Response to reviewer 2:

The authors use a biogeochemical ocean model coupled one-way to a 3 stream radiative transfer model to show how modelled chlorophyll based on modelled spectral reflectance band ratios are more consistent with both satellite ocean colour and biogeochemical Argo float data than chlorophyll estimates derived directly from their physical-biogeochemical coupled model system, NEMO-BAMHBI. They demonstrate that introducing uncertainties in the form of random perturbations of inherent optical properties of different water constituents, improves the simulated distributions of radiative fields. The study is focused only in the deep central areas of the Black Sea, due to the limitations of the CDOM forcing used in the experiment.

This is an excellent piece of work. It significantly advances our understanding of how inherent optical properties of water constituents can be used to constrain biogeochemical models, leading to improved modelled predictions. Moreover, it opens new possibilities for integrating biogeochemical modelling, in situ optical observations and ocean colour remote sensing. The authors also demonstrate that preliminary results from a two-way coupling test show even more promising results.

The paper is well organised and well thought out. The approach and methods are valid. Limitations and assumptions inherent in their approach are discussed in depth and perspectives for future work are provided. I would be happy to see this published in Biogeosciences. It is a very timely and welcome contribution which unifies in situ marine optics, satellite ocean colour and biogeochemical modelling communities.

I have listed some minor comments below for the authors to consider.

We thank the reviewer for the careful review of our paper and for the remarks and suggestions that will help us improve our paper and its clarity. We also thank the reviewer for providing such a positive feedback. Please find below our replies to specific comments and updates we brought to the text. Comments from the reviewer are in bold and our replies are in light below each comment.

All of the figures (except figure 1) should be bigger, with larger fonts on the labelling.

All figures except figure 1 have been remade with larger size and fonts to improve legibility.

A table summarizing the different reference and ensemble runs would be useful.

A new table was added summarising information on the 4 ensemble experiments: number of members and optical properties that are perturbed.

Some references are missing, or in the wrong place.

- ***Line 36: add Cahill et al., 2008, https://doi.org/10.1029/2008GL033595***
- ***Line 49: add Bissett et al., 1999, https://doi.org/10.1016/S0967-0637(98)00063-6***
- ***Dutkiewicz et al., 2015 should be referenced earlier, I think, line 59 after the sentence "In recent years, … reflectance (Dutkiewicz et al., 2015)***

The suggested references were added to the text. The reference for Dutkiewicz et al. (2015) was also moved earlier as suggested.

In places, the English should be improved for better understanding, e.g.

- ***Line 39: "They can be described by the absorption and (back-) scattering spectra of each water …" instead of "They consist in absorption and …"***

Modified as suggested.

- ***Lines 67-68: at the end of the sentence "It solves the spectral wavebands corresponding to those typically used in remote sensing" add an example of what these wavebands are?***

The sentence was modified as: "Its spectral range includes the wavebands corresponding to those typically used in remote sensing (e.g. 412, 490 or 555 nm)."

- ***Lines 86 – 89: Suggest converting the following into a numbered list, easier to comprehend sequence of analysis. "We first assess the effect of … that are consistent with observations."***

This sequence was changed into a numbered list as suggested to improve legibility.

"This analysis comes in three steps:

1. Assessment of the effect of uncertainties in the parametrisation of absorption and (back-)scattering for each constituent separately.

2. Estimation of the combined effect of uncertainties for all uncertain constituents on irradiance and reflectance fields.

3. Evaluation of our ability to provide distributions of sea surface reflectance that are consistent with observations by modelling these uncertainties."

- ***Line 96: change last sentence to something like: "Finally in section 5, we discuss the limitations and assumptions of the study and provide an outlook for future work."***

- ***Line 109: change to " … solved with NEMO 4.2 which is online coupled to the biogeochemical model."***
- ***Line 143: change to "Attenuation coefficients are derived from absorption …".***

Modified as suggested.

- ***Lines 169 – 172: this paragraph appears without any explanation, should be qualified with a statement which explains why the product is mentioned, e.g. to validate the modelled reflectances.***

Indeed a transition was lacking to explain why this product is mentioned. The text was changed to: "RRS (λ, 0+) is directly comparable to remote-sensed reflectance data and will more simply be noted RRS in the following. Among the available satellite products, we will be using here the multi-satellite product provided by the Copernicus Marine Service for the Black Sea for validation and comparison."

- ***Lines 179-181: explain more clearly ecological reasons for choosing the band-ratio algorithm over the NN approach. Your study is focused on waters where the reflectance signal is dominated by phytoplankton, for example?***

The choice is motivated by our focus on the central parts of the basin were the band-ratio algorithm is dominant in the merged product (see Kajiyama et al., 2018). A sentence was added to explain this choice: "This choice over the neural network approach is motivated by our focus on the deep parts of the basin, where the band-ratio algorithm is predominantly used".

- ***Lines 207 – 208: change to " … solved in BAMHBI: these are large flagellates ….and diatoms, all of which are the dominant species in the Black Sea"***
- ***Line 249: change to "When run over the Black Sea, …."***
- ***Line 260: change to "… water column, the water constituent IOPs would not be altered."***

Modified as suggested.

- ***Lines 365 – 371: add table summarizing different simulations.***

Added as suggested, see comment n°2.

- ***Line 426: change to " … until it increases again …"***
- ***Line 430: change to "… at 555 nm, as its contribution to …"***

Fixed.

- ***Lines 447 - 448: change to "… phytoplankton early in the year with a lower contribution of CDOM in the ensemble spread."***
- ***Line 457: change to " … gradually increases with depth …"***

Modified as suggested.

- ***Line 562: "surface chlorophyll is defined as the average concentration over the top 10m." Is this based on some average of the 1st optical depth? Or? Maybe elaborate a little on this choice of depth over which to integrate the data.***

Yes, the depth of 10 metres corresponds to the average first optical depth in the Black Sea. We have added a reference and modified the text to support this assumption: ". For the BGC-Argo and BAMHBI deterministic run, surface chlorophyll is defined as the average concentration over the top 10 m, which corresponds to the average water optical depth in the Black sea (Peneva and Stips, 2005)."