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Interactive comment on "Seasonal effects of photophysiology and chlorophyll *a* abundance on phytoplankton group-specific primary production in the Kuroshio region as revealed by SeaStar/SeaWiFS" *by* Takafumi Hirata and Koji Suzuki

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Reviewer #1:

AC: We would like to thank the Reviewer for his/her useful comments.

RC: Because different phytoplankton has different response to light and nutrients, it is always desired to know group (or class or species) specific photosynthesis rate,

as such information can also improve the estimation of global primary production. To meet this desire and demand, the authors developed specific primary production in the Kuroshio region for three "functional groups" of phytoplankton: diatoms, haptophytes, and cyanobacteria. Subsequently, the authors described their spatial/temporal variations as well as the possible driving factors. This subject is appropriate for the journal and the overall presentation is very good. However, there are serious gaps in this work. Specifically, as the authors indicated, to derive group-specific primary production, it requires 1) Chla, 2) aph, 3) PP, and 4) PAR. Because of lacking or no concurrent measurements of these properties, the authors used products in the Kuroshio region generated by NASA or a not commonly used algorithm for aph510 (see Section 2.1.2)! Note that the algorithms for Chla and PP were designed for global mean states, which very likely don't work for this specific (and unique) region (see the wide scatters for the Chla and PP algorithms). Thus, it is critical to evaluate these products derived from satellite for a specific region! But the authors spent no time to do so or to inform the validity of these products in the Kuroshio region. Without such, the group-specific primary production derived from these products are highly questionable to be the least.

AC: We should refer to the following paper published earlier, in which validity of the SeaWiFS Chla was evaluated for different regions including the Kuroshio region:

Gregg, W. W. and N. W. Casey: Global and regional evaluation of the SeaWiFS chlorophyll data set, Remote Sens. Environ., 93, 463–479, 2004.

In the above paper, the regional assessment for the North Central Pacific, where a significant number of in situ measurements used for the assessment comes from Japanese waters including the Kuroshio region (see their Fig.1), showed that RMSE % log error of the SeaWiFS Chla is 24.7 (their Fig. 4) with r2=0.71 for N=839 (their Fig. 6). In spite that the SeaWiFS Chla algorithm was developed for the global oceans, the validity of SeaWiFS Chla product was thus shown for the regions that include our study area (but except coastal/shelf waters which were not analyzed in our study). We have cited the above paper in our revised manuscript to support the validity of the global

Chla product in this study. The original satellite primary production (PP) data derived from VGPM (Behenfeld and Falkowski, 1997) was evaluated by Ishizaka et al. (2007) for a Japanese bay within the Kuroshio region. They showed a deviation of VGPM from in situ measurements obtained in the bay, and attributed the deviation to a parameterization issue of Pb_opt (the maximum daily net primary production found in a given water column) used in the VGPM. Therefore, we did not use the original VGPM for our regional study to avoid the known issue, but used CbPM (Westberry et al., 2008) instead, which is more mechanistic in terms of phytoplankton physiology in the sense that the chlorophyll-to-carbon ratio (which can vary spatially) was explicitly taken into account. In the revised manuscript, we have discussed potential errors resulting from our input data.

RC: In addition, Eq. 1, which plays a key role in this study, is unclear in many ways: 1) Not clear if it is for water-column integrated PP or PP at a specific depth. If it is water- column integrated PP, it is then not proportional to E (e.g., VGPM); if it is PP at a depth, then phi, E, and aph should be in general a function of depth. 2) After the over-simplification (and not proven), the right side of the equation is a spectrum (wavelength dependent), but the left side is a scalar. The two sides are not consistent!

AC: We have also clarified the depth-dependency in Eq. 1 in the revised manuscript, such that the last line of the Eq. 1 is:

PP(z) = 300 * Phi(z) * PAR(z) * X(lambda,z) * aph(lambda,z)

where PAR (or "E" in the reviewer's notation), Phi, X and aph are functions of depth. The first line of Eq. 1 in the original manuscript has been proven useful and well used in relevant scientific communities thus far (e.g. Emerson et al., 1958; Falkowski and Raven, 2007). On the other hand, we would like to stress that our final Eq. 1 (i.e. the last line of Eq. 1) is strictly the same mathematically as the first line. That is, there was no assumption or approximation used to derive the last line of Eq. 1 (hence, there is no over-simplification). As all lines in Eq. 1 in the original manuscript are exactly the

same, we believe that the last line of Eq. 1 should be valid, as long as the first line of Eq. 1 holds.

The notation of the absorption coefficient of phytoplankton appearing in Eq. 1, aph(lambda) only means that aph is a function of wavelength, lambda. For example, aph(lambda) represents a value (scalar) of aph at a certain wavelength, lambda. Thus, it does not represent a vector as a spectrum. Hence, the right- and left-hand sides of the Eq. 1 are consistent. In our manuscript, we distinguished vectors/matrices from scalars by using bold font for the formers (please see Eq. 3 for example). We believe that this writing style is a standard practice in many scientific journals, but we are happy to change the style in a further revised manuscript if it is required by the journal publisher.

References:

Behenfeld, M. J. and Falkowski, P. G.: Photosynthetic rates derived from satellite-based chlorophyll concentration, Limonol. Oceanogr., 42, 1-20, 1997b.

Emerson, R.: The quantum yield of photosynthesis, Annu. Rev. Plant. Physiol., 9, 1–24, 1958.

Falkowski, P. G. and Raven, J. A.: Aquatic Photosynthesis: 2nd Edition, Princeton University Press, New Jersey, USA, 2007.

Ishizaka, J., Siswanto, E., Itoh, T., Murakami, H., Yamaguchi, Y., Horimoto, N., Ishimaru, T., Hashimoto, S., and Saino, T.: Verification of Vertically Generalized Production Model and estimation of primary production in Sagami Bay, Japan, J. Oceanogr., 63, 517-524, 2007.

Westberry, T., Behrenfeld, M. J., Siegel, D. A., and Boss, E.: Carbon-based primary productivity modeling with vertically resolved photoacclimation, Glob. Biogeochem. Cycles, 22, GB2024, doi:10.1029/2007GB003078, 2008.