Biogeosciences Discuss., 12, C3881–C3887, 2015
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Biogeosciences
Discussions
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Interactive comment on "Phytoplankton dynamics driven by vertical nutrient fluxes during the spring inter-monsoon period in the northeastern South China Sea" *by* Q. P. Li et al.

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Received and published: 29 July 2015

Responses to Anonymous Referee #2

1. [General Comments] "…however, the both sampling period and location are very limited. This is the serious problem with this study. The short observation period (3 days) were not sufficient to discuss the generality of nutrient flux and phytoplankton dynamics in the SCS. The careful discussions considering the temporal scale are needed in the manuscript, though the authors recognized them (P6742, L26). At least, the spatio-temporal variations of wind curl-driven upwelling velocity can be calculated and showed before and after observations."

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Response: The focus of our paper is on the intermittent nutrient fluxes in the NSCS during the spring monsoon transition period including vertical diffusion by turbulent dissipation and curl-driven upwelling by Ekman pumping, which may vary substantially on a short-term time scale. In the revised manuscript, we have included time-series of Ekman pumping at stations C6 and C13 during May-June 2014 (Fig. 2d in the revised manuscript) to demonstrate the temporal variability of curl-driven upwelling in the NSCS. Ekman velocities during the field study are relatively low but representative of the entire spring intermonsoon period from May 8th to June 7th, 2014 with substantially low wind intensity (Fig. 2d).

2. "I cannot judge the downwelling in the offshore area is the typical structure or not in the SCS during the inter-monsoon period. In addition, at the transect observation, the effect of tide was ignored for the diffusive upward flux, and thus it is not clear that the estimated values are over-estimate or underestimate."

Response: There were both downwelling and upwelling in the large area of the offshore regions of the NSCS during May 14th-16th, 2014 (in Fig. 2b). Substantial variations of upwelling/downwelling are also seen in the time-series of Ekman pumping for the offshore station C13 (Fig. 2d in the revised manuscript). The effect of tide on vertical mixing should be reflected by their influences on density profiles. Therefore, the tidal effects have been automatically included in the estimated vertical diffusivity calculating based on density overturns.

3. "The authors said in the Abstract that vertical nutrient flux and turbulent diffusion effect to phytoplankton patchiness in the SCS. This sentence was corresponding to the first paragraph of the discussion (P6738). However, I cannot read discussion based on the authors' results, and thus the sentence in the abstract was introduced by the reviews of the previous studies by authors. In addition, this discussion was qualitative. The authors showed only percentages. Please discuss that how much percentage of new production is dominated by the vertical nutrient flux in the study area and period, and check the consistence to the authors' estimation."

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Response: It is based on our observations not from literature review. In the second and third paragraphs of the discussion (P6739, P6740), we have discussed the influence of turbulent diffusion and curl-driven upwelling on vertical nutrient fluxes and phytoplankton distributions in the NSCS based on our results. If I understand correctly, what the reviewer mean here is the contribution of vertical nutrient fluxes to the percentage of primary production ("new production is traditionally the percentage of primary production that is fueled by upward nitrate fluxes when atmospheric deposition and nitrogen fixation are not considered"). Nevertheless, we have provided estimations for the contribution of vertical nutrient fluxes to the primary production of stations A and B in the revised manuscript. Assuming a vertically constant rate of phytoplankton specific growth, a gram chlorophyll-to-carbon ratio of 0.03 and a molar C/N ratio of 6.625, we estimated a vertically integrated primary production of $\sim$12.3 mmolN/m2/d in station B and $\sim$1.8 mmoN/m2/d in station A. The contribution of vertical nutrient fluxes to primary production would therefore be $\sim$11% and $\sim$26% in stations B and A, respectively, which are comparable with the previous estimates of an f-ratio of 0.14-0.20 in the northern SCS from late March to October (Chen, 2005).

4. "The last sentence in the abstract was over-discussed. The authors did not investigate the phytoplankton composition, and they observed only one station near Dongsha. The authors pointed that the meso-scale eddies are formed near Dongsha (P6733L4), and the observation station was not considered the representative station of Dongsha."

Response: We don't think the statement is inappropriate as it is based on our observations during the study period. We do have pigment data to support the statements. Region of near southeast Dongsha Island has been well documented for its high turbulent mixing because of internal waves and eddies (e.g. Chang et al., GRL, 2006; Chow et al., JGR 2008).

5. [Specific Comments] Abstract: P6724 L10: What is "phytoplankton patchiness"? The abundance and/or community tructure?

Response: phytoplankton patchiness in the paper is referred as chlorophyll patchiness. We have clarified this in the revised manuscript.

6. Introduction P6724 L22: "while the mechanisms... are poorly understood in the SCS" I can see many previous studies as you shown in the Introduction. Why the mechanisms were poorly understood?

Response: What we mean is the inadequate understanding of mechanisms for vertical nutrient fluxes during the spring intermonsoon period with a prevailing low nutrient environment. We have rewritten the introduction paragraph in the revised manuscript.

7. Materials and method P6728 L12: Li and Hansell, 2008 is not the methodological paper and improper. The authors were measured the nutrient in the same system?

Response: We used the same analytical method of Li and Hansell, 2008 for high quality nutrient measurements in the NSCS.

8. P6730 L17: The dilution series was prepared 0%, but we did not see 0% at station B in Fig. 7.

Response: Sample of 0% dilution was not taken in station B during the cruise.

9. Results In this section, many discussions were seen. It is worth considering the aggregation as "results and discussion"

Response: We think it is better to keep the results separated from the discussion section, as there is only very limited amount of discussions provided in the section.

10. P6731L19: T-S diagrams are appropriate to divide the regions. Please consider to show it. T-S diagram was useful to explain the low temperature is originated to the upwelling of the deep-sea water (P6732 L6).

Response: A T/S diagram summary hydrography of the regions has been incorporated into Fig.1 in the revised manuscript.

11. P6732L10: Upward transport... Please show the high resolution data obtained by the sensors instead of the discrete data in Fig. 3a, b.

Response: We don't think it is necessary to replace Fig. 3a,b with high-resolution hydrographic data of CTD, as the upward transport along the shelf-slope is already very obvious in the figures. On the other hand, the resolution of discrete data of Fig. 3a,b will be consistent with data of nutrients and chlorophyll in Fig. 3c,d,e,f.

12. P6734L14: The uplifting of nutricline and the chlorophyll maximum was not seen at station C6.

Response: In Fig.3c, the depth of deep chlorophyll maximum in C6 is 50m following the shore-side uplift of isopycnal ïĄşïĄś 23.5 compared to the nearest station C7.

13. P6734L16: higher nutrient concentration at 250 m was not seen at station C11.

Response: It is a typo, it should be 200m depth (ïĄşïĄś of ∼25.5). The higher nutrient concentration at 200m in C11 was clearly seen in Fig. 3e-3f compared to the nearest stations of C10 and C12.

14. P6734L20: Elevated chlorophyll a was consistent with the high nutrient concentration at C11, but it was also associated with extremely high salinity. This saline water did not see in the deeper layers. I cannot agree with your discussion, which nutrient supplies from the deeper layers. I considered that this saline water indicate the importance of horizontal transport, which the authors ignored and did not discuss.

Response: We agree with the reviewer on the possible horizontal input in station C11 because of the high salinity. While, we argue that the horizontal gradient of nutrients within euphotic zone is considerably lower than the vertical nutrient gradient, therefore, vertical nutrient fluxes would be more important than the horizontal fluxes in offshore regions. Anyway, we have discussed this in the revised manuscript.

15. P6734L21: "below the euphotic layer" The optical sensor was attached to the CTD sensors? I cannot see in the M&M. How it was defined?

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Response: Euphotic zone is defined as the depth of 1% surface PAR (photosynthetical active radiation), which is about ∼100 m in the offshore regions according to measurements made in this cruise and many previous cruises in the same region.

16. Discussion P6740L7: The correlation was terrible. The r value was bad while the C9 was not contained.

Responses: Actually, we think the correction of 0.35 is good enough for biology already. It is certainly true that the correlation will reduce when C9 is included. We think it can be due to the net downward nutrient fluxes out of euphotic zone in this station.

17. P6741L21: The interpretation of grazing and growth was not clear. The nutrients were enriched to the bottles, and thus I think the growth rate was overestimated. How much and what type nutrient concentration were added to the bottles? Why it concluded the station A is stronger nutrient limitation than station B (P6738). How about phytoplankton community structures? I cannot agree with these discussions.

Reponses: As we have already pointed out in the method section of P6731L6, the natural phytoplankton growth rate (u), which is often subjected to nutrient limitation, is estimated from the net growth rate of raw seawater without nutrient enrichment (n_raw) by u=n_raw+g (see Landry et al., 1998). The samples were initially enriched with about 3 uM NO3, 3uM SiOH4 and 0.2 uM PO4. The statement of a stronger nutrient limitation is inferred from the much faster response of phytoplankton to nutrient additions and from the much higher nutrient specific consumption rates in station A than in station B. Picoplankton is dominated in station A, but diatom and picoplankton in station B.

18. Figures Fig.3: Salinity did not need the unit (per mill is wrong, at least).

Response: Symbol of ‰ has been removed from the label of salinity.

19. Fig.4: What indicate the Y-axis? Depth?

Response: it is depth on y-axis. We have added text “Depth [m]” to the y-axis.

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20. Fig.6: Why the breakpoint of nutrient concentration and gradient are same depth?

Response: Nutrient gradients are calculated from nutrient concentrations. They should have the same depths.

21. Fig.7: The label of the x-axis is wrong. This indicated that the maximum dilution factor is 1%. When you did not have the data of 0% at station B, do not draw the regression lines to 0%.

Response: It is a typo; % has been removed from x-axis in the revised manuscript. The regression line is automatically generated by excel, we don't see any need to remove the line between 0-0.25, as it won't have any impacts on our results.

Interactive comment on Biogeosciences Discuss., 12, 6723, 2015.

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