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Biogeosciences Discussions

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10, C713–C719, 2013

Interactive Comment

Interactive comment on "Monthly measured primary and new productivities in the Ulleung Basin as a biological "hot spot" in the East/Japan Sea" *by* J. H. Kwak et al.

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Dear Editor and Reviewer,

Thank you very much for reviewing our manuscript. We have tried to revise the manuscript in line with the suggestions made by the reviewers. Our response to each point suggested by the second reviewer is as following.

General comments

It's necessary to always be careful on the calculation and make sure if the data are "reasonable". Here, PP in the winter and the calculation of new carbon production should be checked again. This paper could be published, but only after major revision.

→ The general comments are indicated as specific comments below. Accordingly, we have tried to revise carefully all the points suggested by the reviewer.

Specific comments

1. Figure 1. Apparently, the primary production are compared among the different regions in the East/Japan Sea. It's an important part in this paper to represent the role of UB as a "hot spot". What I suggest is you should plot the whole EJS in your Fig. 1 and give the borders of those different regions. You could also add some important physical processes like TWC or fronts which is described in the discussion.

→ As indicated by the reviewer, we have inserted geographic features and currents of the East/Japan Sea in the Figure 1. (See Fig. 1)

2. Page 2142, Line 21-24, The assimilated C/N ratio is used to estimate the new carbon production. Is the value 3.4 a depth-integrated value? If so, it is a wrong way to calculate the new carbon production in this paper. In general, primary production is significant lower in the bottom of euphotic zone than in the surface, and it's reverse on the new production. Meanwhile, the assimilated C:N ratios are also different among layers. So you must calculate the new carbon production layer by layer with the accurate assimilated C:N ratios, then integrate the values by depth. I believe that the recalculated export ratio of primary production will be lower than your current prediction (78.0%).

→ We agree to the reviewer's point and have therefore recalculated the new carbon production as suggested by the reviewer. As the reviewer suggested, the recalculated export ratio of primary production is lower than our previous value. We have changed the previous results to the recalculated values in the revised ms as follow: "Based on the C/N uptake ratio in the each layer, new carbon production by phytoplankton was estimated as 145.6 g C m^{-2} yr^{-1} (S.D.= ± 40.8 g C m^{-2} yr^{-1}), indicating that a large portion (53.9 %) of total annual primary production might potentially be exported from

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the euphotic zone to the deeper zone in the UB."

3. Figure 8. In summer, PP decline from a spring bloom is normal in a temperate water. But it seems PP didn't change a lot from summer to winter. It is unusual because there was a great decrease on temperature and also on irradiance in theory. It seems not "reasonable".

→ We have checked our calculations but couldn't find any problem. Although primary productivity at the each layer in winter was lower than that in summer, the depth of euphotic zone in winter was deeper than that in summer. Therefore, the value integrated from the euphotic zone in winter seems to be relatively high. Furthermore, the values in winter are similar with satellite-derived data reported on Yamada et al. (2005). This phenomenon is also explained by little variation of integrated chlorophyll a concentration from summer to winter.

4. Approximately estimated normalized optimal production rates (PBopt) in June 2010 and September 2010 in UB1 from figures in the paper are >14 mg C mg Chla m−3 h−1 and <3 mg C mg Chla m−3 h−1, respectively. These values are above or below one σ range of PBopt at 20 degree which was reported on Behrenfeld and Falkowski's paper in 1997. That's a great change between these two values. From June to September, the chlorophyll a biomass didn't decrease, temperature didn't become lower as well, and even more nitrate and silicate. You should give some explanation to this decline that could support the higher production rates you measured compared to other studies in the same area.

→ Since our study area is located at 37 degree (Fig. 1), our normalized optimal production rates much wider than range of PBopt at 20 degree (Behrenfeld and Falkowski's paper in 1997) could be not strange. In addition, we found that the highest normalized productivities in June 2010 (15–30 mg C mg Chla m−3 h−1) were observed at the surface (100 % light penetration depth; 0 m) and sharply decreased with depth, whereas the highest values in September in 2010 (2–4 mg C mg Chla m−3 h−1) were observed

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at the subsurface layer (50–5 % light penetration depth; 10–30 m). If we calculated them layer by layer with the accurate value at each depth, the range of the normalized optimal production rates in June (7.6 mg C mg Chla m−3 h−1) and September (1.6 mg C mg Chla m−3 h−1), 2010 is not as wide as your estimation from figures. Normally, an integrated euphotic depth, uptake efficiency of phytoplankton (normalized optimal production rate in this case), and phytoplankton biomass (POC, not chl-a concentration) are used for calculating integrated production. Although the normalized optimal production rate as an indication of phytoplankton's uptake efficiency decreased from June (7.6 mg C mg Chla m−3 h−1) and September (1.6 mg C mg Chla m−3 h−1), 2010, other factors such as deeper euphotic depths and higher POC concentrations compensates for the lower efficiency and might sustain a relatively high production in September. Annual primary production estimated by the empirical model (Behrenfeld and Falkowski 1997) using monthly satellite-derived data showed that primary productivity in summer decreases about 2 times compared to that during the spring bloom (Yamada et al. 2005) in the East/Japan Sea. Our primary productivity during the spring bloom is similar to that reported by Yamada et al. (2005), but summer primary productivity is higher than values of Yamada et al. (2005). Kwak et al. (2013) suggested that relatively high summer primary productivity in the Ulleung Basin were induced by high carbon and nitrate uptake rate at subsurface layer.

5. Page 2138, Line 18, the detail of statistics test used here should be described, and the P value.

→ As suggested by the reviewer, we have inserted the detail of statistical test as follow: one-way ANOVA, P=0.967, 0.307, 0.615, and 0.402 for primary, new and regenerated productivity, and f-ratio, respectively. Accordingly, we have inserted "(one-way ANOVA, P > 0.3 for four cases)" at the end of this sentence in the revised ms.

6. Page 2139, Line 21, "rather similar" and "but still lower" are in contradiction.

→ According to the reviewer's indication, we have changed this sentence in the revised ms as follow: “Kwak et al. (2013) found a rather similar summer primary productivity in the present study (Student-t test, P=0.766).”

7. Page 2140, Line 26, please specify the definition of the words "oceanic regions".

→ We have changed the sentence in the revised ms as following: “oceanic regions which are offshore waters in areas deeper than 200 m.”

Technical corrections

→The following corrections were made according to the reviewer’s suggestion.

Page 2129, Abstract, Line 4, "and in biological properties", the "in" should be removed.

Page 2136, Line 6, the first word "was" should be moved to the position after "water column".

Page 2136, Line 21, the "were" after "summer" should be moved to the position in the next line before "depleted".

Page 2142, Line 12, "He found the highest ratio (0.47) in Winter." It is accurately "She" here.

Page 2143, Line 1, "thus high biological pump", the sentence is not complete, it should be "biological pump efficiency" or something else.

Table 1, in the table content, you should always list reference after each data to show clear information to the readers although they maybe the same one. (See Fig. 2)

Fig. 2, Fig. 4, Fig.5 and Fig. 7, The words "one steep slope station, UB1 and two deep basin stations, UB2 and UB3" in the texts, should be moved to the text of Fig. 1. Those are replicated descriptions.

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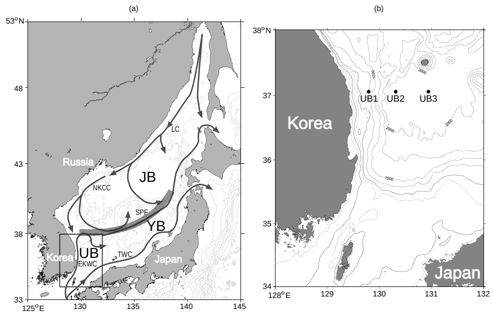

Figure 1. Schematic map of the East/Japan Sea (a; modified from Lee et al., 2009) with sampling locations in the Ulleung Basin (b; one steep slope station, UB1 and two deep basin stations, UB2 and UB3) from May 2010 to June 2011 (LC=Liman Current, NKCC=North Korean Cold Current, EKWC=East Korean Warm Current, TWC=Tsushima Warm Current, SPF=Subpolar Front, UB=Ulleung Basin, YB=Yamato Basin, JB=Japan Basin).

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Fig. 1. Revised Figure 1

1 Table 1. Previous results of primary production, new production, and *f*-ratio in the other regions.

Region	Note	Primary production (g C m^{-2} yr^{-1})	New production (g N m^{-2} yr^{-1})	Reference	*f*-ratio	Reference
Upwelling waters		300		Ryther (1969)	0.57–0.82	Dugdale and Wilkerson. (1992)
Oceanic		50		Ryther (1969)	0.03–0.21	Dugdale and Wilkerson. (1992)
Continental shelf		100		Ryther (1969)		
Offshore ocean	Indian	84		Eppley and Peterson (1979)		
	Atlantic	102		Eppley and Peterson (1979)		
	Pacific	55		Eppley and Peterson (1979)		
Mediterranean	Eastern Basin	109	18	Estrada (1996)	0.11–0.37	L'Helguen et al. (2002)
	Western Basin	158	52	Estrada (1996)	0.38	Van Wambeke et al. (2002)
Yellow Sea		141		Choi et al. (1988)		
East China Sea					0.29–0.33	Kanda et al. (2003)
South China Sea					0.14–0.36	Chen (2005)
Southern Ocean					0.48–0.92	Lee et al. (2012)
East/Japan Sea	Russian coast	170		Yamada et al.(2005)		
	Japan Basin	161		Yamada et al.(2005)		
	Southeastern area	191		Yamada et al.(2005)		
	Southwestern area	222		Yamada et al.(2005)		
	Ulleung Basin	270	61	Present study	0.39–0.81	Present study

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Fig. 2. Revised Talbe 1