

Interactive comment on: “Impact of the Kuroshio intrusion on the nutrient inventory in the upper northern South China Sea: Insights from an isopycnal mixing model” by Du et al.

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Response to Anonymous Referee #2

In this discussion paper the authors examined the impact of the Kuroshio intrusion on the nutrient inventory in the central northern South China Sea (NSCS). To quantify the extent of the Kuroshio intrusion, an isopycnal mixing model was adopted to derive the proportional contribution of water masses from the SCS proper and the Kuroshio. This manuscript provides a preliminary analysis for understanding the spatiotemporal variations of nutrient in the upper layer (upper 100m) of the NSCS. The result is interesting and the analysis is scientifically valuable. However, I think this manuscript will be more convincing and can be published in BG if the authors can properly clarify/address the following questions.

[Response] We appreciate the positive comments from the reviewer.

1. In section 4.1, the authors made a comparison between the diffusive flux along and across isopycnal surfaces to support their statement of “isopycnal mixing was indeed prevailing over diapycnal diffusion in controlling the physical transport of nutrients in the upper central NSCS”. However, it is the total amount instead of flux that determines which one (isopycnal or diapycnal process) is dominated, that is, you should take their respective area (surface area for diapycnal mixing and cross sectional area for isopycnal mixing) into account. Moreover, vertical and horizontal advection has not been discussed, which could be far greater than isopycnal/diapycnal processes.

[Response] We appreciate the comment from the reviewer. It is true that for an Eulerian analysis, i.e. budget diagnosis of a control volume, advection may be far more important than the diffusion. It should be noted however that in water mass analysis based on the T-S diagram, advection is not that relevant. This is because that the advection has no direct contribution to the water mass formation or transformation. In the present case, the formation of any water mass containing a certain fraction of the Kuroshio water is through the mixing between Kuroshio water and the SCS water.

Without mixing, none of the observed water mass would have been formed. Also, in quantifying the relative contribution of the isopycnal and diapycnal mixing, we are working with a selected water mass, rather than a control volume, it is thus not necessary to integrate the area in calculating the fluxes. In addition, in this demonstrating comparison between the isopycnal and diapycnal flux, the calculation of nutrient fluxes along and across isopycnal surfaces is just to give the readers some qualitative understanding on the difference between isopycnal and diapycnal mixing. The overwhelmingly dominant role of isopycnal mixing can also be easily identified from the T-S diagram.

2. In section 4.4, p6955, lines 19-28, the authors calculated the new production for different seasons in the study area and compared it with previous studies. I noticed that the new production in winter is 7.4 ± 2.7 mmolCm⁻² d⁻¹ in this study, but still substantially lower than that reported by Chen (2005) (~21.7 mmolCm⁻² d⁻¹), this is considerable relative to the nutrient inventory (200-290 mmol m⁻² for N+N) and cannot be neglected. I suggest the authors to do a quantitative estimation on the nutrient budget to find out which one (vertical/horizontal mixing, advection, or biological production, etc.) is the major control factor and to evaluate their relative contributions.

[Response] We are aware of the discrepancy between our estimated new production and those based on the ¹⁵N addition method in our original submission and have stated that “The reasons for the discrepancy in the fall and winter new production estimates are unclear and require additional studies”.

We appreciate the reviewer’s comment towards budgeting the nutrient in the upper SCS. We have to point out that this would be an extremely difficult task because of the extremely dynamic nature of the system and the associated complicated biogeochemical processes. Future studies using numerical modeling might be helpful to resolve the full mass balance of the nutrients. At the same time, one of the initiatives of this study in the context of the complexity of the nutrients behavior, was to attempt to adopt the simple isopycnal mixing model to approach such issues, and we have demonstrated that such a simple mixing model was able to distinguish the physical mixing and the biogeochemical alteration.

Minor comments:

1. In section 3.3 or Fig. 4., I suggest use N+N to replace the SRP to keep consistency, since the authors stated that “we used N+N as an example throughout this paper unless otherwise indicated” (p6944, lines 22-23). Otherwise, justification for use SRP in this figure should be provided.

[Response] The reason that we used SRP was simply that there were not enough nanomolar N+N data collected in the upper layer at SEATS station during the four cruises.

2. P6953, line 28, “N₂-fixation is a net sink for the N+N inventory”, should be “a net source”.

[Response] Agree, modified as suggested.

3. Fig. 3. the legends, labels and titles are too small.

[Response] We have revised these figures.