

Interactive comment on “Assessing the value of BGC Argo profiles versus ocean colour observations for biogeochemical model optimization in the Gulf of Mexico” by Bin Wang et al.

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This manuscript presents a very well developed and well described parameter optimization process for biogeochemical models using available sea surface and profile observations. The authors show that a model parameterized with both surface chlorophyll from satellite and BGC-Argo profiles of chlorophyll and POC best represents the available observations of ecosystem state and fluxes. The authors demonstrate that the parameter choice has important implications for carbon cycling and export.

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Comments:

2. Study Region

This section is very useful as an orientation to the region. Since one of the major objectives of the study is to analyze carbon export, it would be useful to include more in this section about what is known about carbon export in the Gulf of Mexico.

3. Methods

p. 6, Line 147: Earlier in this section, the satellite chlorophyll was adjusted to the float chlorophyll, but here the float backscattering is adjusted to the satellite backscattering. Why is this? These adjustments may have important implications for the POC profiles and partitioning of POC between phytoplankton, zooplankton, and POC. The reasoning for and implications of this choice should be explained.

p. 7, Line 167: What is the range of the vertical resolution of the ROMS model in the upper 200 meters? This information will be useful for comparison with the 1D model.

p. 8, Line 187: Since the biogeochemical model functional forms are essential to evaluating the model performance and the parameter optimization results, the biogeochemical model equations should be reproduced in this manuscript or in an appendix, rather than referring the reader to a different paper.

p. 8, Line 199: "Zooplankton and small detritus were assumed to amount to 10% of phytoplankton biomass and the remaining fractions of POC attributed to large detritus." Why is this assumption made? Is this assumption only employed to define the initial condition?

p. 8, Line 210: The 1D model setup is sensible, but more information is needed to understand, evaluate, and reproduce the 1D model - Why is a 5 meter vertical resolution chosen in 1D and is the model sensitive to this choice? - What are the units for the diffusion coefficient and why are these values chosen? They are substantially higher than typical vertical diffusion coefficients in 3D models. - Are all of the parameters that

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are taken from the 3D model seasonally varying (the mixed layer depth, temperature, solar radiation, and NO₃ below 100 meters)? If so, what the temporal frequency at which they are updated? - Why is the temperature and mixed layer depth determined using values from the 3D model rather than the floats, which also have that data?

p. 11, Line 281: Why is the ratio of 0.1 between the sinking speed of the small and large detritus selected? How sensitive are the results to this choice?

4. Optimization of 1D model

This section is well written and clear. The discussion of the differences between the surface chlorophyll and vertical profiles is particularly clear and interesting.

p. 13, Line 329: “Unlike phytoplankton, the observations show that the POC concentrations are 19 mg C m⁻³ at about 200 m depth because of the existence of detritus (Figure 4c).” What is the evidence that the POC is in the detritus class rather than zooplankton? This point is not supported, but is used later to discriminate between models.

Section 4.2: In the section for each experiment, remind the reader what data is used the optimization and which parameters are included in the parameter optimization

Could you plot the mixed layer depth of the 1D model for comparison to the DCM depth? In the 1D model, the mixed layer depth is the main physical control. One option would be to plot the mixed layer depth in figure 3e.

The supplemental figure S1 shows that even the corrected satellite data does not capture the seasonality observed by the floats. One sentence here describing the differences that remain between the floats and corrected OC-CCI could help us to better assess why experiment A in particular does not capture the seasonality.

p. 15, Line 375: “Although a slight increase in the misfit occurs for the surface chlorophyll (~5%),” Is the increase of 5% relative to experiment B?

Table 2: In the caption, explain what the dashes in the table mean. In the cases where the parameters are not included in the optimization, are the values that are presented in table 1 used? It would be helpful to the reader if the experiment that is discussed in the text is highlighted. Since different parameters are used in the 3D experiment, include additional lines in this table for the parameters that are used in the 3D experiment.

Figure 3: Include what data is used for each experiment in the figure caption. Could error bars be added to the observational points in this figure?

Figure 4: What do the error bars represent? Are they the interquartile range?

5. 3D biogeochemical model

p. 16, Line 421: How were the parameters that were modified manually chosen? It would be useful to provide more discussion of this choice.

p. 17, Line 442: Here the authors point to specific parameters that were inappropriate, but on p. 10, Line 246 the authors say that parameters are not allowed to exit a predefined range (which is shown in table 1). This seems inconsistent given that the method could have excluded inconsistent values. Could this difference be explained in more detail?

Section 5.1: The authors state that the 3D model does not perform well in coastal regions and therefore choose to exclude those regions from the model evaluation. This may be justified based on the statement in section 2 that there is little cross-shelf exchange in the Gulf of Mexico. However, this point should be discussed in more detail in order to justify ignoring the shelf. In particular, it is important to discuss the extent to which nutrients are supplied to the oligotrophic regions from either the shelf or the open ocean boundary. What is the importance of the boundaries relative to the biogeochemical cycling in the interior? In a 3D model, the boundaries could be very important for setting the primary production in the oligotrophic region.

p. 18, Line 451: What is meant by “different spatio-temporal scales between the two

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model versions”? This point seems important and could be clarified. Is it referring to time stepping, resolution, retention in a 1D location, or the presence of a seasonal cycle?

p. 19, Line 479: “cannot” should be “can not”

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