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Biogeosciences Discussions

Interactive comment on "Projected 21st century decrease in marine productivity: a multi-model analysis" *by* M. Steinacher et al.

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The authors distinguish between mechanistic models, which show a decrease in both EP and PP and the empirical approach of Sarmiento, which shows an increase. In the introduction they mention the studies by Schmittner et al. (2008) and Oschlies et al. (2008) as "outliers" in the mechanistic model category because these studies also show an increase in PP (albeit they also simulate decreases in EP). The sentence than mentions these two studies implies that the model response is due to pCO2-sensitive biotic C:N ratios. However, this is not true. In fact, the Schmittner et al. (2008) model does not use pCO2 sensitive C:N ratios. This should be corrected.

The reason for the increase in PP in Schmittner et al. (2008) is discussed in that paper (I recommend reading this discussion). It is due to the dependency of phytoplankton

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growth rates on temperature. Schmittner et al. use the compilation of laboratory experiments from Eppley (1972), which is based on measurements of phytoplankton growth rates. Unfortunately, the authors do not even discuss the physiological basis of temperature dependent growth and the Eppley paper, which to me seems to be crucial if one is to understand the response of NPP to warming.

I suggest including information about how the temperature dependency of phytoplankton growth is dealt with in the various models. For the NCAR model there is a formula given (eq. 4), which I don't understand. Where does this come from? What is the basis for this formula (T+2)/(T+10)? It seems to be contrary to the Eppley results and other measurements.

The Schmittner et al. study, which is a mechanistic model, agrees with the results from Sarmiento (at least qualitatively). Therefore, there is not a real dichotomy between "mechanistic models" and "empirical models" but the mechanistic models also don't agree. I think a large reason for this is the treatment of the temperature dependency of growth. (I note that Schmittner et al. reproduce the global NPP estimates of about 40 GtC whereas most of the models used here underestimate it).

I also want to express caution when using the satellite estimates as truth. Satellites only see the surface, whereas much of the productivity occurs below the surface. To me it is unclear how good satellite estimates represent the real ocean.

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