

Biogeosciences Discuss., author comment AC3  
<https://doi.org/10.5194/bg-2021-17-AC3>, 2021  
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## Reply on RC3

Jia-Jang Hung et al.

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Author comment on "Active and passive fluxes of carbon, nitrogen, and phosphorus in the northern South China Sea" by Jia-Jang Hung et al., Biogeosciences Discuss.,  
<https://doi.org/10.5194/bg-2021-17-AC3>, 2021

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### Reviewer 3

Major

- Authors here present a logic behind: what they all estimated in current work are all belonging to BP. But they don't ask readers' idea. What if some readers doesn't agree? To investigate vertical flux is important, but I don't think it is good to changing classic concepts without clarifying it.

Reply: Although "biologic pump" has widely used to represent active and passive fluxes, we agree with the reviewer's points (and also suggests from reviewer #1) and therefore the "BP" was replaced by active and passive fluxes in the revised manuscript except for citing previous reports that used BP in their papers.

- The zooplankton-related vertical fluxes, including gut flux, respiratory flux, excretory flux, mortality flux, how about the uncertainties? I would guess the uncertainties are large. If so, some of the authors conclusion may change accordingly.

Reply: The gut flux, respiratory flux, excretory flux, and mortality flux were widely regarded as major components of active fluxes (for example, Hannides et al. 2009; Hernández-León et al., 2019). You can find numerous papers using some of them as "active flux" regardless the incomplete estimate. Although each flux was derived from certain calculation under particular assumptions, the calculation was also based on in-situ data (for example, CTD, measured Chl-a data, and zooplankton data) rather than derived simply from modelling. The uncertainty contributed to the total vertical flux would be acceptable because of a fraction (1/3) of active flux to the total vertical flux. The active flux in the SCS will be improved certainly if more data are available. Unfortunately, very limited data are available at the current state in the SCS.

- Another question is how to persuade readers that by equations from other sites, the zooplankton-related vertical fluxes are still valid and make sense for the SCS case? For example, the Takahashi 2009 equation is from a subarctic pacific ocean, how can it be applied in the tropical SCS? how can respiration rate be the same between sharp habitat background? Even if yes, this meant large uncertainties, how to access its impact on your presented result and conclusion? I failed to see it.

Reply: I understand reviewer's concerns. However, the used carbon respiration rate that was not a specific value reported by Takahashi 2009; rather, it was estimated from the empirical equation that was dependent on in-situ temperature and zooplankton size. Therefore, the respiration rate was determined under considering the local ocean conditions.

- It is clear zooplanktons also breathe, release, eat, and excrete when they are in upper water columns. Some of them even die (e.g., be grazed by fish) when in the upper water columns. All these activities means that presence of zooplankton in the upper water column also contributes CNP to the upper water column. This is, I guess, in the reverse way the authors are discussing. I guess authors have considered and made calibration against this process. But I failed to see it. Can authors explain this more clearly? How they cancel out this part?

Reply: You don't need to worry about how zooplanktons eat, breathe, and excrete in the upper water column. The logic behind the active flux was that the flux was determined by migrators (difference between night abundance and day abundance in the top layer of 200 m) that carry carbon and elements through the water column without considering the metabolic states in upper and mesopelagic zones. All zooplankton's consumption and release (i.g. POC, DOC) in the upper layer may eventually have impacts on POC sinking fluxes or DOC vertical fluxes which belong to passive fluxes.

- I have doubts in simply comparing collected zooplankton biomass between day and night net. In addition to vertical migration, how to consider zooplankton lateral migration across slope area along with tide? Quite a few sites are on slope regions as is shown in figure 1. so these sites should be under such impact.

Reply: Overly concerned. The lateral flux is ubiquitous but active flux was not determined exclusively by the state of zooplankton abundance in a specific layer. Once again, the active flux was determined by vertical migrators that were determined by a period of time during repeated trawling at night and day. In addition, the effect of lateral migration on zooplankton abundance could be same at day- and night- time if there had pronounced tidal effects.

according to the methodology, I don't think the authors present results are PON, it is acid-rinsed PN. Some ON may be lost during acid rinsing process

Reply: I agree with reviewer's point. PON was replaced by PN in the manuscript.

- Vertical fluxes of DOC and DON: though I am not familiar with the way authors did the calculation, why the authors are sure the vertical flux is one-way only (from upper to bottom layer)? How if the upwelling or any other physical process that brings bottom water (hence DOC and DON) to shallower layers? I see usually DOC concentration vertically dropped from surface to bottom waters, but if there is upwell-like phenomenon, how to make sure the down-ward flux of DOM, as present in current work, exist?

Reply: Vertical fluxes of DOC and DON were determined by vertical concentration gradients and diffusivities. Any physical processes may affect DOC and DON concentration in depths but were not critical factors in determining DOM fluxes. The vertical flux was primarily determined by how DOM accumulates in the upper layers during stratification (e.g. summer) and vertical transfer during turbulent mixing in winter.

- Eddies indeed play an important role in determination of vertical fluxes. Recent work shows that in SCS, the detailed eddy information is also very important in its determination of ecosystem and biogeochemistry. At the edge of warm eddy, it can be

upwelling, whereas at the edge of cold eddy, it can be downwelling [1]. The timing of eddy is also important[1]. In current work, the site and timing of eddy information is missing. So it is hard to judge the eddy contribution to vertical flux.

Reply: Many thanks for comments and providing valuable paper for reference. We have added important information of anticyclonic eddy to the Discussion section, including the section 4.1 for the description and mechanism of eddy formation and section 4.2 in elucidating the effects of eddies on vertical POC fluxes. References (Xiu et al., 2010; He et al., 2019; Zhou et al., 2020) were added for citation in the text.

- Line580 extrapolate the entire SCS via continental-slope-based data should be viewed with caution, as slope region is different from basin area in SCS.

Reply: We understand the limit in doing extrapolation. Hopefully, the data will be improved while more data become available in the SCS.

### **Specific:**

Abstract: this sentence is confusing: Vertical fluxes of dissolved organic C, N, and P generally contributed to less than 5% of passive fluxes. In word, this is not logic. What do you mean?

Reply: The statement was revised (Vertical fluxes of dissolved organic C, N, and P were small (< 5%) relative to passive fluxes).

### Introduction

Line 49-50: This active transport may not only be important in sustaining the metabolic requirement of mesopelagic community, but also provide partial energy demand of mesopelagic ecosystem---this two aspects are the same thing.

Reply: The statement was changed (This active transport was important in sustaining the metabolic requirement of mesopelagic community through providing partial energy demand of mesopelagic ecosystem)

Lack of scientific question in the introduction part

Reply: Introduction was revised considering comments from all reviewers.

Line136 0.125 lack unit

Reply: Yes, done.

In offshore regions, SCS water is very clean and less of POM. Would it be enough to measure POC precisely based on only 1.5L of seawater? Authors should present their instrument detection limit accordingly.

Reply: This should be 1500-2500 ml after checking original data. Sorry for incorrectly applying ECS cases on the sampling statement. Thanks.

Line 227-228: ¼ □ Organic matter content was estimated from POC content by a factor of 2. What does this mean?

Reply: Adding ( $\%POM = \%POC \cdot 2$ ) to the sentence.

Line 395 Missing 'than'?

Reply: Ok, thanks.

Line 518 bracket wrong

Reply: Ok, thanks.