Anonymous Referee #2

The Influence of Turbulent Mixing on the Subsurface Chlorophyll Maximum Layer in the Northern South China Sea by authors: Chenjing Shang et al. MS No.: os-2020-26

This manuscript considers biophysical implications of internal waves in the South China Sea using combined turbulence and nutrient data. While it is quite descriptive, the region and dynamics are very interesting and the results appear well-structured and can be considered in a wider context of other studies in the region. My general comment is it needs to clarify if it is a study about the generalities of SCM or is it primarily the biophysics of the South China Sea area? And the conclusion that a more turbulent region does more to diffuse and scatter a layer of increased productivity is not as clear and strong as it could be.

In terms of language and grammar, while the text is readable and meaning is generally clear, there are many awkward or incorrect wordings/structures/spellings that a language edit would quickly clean up and make for a much easier read.

Responses: Thanks for your comment and advice. The study is primarily the biophysics of the South China Sea area. We have revised the article carefully, especially the discussion section, as suggested by the reviewers. In addition, the colourmap of Figures 5-8 in the revised text was modified according to different variables, and a range more friendly colourmaps were used. The English has been improved by a natural English speaker (Figure R1).

Invoice

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Invoice

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Figure R1: Invoice of language editing.

Introduction

This section consists of two quite dense paragraphs. I think these could be broken up and expanded on a. In the first paragraph I wanted to know more about horizontal variability. In the second I wanted to know more about the region – e.g. the actual location Figure is not referenced until the Methods section.

Responses: Thanks for your comment and advice. We have broken the introduction into four paragraphs. More details about the observational region are added and the location Figure is referenced in the introduction (lines 29-86).

Line 52-on - as above it would be good to clarify if it is a study about the generalities of SCM or is it primarily the biophysics of the South China Sea area?

Responses: Thanks for your comment. The study is primarily the biophysics of the northern South China Sea. We've clarified this in the revised text (lines 82-83).

Line 62 – here and elsewhere values for dissipation rate are quoted. It would be good to get some sense of if these are average values or peak. This is especially true for internal wave driven processes which are typically sporadic – or at least spatiotemporally variable.

Responses: Thanks for your advice. More details have been added to the revised text (lines 58-69).

Line 71-73 It would benefit from a clear statement about the scientific question(s). Presently "In this study, the microstructure, Chl-a, and nutrient data obtained from two transects of the northern SCS are used to investigated the impact of turbulent mixing on the distributions of nutrient and Chl-a." seems quite vague. The material here has the building blocks of actual scientific questions, but they are not articulated. Is it all about internal waves? Are their horizontal nutrient gradients too? What are the temporal dynamics if it is internal wave mixing and this peaks for only a few hours every tidal cycle and shifting in/out of phase with daylight? Also, some later material on mixing parameterisation (lines 210-) might be better here or methods.

Responses: Thanks for your comment and advice. In the study, we investigate the effect of vertical turbulent mixing on the vertical distribution of nutrients and chlorophyll. Turbulent mixing here is the result of the effects of internal waves with various frequencies and wavelengths. Without time series data, we cannot explore how the internal waves affect the vertical turbulent mixing at different periods and locations. We are also unable to explore the effects of horizontal transport on the distribution of nutrients and chlorophyll due to the lack of horizontal turbulent mixing and horizontal flow data. We have added more details about our research in the introduction (lines 82-86). We have removed the mixing parameterization since it is not really relevant to the content of the article.

Methods

Fig 1 – a zoom out would help locate for the unfamiliar. Also – how extensive are the results of Zhao et al. 2004 – do internal waves never penetrate to transect A? Line 88 what frequency ADCP?

Responses: Responses: Thanks for your advice. We have embedded a zoomed-out map in Fgiure 1. The internal wave packets in Zhao et al. 2004 are extracted from satellite images acquired from 1995 to 2001. Their results are extensive in the northern SCS. Internal wave packets propagate westwards to the continental shelf and dissipate there. Almost no internal wave packets penetrate to transect A. The ADCP we used is a 38 kHz ADCP. We have added the frequency to the revised text (lines 115-117).

Line 94: Turbomap – I didn't think this was a Rockland Product. Line 109-116 Turbulence analysis – there are some quite sophisticated and widely used methods for this. Were they used? Various references by Lueck, Wolk and colleagues look at vibration limit identification and replacement of the missing spectral region. Why was 1 m chosen as bin size?

Responses: Thanks for your comments and questions. We removed the 'Rockland Scientific Inc.' in the revised text (line 123). We used an integrated software application TMTools^{TM} developed by Alec Electronics Co., Ltd. to derive the dissipation rate (lines 133-135). 1 m was chosen because the instrument itself swings at low frequency during the free falling process. These low-frequency oscillations would contaminate the low wavenumber region of the spectrum.

Line 122 – "time interval of turbomap"? You mean the individual profiles of the full sampling period?

Responses: Yes, averaged velocity during Turbomap measurement.

Results

There are many brief statements here that would better fit in the Discussion in a more expanded form. E.g. lines 161-162, 178-179

Responses: Thanks for your advice. We have moved these statements to the introduction (lines 58-62).

Line 190-191 – better placed into methods.

Responses: Thanks for your advice. We have moved it to the methods (lines 145-146).

Lines 210-on The Gradient Ri gets introduced here which seems strange. It is not

clear why it is required as there exists direct measures of turbulent mixing? Saying that, I do see the point about high vs low shear and stratification.

Responses: Thanks for your comments. We deleted this part in the revised text.

Discussion

This section is unstructured and would benefit from some clear themes building from the introduction. I think this needs significant work to give it structure and better bring together the results.

Responses: Thanks for your advice. We have reconstructed the discussion carefully (lines 301-351).

Lines 260-262 - Instead it starts with some introductory material.

Responses: Thanks for your advice. We have fixed it in the revised text (lines 291-293).

Line 260 “chaotic”? Is it actually chaotic or under-sampled? Under-sampling is inevitable in some situations so it is important to be clear. Do we have any sense of nutrient spatial variability beyond the transect data? e.g remote sensing or is the suggestion that these data are of limited use due to the subsurface biological processes?

Responses: We apologize for our inappropriate expression. It is not under-sampled. What we want to express is that the distribution of nutrients in transect B is scattered. We have deleted this word to avoid ambiguity (line 290).

We can obtain the sea surface chlorophyll a from ERDDAP (https://coastwatch.pfeg.noaa.gov/erddap/index.html), which is showed in Figure 1. Sea surface chlorophyll a in the region where transect B located was higher than that in the region where transect A located, which suggests that there were more nutrients in the surface layer to support the primary productivity of the region where transect B located. Strong nutrient flux induced by turbulent mixing plays an important role to transport nutrients from deep layer to surface layer.

Lines 359-375 - I don’t really see the need for separate conclusions especially as they have much in common with abstract.

Responses: Thanks for your comments. We incorporated the conclusions into the discussions (lines 378-395).

Can you plot biological production as a function of the nutrient flux in a way that shows how the two transects differ/compare?

Responses: We cannot estimate biological production due to the lack of data. The relation between Chl-a concentration and $NO_2 + NO_3$ flux is shown in Figure R2. There is no good correlation between Chl-a concentration and $NO_2 + NO_3$ flux. This is expected since nutrient flux is related to the turbulent mixing and the strong nutrient flux mainly occurs in the upper layer, while Chl-a mainly appears in SCML.

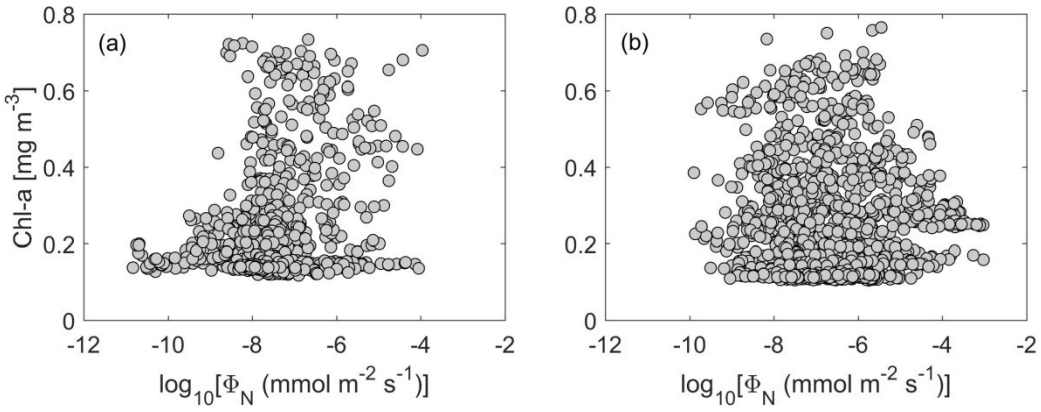

Figure R2: Chl-a concentration plots against $NO_2 + NO_3$ flux for (a) transect A and (b) transect B.

Can you develop some kind of regime diagram where we have internal wave activity, nutrient availability and wind/upwelling and somehow present your findings for production in these terms? Seasonality gets a minor mention but it would be useful to discuss more fully how these present results could/would translate through the annual cycle.

Responses: We have developed a regime diagram (Figure R3). It is not good as we expect. So we decide not to put it in the text. We have added some discussion about the seasonality in the revised text (lines 385-395).

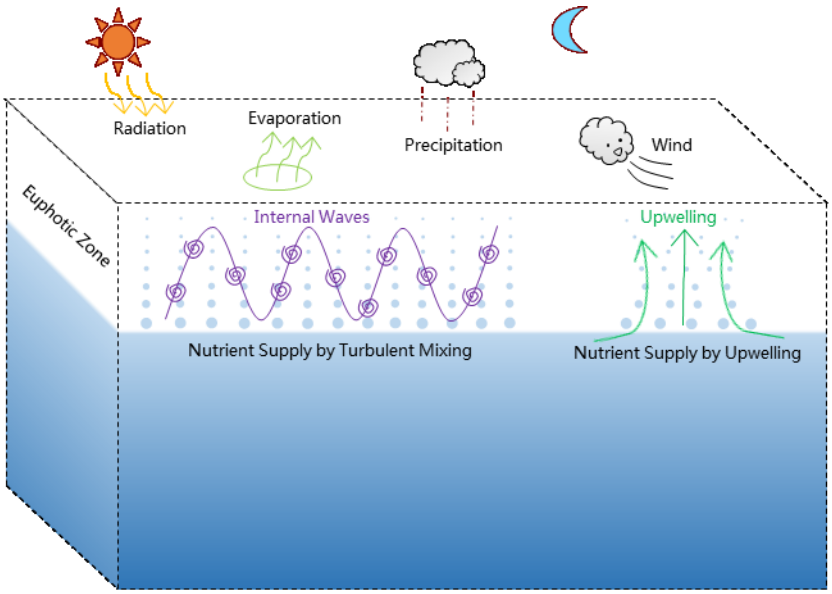

Figure R3: Sketch (not to scale) showing some dynamic processes that are related to nutrient supply.

Minor

Potential temperature – some confusing notation and labelling – be good to be clear and use the accepted symbolic notation for potential temperature θ_0.

Responses: Thanks for your advice. We have replaced "T" with "θ_0" for potential temperature (line 180).