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Interactive comment on “Response of ocean phytoplankton community structure to climate change over the 21st century: partitioning the effects of nutrients, temperature and light” by I. Marinov et al.

Anonymous Referee #1

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The manuscript ‘Response of ocean phytoplankton community structure to climate change over the 21st century: partitioning the effects of nutrients, temperature and light’ by Marinov et al poses a mathematical formalism to compare the strength of phytoplankton physiological response to temperature, nutrient and light as well as inter-compare phytoplankton groups. As ecosystem models become increasingly complex, this scope of simplifying theoretical interpretation of model behavior and competitive mechanics becomes increasingly valuable. I think the manuscript is well written (minor exceptions listed below) and does a good job in laying out the potential value of the

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approach for one example model, though it is unclear to me how the approach will be utilized in the more general case of comparing across multiple nutrients and when comparing changes across different models with differing mathematical forms. This is a challenge that I would hope the authors will perhaps attempt in a future manuscript. For the present one, I recommend publication with minor revision.

4566:2 – The response of ocean phytoplankton community structure to climate change will likely depend on many additional factors in addition to those three described here, including grazing, viruses, toxins, mixing, acidification, evolution, and many others, so the first sentence is vastly incomplete. Perhaps add ‘We study’ to the beginning of the sentence. Otherwise it sounds like the factors are the only ones.

Missing in the methods is a description of the scope of analysis – was it restricted to the surface, the mixed layer, or some modal value? Was depth variation considered? Was the seasonal cycle considered?

4575:5 – What do the authors mean by ‘particularly at the poles’? Is it apparent everywhere but most significant at the poles?

4577:10 - Is this response just because the base growth rate for small is higher, or is the relative growth rate change also higher for small?

4577:17 – This section leads a lead-in sentence. . . Otherwise, why should the reader bother assuming small and diatoms are limited by the same nutrient?

4578:4-5 - Figure 10 is not introduced and discussed sufficiently. What do the authors mean by ‘win’ when saying that diatoms ‘win’ under NO_3 and Fe limitation – higher biomass? higher growth rates? Why does the model not exhibit the yellow, blue and orange areas predicted by the theory? I would consider this a very significant difference.

4581:2,23 – The phrasing of ‘Now we turn’ and ‘We next try’ is not an appropriate way to introduce the new analysis, partially because of tense, partially because of the lack

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of context. Instead, something like, 'In order to consider the role of each individual term on the overall growth rates, we first' and then, 'Moving from the temperature effect to the nutrient effect, we next'

4581:8 – The rationale for invoking this toy function is unclear here. Equations 3 and 12c are listed, but their relationship to the function is not readily apparent. The previous sentence suggests that V_x and L_x are going to be the focus... would it simply be appropriate to add, 'These two variables are linked via Equation 6 which is a function with several notable properties.'? That would help guide the reader (if I am inferring the authors' logic correctly).

4581:11 and Equation 18 – With respect to θ_{c_x} / V_x , are the authors trying to assert that θ_{c_x} itself is invariant or that the variability in θ_{c_x} is driven by V_x such that the ratio is relatively invariant? Why no light modulation?

Throughout this section, it is often unclear to me whether the authors are intending the 'x > y' type statements to indicate the proof of a global truism (i.e. we have just proven that x must always be greater than y), or a conditional case that is being examined (i.e. under conditions of x being greater than y, another set of conditions follow). This would be clarified by replacing the phrasing of 'we have:', 'we can now write:', 'we can show that' with the appropriate descriptive introduction to introduce the conditional statement that tells the reader from whence the statement follows.

Equation 21, and 4582:16: Where does the left hand inequality come from? I cannot get it by combining equations 20, 12b, and 12c. Also, what does the two-way arrow symbolize? Given my uncertainty, the paragraph introductory statement 'Equation (21) intuitively makes sense' seems inappropriate to me given that I could not follow either where it came from or what it signified.

4588:7-9 – A stronger response overall, or incrementally relative to the present day conditions?

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4588:22 – ‘suggesting increase cloudiness’ implies that the authors are attempting to make inferences about the atmospheric model behavior based on the ocean interior light fields – why not just look at the atmospheric model directly?

4588:27-28 – What does “In the biome average’ mean? Is this a global average, just the subpolar South Pacific, or perhaps small+diatoms across the subpolar biome?

4588:28-9 – This statement seems in contradiction with the one in 4588:7-9 – is the subpolar southern ocean biome defined as not effected by sea ice?

4589:17 – ‘decay’ seems an odd word to use here – perhaps ‘decrease’?

4589:19-20 – I think the authors intend to add ‘community composition’ after ‘phytoplankton’ – Otherwise, it makes it sound like the authors are unaware of the CZCS, SeaWiFS and other ocean color datasets. Beyond this, and while I understand that the author’s intention is to motivate further research on satellite and field phytoplankton compositional variability, the sentence currently reads a bit insulting in the face of all of the existing studies in addition to Alvain (e.g. Mouw, Sathyendranath, Bracher, Balch, Uitz, Peloquin and others). Perhaps the authors should rather stress the lack of consistency and robustness between these data products.

4589:27-28 – This sentence comes off as a terse non sequitur and should be either removed or clarified.

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