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Discussions

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Interactive comment on "Biogeochemical characteristics of suspended particulates at deep chlorophyll maximum layers in the East China Sea" *by* Qianqian Liu et al.

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Anonymous Referee #2

General overview

The manuscript of Liu et al. is focused on characteristics of suspended particulate organic matter (SPOM) in the deep chlorophyll maximum (DCM) of the Eastern China Sea (ECS) during summer 2013. It is based on bulk descriptors of SPOM (C/N and POC/Chl a ratios as well as $\delta 13C$ and $\delta 15N$). The mains findings are: 1) DCM SPOM mainly originates from in situ primary production, 2) terrestrial POM slightly or insignif-

icantly contributes to DCM SPOM composition, and 3) the latter is contradictory to previous studies but illustrates the drastic decrease in the contribution of the terrestrial POM originating from the Yangtze River to the SPOM composition in the ECS. These findings are sounded and clearly illustrated by the present data set.

The manuscript is well organized and usually well illustrated.

It is of broad audience for scientist who are interested in organic matter cycling and land-to-sea export. It is within the scope of BG. However there are some issues in the present version of the manuscript that preclude the acceptance of the manuscript in its present version. These issues are:

- a lack of information in the methods - many unneeded details and miscellaneous information that are not needed in the discussion, that rend the discussion too wordy and that dilute the main messages of the study. Authors should focus on what the data indicate, which is usually very clear. - interpretations of $\delta 15N$ data set that are not correct or at least very partial. This data set cannot be published within this manuscript without deeply reconsidering its interpretation and without additional data set regarding N-nutrient (at least nitrate and ammonium) concentrations. There are also some inconsistencies and language errors that have to be corrected. Thus, I recommend major revision

Reply: Thank you very much for your appreciation on the overall performance of the manuscript and critics on the discussion part and interpretations of $\delta 15N$ data.

Detailed comments

Referee 2: Section 3: lack of information and details needed Conversion of fluorescence into chlorophyll a concentration: Since Chl a is a key parameter of the study and is used to calculate POC/Chl a ratio (which values are compared to reference values), it should be explained how in situ fluorescence was converted into Chl a concentration.

Reply: Chlorophyll a was determined spectrophotometrically according to Lorenzen

(1967) and Aminot and Rey (2000). However, we randomly measured five SPM samples (DH1-2, DH2-1, DH3-1, DH7-1 and DH7-7; Fig. R1) from water depths between 20 m and 70 m. Linear correlation between the fluorescence values obtained directly from the calibrated sensor attached with the CTD rosette and our measured values is high with R2 = 0.93 (Fig. R1). Therefore, as mentioned in Page 11, Lines 18-21 in the original manuscript, we applied Chl a values obtained in situ by fluorometer without any conversion in this study.

Referee 2: Section 3.1, line 9: indicate the range of depths of the samplings for SPM.

Reply: The sentence has been revised as follows:

To investigate the biogeochemical characteristics of POM in DCM layers of the southern East China Sea, suspended particles around DCM water depths (10-130 m) were collected from thirty-six stations along seven transects across the continental shelf by the Science Cruise during summer (June 22-July 21) 2013 (Fig. 1).

Range of sampled depths (10 m -130 m) is also mentioned in Table 1.

Referee 2: Section 3.1: indicate how the filters were rinsed right after the filtration

Reply: In this study, filters were not rinsed/washed after the filtration. Therefore, the sentence has been revised as follows: After filtration, un-rinsed filters were folded and wrapped again in aluminium foil and stored at -20 °C immediately in a freezer onboard before they were brought back to the laboratory for further analysis.

Referee 2: Section 3.2, line 28: detail how the filters were treated with HCl 1N

Reply: A half of each filter with SPM was placed in a polyethylene culture dish and 3 ml of 1N HCl was then added into the dish by a dropper and allowed them to react 16 h to remove inorganic carbon (mainly carbonate).

Referee 2: Section 3.2, line 30: indicate the diameter of the punches

Reply: The diameter of filter has been included in the revised version as follows: Then

a half of de-carbonated filter (i.e. a quarter of the original GF/F filter - 11 mm) was then punched in tin capsules for further analysis.

Referee 2: Section 3.2, lines 30-31: it looks like δ15N and PN were analyzed on the decarbonated part of the filter. Why not on the un-decarbonated part of the filter? There is always chance to bias δ15N and PN using decarbonated material for these measurements (e.g. Lorrain et al (2003) and other references). Also, it looks like there was a very small part of the filters that were analysed for C and N elemental and isotopic composition. What quantities of C and N were analysed?

Reply: We thank the referee to bring the reference Lorrain et al. (2003) to our kind attention. Lorrain et al. (2003) cautioned that the measurement of PN and δ15N after freezing increases the uncertainty of δ15N and in combination with concentrated HCl treatment, leads to a loss of PN and alteration of the δ15N signature. However, previous studies in the East China Sea always followed freeze-drying and carbonate removal using 1N HCl to analyse four parameters (POC, PN, δ13C and δ15N) from a single filter.

In general, SPM collected close to the major river-dominated margins contain particles, including particulate inorganic carbon in the form of calcite, aragonite and dolomite, either supplied from the land and/or from the surface productivity. When we deal with the particulate organic matter that produced mainly by primary producers (i.e. phytoplankton), PN and δ15N values obtained using de-carbonated filters are more appropriate than such values obtained from the un-acidified filters. Similar methodological approach has been adopted by Wu et al. (2003) while investigating suspended particles along the PN transect in the East China Sea and by Hung et al. (1996) while studying the suspended particles in the entire East China Sea. For instance, the range of PN and δ15N values obtained in the present study is comparable to the range of PN and δ15N values obtained by Wu et al. (2003) (δ15N: ca. 0.7-9.4‰. Since we made a comparative discussion of our δ15N data with the data of Wu et al. (2003), similar pretreatment of samples is a prerequisite for such comparison. On the other hand, Gao

et al. (2014) collected the SPM along the Changjiang transport pathway in different seasons and measured PN and δ15N with the un-acidified filters. In their paper, δ15N values are mostly shown as a distribution diagram and the range of scanned δ15N values (ca. -3.0 to +9.4‰ indicate that the presence of inorganic N might be responsible for negative δ15N values or δ15N measured in their study may not fully represent the true range of δ15N composition of organic matter in their study area.

In our study, the amount of measured C and N ranged from 68.24-322.18 μg and 14.46-64.69 μg, respectively. Precision for δ13C and δ15N decreases for samples containing less than 100 μgC and 20 μgN, respectively. Among thirty-six filters analyzed for the present study, only five (three) filters contain less than 100 μgC (20 μgN).

Influence of CDW at DCM depth in the ECS

Referee 2: It cannot be stated that the influence of CDW in the study site is nil or insignificant. The low salinity measured at some of the sites (Fig. 3) clearly indicates the influence of CDW. It is mainly the case in surface water but also the case at some of the DCM depths where water was sampled for SPM (stations DH1-1, DH2-1, DH2-2, DH3-1 and CON02). This is also clear from Fig. 6b where five stations falls within the SMW square, SMW being clearly a water body composed of a mixing between KSSW and CDW.

It should better be written that the influence of CDW in the study site is low (see some of the 'minor points' below) or weak (as written in section 5.1, P8, line 34).

Reply: As suggested by the Referee, we have softened the tone of the influence of CDW shown in Fig. 3 and Fig. 6b in the revised text.

End of section 5.1 (P9, lines 1-9) and Fig. 7 Referee 2: Only the DCM depths (= the depths of interest for the present study) should be considered for delineate the polygons of Fig. 7. Was it the case? For similar reason, I think that the sentence "Interestingly...study area (Fig. 7)" should be deleted or reworded without citing Fig. 7

(but rather Fig. 3?) since it is quite confusing. Another option may be to not cite depth limitation of the water masses influences but only describe Fig. 7.

Reply: We disagree with this suggestion mainly because the conditions of how different water masses (CDW, TWCW and KSSW) are influencing the DCM depths are shown in Fig. 6b. Further, in Fig. 7 we delineated areas influenced by three water masses both horizontally and vertically for the entire water column. Furthermore, the water masses were delineated based on the T-S combination and therefore, citing Fig. 3 along with Fig. 7 is fine, but deleting the mention of Fig.7 without water depths may mislead the meaning. Therefore, based on Referee's suggestions, we revised the first paragraph of section 5.1 as follows:

5.1 Influence of different water masses in the southern ECS

In order to identify the different water sources in the study area, temperature–salinity (T-S) diagrams were drawn for the entire water column (Fig. 6a) as well as for the SPM sampling depth around DCM layers (Fig. 6b). The T-S diagram for all the water depths (Fig. 6a) shows a convergence at around 17 $^\circ$C, 34.6, representing the upwelling of KSSW (Umezawa et al., 2014). There are two trends in the T-S diagram, indicating a mixing of three water masses: one is less saline and much colder water, mainly CDW, another is more saline and warmer, mainly Taiwan Warm Current Water (TWCW), and the third one is KSSW (Fig. 6a). The shelf water in the entire ECS in summer 2013 was mixed primarily by three water masses, CDW, KSSW, and TWCW (Fig. 6a). The low salinity observed at five coastal sites (DH1-1, DH2-1, DH2-2, DH3-1 and CON02) indicates the influence of CDW mostly in surface water, but also some of the DCM depths where water was sampled for SPM (Fig. 3). This is also evident from Fig. 6b where these five stations fall within the area of SMW, which is a water body composed of a mixing between CDW and KSSW. However, except these five coastal stations, most DCM depths where water was sampled for SPM seem to be weakly influenced by the CDW (Fig. 6b). Based on the T-S range of different water masses (Fig. 6), we further delineated the area influenced, along with water depths, by three important

water masses: CDW, TWCW and KSSW (Fig. 7). Interestingly, the influence of CDW was constrained only in the upper 0-10 m in five coastal stations during the sampling time, whereas TWCW influences around 0-30 m, covering three-fourths of the study area, and KSSW seems to be largely influenced the bottom water of the entire study area (Figs. 3, 6a and 7).

Referee 2: The last paragraph of section 5.1 is also quite confusing. Reword it as: "In summary, although the river runoff was huge, the influence of CDW plume in the southern part of the ECS was insignificant during summer 2013, mainly because most of the CDW plume was transported to northeastward of the Yangtze estuary to the Korean coast (Isobe et al., 2004; Bai et al., 2014; Gao et al., 2014). This contrasts with summer 2003 when the plume front moved southward (Bai et al., 2014). Meanwhile, the intrusion of TWCW and KSSW was strong in the continental shelf of the East China Sea during summer 2013."

Reply: The last paragraph of section 5.1 has been reworded exactly, as suggested by the Referee.

Section 5.2.1 Referee 2: I fully agree the main conclusions of this section and most of data interpretations (especially the first and the last paragraphs).

However the second paragraph adds detailed discussion with literature comparison that is not needed (especially when dealing with zooplankton and Trichodesmium) for the present study. Authors should better goes directly to the conclusion (i.e. the last paragraph) without diluting the main conclusions with unneeded wording. Thus, the second paragraph should be deleted.

Reply: As suggested by the Referee, the second paragraph of section 5.2.1 has been deleted in the revised version.

Section 5.2.2 Referee 2: As for the previous section, I fully agree the main conclusions and most of the data interpretation, but this section is too wordy and gives too many

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details (especially too many values from the literature). Authors should better focus on the main information and the main conclusions.

Thus, I suggest the following:

Referee 2: - P10, lines 26-34: one-two sentence(s) should be enough

Reply: Lines 26-34 have been shortened/revised as follows:

Moreover, the POC/Chl a ratio of 35.3 g g–1 derived from the slope of a regression line (y = 35.3 ($\pm$8.56) x + 44.0 ($\pm$6.27) (Fig. 8b) is consistent with the reported POC/Chl a ratios in the ECS, (36.1 g g-1; Chang et al., 2003) and the North-western Pacific (48 g g-1; Furuya, 1990). However, our POC/Chl a ratio is lower than that estimated (64 g g-1) for the sinking particles in the ECS and the Kuroshio region, off northeast Taiwan Island (Hung et al., 2013). The range is well within the range (13–93 g g-1) reported by Chang et al. (2003) in the ECS and estimated (18–94 g g-1) from phytoplankton cell volumes by the same authors.

Referee 2: - P11, lines 2-4: keep this sentence but rephrase the last line as "filtered particles (Chang et al., 2003; Hung et al., 2013)"

Reply: As suggested, the sentence has been rephrased as follows: Although the Chl a concentration in our study was measured in situ by fluorometer attached with the CTD, it is more or less similar to Chl a concentrations obtained in the above-mentioned studies, which were mostly extracted from filtered particles (Chang et al., 2003; Hung et al., 2013).

Referee 2: - P11, lines 8-10: do not report all these values

Reply: These lines have been modified in the revised version as follows: The POC/Chl a ratio of living phytoplankton was reported to be between 40 and 140 g g-1 (Geider, 1987; Thompson et al. 1992; Montagnes et al. 1994; Head et al. 1996).

Referee 2: Regarding the high POC/Chl a ratio, did authors check if these high values

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were rather due to very low Chl a concentration or high POC concentration? If the former, these high values may be associated to high uncertainty on the Chl a estimation when values are low. If the latter (high POC concentration associated to Chl a concentration similar to surrounding stations), this may be effectively due to heterotrophic biomass.

Reply: In this study, only two SPM samples contain high POC/Chl a ratios of >200 g g-1 (DH5-2: 369 g g-1 and CON02: 617 g g-1). Although both show neither high POC concentration (DH5-2: 62.6 μg L-1, CON02: 92.6 μg L-1) nor high Chl a content (DH5-2: 0.17 μg L-1, CON02: 0.15 μg L-1), the Chl a values in these two stations are relatively low, as shown in Fig. 8b. Therefore, higher POC/Chl a ratio in these two SPM samples is perhaps because of the uncertainty associated with the estimation of Chl a using fluorometer on board.

Section 5.3: first three paragraphs Referee 2: I fully agree the main conclusions and the data interpretations of the first three paragraph of this section.

I suggest authors to have a look at Lowe et al. (2014) and Miller et al (2013): these articles are of interest for the present section.

Page 12, Lines 18-26: two other processes may influence phytoplankton δ13C: temperature and degradation. This is discussed in Savoye et al. (2003) that authors cite in many occurences. Authors may have a look at biplots like δ13C vs temperature and versus POC/Chl a and C/N (considering these ratios may also indicate phytoplankton decay). They also may check the normalization of δ13C by temperature (as in Savoye et al., 2003) before plotting normalized δ13C versus POC, since temperature usually have (indirect) influence on phytoplankton δ13C.

Reply: As directed, a section 5.4 on "Temperature effect on δ13CPOC" data has been included in the revised version as follows:

5.4 Temperature effect on δ13CPOC data

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Apart from primary production and the growth rate and species composition, temperature and biomass degradation may influence the carbon isotopic composition of phytoplankton (Savoye et al., 2003; Miller et al., 2013; Lowe et al., 2014). Temperature has an indirect effect on isotopic fractionation between phytoplankton carbon and dissolved CO_2, and therefore on phytoplankton δ13C (e.g., Rau et al., 1992; Savoye et al., 2003). The C/N ratio, POC/Chl a ratio and δ13CPOC indicated that the POM around DCM layers is dominated by newly-produced phytoplankton OM (see Sections 5.1-5.3). Therefore, to understand the temperature effect on δ13C of phytoplankton, we plotted our δ13CPOC data against temperature into two groups by separating approximately at ~24°C (Fig. 2Ra). Data points of both groups show a decreasing δ13C of phytoplankton biomass while temperature increases at DCM layers in the southern East China Sea (Fig. 2Ra). Such a relationship is in contrast to the positive relationship between these two variables observed for the surface ocean around the world (Sackett et al., 1965; Fontugne, 1983; Fontugne and Duplessy, 1981).

The negative relationship between δ13CPOC and temperature is likely related to biological activity and carbonate dissolution equilibrium, both may control the dissolved inorganic carbon concentration in the DCM layers, which are closer to euphotic depths (see Section 4.1). The weak correlation between δ13CPOC and temperature supports a weak influence of temperature on δ13CPOC around DCM layers in the southern East China Sea (Fig. 2Ra). A decrease in fractionation of approximately -0.56‰ °C-1 is estimated for POM collected at <24°C, whereas a decrease in fractionation of roughly -0.51 °C-1 is estimated for POM collected at >24°C (Fig. 2Ra). In order to distinguish the influence of biological parameters from temperature on δ13CPOC, the δ13CPOC data were corrected for the 'temperature effect' by normalizing the data using an equation: δ13CPOC = f (T).

Since most of our δ13CPOC values come from the DCM layers and the δ13CPOC is negatively correlated with temperature, we applied our own temperature coefficients (-0.56‰ °C-1 and -0.51‰ °C-1) and δ13CPOC was normalized at 24°C (i.e. the mean

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temperature at sampled water depths) using the formula (Savoye et al., 2003):

δ13C24$°$C = δ13C - s (T - 24), where δ13C24$°$C is the temperature-normalized δ13CPOC, T is the seawater temperature in $°$C from water depths where SPM sampled, and s is the slope of the linear regression δ13CPOC = f (T) in ‰ $°$C-1 obtained from Fig. 2Ra. There are significant correlations between δ13C24$°$C of biomass and POC concentration (circles: R2 = 0.71; p<0.0001; n = 18 and triangles: R2 = 0.66; p<0.0001; n = 18; Fig. 2Rb), indicating that primary production drives ∼70% of the variation of phytoplankton δ13C around DCM layers in the southern East China Sea. On the other hand, δ13C24$°$C correlated insignificantly with POC/Chl a ratio and C/N ratio (Figs. 2Rc and 2Rd), implying that degradation has a minor effect on the isotopic composition of POM in this study.

Section 5.3: last three paragraphs

Referee 2: I do not think that the last three paragraph of the section are needed. The objective of the two paragraphs before the last (from "The nutrient N/P ratio" to "this mechanism is most likely") is to decipher whether POM sampled in the DCM came from in situ production or from surface production (cf. the fourth paragraph of the section). In fact, these two paragraphs lay on very putative argumentation and do not allow (and are not convincing in) deciphering between the two hypotheses. These hypotheses have already been discussed in sections 5.2.1 and 5.2.2 with sufficient argumentation for considering that POM mainly came from in situ production. To my point of view, these two paragraphs of section 5.3 are not needed in this section neither in the manuscript.

Reply: As suggested, these two paragraphs have been deleted in the revised version.

Referee 2: The last paragraph of the section is a tentative of inventory of POC in the DCM layer. The estimation is very rough, is associated to large uncertainty, and the calculation is not convincing. It is also completely disconnected from the rest of the section, which is focused on δ13C dynamics (see the title of the section). Again, this

paragraph is not needed in this section neither in the manuscript. Thus, the last three paragraphs of the section should simply be deleted and the fourth paragraph of the section ("The range... DCM layers?") should be replaced with a brief conclusion of the first three paragraphs of the section.

Reply: We agree that the POC inventory in the DCM layer has been done approximately and therefore can be deleted in the revised version.

Referee 2: Section 5.3 would better stand with the first three paragraphs and a conclusion without the unclear and unconvincing last three paragraphs.

Reply: As suggested, all three paragraphs have been deleted in the revised version.

Section 5.4 Referee 2: This section is the less clear and the less convincing of the manuscript. The main conclusion (POM δ15N distribution is primarily governed by the nutrient status and δ15N of nitrate) is mainly guess. One of the main issues of the section is the lack of nutrient data. This rend the data interpretation mainly guesswork. Another issue is that authors mainly take into account nitrate as a nutrient for phytoplankton. Ammonium appears only in the last paragraph. The other species of N-nutrient (N2, dissolved organic nitrogen as urea) are not mentioned. However, it is reported that "Kuroshio Water and TWCW induced Trichodesmium" (P10, line 7). Thus, PN δ15N values should also be discussed considering N2-fixers (diazotrophs). At last, many sentences are not clear. This gives the impression that authors do not fully have in mind what processes drives PN and phytoplankton δ15N.

Thus, this section should be deeply reworked including deep data re-interpretation. To me, such section dedicated to PN/phytoplankton δ15N cannot stand without data of nutrient concentration originating from the same cruise. If these data are not available, PN/phytoplankton δ15N cannot be discussed. If it would be the case, δ15N data should be removed from the manuscript.

Reply: Thank you for the suggestion! At present, we don't have depth profiles of ni-

trate or ammonia or nitrogen isotopic composition of nitrate to strengthen the PN/δ15N data and related interpretations. To our knowledge, all our interpretations of PN/δ15N are based on our understanding of nitrogen dynamics in the ECS and are consistent with the literature cited. This part is also appreciated by Referee 3, but also suggested to strengthen the interpretations using depth profiles of nutrients. However, there is no much information related to δ15N data, especially from the biota-dominated DCM layers, in the East China Sea. Since we proved that the POM is dominated by phytoplankton, publishing δ15N data of this study may create some awareness/interests among readers to conduct such investigations in the marginal seas of the western Pacific in detail. Given this, we request anonymous reviewers and Associate Editor to allow this section for publication because we interpreted PN/δ15N data based on the published information from the East China Sea with some speculations, a practice that is normally encouraged in the scientific field when the availability of data is relatively less such as δ15N.

Section 5.5 Referee 2: This section gives an important conclusion: the influence of terrestrial POM (mainly originating from the Yangtze River) has drastically decreased in the ECS. This section is mainly based on literature data and conclusions. These inputs from the literature are of interest, but the section should also compare data from the present study with previous data. Thus, this section should start with the comparison of POC/Chl a and C/N ratios, and δ13C values between the present study and previous studies. Then, the decrease of terrestrial POC fluxes and deposition can be cited (literature data). Last lines of the section: there are again unneeded details in these lines. Avoid describing the degradation index but directly give the conclusions of Wu et al (2007b).

Reply: As directed, section 5.5 has been revised as follows:

We examined elemental and isotopic compositions of carbon and nitrogen (POC, PN, δ13C and δ15N) in suspended particulate matters and water column hydrographic and environmental parameters around the deep chlorophyll maximum (DCM) layers in the

continental shelf of the southern ECS during summer 2013. The range of POC/Chl a obtained in this study (26-200 g g-1) is within the range (<200 g g-1) reported for the phytoplankton-dominated POM in the coastal and shelf waters (e.g., Chang et al., 2003; Savoye et al., 2003; Hung et al., 2013; Liénart et al., 2016). We obtained a narrow range of C/N ratio (4.1-6.3), but a wide range of δ13C (-25.8 to -18.2 ‰ compared to previous studies in the ECS (Liu et al., 1998; Wu et al., 2003). Our results indicated that POM around the DCM water depths was largely derived from the synthesis of in situ phytoplankton and the influence of terrestrial OM supplied by the Yangtze River in the ECS is low. The missing of terrestrial OM signals seems to be related to reservoir and dam buildings along the river in recent years that has shifted the location of the Yangtze-derived POC deposition from the inner shelf of the ECS to terrestrial reservoirs (Li et al., 2015). The sediment delivered from the river to the estuary has reduced by 40 % since 2003 when Three Gorges Dam (TGD) has completed (Yang et al., 2011 and references therein). Recently, Dai et al. (2014) reported that the particles discharged by the Yangtze has declined to 150 Mt yr-1, less than $\sim$70% of its sediment delivery to the ECS during 1950s. Although 87 % of the mean annual sediment of Yangtze River was discharged during the flood season from June to September (Wang et al., 2007; Zhu et al., 2011), approximately 60 % of the fine-grained sediments are temporarily deposited near the estuary and then later resuspended and transported southward along the inner shelf, off the mainland China coastline (Chen et al., 2017 and references therein). The Yangtze-transported POM moves up toward the northeast across the shelf along the so called the Changjiang transport pathway in summer season (e.g., Gao et al., 2014), which is largely driven by the combined effects of high river discharge, southwest summer monsoon and the intensified TWC (Beardsley et al., 1985; Ichikawa and Beardsley, 2002; Lee and Chao, 2003). The T-S diagrams (Figs. 6 and 7) of this study also illustrate this view.

Accompanying with the decreasing sediment input, dam building in the Yangtze River basin has buried around 4.9$\pm$1.9 Mt yr-1 biospheric POC since 2003, approximately 10% of the world riverine POC burial flux to the oceans (Li et al., 2015). The POC input

flux from the Yangtze to the ECS (range: 1.27-8.5 x 1012 g C yr-1; Wang et al., 1989; Qi et al., 2014) was significantly less than the estimated primary productivity (72.5 x 1012 g C yr-1; Gong et al., 2003), implying the predominance of marine-sourced organic matter in the ECS. Moreover, the substantial quantity of organic substances that transported by the Yangtze River may be completely modified before being ultimately deposited onto the ECS inner shelf and being transported further offshore (Katoh et al., 2000; Lie et al., 2003; Chen et al., 2008; Isobe and Matsuno, 2008). Wu et al. (2007b), for instance, observed an advanced stage of POM degradation in the entire Yangtze River with an average degradation index of -1.1. Based on the investigation of lipids biomarkers in a sediment core collected from the ECS, Wang et al. (2016) suggested the dominant preservation of marine autochthonous organic matter ($\sim$90 %) in the ECS.

English language Referee 2: The language is usually quite understandable, but there are many errors or mistakes. Part of them is listed in the 'minor points' below. Nevertheless, the whole manuscript should be deeply checked for English language.

Reply: The whole manuscript has been carefully checked for grammatical errors.

Inconsistencies Referee 2: There are some inconsistencies between values that are cited in the text and values reported in the tables (see 'minor points' below). Please, check the consistency between all the values reported in the text and tables.

Reply: Cross-checked and corrected.

Abstract, Introduction and Summary and conclusions Referee 2: Sections 'Abstract' and 'Summary and conclusions' should partly be re-written taking into account the above detailed comments.

Reply: As suggested, these parts have been modified.

Referee 2: The third objective that appear in section Introduction should be removed (see one of my comments dedicated to section 5.3 âËŸAËĞT three last paragraphs

âËŸAËĞT above).

Reply: The third objective in the Introduction part will be deleted in the revision.

Minor points

- P1, Line 20: what do you mean with 'straddling'?

Reply: It means locating or moving around DCM depth intervals.

- P2, line 9 and in the whole manuscript: replace 'endmember' with 'end-member'

Reply: Replaced.

- P3, line 8: remove 'which in turn, the elemental and isotopic compositions of marine productivity' since it is not correct

Reply: Deleted.

- P5, line 1: depending what you want to say, add 'by' or 'to' between 'decreased' and '86%'

Reply: As suggested, 'by' is added.

- P5, line 17: replace 'had' with 'have'

Reply: Replaced.

- Last sentence of section 3.1: place this sentence in section 3.2 since it is not sample collection. Rename section 3.2 as 'Determination of SPM concentration and analysis of POC, PN, δ13C and δ15N

Reply: The last sentence of section 3.1 has been shifted to section 3.2. As suggested by the Referee, section 3.2 has also been renamed in the revised version.

- P5, line 30: replace 'with' with 'and placed in'

Reply: Replaced.

- Section 3.2, P5-6, sentence "organic carbon and nitrogen ... entering the IRMS": remove the sentence since such level of detail is not needed

Reply: The sentence has been deleted in the revised version.

- Section 3.2: remove the three last sentences ("Conventional...Sigman et al., 2009" since the first one is unneeded detail and the two last ones do not stand in a section dedicated to methods.

Reply: As suggested, the last three sentences in section 3.2 have been deleted in the revised version.

- P6, line 22: add 'usually' between 'profiles of Chl a' and 'show'.

Reply: Added.

- Section 4.1.3: since Fig. 3 illustrates at maximum the first 300m of the water column and since the sampling depth was within this depth interval, please do not describe deeper water, either the reading is quite disturbing. Thus, the temperature ranged between 30 and ca. 15 °C.

Reply: We agree with the Referee's view and therefore the paragraph describing the range of temperature has been revised as follows:

Figure 3 illustrates the vertical distributions of temperature and salinity along seven transects in the ECS. In the entire study area, temperature in the 300-m water column varied from 15 °C to 30 °C and distinct water column stratification was evident from the temperature profiles (Fig. 3). The temperature decreases when depth increases and the highest temperature (>30 °C) seen mostly in the surface water and the lowest temperature (5 °C) was observed in stations DH7–8 and DH7-9 at water depths of 850 m and 800 m, respectively (not shown). Temperature at sampling depths of SPM ranged from 19.1 °C to 28.2 °C, showing a general decreasing trend from the inner to outer shelf in each transect (Fig. 3).

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- P7, line 16: replace 'increasing' with 'increases'; reword "with the high temperature (>30 °C) spreads widely".

Reply: Replaced. Please see our reply to the previous comment.

- P7, line 29: replace 'insignificant' with 'low'.

Reply: Replaced.

- P8, line 4: '4.4' or '4.5' as reported in table 1?

Reply: The correct value is 4.4 and it is corrected in Table 1.

- P8, line 5: '17.7' or '17.8'?

Reply: The correct value is 17.7 and Table 1 is corrected accordingly.

- P8, lines 7-8: please also indicate where the highest POC and PN concentration were located.

Reply: The following sentence has been included in the revised version: The highest concentrations of POC (263 μg L-1) and PN (52.8 μg L-1) are associated with station DH5-1 (Fig. 4).

- P8, line 17: '8.0' or '7.8' as reported in Table 1?

Reply: The correct value is 8.0 and Table 1 is revised accordingly.

- P8, lines 17-18: please also indicate where the highest δ13C values were located.

Reply: The following sentence has been included in the revised version: Consistent to the POC concentration, the highest δ13CPOC value (-18.2 ‰ is also associated with station DH5-1.

- P8, line 21: Fig. 10 is cited before Fig. 5. Check the numbering of the figures.

Reply: Fig. 10 is cited after Fig.5, which was cited just above in the text. We have cross-checked all figure numbers in the revised version.

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- P8, line 33: SMW is a water body that is composed of a mixture between two other water masses (CDW and KSSW; Fig. 6). So, do not consider SMW as a water mass and remove it from this list.

Reply: Removed.

- P10, line 25: remove the word 'moderate' since this information is not useful here.

Reply: Deleted.

- P10, line 29: '48' or '52' as reported in Table 2?

Reply: According to Table 2, the value 48 is for the northwestern Pacific and the number 52 is for the western Pacific. As suggested by the referees, Table 2 has been deleted in the revised version.

- P11, line 28: replace 'less' with 'low'; delete "and unrecognized content of terrestrial POM".

Reply: Replaced and deleted.

- P12, 2: replace 'to be' with 'would be'.

Reply: Replaced.

- P12, line 8: replace 'more positive' with 'less negative'.

Reply: Replaced.

- P12, line 34: delete 'As for species,'.

Reply: Deleted.

- P13, line 7: delete 'that'.

Reply: Deleted.

- P13, line 8, 9 and 10: replace 'larger' with 'higher'

Reply: Replaced.

- P13, lines 9 and 10: replace 'size species' with 'phytoplankton'

Reply: Replaced.

- P15, line 33: replace 'significantly less' with 'low'.

Reply: Replaced.

- P16, line 12: replace 'proved' with 'illustrate'.

Reply: Replaced.

- Table 1: add POC/Chl a values in this table; indicate in the caption what means 'SD'.

Reply: POC/Chl a ratios have been included in Table 1 with SD abbreviation has been indicated.

- Figure 1: indicate KSSW on the figure; be consistent with Fig. 6. Indicate on this figure the location of the stations that appear on Fig. 2 and 3 but were not sampled for SPM in the DCM.

Reply: Fig. 1 shows the simplified current pattern in the ECS, and the center of the upwelling region. As one of the water masses, it is appropriate to show KSSW in Figures 6 and 7 along with other water masses.

Stations where SPM were not sampled at the deep chlorophyll maximum layer are listed in Table S1 and those stations are also marked in Fig. 1 in the revised version (red circles in Fig. 1).

Figure 6: the two colours are not distinguishable. Choose other colours. Remove 'from' in the second line of the caption. Add 'were' after 'matters' in the third line of the caption.

Reply: The two colours in Figure 6 are changed. Other corrections are included, as suggested.

Figure 7: replace 'black' with 'grey' in the second line of the caption.

Reply: Replaced.

Figure 8: first line of the caption: it is POC vs. PN and POC vs. Chl a.

Reply: Corrected.

Additional references

Lorrain A., N. Savoye, L. Chauvaud, Y-M. Paulet and N. Naulet, 2003. Decarbonation and preservation method for the analysis of organic C and N contents and stable isotope ratios of low-carbonated suspended particulate materiel. Analytica Chimica Acta, 491, 125-133. Lowe, A. T., A. W. E. Galloway, J. S. Yeung, M. N. Dethier, and D. O. Duggins. 2014. Broad sampling and diverse biomarkers allow characterization of nearshore particulate organic matter. Oikos. 123: 1341–1354, doi:10.1111/oik.01392 Miller, R. J., H. M. Page, and M. A. Brzezinski. 2013. _13C and _15N of particulate organic matter in the Santa Barbara Channel: drivers and implications for trophic inference. Mar. Ecol. Prog. Ser. 474:53-66, doi:10.3354/meps10098

Reply: These additional references are included in the revised version.

Thank you very much.

Additional References

Aminot, A., and Rey, F.: Standard procedure for the determination of chlorophyll a by spectroscopic methods, ICES Techniques in Marine Environmental Sciences, Copenhagen, Denmark, 8-11, 2000.

Fontugne, M. R.: Les isotopes stables du carbone organique dans l'océan: application à la paléoclimatologie, PhD thesis, Université de Paris XI, 1983.

Fontugne, M. R, and Duplessy, J. -C.: Organic carbon isotopic fractionation by marine plankton in the temperature range -1 to 31°C, Oceanol Acta, 4, 85-90, 1981.

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Lorenzen, C. J.: Determination of chlorophyll and pheo-pigments: Spectrophotometric equations, Limnol. Oceangr., 12, 343-346, 1967.

Lowe, A. T., Galloway, A. W. E., Yeung, J. S., Dethier, M. N., and Duggins, D. O.: Broad sampling and diverse biomarkers allow characterization of nearshore particulate organic matter, Oikos, 123, 1341-1354, 2014.

Miller, R. J., Page, H. M., and Brzezinski, M. A.: δ13C and δ15N of particulate organic matter in the Santa Barbara Channel: drivers and implications for trophic inference, Mar. Ecol. Prog. Ser., 474, 53-66, 2013.

Rau, G. H., Takahashi, T., Des Marais, D. J., Repeta, D. J., and Martin, H.: The relationship between δ13C of organic matter and [CO2(aq)] in ocean surface water: data from a JGOFS site in the northeast Atlantic Ocean and a model, Geochim. Cosmochim. Acta, 56, 1413-1419, 1992.

Sackett, W. M., Eckelmann, W. R., Bender, M. L., and Bé, A. W. H.: Temperature dependence of carbon isotope composition in marine plankton and sediments, Science, 148, 235-237, 1965.
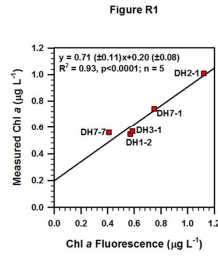
Figure R1. The relationship between the concentration of Chl *a* measured in the laboratory and the fluorescence values obtained using *in situ* fluorometer onboard.
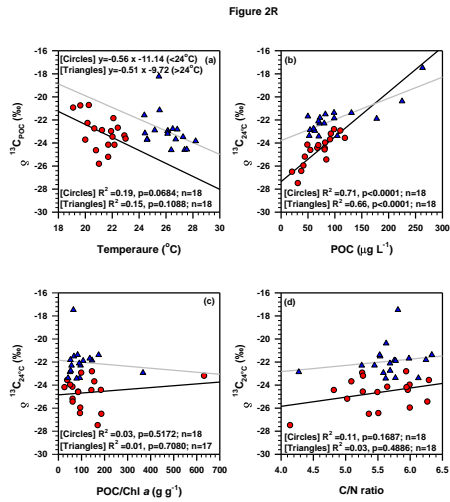
Fig. 1. Figure R1

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Figure R2. Bi-plots showing the relationships of (a) $\delta^{13}C_{POC}$ vs. temperature for samples separated into two categories based on temperature: <24 ℃ and >24 ℃, (b) temperature-normalized $\delta^{13}C$ ($\delta^{13}C_{24\,℃}$) vs. POC concentration, (c) $\delta^{13}C_{24\,℃}$ vs. POC/Chl *a* ratio and (d) $\delta^{13}C_{24\,℃}$ vs. molar C/N ratio in suspended particulate matters from the deep chlorophyll maximum layers in the southern East China Sea.
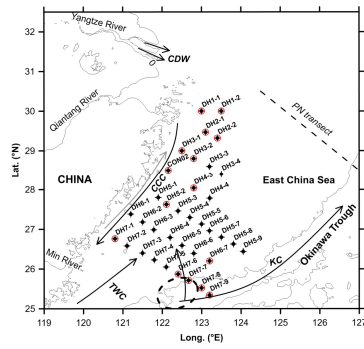
Fig. 2. Figure R2

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Figure 1. Map showing the locations of suspended particulate matters (SPM) collected around the deep chlorophyll maximum (DCM) layers from the East China Sea (ECS) during summer (June 22–July 21) 2013 for the present investigation. Also shown are the modern current patterns in the ECS. Red circles mark the SPM samples that were collected either below or above the DCM layer. CDW – Changjiang Diluted Water, CCC – China Coast Current, TWC – Taiwan Warm Current and KC– Kuroshio Current. The dashed ellipse represents the center of Kuroshio upwelling due to an abrupt change in the bottom topography in the northeast of Taiwan Island (Wong et al., 2000). Also shown is the PN transect, a cross shelf transect that is relatively well studied for particulate organic matter dynamics in the East China Sea.
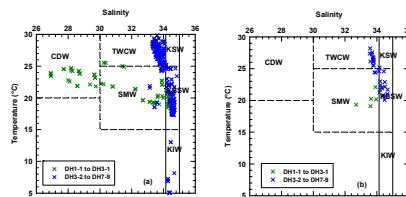
Fig. 3. Revised Figure 1

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Figure 6. Temperature–Salinity (*T*–*S*) diagrams for (a) the entire water column in the East China Sea and (b) the deep chlorophyll maximum layers where the suspended particulate matters were collected for the present investigation. *T*–*S* ranges of six water masses are taken from Umezawa *et al.* (2014). TWCW – Taiwan Warm Current Water; SMW – Shelf Mixed Water; KSW – Kuroshio Surface Water; KSSW – Kuroshio Subsurface Water; KIW – Kuroshio Intermediate Water.

Fig. 4. Revised Figure 6