Author responses to the comments are in blue.

We thank the reviewer for their comments and suggestions.

It is unclear to me what assumptions the model makes about the rates of mixing within the mixed layer.

Estimates of photosynthetic rates based on in situ incubations typically involve suspending incubation bottles at fixed depths so that there is no possibility for vertical movement. In 1978 John Marra (Marine Biology 46:203–208) explored the implications of this compared to systematically alternating the irradiance to simulate vertical movement. He found that vertical movement increased production versus keeping the phytoplankton at a fixed depth. I would assume that similar issues would apply to UV light effects. Because the effects of UV are nonlinear, assuming that the phytoplankton move up and down rapidly would likely lead to different conclusions than assuming that they stay at a fixed depth within the mixed layer. It is unclear to me what the model assumes about vertical movement. That might be something to explore in the future.

POP uses the K-Profile-Parameterization (KPP; Large et al., 1994) to parameterize vertical mixing in the mixed layer. Thus, there are wind driven vertical fluxes. Phytoplankton and zooplankton are tracers that will follow the currents horizontally and vertically in addition to being altered by photosynthesis and grazing, respectively (Long et al., 2021). MARBL has a vertical resolution of ~10 m in the mixed layer and the top two layer midpoints are 5 m and 15 m depth (Long et al., 2021). Sub-grid scale vertical fluxes that may move phytoplankton closer to the surface may not be well represented because of the vertical resolution of the model. This could be solved by simply increasing the vertical resolution of the model. This is beyond the scope of this work, but the methodologies described in this manuscript can easily be applied to a higher resolution model in the future. The Discussion section includes text about some of these caveats.

“Finally, because UV attenuates so quickly with depth, the available 10 m vertical spacing in CESM2-UVphyto may produce small inaccuracies in UV inhibition of photosynthesis that can affect the vertical profile of phytoplankton and as a result, the shading of PAR and PAR amounts deeper in the water column. Implementation of UV inhibition in a model with higher vertical resolution would likely resolve these processes with greater accuracy.”

How to deal with the CFC problem seems to be a work in progress. The initial fix was hydrochlorofluorocarbons (HCFCs), and then came hydrofluorocarbons (HFCs). The former are unsatisfactory because they still contain chlorine, and the latter are unsatisfactory because they are potent greenhouse gases. Both have been mandated to be phased out. In the meantime, the residence time of chlorine in the stratosphere is 40–100 years, which explains why there has been little perceptible improvement in the ozone hole (https://ozonewatch.gsfc.nasa.gov/).

Thank you for your comment. In the text, we have lightly edited the text to clarify that the ozone hole stopped growing in response to the Montreal Protocol, but has not recovered yet.

There is a lot of discussion in the paper about coccolithophores. I have attached a very recent paper by Bradley and Laws (Water 16(22): 3184 https://doi.org/10.3390/w16223184) that concerns effects of elevated CO_2, temperature, and nutrient limitation on *Emiliania huxleyi*. This is one strain of *E. huxleyi*, and not all strains can be expected to behave in the same way. The PIC/POC ratio was greater than 1.0, and calcification was surprisingly insensitive to increases of pCO_2.

Thank you for this reference. In MARBL, the existing coccolithophore functional type represents species including Calcidiscus leptoporus, Gephyrocapsa oceania, as well as four different morphotypes of Emiliania huxleyi (Krumhardt et al., 2017; 2019). Together, these cover most parts of the global ocean. The reasoning for considering many species was to capture broad scale responses. Text has been added to the text to make it clear how this was designed and may not consider individual strains.

"In total, the dynamics four morphotypes of *Emiliana huxleyi*, as well as other species such as *Calcidiscus leptoporus* and *Gephyrocapsa oceania* were used to construct the PFT, allowing the model to simulate the general response of coccolithophores to environmental changes (Krumhardt et al., 2019)."

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