

Interactive comment on “Summer-time episodic chlorophyll-a blooms near east coast of Korea” by Young-Tae Son et al.

Anonymous Referee #1

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Review of:

Summer-time episodic chlorophyll-a blooms near east coast of Korea

by Young-Tae Son, Jae-Hyoung Park, and SungHyun Nam

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General comments

This paper deals with summertime coastal phytoplankton blooms off eastern Korea, as measured at the ESROB fixed buoy site. The Authors show how advection of chl-rich, low salinity (due to typhoon-related heavy rainfall), water to the site triggers chl blooms, during which chl a reaches 4 ug/l and beyond. I find this paper very interesting, both

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in a phenomenological sense and because of the completeness of the parameters measured at ESROB, accompanied by satellite imagery. The text is well written even though it needs a little English improvement. However, I have some reserves before recommending publication, which are explained in detail below in the particular comments. To sum them up, I am mainly concerned with: 1) the fact that Total Suspended Matter (TSS) and chl a don't co-vary for chl a > 3 ug/l, so high chl may actually be due to non-chl particulate optical signature; 2) the interpretation of the dynamic situation, i.e. I have a problem with the wind re-stratifying a water column. Also, upwelling is visible in the ESROB T and S record during poleward wind events, but it is not mentioned: even though it is not relevant for blooms, it should be, to make the physical interpretation complete 3) the lack of the description of the method for which the Authors find out that advection "... is primarily responsible for most (80 %) of the CF events" 4) the fact that salinity at ESROB never goes below 30 g/kg, except for E03, while SSS data indicate 27-29 g/kg for the plume in 2013. So does the plume really reach ESROB? Or maybe a mix of plume and offshore water? 5) the lack the suggestion for the mechanism for which the northern plume or southern chl-rich waters trigger blooms; also, why are there no other strong blooms north of ESROB? Has the nutrient load of such surface, fresh waters anything to do with bloom triggering?

Therefore, I do not recommend publication, but I do strongly encourage the Authors to revise the manuscript and challenge the above issues. Details can be found below, and the Authors can contact me via the Editor, anytime for any questions.

Form

The English of the manuscript is quite correct, but needs improvement. I tried to help with the list of corrections suggested below.

Particular comments and suggested text corrections

Title

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Replace "summer-time" with "summertime" (hereafter "replace" will be represented as "->"). Please correct this also in the rest of the text.

"near east coast" -> "near the east coast"

Abstract

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Line 23. Replace "accompanied" -> "were accompanied by".

1. Introduction

Page 3

Line 37. "among others" -> "among other phenomena" Line 40. "plume-delivering" -> "plume-delivered". Line 42. "and significant" -> "and a significant". Line 43. "plume" -> "plumes". Line 44. "demonstrating localized"-> "demonstrating that localized". Line 45. What do you mean by "diversion"? Line 47. "differences with respect to the plume" -> Do you mean "differences between the plume and surrounding waters"? Please clarify. Line 57. "limited short-duration" -> " short-duration ". "limited" is redundant.

2 Data and Methods

Line 68. "The data collected includes" -> "The collected data include" Line 70-71. "vertical profile of current" -> "current vertical profiles" Line 71. "upper most" -> "uppermost".

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Line 76. "alongshore current" -> "alongshore northward current", right? Line 79. "is needed to calibrate" -> "always needs calibration". Line 79. "owing to long-term sensor drift" -> "owing both to long-term sensor drift and to the fact that different chl a concentrations may yield the same fluorescence energy, i.e. the same number from the fluorimeter, because of temporal differences in phytoplankton species assemblage and

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of the adaptation of species to different light conditions". I should add this because, as the Authors know, this point is very important if one wants to obtain realistic chl a quantities from a fluorimeter. See for example Longhurst et al., Prog. Oceanog. Vol 22, pp. 47 - 123, 1989, but also more recent references, with which I'm sure the Authors are familiar. Line 92. "geostationary ocean color satellite" -> is this the "NASA Geostationary Ocean Color Imager (GOCI)"? If not, which satellite? By the way, if you write the acronym of the satellite you can use it in the text instead of repeating "the ocean color satellite" every time. Line 94. "... at a grid 50 times further...". What do you mean? Please rephrase. I know that polar orbiting OC products have resolution of from 1 km onwards, so why 50 times? The 500 m grid would be 2 to 5 times finer, maybe. If "further" means "finer", that is. Line 95. "by the total" -> "by total". Line 98. "software modules applying a correction algorithm for the TSS and CDOM". Please cite software name and authors, as well as the reference or SW manual. These modules should be well described for anyone who might want to use them, because these corrections are very important. Line 101-102. "This indicated that Chl a can be measured regardless of the TSS both in the coastal and outer sea" -> I disagree: from Fig. 2b it seems that your Chl a measurements co-vary with TSS significantly only up to chl a = 3 ug l-1 and TSS = 2 mg m-3. This means that, up to these values, TSS is reasonably made only of phytoplankton. But when TSS is high, other particulate besides phytoplankton is present, so your satellite chl a algorithm may fail because it may mistake the light signal coming from other particulate for phytoplankton. Please comment or correct phrase. Is this issue crucial for what follows? That is, how much of the CF peaks in Fig. 4 is actually due to non-phytoplankton fluorescence? I say this because the peak values are beyond the range of chl a-TSS tight covariance. So are they really phytoplankton blooms? Suggestion: why not over-plot the in situ chl a data in Fig. 4, e.g. as asterisks or crosses? This would make sure that the peaks are real chl a.

Line 106-107. "Precipitation in unit of mm/day recorded" -> "Precipitation (mm/day) was recorded". Line 109. "were proxied as freshwater..." -> I think there is a piece of

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sentence missing.

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3. Results

3.1. Climatological CF variations

Line 21. "trophic situation" -> "the trophic situation". Line 120. "upper most" -> "uppermost". Line 121. "summer-time" -> "summertime".

3.2. CF events observed in summers of 2011, 2012, and 2013

Line 134. "over considerable period (Fig. 4, Table 1)" -> "over a considerable period, i.e. days to weeks (Fig. 4, Table 1)". Line 136. "when CF > 1.0 $\mu\text{g/l}$ " -> "I don't understand this third condition, given the first two." Line 137. "three each year" -> "three in each year" Line 141. "rainfalls" -> "rainfall". For this word, usually plural not used. Pls correct also rest of manuscript.

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Line 152. "wind stress, strong" -> "wind stress, the strong". Line 153. "developed before E04" -> should this not be "developed before and during most of E04"? Refer to Fig. 5. Line 157. Eliminate "both" if you use parentheses for opposing effects. Line 156-159. "poleward (equatorward) wind stress re-stratified (well-mixed)" -> In my opinion, it is impossible for wind stress to re-stratify a water column, no matter its direction. So, I think that poleward (and, by the way, strong) wind stress cannot re-stratify, but mix only. Indeed, if one looks at the T and S time series of Fig. 6c and d, in correspondence of the B poleward event, the isotherms drop and the isohalines rise, but remain separated, except for the 1 and 5 m isolines. This indicates upwelling, which is consistent with the wind and coast configuration. Next, during the T (equatorward) event the isotherms rise and the isohalines drop, indicating downwelling, and after the events the isolines settle to their normal values. So mixing is not so visible, to my opinion. However, Authors are right about mixing for the M1, T and S events, all equatorward, when

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the 1, 5 and 20 m isolines join. In sum, it looks like during equatorward events the mixing takes place and stays there so it can be measured (Ekman transport is onshore). On the other hand, during poleward events, mixing probably takes place, but is either less intense or is not visible at ESROB, because mixed water is displaced offshore by Ekman transport, and only the "frictionless" effect of upwelling is measurable. What are the Authors' comments? Line 164 "did not accompany preceding heavy" -> "did not follow heavy".

3.3. Surface CF distributions

Line 176. "(Fig. 9a, b, c and d)" -> "(Fig. 8a-d)" Should this be Fig. 8, not 9? Line 177. "e.g. off the SP, HH, and WS," -> "e.g. off the SP, HH, and WS sites," Lines 178 - 179. "and extended" -> "while a more coastal branch extended" Line 179. "(Fig. 9a, b, c and d)" -> "(Fig. 8a-d)" Again should it be Fig. 8? Lines 179-180. "coast during the period (Fig. 9a, b, c and d) after the heavy rainfalls in July 19–24 (Fig. 7a)." -> "coast (Fig. 8a-d) after the heavy rainfalls of July 19–24 (Fig. 7a)."

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Line 184. "(Fig. 9e and 9f)" -> "(Fig. 8e, f)". Again Fig. 8. Line 188. "A pattern of" -> "The patterns of" Line 190. "within cyclonic" -> "within the cyclonic" Lines 194-195. "coastal zone" -> "coastal zone, near DH and ESROB, as well as equatorward currents just to the north". Line 196. "(as cases of many other events, see Fig. 1 or Fig. 8)" -> "(see Fig. 7, but also other similar events, as in Fig. 1 or Fig. 8)"

4.1. Horizontal advection

Line 203. "and is primarily responsible for most (80 %) of the CF events." Please tell how the Authors checked this, practically. Did they see if the plume could reach ESROB for each event, given the duration of the event and the equatorward current? Did they use the current at ESROB or available imagery, as in the example of Fig. 8? Line 205. "measured to 100 km (= dy)" -> "measured to be dy = 100 km" Line 206. "with Chl

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a change of about 2.5 $\mu\text{g/l}$ ". Is this the difference between chlorophyll at the plume source and the initially oligotrophic water at ESROB? If not, between which points is this difference computed? Please specify. Line 207. "(Fig. 9a, b, c and d)." -> "(Fig. 8a-d)." Again Fig. 8. Lines 201-214. I understand the calculation and it is good that the computed advective rate of change matches local change at ESROB. However, I do notice that the maximum chl in the plume doesn't exceed 2.5 $\mu\text{g/l}$ (Fig. 8), and that this is the source value at the plume's origin, which never moves south. Indeed, the water that eventually reaches ESROB has much lower chl, according to Fig. 8, i.e. max 1-1.5 $\mu\text{g/l}$. So how can E09 reach a peak of 3.5 $\mu\text{g/l}$ (Fig. 7) if it is only fueled by the plume? Maybe the plume is more important as a nutrient carrier than a chl carrier, so arriving at ESROB it triggers a bloom? However, if so, why are there no other strong blooms north of ESROB in the images of Fig. 8, but only the southward-decreasing chl a plume signal? If the plume is the responsible for the blooms, then there should be even more intense blooms north of ESROB. Am I missing something? Please comment/revise in text. Also, concerning the plume investing ESROB: from ESROB and SSS cruise data in Figs. 7 and 8 one sees that $S = 31.5 \text{ g/kg}$ at ESROB at the peak of the E09 event, but the plume salinity seems much lower from Fig. 8e, i.e. $S < 29$. So which water reaches ESROB? It doesn't look like pure plume water; maybe it is a plume-offshore mix? I think the Authors should clarify this issue.

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Line 224. "estimated to 0.86" -> "estimated to be 0.86" Lines 225-226. "demonstrating a high CF region offshore of ESROB (Fig. 9a, d)" -> "demonstrating the influence of the high CF region offshore on the ESROB site (Fig. 9a, d)". Do I understand well? Line 227. "nutrient rich" -> "nutrient-rich" Line 227. "accounting for half the CF change" -> "accounts for half the CF change". Question same as above: since E07's peak reaches 3.5 $\mu\text{g/l}$ and the offshore water carries 1.6 $\mu\text{g/l}$, then where does the remaining chl (3.5 - 1.6 = 1.7 $\mu\text{g/l}$) come from? Line 230. "significant as that of E10" -> "significant, as happens for the E10 bloom". Do I understand well?

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4.2. Other mechanisms

Line 244. "different each other" -> "different from each other" Line 251. "euphotic zone" -> "euphotic zone depth". Line 251. "was compared with others" -> "were compared with others". What do you mean by "others"? Line 252. "events from two PAR" -> "events, using two PAR" Line 252-3. "Basically, Zeu of 18 m averaged over E04-E10 was deeper" -> "Basically, the average for the E04 to E10 bloom periods, Zeu = 18 m, was deeper".

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Line 255. "Zeu of 20 m averaged" -> "A Zeu of 20 m obtained by averaging".

4.3. Inter-annual variations

Line 265. "typhoons passed through" -> "typhoons that passed through" Line 277. "summer-time" -> "summertime".

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5. Concluding remarks

Line 296. "high surface CF enhancements" -> "high surface CF events" or "enhanced surface CF" Lines 297-299. "Alongshore advection... in summer". I think that this is my main concern about the paper. That is, the Authors have demonstrated that the blooms at ESROB are not driven by local vertical nutrient supply (text relative to Fig. 10). In addition, the Authors show that chl-rich plume waters or southern waters reach ESROB. So they argue that such advection is responsible for most events. But, I ask, how? What is the biogeochemical mechanism that triggers the blooms at ESROB, after the chl-rich water hits the site? This is not clearly stated. Especially since the advected waters that arrive at ESROB have only about half of the peak chl that is measured during blooms. Why is ESROB so special about blooms, with respect to the rest of the? Or maybe other blooms are visible in other sites? I suggest that Authors should (1) propose a mechanism for bloom generation (also tentative, that's OK); (2) discuss

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the occurrence or lack thereof of such other blooms at other sites along the coast, by showing or commenting evidence from satellite imagery (or other available data). By the way: (3) is there an image showing any of the blooms at ESROB itself, to have an idea of the bloom's extension around the site?

Line 303. "the equatorward and cross-shore advections" -> "the equatorward and cross-shore advection". No need for plural.

Line 303. "SSS plays" -> "SSS play"

Tables, Figures and captions

Table 1 caption. "duration in day" ->"duration in days".

Line 405. Figure 1 caption. "water depth in meter" -> "water depth in meters" Line 422. Figure 4 caption. "at the ESROB" -> "at ESROB" Line 430. Figure 5 caption. "at surface" -> "at the surface" Line 431. Figure 5 caption. "at the ESROB" -> "at ESROB" Line 437. Figure 6 caption. "except for 2012 bloom events" -> "but for the 2012 bloom events" Line 442. Figure 7 caption. "except for 2013 bloom events" -> "but for the 2013 bloom events" Lines 446-7, Fig. 8 caption. "Surface distributions of e) salinity and f) temperature observed using a small research vessel (ship tracks and CTD stations are remarked with dashed lines and dots)" -> "In situ surface distributions of e) salinity and f) temperature (dashed lines: ship tracks; dots: CTD stations)" Line 459. Figure 10 caption. "in summers" -> "in the summers" Line 460. Figure 10 caption. "A standard deviation of" -> "Standard deviations for".

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