Response to reviewer 1:

The authors investigate the influence of uncertainties in the inherent optical properties on the modelling of radiometric quantities adopting a radiative transfer model applied to the Black Sea. A detailed study is presented that considers several important optical components and discusses their role in light propagation. An advanced stochastic approach is used to understand the uncertainty and the relative contribution of plankton, nap, CDOM.

The results are clearly explained, the approach used is new and represents an important advance for biogeochemical modelling as it increases the realism of the models. Moreover, the analysis presented could be useful for the marine biogeochemical modelling community.

Below I list some minor revisions that I think could improve the text.

We thank the reviewer for the careful review of our paper, positive comments and for the remarks and suggestions that will help us improve our paper and its clarity. We have detailed below our replies and updates according to these suggestions. Comments from the reviewer are in bold and our replies are in light below each comment.

Pg2 lines 47-48 "Over the years, various models were developed with different approaches to refine the representation of light in models (Gregg and Casey, 2009; Mobley et al., 2009)." I would remove the repetition of models.

Pg 3 lines 69-70 "The penetration of the spectral irradiance is determined by the absorption and scattering properties of the medium that are derived from concentrations of optically active components, in 33 wavelengths." I would substitute with "The penetration of the spectral irradiance is determined in 33 wavelengths by the absorption and scattering properties of the medium that are derived from concentrations of optically active components."

These has been changed according to the suggestions made by the reviewer.

Pg 6 Eq.4 I would give the unit of measurement of PAR. Since the previous section mentions the one-way coupling with the RT model, I would explain why the PAR is introduced by the RT model since there is no feedback with biogeochemistry.

The units of PAR have been added to the text. To justify the introduction of PAR despite the absence of feeback with biogeochemistry, the following sentence was added: "Although the PAR simulated by the RT model is not used in the coupled framework in a one-way configuration, it is a useful quantity that can be used for comparison with in situ data."

Pg 15 Ensemble simulations. I would suggest that the authors create a table summarizing the properties of each of the 4 experiments.

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

Pg 17 line 426. "until in increases" should be "until it increases".

Fixed.

Pg 18 Figure 6 is very small and very difficult to read. Units of measurement in the y-axis are missing. In general, many of the illustrations in this manuscript are very small, especially the fonts, and the fonts, size and legibility should be enlarged.

Units were added to figure 6. All figures except figure 1 have been remade with larger size and fonts to improve legibility.

Pg 22 Figure 10, again the figure is very small. PAR should normally be expressed in quanta, and the PAR data from the BGC Argo float is also normally expressed in quanta. How did you convert to have W/m2? Perhaps the conversion formula could explain the discrepancy in PAR in Figure 10?

Additional text was added to explain how the conversion is performed: "PAR data from BGC-Argo floats is given in units of µmol/s/m2. The conversion to W/m2, the unit used in model outputs, is performed using 1 W/m2 = 4.6 µmol/s/m2 to obtain comparable quantities. This approximation is given for daylight conditions in Thimijan and Heins (1983). In sunny conditions, this coefficient would normally have to be lower."

It is true that the use of a constant coefficient to perform unit conversion is an approximation. In particular, the conversion factor would likely be lower in summer, when sunny conditions are more frequent. It also happens to be the time of the year where discrpencies are the largest in irradiance and PAR data. However, if we refer to Thimijan and Heins (1983), the variations in the conversion factor would not be large enough to explained the discrepancies observed here. A sentence was added later in the text to highlight the potential role of the factor: "For PAR data, part of the discrepancies in summer could be explained by an inconsistent unit conversion in sunny conditions."

Pg 22 lines 513- 521 Rank diagrams should be explained in more detail so that they are fully understandable, especially for the readers without expertise in ensemble modelling.

This paragraph was rephrased to explain in more detail rank histograms: "To each observation is attributed a rank that is equal to its relative position the realisations of the ensemble for this observation. The entire set of observations is ranked within the sorted ensemble of corresponding

simulated data. A flat histogram evidences perfect reliability, i.e. an ensemble distribution that matches the distribution of observations. A convex rank histogram suggests that the ensemble is over-dispersive (all observations tend to be within the ensemble), while a concave rank histogram suggests that the ensemble is under-dispersive (observations tend to be outside of the ensemble). The extreme ranks correspond to observations that are lower or higher than all realisations of the ensemble."

Pg 22 lin 524 iis the reference to Fig. 9 correct? The matching between model and data in Fig. 9 are very good, so the comment is unclear.

The reference is correct, but the comment was indeed unclear. Figure 9 shows a good agreement in the upper ~15 metres for irradiance at 490 nm, but an overestimation below. The idea here is to comment on this overestimation deeper in the water column. The text was changed to: “Fig. 9 shows that despite the excellent agreement close to the surface (also evidenced in Fig. 10), irradiance tends to be slightly overestimated deeper in the water column, regardless of the perturbation. The ensemble is nonetheless close to representing the distribution of measured irradiance streams.”