

Interactive comment on “Light absorption by marine cyanobacteria affects tropical climate mean state and variability” by Hanna Paulsen et al.

Anonymous Referee #2

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Paulsen et al. implement light absorption by cyanobacteria in the MPI ESM and discuss its impact on the mean climate as well as on the seasonal SST cycle and interannual SST variability. They suggest that cyanobacteria lower SST due to a shading effect: the sub-surface water cool because they receive less sunlight, and the upwelling of these sub-surface waters lead to a SST decrease. Changes in SST gradients induce changes in ocean currents, thus slightly altering the mean climate state. Light absorption by cyanobacteria also leads to a greater seasonal SST cycle in the tropics.

Paulsen et al., implement a new effect, that is neglected in most models I believe. The parametrization implemented makes sense and the MPI model is well tested. The impact on sub-surface temperature seem justified. The manuscript is clear and well written. I thus recommend publication after the comments below are addressed.

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1) This new implementation affects the oceanic and atmospheric circulations with effects reaching the mid latitude. Explaining some of these changes is not straight forward, and the authors suggest changes in the Hadley cells and the Walker circulation. In the present state of the manuscript it is not possible to check whether this is really the case. Changes in the Hadley cells and the Walker circulation would need to be shown: figures of the atmospheric circulation are needed. Figures showing changes in ocean surface currents would also help as they are discussed in the text.

If the Walker circulation is stronger (p11, L.17), shouldn't the upwelling in the Eastern equatorial pacific be stronger (p10, L.18)? From Fig. 6, I can see that the upwelling in the EEP and EEA are indeed weaker, and that the barotropic stream-function seems weaker almost everywhere. This is consistent with weaker wind-driven circulation as mentioned p13, l12. I can see that in other parts of the text the authors suggest the strengthening is mostly restricted to the western side of the Pacific basin. Please make sure your description of the Walker circulation changes are accurate. The northward shift of the Gulf Stream is consistent with Fig.6b, however the change in the Kuroshio is less clear.

P13, L.1: It is stated that the Hadley cells are expanded: is it in both hemispheres?

P13, L. 19-20: This sentence is really confusing. Are the authors really talking about the Northwest Pacific Ocean? Is there really southerly winds dominating there (I would have thought it would have been westerlies)? Latitude and an East-West location are needed to really understand this sentence. As mentioned above a figure of winds and wind anomalies would really help to understand.

2) Section 5: seasonal dynamics. It might help to mention at which time the cyanobacteria blooms occur. The timing of the blooms will most likely significantly impact the seasonal changes. Is the timing of the blooms in agreement with observations?

3) Figures: Figure 1: Add Latitude in plot 1b as it is different from a, c and d It would be nice to add the satellite estimate of Chla for comparison.

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Figure 2: why are the plots cut at 50deg? It might help to see what's happening poleward of 50deg, particularly for the change in Kuroshio and Gulf Stream.

Figure 11: Should the authors also plot PHY_ONLY-CTRL? In that way in one figure one can see the impact varying light attenuation, and the impact of the cyanobacteria. This would be particularly useful as the high latitude regions are not shown in Figure 2.

4) Minor and typos: P6, L. 13: "Furthermore, we..." P6, L. 33: "For comparison..." (remove the) P10, L.19: "...surface warming." (remove effect) P11, L. 4-5: Rephrase "Here, it is probably the changes in the circulation system that is causing the anomalies instead of the local heat absorption effect." P13, L.3: "There" instead of "Here" P13, L. 21: "Interior"

Section 6: Many sentences have a weird structure. It would be worth trying to improve the flow of the section.

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