Referee Comment No.3:

General comment:

The manuscript “A Limited Effect of Sub-Tropical Typhoons on Phytoplankton Dynamics” by Fei Chai et al. describes the upper-ocean response, in terms of specific physical and biogeochemical features (temperature, mixed layer depth, chlorophyll, deep chlorophyll maximum), to the passage of Typhoon Trami (TT) offshore southern Japan coasts (Northwest Pacific Ocean). The issue has been already investigated in literature, recently showing that the overall role played by tropical cyclones on global primary production is quite limited (e.g. see Menkes et al., 2016, using ocean simulations). The novelty here is the use of high-frequency sampling vertical profiles of temperature and chlorophyll made available by a BGC-Argo float located near the Typhoon wake. BGC-Argo data significantly extend the amount of observations in comparison to what usually extracted from satellite, able to measure the surface in cloud-free conditions only. Conclusions show that mixing plays a larger role than upwelling, and TT weakly impacted on net primary production.

The manuscript is short and clear, with few but significant figures, very well explained and commented. However, I would point out some suggestions that may improve this study.

Dear Reviewer,

Thank you so much for providing the positive feedback on our manuscript; your endorsement is highly encouraging. We truly appreciate the valuable comments, which are important for improving the manuscript. We hope the revised manuscript fully meet your expectations. Please let us know if you have further comments.

1. I think the paper would greatly increase its impact with some more deep investigation on the vertical mixing *vs* upwelling mechanism and the associated nutrient vertical flux, further supporting the thesis that no penetration through nutricline has effectively occurred. For example, would it be possible to include in the study some nutrient data (e.g. from a model, if not available from other sources) in order to fully demonstrate the typhoon impact as explained by the analysis of the BGC-Argo float measurements? As an example, data from EU Copernicus Marine Service could support the analysis of the physical driver (Global Analysis & Forecast Physics at 1/12 degree), though not the same can be said for the biogeochemical parameters since the resolution at 1⁄4 degree is possibly too coarse. I wonder whether Japan or China Ocean Forecasting operational centres may provide such model-derived data, or they can be available from other platforms. Another, probably more feasible, possibility would be to use a 1D-model approach, as the one developed by Terzic et al. (2019; https://doi.org/10.5194/bg-16-2527-2019) coupled with BFM biogeochemical model. In this direction, the study would surely benefit a lot from a model experiment which could reproduce the phenomenon and give the opportunity to deeply investigate the coupled physical-biogeochemical processes involved.

Response: Thanks for the comment. The current study focuses on the use of a high-frequency vertical observation to study the impact of a typhoon on the upper ocean, e.g., temperature and chlorophyll. It will be ideal to have the nutrient observations from BGC-Argo, but unfortunately, the BGC-Argo was not equipped with nitrogen sensor. On the other hand, no net change was identified for chlorophyll and bbp within the top 150 m (Figure 3d), indicating that there was no net production being generated in the upper ocean. Following your suggestion, we have investigated the typhoon-induced nutrient changes by combining reanalysis data from HYCOM, climatological profiles from the World Ocean Atlas (WOA) and obtained BGC-Argo data in the current study. However, the HYCOM reanalysis is not capturing the typhoon-induced changes during the passage of typhoon (Figure R1). The climatological nitrogen profile in September and October shows low value (< 2 μmol/kg) within the upper ocean till 125m, corresponding to the nutricline depth. Thus, in this case, the typhoon-induced mixing cannot introduce nutrients into the upper ocean, and the redistribution of nutrients within the mixed layer cannot stimulate the net growth of phytoplankton. Our conclusion is consistent with the model result from Menkes et al. (2016), showing limited contribution of typhoons to promoting net primary production. The suggested reference is very helpful to guide future studies. As such, we will employ a numerical model to simulate comprehensively upper ocean processes during typhoon passage as typhoon-induced changes may vary considerably across individual cases, depending on typhoon characteristics and oceanic conditions. Nevertheless, it is important to note that the main conclusion of this study (i.e., limited contribution of typhoons to promoting net primary production) is important but may not be applicable to all cases of typhoons.

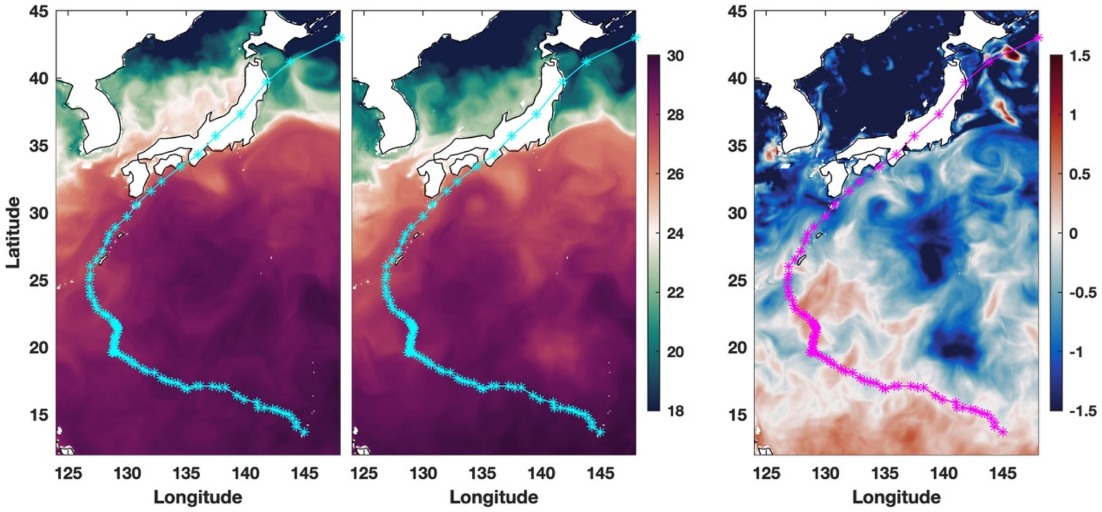

Figure R1. The sea surface temperature (SST) averaged for the period (left) before, e.g., between Sep. 16 and Sep. 30, and (middle) after, e.g., between Oct. 1 and Oct. 15, the passage of typhoon Trammi whose trajectory is shown in cyan color. (right) The change of SST, e.g., the averaged SST after typhoon minus the averaged SST before typhoon.

2. The paper focus is on typhoons, however, from the point of view of a reader, it would be interesting to know whether the results may be extended to all intense tropical cyclones (on the global scale) and which differences may be expected (also referring to literature) with extra-tropical cyclones.

Response: Thank you for the suggestion. Indeed, the current study focuses on a single typhoon based on the unique BGC-Argo observations. The result is representative of a general situation and can be applicable for other tropical cyclones. We have added a general discussion and conclusion on the application of the acquired information. However, it is important to point out the typhoon-induced ocean responses can vary depending on the feature of the typhoon, e.g., the strength and translation speed, and the status of the upper ocean including the mixed layer depth, stratification, nutrients and chlorophyll. There are some classic (Babin et al., 2004) and recent studies (Lin and Oey, 2016; Lin et al., 2017; Wang, 2020) that investigated the prototypical oceanic responses to tropical cyclones by compositing different tropical cyclones. Their results can be representative for delineating the typhoon-induced changes, since the investigated scenario is highly representative in typhoon intensity and trespassing environment. Corresponding text has been added in the revised manuscript (L. 256-264, 283-290).

3. Some typos and language editing are needed. Since I am not English mother-tongue I have only highlighted some points, but my feeling is that the paper readability would greatly benefit after a language editing.

Response: Thank you very much. Following your suggestion, we have requested language editing by a native English speaker. We hope the improved manuscript can ease your concern.

Specific comments:

1. L30: “an increase in the number of intense typhoons in the region” ... how is quantified the intensity of typhoons? Readers of Biogeosciences may not be totally aware of typhoon intensity scale, so maybe a short comment can be added here. Further, the intensity classification has also been object of wide discussions (e.g. Lei et al., 2017, www.sciencedirect.com/science/article/pii/S2225603218301589), so a clarification may be worth.

Response: Thank you for the suggestion. The information for typhoon intensity is added in the revised manuscript, along with the associated reference (L. 125-131).

2. L38: “resulting in a negative response proposed to **facilitate** continued global temperature increase” ... do you mean “support, sustain”? ...not totally clear, please explain and rephrase.

Response: Thank you for the comment. Because of increased stratification resulted from global warming, the typhoon can hardly elevate ocean primary production that can relax the warming by absorbing carbon dioxide (He and Soden, 2015). The reduced primary production accelerates the warming trend. The ‘negative response’ can lead to misunderstanding for readers, and we have removed it and rephrased the sentence to improve the clarification (L. 36-41).

3. L49: “e.g., category 4 or 5” ... this may be clearer when specific comment n. 1 has been fulfilled.

Response: Thank you. The description for the intensity of the typhoon is incorporated in the revised manuscript following your suggestion (please see response to Specific Comment No. 1 above).

4. L59-L68: the mechanism is clearly explained, though concisely. I think an illustrative sketch with mid-latitude / extra-tropical vs tropical regions would further help the reader to understand it.

Response: Thank you for the suggestion. The majority of BGC-Argos currently in the water are in the Antarctic Ocean. In the future, we plan to deploy more BGC-Argos in the mid-latitude and tropical western Pacific, and we hope they can offer a more comprehensive description for the typhoon’s impact in regions with different stratification, vertical structure of nutrients among others.

5. L74: “It was suggested that the delayed response of surface chlorophyll is related to the growth time needed for phytoplankton to exploit the increased nutrient concentrations” ... it would be interesting to explicitly add (or at least give a reference for) a time scale for the growth time.

Response: Thank you for the comment. The typical growth rates of phytoplankton, e.g., the time required to double the biomass, is around few days, depending on the species of phytoplankton. Previous studies revealed a diatom bloom 3 days after the passage of a typhoon in the Northwest Pacific Ocean (Pan et al., 2017). In addition, substantial works based on satellite observations indicated that the chlorophyll peak happens between 5 and 7 days after a typhoon, which was suggested to be the time required for phytoplankton accumulation (Wang, 2020). Corresponding information has been added in the revised manuscript (L. 81-83).

6. L94: “Float data passed through a computer-based real-time quality control (RTQC)” some basic details about the RTQC would be helpful.

Response: Thank you. The float data was quality controlled following the requirement of the BGC-Argo Program (Schmechtig et al., 2016), and this information has been added to the manuscript (L. 108-112).

7. L100: “MODIS L3 daily data” please provide more info for this data here, not just in the Acknowledgements.

Response: Done. The information is added in the method section (L. 114-118).

8. L106: “On September 30, a sublayer formed above the mixed layer.” ... where this information is extracted from? Fig.2 seems the right candidate, so you should refer to that one here.

Response: Thank you very much for the comment. Actually, the sublayer is not influential on the calculation of MLT and MLC, thus the related text is removed in the revision.

9. L115-119: this information can be included in the “Methods” Section.

Response: Deeply appreciate your nice catch. There is indeed some duplication between the pointed results and method. We have removed the description for Argo sampling from the result. Thank you.

10. L133-136: a slight increase in surface Chla can be observed between 25 and 28 September, corresponding to weakening of the DCM chlorophyll intensity: can you comment on that? Moreover, the “reference baseline” of the surface Chla should be the one measured until 24 September, with almost constant values around 0.05 mg/m^3. Finally: any idea on the discrepancy between satellite and BGC-Argo following the second peak, later than 4 October?

Response: Thank you for asking; this is definitely a good question. The slight increase in Chl is related to the seasonal evolution of the mixed layer (ML), which is deepening associating with increasing wind (Figure 3a). In the current study, BGC-Argo is moving northward by 120 km from Sep. 20 to Oct. 3 (Figure R2). Specifically, BGC-Argo locates at 133.1°E, 30°N on Sep. 25, 133°E, 30.7°N on Sep. 30, and 133.3°E, 31.1°N on Oct. 3. As BGC-Argo approaches the coast, the vertical distribution of chlorophyll changes with weakening of the DCM and an increasing MLD. The climatological MLD, which is derived from the World Ocean Atlas (WOA; Locarnini et al., 2018) following the method of Kara et al. (2000), for the float location in the north is 30 m, 46 m and 66 m on August, September and October, respectively, while that in the south is 28 m, 41 m and 60 m, correspondingly. Thus, the movement of BGC-Argo, though it travels a small distance, can end up in a different environmental, which can be captured in the sections. The elevated surface Chl is at least related to the gradual deepening of the ML (Figure 2b), which simultaneously increases the surface temperature (Figure 4a). The process is different from the typhoon induced dynamics that tends to decrease temperature and increase Chl at the surface while increase temperature and decrease Chl at the subsurface. The corresponding information is added to the discussion (L. 149-154, 188-190, 248-252).

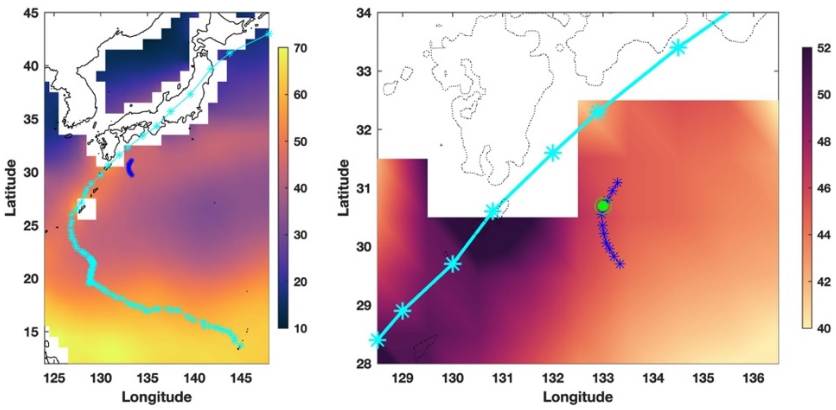

Figure R2. The averaged mixed layer depth (meter) in September and October overlaid with the trajectories of typhoon (cyan color, from Sep. 20 to Oct. 1) and BGC-Argo float (blue color, from Sep. 23 to Oct. 3). The right panel is showing an enlarged region showing the trajectory of the float, with the location on Sep. 30 labeled in green, corresponding to the location shown in Figure 1.

The reference is important for determining the responses of the upper ocean. In this study, we used the original time series as much as possible, but we needed to use the anomaly for acquiring typhoon-induced changes, e.g., Figure 1 and 4. Because the longevity of typhoon spans from Sep. 21 to Oct. 1, a 20 day average before (Sep. 10 to Sep. 30) and after (Oct. 1 to Oct 20) the typhoon is used to capture the pre- and post-typhoon situation for the entire region. For the location of BGC-Argo, only a 7-day average, e.g., Sep. 13 to 19, is applied as the reference. This is because the typhoon can induce ahead-of-eye cooling (Glenn et al., 2016) and the ocean surface responses can take place much earlier before its arrival (Figure 2c; Wang, 2020). Because the obtained anomaly in temperature and chlorophyll are close to zeros (Figure 4c), the different is less prominent for the period from Sep. 13 to 19 and from Sep. 19 to 24. Thus, the reference is defined using the period much earlier.

The observed difference in chlorophyll after October 2 is believed to be related to the limited observations of the satellite. The typhoon can induce strong rainfall associated with large area being covered by cloud (Lin and Oey, 2016); thus, the available satellite data are often sparse. In addition, the coastal region is characterized by high chlorophyll and can still impact the region, though the area less than 10 km from the coast is excluded. As more satellite observations become available, the difference between satellite and BGC-Argo data may be less pronounced on October 10 or later (Figure 2d).

11. L230: "The BGC-Argo floats typically provide three-dimensional observations at a 10-day profiling cycle to extend their operational lifetimes (Johnson and Claustre, 2016), a sampling frequency too low to capture synoptic weather and other short-term events." ... Totally right, however BGC-Argo floats may also have shorter profiling cycles, e.g. 5-day (see Bittig et al., 2019; www.frontiersin.org/articles/10.3389/fmars.2019.00502/full).

Response: Excellent point. Your suggestion is absolutely consistent with the message we hope to deliver in the current study, along with typhoon-induced mixing. The sampling frequency is critical, as different profiling cycles can result in various conclusions. For example, the applied BGC-Argo is sampling one cycle per day, which can resolve the peak of chlorophyll on Sep. 30. However, if we adjust the sampling frequency to once every 5 days, the likelihood of missing the peak would be 80%. We have discussed this in-depth in one of our recent publications on GRL (Xing et al., 2020), and a consistent statement is added in the revised manuscript. Even so, we now refer to float cycling times of 5-10 days (L. 275-277).

Technical / other corrections:

1. L28: "the heat content in the upper ocean (with the sea surface temperature (SST) as the indicator)" ... possibly: "the heat content in the upper ocean (**quantified by** sea surface temperature (SST) as an indicator)" or something similar.

Response: Done.

2. L43: "The feedback from ocean to typhoon is important for the development and maintenance of typhoons, as **the** requires extracting energy from ocean surface" ... maybe "it"?

Response: Done.

3. L67: "thereby **transfer** new nutrients into the photic zone" ... maybe "transferring"?

Response: Done.

4. L70: "Besides the intensive wind field, typhoons are also **associating** with intensified rainfall and cloud" ... maybe "associated"?

Response: Done.

5. L71: "Satellite-based studies occasionally capture the ocean surface **feature** during the passage of typhoon and offer **more dataset** at the wake following typhoons" ... maybe "features" and "more data" or "a richer dataset", or something similar?

Response: Done.

6. L83: a short sentence closing the Introduction which states the object of the present work would be nice.

Response: A brief summary for the introduction and the object of the paper is added (L. 93-95).

7. L95: "Data used in this study **are available at from** the Coriolis GDAC FTP server" ... maybe "have been made available from" or simply "are available from"?

Response: Done.

8. L108: MLT and MLC acronyms – though clear – have not been properly defined. You could simply say "We define MLT and MLC as ..."

Response: Thanks. The definitions are added (L. 135-143).

9. L127: "Figure 2a, **b**" ... according to Fig.2, this should be Fig. 2a, c.
10. L132: "Figure 2b, **c**" ... according to Fig.2, this should be Fig. 2b, d.

Response: Thanks for the suggestion. We have modified the text when referring to sub-panels in Figure 2 (L. 158, 163).

11. L193: "This is at least attribute to the solar radiation is much weaker comparing with tropics where the SST and stratification rebound quickly after passage of a typhoon" ... this sentence should be corrected: "This is at least **attributed** to the solar radiation **which** is much weaker comparing with tropics where the SST and stratification rebound quickly after passage of a typhoon".

Response: Done.

12. L208: two "indeed" in the same sentence, please correct.

Response: Done.

13. L213: "The decreasing in SST is a general pattern", what do you refer to "general"? Do you maybe mean "well-known"?

Response: Done.

14. L218: "The BGC-Argo measures vertical profiles that can be helpful to determine whether a net increasing in primary production, e.g., nutrient injection to upper ocean or subsurface bloom (Ye et al., 2013), taking place." ... this sentence should be corrected: "The BGC-Argo ~~**measures**~~ vertical profiles ~~**that**~~ can be helpful to determine whether a net increasing in primary production, e.g., nutrient injection to upper ocean or subsurface bloom (Ye et al., 2013), **takes** place."

Response: Done.

15. L241: "redistribution of DCM over the mixed layer;" ... I would say "redistribution of the DCM-localized chlorophyll content over the mixed layer" or something similar.

Response: Done.

16. L242: "the delayed bloom that induced by typhoons may be due to the cloud coverage during the passage of typhoon. Thus, it implies an underestimation for the typhoon induced mixing and its associated vertical redistribution of water masses, while the impact of nutrients that being injected into euphotic zone can be overestimated." ... this sentence should be corrected: "the delayed bloom ~~**that**~~ induced by typhoons may be due to the cloud coverage during the passage of typhoon. Thus, it implies an underestimation for the typhoon induced mixing and its associated vertical redistribution of water masses, while the impact of nutrients ~~**that**~~ being injected into euphotic zone can be overestimated."

Response: Done.

17. L421: caption of Fig. 5 ... blue dashed lines should correspond to vertical profiles before typhoon, red solid lines should correspond to vertical profiles at the typhoon passage on 30 September; blue/red dashed arrows mean decrement/increment (of T and Chla, values lacking in the 100m - layer) ... please confirm and add to the caption.

Response: Thank you very much. Corresponding information has been added in the caption.

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