

Answer to Referee #2:

**Referee (R):** The manuscript was a joy to read. The authors evaluated the potential of using XGB and random forest to reconstruct POC in the global ocean. The authors found XGB performs marginally better than random forest.

The authors described the method very well and like that that testing was in regions away from training data.

**Authors (A):** We thank the referee for the positive feedback.

**R:** I would consider explaining variable importance and what it physically means. The authors note that the sine of latitude is in the top 10 drivers that influence large POC. Is this to be expected?

**A:** The role of latitude in the distribution of large POC was expected as there is a lot of meridional variability of POC distribution, which we can see in Figure 8b. We added in the text (lines 357-358 in the revised manuscript): *POC<sub>L</sub> distribution has a lot of meridional variability that results in the sinus of latitude being in the top 10 drivers.*

**R:** My only question is do ML algorithms like this one have the potential to replace parameterizations in ocean models?

**A:** Machine Learning techniques can help to improve parameterisations in ocean models. For example, ML can replace parameters used in parameterisation and make them region or/and time dependent as well as dependent on the ecosystem conditions as in our case with the POC concentration. We will not say that ML techniques will replace parameterisations, but they have the potential to improve it for sure. We added in the text (lines 521-526 in the revised manuscript): *The relationships between key variables and surrounding conditions based on Machine Learning can provide a new way for establishing parameters in ocean model parameterisation. The parameters can be time and space dependent and, thus, vary from one region to another better representing the physics. Relationship between POC concentration and environmental and ecosystem conditions can help to replace parameters in parameterised sinking velocity in PlankTOM. The reconstructed POC concentration over the global ocean will contribute to the reconstruction of porosity and opacity of particles that are key variables in the sinking matter velocity.*