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Biogeosciences Discussions

Interactive comment on "Regulation of phytoplankton carbon to chlorophyll ratio by light, nutrients and temperature in the equatorial Pacific Ocean: a basin-scale model" *by* X. J. Wang et al.

Anonymous Referee #1

Received and published: 20 January 2009

The manuscript 'Regulation of phytoplankton carbon to chlorophyll ratio by light, nutrients and temperature in the equatorial Pacific Ocean: a basin-scale model' by authors Wang et al. investigates the sensitivity of modeled carbon to chlorophyll ratios (C:CHL) to temperature, nutrients and light. C:CHL ratios are useful numbers for the derivation of phytoplankton biomass from chlorophyll concentrations. While the former are difficult to be measured directly, the latter can be obtained from satellite measurements of ocean colour. The main result is that sea-surface temperatures (SSTs) have only a minor influence on the C:CHL, while nitrogen (iron) is the dominating factor in the western (eastern) Pacific. A vertical gradient is maintained by light availability (photo acclimation). The topic of the study is timely and of general interest to the readership

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of BG, and the results are very interesting. However, the text needs large scale clarification and modification, particularly concerning the interpretation of the results with regard to spatial and temporal variability of the equatorial Pacific. Some of the figures will have to be revised. I therefore suggest publication after major revisions.

General Comments:

My main concern is the separation of the signals of spatial, seasonal and interannual variability in the model-data comparison, which is not done appropriately in the present form of the manuscript. The equatorial Pacific is characterized by strong seasonal and interannual variability and distinct spatial separation into the Western Pacific Warm Pool and the Equatorial East Pacific (EEP) upwelling zone. The results therefore have to be analyzed and interpreted more in the context of these general characteristics. For example, the time periods chosen in Figures 4-6 are determined by data availability. It has to be mentioned to what phase of the ENSO cycle (warm/cold) the periods belong and the results have to be explained against this background. A more consequent spatial separation between results from the Western Pacific Warm Pool (WPWP) and the Eastern Equatorial Pacific (EEP) upwelling regime would also help for clarification.

At several points the authors speak about model skill and model performance, however, no such analysis is presented. The evaluation of model skill should yield some statistical value that enables to rate the model among alternative solutions. This is not the case in the present study. More information on the model tuning, which is mentioned in the text but by no means explained, and the criteria applied could probably serve as evaluation of model skill.

The study gives a brief and well formulated introduction into the usefulness of C:CHL ratios of phytoplankton for the determination of marine productivity and carbon turnover. However, a few more words about photo acclimation and its relevance for the ecosystem and carbon cycling would be desirable, particularly in the context of anticipated future climate change and ocean stratification.

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When comparing the model output with CHL-data from remote sensing it has to be made clear that these are not direct measurements either. Satellite CHL is derived from ocean colour, which involves a further model application.

Specific comments:

p. 3875, l. 6-13: Is the cited linear relationship between C:CHL and growth rate positive or negative or is this unclear? Please clarify your statement in the text.

p. 3876, l. 20-24: maybe you should also mention sub grid scale (spatial) variability in the field data, that is probably not resolved by the model

p. 3876, l. 25: typo: 'field'

p. 3877, l. 1: replace 'coherent with' by 'represented by'

p. 3877, l. 2-4: I cannot see a significant difference between the results for those two transects, please see also comments below for Figures 2 and 3.

p. 3878, l. 13: there is no evaluation of 'model skill' in the present study. The study is a model-data comparison, while the evaluation of skill should include a further statistical measure (skill-score), please see general comments above.

p. 3879, l. 10: model performance (see comments above)

p. 3880, l. 13-14: 'annual mean longitude of the front between the HNLC and the warm pool': please explain the meaning of east-west shifts of this front.

p. 3880, l. 26: 'under-estimate': compared to what?

p. 3881, l. 3-5: where can those results be seen?

p. 3882: the results explained here are difficult to be found in Figure 11, please see comments for Figure 11, below.

p. 3883: l. 3: I do not agree that the ratio of standard deviations for iron is so much better than the one for nitrate in the frontal zone.

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Figure 2: On the left shown are model results for temperature, salinity and nitrate, which are not compared to observations. I would suggest to either include observations and to derive a model skill score for ocean circulation and nutrient distributions from this comparison or to remove Figure 2 entirely. The sub panels (b), (d), and (f) are not very much different from what is shown in Figure 3 and therefore not needed.

Figure 3: It is a good idea to display zonal and meridional transects of model output. However, to get a better idea of the 3-D distributions and the distinction between the WPWP and the EEP it would be good to have a second meridional transect for the eastern part of the Pacific (e.g. 120W). Furthermore, Figure 2 shows that the high sub surface CHL concentrations close to the equator are restricted to a very small area (Figure 3b). They are averaged out in the zonal section (Figure 2a) when a too large region (2N-2S) is included. I suggest displaying Figure 2a, c, e from 1N-1S.

Figure 4: To my eye the differences between the two meridional transects (125W, 140W) are not obvious. I'd suggest to either remove one of them or to chose two transects that clearly separate between the Western Pacific Warm Pool (WPWP) and the Eastern Equatorial Pacific (EEP) upwelling zone. Anyways, the more western transect should be displayed in the left column, the more eastern transect on the right.

Figure 9: I suggest separating the Hovmoeller Diagrams into seasonal and interannual variability by showing first the average seasonal cycle of CHL and then the temporal evolution as anomalies to the seasonal CHL. This allows for a clear distinction between seasonal and interannual variability, once as 'observed' by the satellite and once as obtained from the model.

Figure 10: Please move sub panels (e) and (f) to Figure 11 (see comments below).

Figure 11: It is difficult to distinguish the actual differences between the sensitivity experiments and the control experiment. I'd suggest to show the absolute values for C:CHL ratios from the control in the top line of Figure 11 and then display the results from the sensitivity experiments as anomalies (differences) to the control. Here again

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two meridional transects, as exemplary for the WPWP and for the EEP, might give a clearer picture of the spatial patterns (see comments for Figure 3, above).

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