Biogeosciences Discuss., author comment AC1
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# Reply on RC1

Chuanqiao Zhou et al.

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Author comment on "Rapidly increasing sulfate concentration: a hidden promoter of eutrophication in shallow lakes" by Chuanqiao Zhou et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2022-77-AC1, 2022

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Reviewer 1:

In this manuscript, authors focused on the widespread increase of $SO_4^{2-}$ concentrations in eutrophic lakes, and they explored the driving mechanism on why increased sulfate concentration was a hidden promoter of eutrophication. Authors arranged a series of microcosms and measured chemicals including sulfate, $\sum S^{2-}$, AVS, $Fe^{2+}$, $Fe^{3+}$, TP and SRB in overlying water and sediments, which was comprehensive. This work provided new insight into the effects of sulfate reduction on the promotion of iron reduction and the release of endogenous phosphorus in freshwater lakes. Overall, I feel that the manuscript is easy to follow, and it is also interesting. However, several issues that need to be modified in this manuscript.

1.In this study, the sulfate concentration up to 150 mg/L was selected in the microcosms, however, such high sulfate might not occur in lakes. Authors need to add field data to prove this possibility.

Response:

Thanks for the reviewer's question. The sulfate concentration in the freshwater lakes increased significantly around the world [1]. Particularly for Lake Taihu, the sulfate concentration increased from 30 mg/L to 100 mg/L from 1960 to 2010[2]. In addition, it has been reported that the sulfate concentration will continue to increase in the future[3]. In this study, we set up the initial sulfate concentration according to the data from these studies and the future level in the eutrophic lakes.

[1] Holmer, M., Storkholm, P. Sulphate reduction and sulphur cycling in lake sediments: a review. Freshwater Biology, 2001, 46:431-451.

[2] Yu, T., Zhang Y., Wu, F.C., et al. Six-decade change in water chemistry of large freshwater lake Taihu, China. Environmental Science & Technology, 47(16): 9093-9101.

[3] Chen, M., Li, X.H., He, Y.H., et al. Increasing sulfate concentrations result in higher

sulfide production an phosphorous mobilization in a shallow eutrophic freshwater lake. Water Research, 2016, 96: 94-104.

2.Line 85 "30mg/L to 100mg/L" lacks of space and the first mg/L need to be deleted. Please check throughout the manuscript.

Response:

We are sorry for our negligence. We have carefully checked and revised these errors throughout the manuscript.

3.Line 141 "0.11g if cyanobacteria powder were added into each bottle" What is the purpose of using cyanobacteria powder instead of fresh cyanobacteria? They have completely different ecological effects.

Response:

Thanks for your professional questions. In this study, we only considered the decomposition process of cyanobacteria, not the decay process. Therefore, we used the cyanobacteria powder instead of fresh cyanobacteria.

4.Line 141 "200 ml of water", water from Lake Taihu or prepared water in laboratory? How did you deal with it? Please explain it clear.

Response:

Special thanks to reviewer for your high perspicacity. In this study, the “200 ml of water” was prepared in laboratory, since the water from lake Taihu has the high concentration of sulfate[1]. It will affect the setup of microcosms for the initial sulfate concentration from 30 to 180 mg/L.

[1] Yu, T., Zhang Y., Wu, F.C., et al. Six-decade change in water chemistry of large freshwater lake Taihu, China. Environmental Science & Technology, 47(16): 9093-9101.

5.Lines 147-148 "Since the sampling method of the experiment is destructive sampling" what was "destructive sampling"? After sampling, how can you guarantee the stable anaerobic environment?

Response:

Thanks for the reviewer’s question. In this study, we used the method of destructive sampling. At the beginning of the experiment, we set up a time series microcosms including 1, 2, 3, 4, 5, 6, 7, 9, 11, 14, 18, 23, 28, 33, 38, 43 and 48 d. At each time point of sampling, a few of anaerobic bottles were opened for testing, which ensured the anaerobic environment for other bottles.

6.Tab.1 and Tab.2: Why use the sampling data at 7 and 38 d? Why not the whole incubation? Please provide the reasons.

Response:

Thanks for the meaningful question. On 7 d, the TP in the overlying water was up to the highest concentration with the highest reduction rate of sulfate. Although the whole incubation lasted 48 days, all elements (S, Fe, P) in the anaerobic bottles remained stable after 38 d. Therefore, we used the sampling data at 7 and 38 d.

7.Line 311 "When the sulfate reduction process mediates the iron reduction process…" How can we confirm the occurrence of iron reduction or sulfate reduction? Authors need to explain the process and make it clear.

Response:

Thanks for your constructive suggestions. In this study, cyanobacteria decomposition formed the anaerobic environment in the overlying water which was an important factor for the occurrence of iron reduction and sulfate reduction. For iron reduction, the concentrations of $Fe^{3+}$ and $Fe^{2+}$ increased significantly in the overlying water. However, due to the iron reduction, the $Fe^{3+}$ concentration was lower than the $Fe^{2+}$ concentration. For sulfate reduction, the sulfate concentration in the overlying water decreased significantly and the concentrations of $\sum S^{2-}$ and AVS increased. Therefore, we can confirm the occurrence of iron reduction and sulfate reduction in this study.

8.A thorough byproducts investigation might be required to show the change and shift of oxidation-reduction processes.

Response:

Thanks for the reviewer’s good suggestion. In this manuscript, we showed the dynamic changes of iron and $\sum S^{2-}$ concentrations in the overlying water, and the AVS concentration and SRB abundance in the sediment. These were important byproducts during oxidation-reduction processes.

9.Sulfate addition would affect the microbial diversity and cause the increase in SRB. SRB played an important role of sulfate reduction. However, there are no data to report these results.

Response:

As the reviewer has pointed it out, the sulfate addition affected the microbial process including SRB, actually, we have showed the dynamic changes of the SRB abundance on 0, 7 and 38 d in Table 2.

10.What is the minimum TOC for the occurrence of sulfate reduction and iron reduction for TP release? According to the discussion, lines 279-280, "Cyanobacteria released large amounts of organic matter during their decay and decomposition", the TOC might come from the cyanobacteria bloom. This indicates that some other carbon and nutrient sources are required to simulate the cyanobacteria bloom. Please clarify this description to prove your point "sulfate concentration increased was a hidden promoter of cyanobacteria bloom. "

Response:

Thank you for your important question. In this study, we focus on the endogenous phosphorus release from sediments. Cyanobacteria decomposition released phosphorus and the cyanobacteria biomass remained equal at the initial stage in all anaerobic bottles, however, the phosphorus concentration in the overlying water showed positive correlation with the initial sulfate concentration. The phosphorus concentration in the sediment showed the negative correlation with the initial sulfate concentration. These results clarified that the sulfate concentration promoted the endogenous phosphorus released from sediment to overlying water.

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2022-77/bg-2022-77-AC1-supplement.pdf