Biogeosciences Discuss., author comment AC2
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Reply on RC2

Jiaying Abby Guo et al.

Author comment on "Investigating the effect of nickel concentration on phytoplankton growth to assess potential side-effects of ocean alkalinity enhancement" by Jiaying Abby Guo et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-312-AC2, 2022

Dear referees,

Thank you for your comments on my manuscript. We appreciate the time and effort that you have dedicated to providing your valuable feedback on our manuscript. Here are our point-by-point responses to these comments and concerns.

Comments from the reviewer2

Comment: This paper studies the influence of changing dissolved Ni concentration on the growth and fitness (photo-physiological response) of a wide range of phytoplankton species. This topic is under-studied and, therefore, this report is an important addition to our knowledge of Ni biogeochemistry in the ocean. Interestingly, the authors found that most of the species are either insensitive or show a limited response to the applied Ni gradient. Observed sensitivity for cyanobacteria and diatom species are in agreement with previous reports. Based on their results, the authors discuss the implementation strategy for the OAE and EW (utilizing olivine) to mitigate the increase in atmospheric CO2 and minimize the impact of associated excess Ni supply on marine ecology. Overall, the manuscript is well-written and structured. However, the manuscript needs to be revised before publication. I hope the comments below can help the authors improve their manuscript.

Response: We thank reviewer 2 for their kind comments.

Comment: 1) Discussion on the observed sensitivity of photo-physiological parameters (Fv/Fm and σ_{PSII}) to the applied Ni gradient seems limited. As shown, some species exhibit significant change in Fv/Fm or σ_{PSII} (e.g., Geitlerinema, Prymnesium parvum, Synechococcus). Also, Fv/Fm trends are very different for different species, for example, Synechococcus and Geitlerinema. It is less clear how Ni-replete or depleted conditions affect these parameters for different species. Do the authors suggest any causal relationship between changes in Ni and these parameters?

Response: Based on our results of F_v/F_m and σ_{PSII}, we can only confirm that the pNi 8-6 range enhanced photosystem II photochemical in *Synechococcus* sp. For the other species, we observed limited influence of Ni on photo-physiology though some species exhibited significant changes (p-value <0.05). We think there is likely to be a causal relationship as Ni was the only parameter varied across the experimental treatments.

However, we remain unable to provide sound speculations on why there were (seemingly rather random) differences between treatments. We, therefore, prefer to refrain from speculation.

Comment: 2) Based on their results or references to literature (lines 377-386), the authors suggest that total dissolved Ni ('free' plus ligand-bound) may influence the physiology of phytoplankton. As the experiments using Southern Ocean water (i.e., with high 'free' Ni) were not performed with all the species, it remains uncertain in this study if organic complexation could have a significant influence on the Ni bioavailability for a wide range of species. In this context, the authors' conclusion (lines 440-442) on utilizing organic ligand-rich regions for OAE application, presumably due to reduced Ni bioavailability, seems non-aligned to the above-mentioned discussion in the paper.

Response: Thank you for this excellent comment. We agree, our data do not allow such a claim. We removed this speculation from the abstract and revised the text in the discussion accordingly. We do believe that the underlying thought is worth mentioning in the Discussion, but we shortened it and stressed that the thought is based on an assumption.

Comment: Overall, I would recommend publication of the manuscript pending consideration to the issues mentioned above and other minor comments mentioned below. Other comments:

Line 50: What do you mean by 'quality'?

Response: We have changed the word "quality" to "composition". Thank you.

Comment: Line 53: Interested to know if, similarly, Mn would also be released. Mn is one such element which could be enriched in olivine, and rivers are one of the important external sources of Mn to the oceans. Mn is also a micro-nutrient for marine phytoplankton.

Response: Thank you for your suggestion. Yes, as you mentioned Mn would be released and can potentially influence the phytoplankton community as well. Mn may be our next subject to study in this context.

Comment: Line 60: Also, in the Atlantic (Middag et al., 2020) and the Indian Ocean (Thi Dieu Vu and Sohrin, 2013).

Response: Thank you for this information. We have added these references at line 60.

Comment: Line 63: 'bioactive element for phytoplankton in some areas' – appropriate reference(s) required.

Response: We have added Glass and Dupont, 2017 as a reference.

Comment: Lines 139-141: Some insights are required on how the 'free' Ni concentration is estimated using the software visual MINTEQ 3.1. Either it could be included in the main text or else in the appendix.

Response: Thank you for your suggestions. We have included our visual MINTEQ protocol in the Appendix.

Comment: Lines 149-151 (also 220-222): 'assumed the organic ligand…… in Aquil medium.' – some comparison (in numbers) and reference(s) are required.

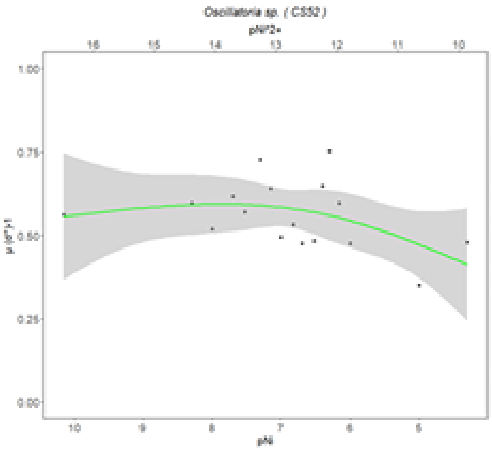
Response: We have added more information in the method part explaining the organic ligand concentration in the Southern Ocean seawater: "There was little information about concentrations and types of Ni-binding organic ligands in the Southern Ocean because these ligands occur at very low concentrations within a highly complex mixture of organic matter (Boiteau et al., 2016). If we take Fe-binding organic ligands as examples: the characterized types of Fe-binding organic ligands were different in various studies due to the diverse measuring protocol, and the concentrations of these ligands in the Southern Ocean varied from 0.72 to 12.3 nmol/L (Nolting et al., 1998; Boye et al. 2001; Buck et al., 2010). Therefore, the Southern Ocean seawater we used in the experiment was estimated to have lower organic ligands than the Aquil media (100 μmol/L EDTA)." (line 142)

Comment: Lines 196-198: "Typically, cells …. phase.' I did not understand this statement. Please explain and rephrase, if possible.

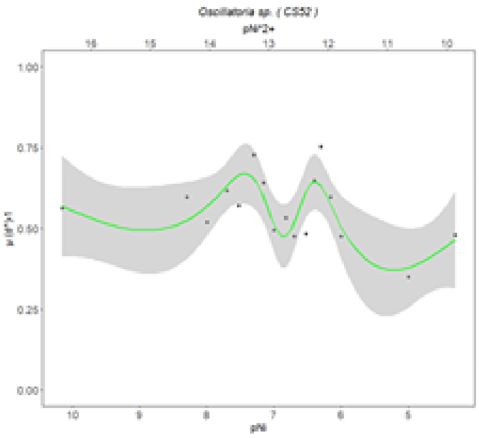
Response: Thanks for pointing this out. We will revise the sentence according to your suggestions:" The value of F_v/F_m and σ_{PSII} are known to vary among algal taxa (Suggett et al., 2009). Typically, cells growing in batch cultures at the exponential growth phase exhibit a constant value of F_v/F_m and σ_{PSII} (Parkhill et al., 2001)."

Comment: Line 213: What does "over- or under-fitting" imply?

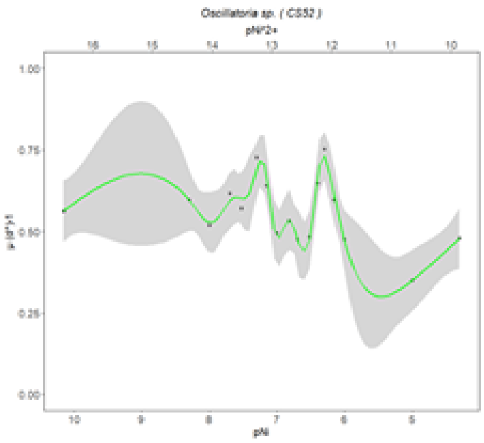
Response: The K-value is chosen according to the fitted results. If the k-value is too small, the fitted curve will be close to a straight line and will ignore the trend of Ni effects; if the k-value is too large, the fitted curve will be very wiggly and fit a model that intersects with every sampling point, thereby fitting methodological variability. Thus, the adjustment of k-values is needed to balance the complexity of the applied statistical model. We have added this explanation in the text (original lines 213).



K = 4



K = 7



K = 15

Comment: Line 240 and 292: How small?

Response: We have used a quantitative description here.

Comment: Line 306: It should be shown statistically.

Response: We have added the specific growth rate in the text (Lines 306-307).

Comment: Line 422: 'A potential dependency …… ligands' Is this established in the study?

Response: Good point. This was revised (see our response to your main comment).

Comment: Figures 2, 3 and 4: It is very difficult to read data from these figures. Optimal scales for y-axes of sub-figures should be used to so that trends discussed in the text are more apparent. If possible, results (sub-figures) can be divided according to different phytoplankton groups for better understanding.

Response: Thank you for your suggestions. The sub-figure will be hard to read if we plot three or four species together according to their functional group and it won't be easy to compare with other species. We have expanded the y-axis and narrowed the x-axis so that the response of each species is more obvious. We have also increased the font size of labels to make them easier to read.

Reference:

Buck, K.N., Selph, K.E. and Barbeau, K.A.,: Iron-binding ligand production and copper speciation in an incubation experiment of Antarctic Peninsula shelf waters from the Bransfield Strait, Southern Ocean. Mar. Chem., 122, 148-159, https://doi.org/10.1016/j.marchem.2010.06.002, 2010.

Boiteau, R.M., Till, C.P., Ruacho, A., Bundy, R.M., Hawco, N.J., McKenna, A.M., Barbeau, K.A., Bruland, K.W., Saito, M.A. and Repeta, D.J.: Structural characterization of natural nickel and copper binding ligands along the US GEOTRACES Eastern Pacific zonal transect, Front. Mar. Sci., 3, 1-16, https://doi.org/10.3389/fmars.2016.00243, 2016.

Boye, M., Berg, C. M. G. V. D., Jong, J. T. M. D., Leach, H., Croot, P., and Baar, H. J. W. D.: Organic complexation of iron in the Southern Ocean. Deep-Sea Res. Pt. I, 48, 1477 - 1497, https://doi.org/10.1016/S0967-0637(00)00099-6, 2001.

Nolting, R.F., Gerringa, L.J.A., Swagerman, M.J.W., Timmermans K.R., and Baar, H.J.W.: Fe (III) speciation in the high nutrient, low chlorophyll Pacific region of the Southern Ocean, Mar Chem., 62, 335-352, https://doi.org/10.1016/S0304-4203(98)00046-2, 1998.

Cheers,

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