Interactive comment on “Capturing optically important constituents and properties in a marine biogeochemical and ecosystem model”

by S. Dutkiewicz et al.

Interactive comment on Biogeosciences Discuss., 12, 2607-2695.

Response to Reviewer 2:

Reviewer’s comments are in black, our replies are in blue.

The manuscript describes an update version of the MIT biogeochemistry and ecosystem model that contains explicit treatments of the main optically active constituents (OAC) of seawater, including 9 different phytoplankton functional groups. One important feature is the independent treatment of detritus and CDOM. The model is presented, and simulation results are compared to selected field data. By changing the relative importance or optical characteristics of each OAC, the numerical experiments allow to estimate feeds back to the system’s biogeochemistry, and that is the main goal of the manuscript. The work is well written and relevant, and the model will be much improved by discussions and input from the scientific community, making Biogeosciences Discussions a good forum for the paper. I thus recommend the publication of this work.

We thank the reviewer for the positive comments and we do welcome input on this model and the results from the scientific community. The comments below were very useful and we have adjusted the revised version of the paper to take these into account.

Questions and Comments:
1- Introduction: It is not clear to me the choice of using a specific AMT-15 cruise, as oppose to the others.

The AMT-15 had a particularly diverse and relevant set of optical measurements. In particular the light penetration data used in Fig 5 has been very useful in model development. We decided to stick to just one cruise to avoid interannual variability and the differences in cruise tracks which we believe would have distracted from the main points that we want to make. To retain a clear manuscript – and with just one transect on the figures – we chose to stick with just this cruise. We discuss this choice further in the revised text (going just after old text pg 2620 line 25)
“*Though there are other AMT cruises that include some similar and/or different combinations of optical data (e.g. AMT-19, Dall'Olmo et al., 2012, Martinez-Vicente et al., 2013), we chose to look at only a single transect for clarity. In particular, the combination of data on spectral irradiance penetration, a_{CDOM} and light absorption by phytoplankton were of particular use in model validation”*

We already had in the introduction (pg 2611, line 14-19):
"In particular we use a comprehensive data set from an Atlantic Meridional Transect cruise which includes detailed concurrent optical, biogeochemical, and ecosystem observations between the UK and South Africa in September/October of 2004 (AMT-15). Some of the observations are published here for the first time. The data set is ideal for evaluating how our model captures the amount and nature of the light that penetrates the water column across basin scale along with the relevant ecological properties."

2- Model description:
a. are the 25 nm bands averages?

Yes, we make this clear in the revised text (pg 2612, line 27):
"*Irradiances are provided averaged in 25nm wavebands from 400 to 700 nm.*"

b. What are the spectral resolution of the absorption and scattering coefficients used?

We use the same resolution (25nm) for the absorption and scattering coefficients. We make this clearer in the revised text (old text, pg 2615, line 5, i.e. just below the equations):
"*In the model we use absorption and scattering coefficients averaged over 25nm bands to match the irradiance input (Fig. 1) from a variety of sources, detailed below*."

And at the end of the caption of Figure 1:
"*Spectra are shown here with 1nm resolution for clarity, the model uses the average over the 25nm bands (vertical grey lines).*"

c. Phytoplankton functional types – throughout the text, the term is sometimes replaced by community or species. I would suggest to keep as PFT, to be consistent with the objectives of the work.

We agree that using "species" is not consistent, and have changes this in the revised version as suggested. Occasionally we do want to use the term "community" to address the combination of PFT's in any location.

d. How should the reader interpret the "phytoplankton establish a repeating pattern after about 3 years".

We make this statement to assure the reader that by year 10 (from which we show the results) the model has already reached a quasi-steady state in the ecosystem. We make this clearer in the revised version by adding the following (at old text pg 2620 lines18)
"*The phytoplankton establish a repeating pattern after about 3 years such that we can assume a "quasi-steady state" by year 10*."

3- Model results a. I found section 3 too long, and I am also not too sure what new can be learned from the individual comparisons with PHYSAT results and MAREDAT dataset

In the revised version we have shortened section 3 (from 5 ¾ pages to 4 3/4). We have however decide to keep the comparison to PHYSAT and MAREDAT, though now the discussion is significantly shorter (23 lines compares to 39 previously). Though we agree that these give little extra input, it is important to show that our results do not disagree with other established observations (or inferred observations). We also believe that it is important to engage with the communities that have produced these output. It is however also noteworthy that the insitu observations are very sparse – we make this point as a call for more observations in the revised version. Near old text pg 2626, line 12:
"*These global "observations" contain many uncertainties stemming mainly from the scarcity of insitu data, but the model does not disagree with their findings*"

4- Sensitivity experiments a. I missed a discussion for probable causes for the experiments dealing with bb of phytoplankton had no apparent feedback on the system

Changes to scattering had minimal result on the depth (or spectrum) of light penetration as absorption is the main form of attenuation. Scattering does however have a major impact on the amount and spectrum of the upwelling light. To make this clear in the revised version we have added to the abstract (old pg2609, lines 22-24):
"*Absorption is the main cause of attenuation of irradiance with depth, and as such changes to scattering does not as strongly affect the ecosystem and biogeochemistry fields within the water column but since scattering is important for the amount and type of upwelling irradiance, it is important for setting sea surface reflectance*."

And by altering the paragraph (old version) pg 2629, lines15-18 to:
"*The main attenuation of light with depth is through absorption, and as such alterations to the backscattering by detrital matter (EXP-D3 and EXP-D4) have little effect on the irradiance fields at depth (Fig. 16a) and thus little change to the dominant functional type (Fig. 16c). However scattering has major impact on the amount and quality of the upwelling light and as such the changes to the reflectance is large (Fig 16d)*."

And similarly (old) pg 2632 lines 22-25:
"*As discussed above, the main attenuation of light is through absorption, and thus when we assume no scattering by phytoplankton (EXP-P3) there is almost no change in dominant functional type, but because scattering does substantially affect the upwelling light there is some (though small) change to reflectance compared to the default run (EXP0). An experiment with four times b_phy has similar results (not shown here)*."