season, and November to March for the dry season.

RC: Page 5629, line 9: The air-sea CO_2 fluxes seem to be very high and specially in relation to the O_2 fluxes. Are they correct? Response: We added a discussion to clarify: The air-sea fluxes of CO_2 varied from -3 mmol C m-2 d-1 in EW to -40 mmol C m-2 d-1 near the PRE (Fig. 4), while Zhai et al. (2005) reported that air-sea fluxes of CO_2 was -10 to 18 mmol C m-2 d-1 in inner/coastal shelf waters. The slope of regression between the air-sea fluxes of CO_2 and O_2 indicated that O_2 flux was ∼7-fold faster than CO_2 (Table 2). Carrillo et al., (2004) reported that oxygen concentrations approach atmospheric equilibrium in approximately 30 days, while CO_2 only changed by approximately 12% during the same time span, suggesting that O_2 flux was ∼8.3-fold faster than CO_2. Zhai et al., 2009 reported that the ratio of fractional change in seawater pCO_2 to the fractional change in total DIC is ∼10 (Revelle ratio) in the northern South China Sea, which could result in the different gaseous flux rates between O_2 and CO_2.

RC: Wind speed data should be also included in Figure 4. Discussion.- Page 5632, line 24: It would be more appropriate to indicate that downwelling conditions are due to Ekman transport rather than to the Coriolis effect.

Response: revised as Ekman transport

RC: Page 5634: I don't quite understand how the effect of mixing on carbon dynamics is addressed here. Please clarify the equation and the contribution of each term in the vertical profile.

Response: each term was clarified in vertical profile.

RC: Page 5635, lines 7-9: The work by Borges and Chen (2009) reconciling opposing views on carbon cycling in the coastal ocean should be mentioned in this part and overall, considered in the entire section 4.4 for discussion.

BGD

7, C3396–C3401, 2010

Interactive Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

Response: We added: In contrast to the relative consensus on positive NPP, whether coastal waters are sinks or sources of atmospheric CO2 had been regarded as very controversial topic (Ducklow and McCallister, 2004). However, more recent studies have addressed the air-sea CO2 fluxes in coastal environments (Borges et al., 2005; Cai et al., 2006; Chen and Borges, 2009; Laruelle et al., 2010). For example, the synthesis of worldwide measurements of the partial pressure of CO2 (pCO2) indicates that most inner estuaries and near-shore coastal areas are over-saturated with respect to atmospheric CO2 (Chen and Borges, 2009).

RC: Page 5636, lines 14-16: Conclusions drawn from this study can not be generalized to other coastal areas, as in fact, this geographical region seems to be very particular in terms of hydrodynamics and human forcing.

Response: We agreed. We revised as: the trophic state does not always determine whether the water is a source or sink of CO2 (Thomas et al. 2005a; Chen, 2010), especially in dynamic coastal waters with anthropogenic forcing and complicated hydrodynamics.

RC: Figures: -Please make Fig. 3 bigger. -Please add the atmospheric pCO2 value in on Fig. 4 along with the wind speed data.

Response: Fig. 3 was enlarged, and atmospheric pCO2 value along with the wind speed data was added on Fig. 4

Interactive comment on Biogeosciences Discuss., 7, 5621, 2010.