Reply to Anonymous Referee #1

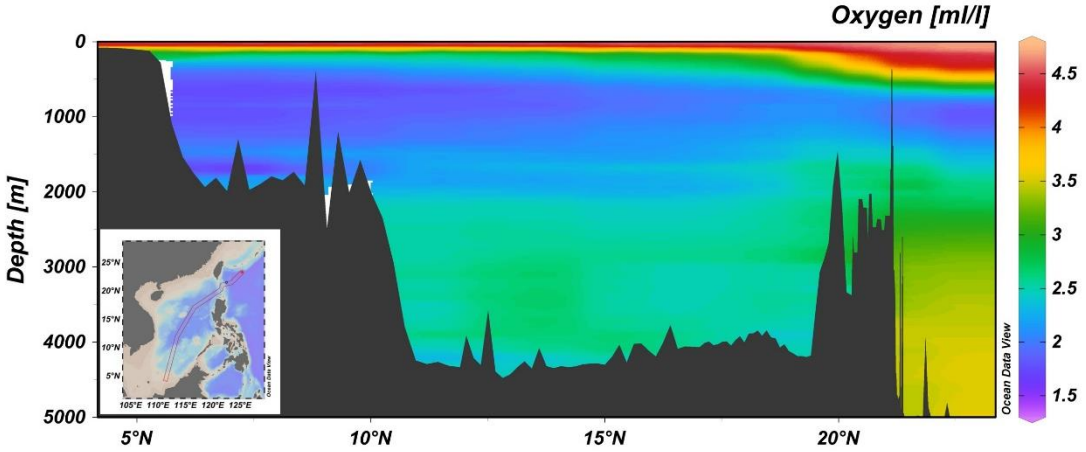
Received and published: 26 April 2016

Kao et al. show a numerical simulation of the South China Sea (SCS) under both present-day and glacial sea level as well as with double wind speed. They also present a Mn/Al record from core MD972142 in the SCS. The goal of the study is to figure out whether biogeochemical changes observed at MD972142 can be explained by changes in oxygenation or changes in productivity. As the numerical study suggests that under lower sea level but stronger wind the residence time of the water in the SCS does not change much, they conclude that it is not changes in oxygenation that drove changes in biogeochemical proxies but changes in export production. The study is generally interesting and is worth publishing in Climate of the Past, if the comments below are addressed.

1) While the modeling work is interesting some links might be missing. At the moment the modeling and proxy work almost read like 2 separate stories. - There is no biogeo-chemical module in the model, therefore residence time of waters in the SCS is taken as a proxy for oxygen, thus suggesting that the main O_2 supply is through flushing of the SCS. Maybe a map of O_2 in the SCS and of the western Pacific Ocean (water feeding the SCS) would be helpful to make that point.

Reply: Thanks for this constructive suggestion. We will add a dissolved O_2 profile into Figure 1 and add more illustrations why the through flow of the intermediate water is important in determining the basin wide redox status. This will be a link to connect modeling work and biogeochemical records as indicated by reviewer.

The biogeochemical module will be added in our future works; however, it is a long way to go to properly validate the three dimensional biogeochemistry (i.e., not only the surface Chl-a but also the vertical oxygen and POM distribution). At current stage, we used the physical model that had been very well validated by modern physical observations in the SCS (Hsin et al., 2008, 2010, 2012).



O_2 profile along the red band on insert map. O_2 data source from WOA2013, http://www.nodc.noaa.gov/OC5/woa13/woa13data.html.

- The residence time increases during low sea level from 19 to 23 years. However, if the climatological wind is doubled then the residence time under low sea level is close to present day with 18.4 years. Most of the conclusions of the paper thus rely on the hypothesis that the winds

associated with both the summer and winter monsoons were twice stronger during glacial times in the SCS. Evidence for such changes should be discussed in the text. A previous study suggests that most PMIP models suggest weaker summer monsoon and about half of them suggest stronger winter monsoon. Jiang and Lang, Last Glacial Maximum East Asian Monsoon: Results of PMIP Simulations, 2010, DOI: http://dx.doi.org/10.1175/2010JCLI3526.1 In addition, since both winter and summer winds were strengthen, the impact of weaker summer winds during glacial time on the residence time should at least be discussed.

Reply: Basing on this comment, we have carried out two new cases for the low sea level condition. In the first new case (HQSK2b), summer wind was reduced 50% and winter wind remained unintensified, i.e. modern winter wind intensity. From this case, we realized the intermediate water through flow reduced to 4.69 Sv resulting in a slightly longer residence time of 26.3 year (see Table 1 below). The second case (HQSK2a) was set for stronger winter monsoon (1.2 times of modern winter wind) and reduced summer monsoon (0.75 times of modern summer wind) according to the result from PMIP published by Jiang and Lang (2010). The intermediate water through flow was 4.95 Sv, which is comparable but resulting in a slightly shorter residence time of 24.9 year. Both new cases gave slightly longer residence times as speculated by reviewer, however, the oxygenation state deduced from these new results would not alter our original story. In this revised version, we will also add more illustrations for the reasons of wind speed selection. The mentioned reference will be added also.

Table 1. Estimated residence time for the SCS based on the net transport of intermediate water through the Luzon Strait.

Case lable	QSK	QSK2	HQSK	HQSK2	HQSK2a	HQSK2a
LS TP interval (m)	135–1190	20–1190	310–1230	310–1270	310–1230	310–1230
TP (Sv)	-7.04	-10.41	-5.35	-6.71	-4.95	-4.69
RT (year)	19.0	12.8	23.0	18.4	24.9	26.3

- It is mentioned in the abstract and in the text that the upwelling west of Luzon and east of Vietnam were enhanced. Changes in upwelling are not directly shown in the paper. A map of upwelling areas and strength for the 4 experiments could at least be shown. I guess the reason why the authors suggest the upwelling was stronger is because they assume the wind was stronger. Stronger wind leads to stronger upwelling, which leads to higher productivity. But this is entirely built on an hypothetical stronger wind……So basically, the authors hypothesize that the wind was stronger during glacial times, thus leading to no significant changes in residence time. In addition, if the wind was stronger then the upwelling was stronger, which is a bit of a circular argument.

Reply: In fact, changes in upwelling west of Luzon and east of Vietnam for these 4 cases were displayed in Figure 2 in old version. However, the color bar we applied did not properly reveal these differences. We will redraw Figure 2 using non-linear style color bar. As replied above, we ran two more cases with reduction summer wind, which provided consistent results, to support our hypothesis.

Minor comments/typos

More explicit name of experiments could be useful.

Reply: More explicit names will be provided in the following revised version. .

P2, L.24: wrong reference to dashed line in figure 1.

Reply: Corrected. Summer surface circulation is represented by solid line in Figure 1.

Typos and grammar: Some issues with English

P 11, L10: “westward flow”

Reply: Corrected. It is westward flow.

P11, L.21-22: rephrase

Reply: We will add results from these two new cases and revise this the following revised version.

p12, L.20; "based on..."

Reply: Corrected.

p13, L. 22: "Based on ..."

Reply: Corrected.

P16, L.1-2: rephrase

Reply: We made revision as follows:

“The content of Al is often used to infer the terrestrial input (Brumsack, 2006) and the normalization onto Al may eliminate the dilution effect on proxies. However, recent studies have indicated that sedimentary Al may have biogenic source (Wei, G. et al., 2003; Murray and Leinen, 1996). Thus, before applying the Mn/Al ratio for discussing environmental redox change, we need to confirm sedimentary Al in our core was not influenced by biogenic process.”

Figure 2: Maybe a different color bar should be used (non linear). The x axis is too crowded, less numbers should be displayed.

Reply: We will redraw Figure 2 by using proper color bar.