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Biogeosciences Discussions

Interactive comment on "Effects of eutrophication on sedimentary organic carbon cycling in five temperate lakes" *by* Annika Fiskal et al.

Anonymous Referee #2

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General comments

The paper studies sediment records of five different lakes that differ in trophic state and investigate the relationships between TOC accumulation, burial and historical P levels (eutrophication). I like the approach of comparing measured, modeled and reconstructed TOC to understand how sediment record was affected by eutrophication history. The MS is also informative by providing a nearly complete set of porewater chemistry data. However, I suggest the authors better describe the modeling methods, particularly the terms used (TOC accumulation, burial, TOC modeled, TOC reconstructed, etc.; see specific comments), which is important for the manuscript but poorly presented in the current version. I also find the results and discussions in cell counts, cell-specific rates less useful and largely speculative. I suggest reducing this part of

the discussion so that the paper has a better focus.

Specific comments: 1. Page 1, line 1: It's not obvious what is not well known. The introduction states that eutrophication increase TOC burial (page 3, line 9-10 and the references cited).

2. Page 1, line 25: I am not sure what "zonation of microbial respiration" means.

3. Page 1 line 29-30 "Instead, artificial lake ventilation, which is used to prevent water column anoxia in eutrophic lakes, may help sustain high rates of TOC burial and accumulation in sediments despite strongly reduced water column P concentrations." – This is speculative.

4. Page 30 – 35: very general statement. What insights?

5. Page 4, line 9- 21: I found the detail description here not necessary because Figure 1 is very self-explanatory. However, this is just a minor suggestion.

6. Page 5, line 11-12: Was air bubbling only done in oxygenated cores or all cores (e.g., cores under anoxia water)?

7. Page 7-8, Modeling of OC burial and accumulation rates through time: The calculation (equations) should be spelled out. It's not clear how what are calculated and how they are calculated. There seem to be multiple calculations here:

1) TOC modeled: using the surface TOC% to calculate the subsurface TOC% (based on the Middleburg power law), and comparing to measured subsurface TOC%. The purpose of this calculation is explained "...subsurface TOC% values that are higher ...", but it's better to spell out the equations, etc.

2) TOC reconstructed (but is this the same as TOC accumulation rate?) : using the TOC burial rate measured at depth to calculate TOC accumulation rate in the pass when the sediment of the specific depth was deposited at surface. The purpose of this calculation is not well explained. Also, the author should consider explaining the

calculations right after introducing TOC buried and TOC accumulation rate (line 9-11, equations 4 and 5).

These calculations and purpose of the calculations are important for the paper, but overall poorly described.

8. Equation 8: “n is porosity” should be mentioned here.

9. Page 10, line 15- 17: Is this based on TOC% in deeper sediments in Lakes Greifen and Zug? It’s not clear.

10. Page 12, line 4-6: how were rates of aerobic respiration estimated? O2 fluxes?

11. Page 12, line 15-18: Bottom water NO3 may indicate denitrification rates in the water column, not necessarily denitrification in the sediments. Bottom water NO3 concentrations affects sediment NO3 penetrations, thus NO3 penetration depth in sediments is not a good indicator for sediment denitrification either. The authors may consider calculating NO3 fluxes, which is integrated rates (mmol/m2/d) for comparison.

12. Page 13, SO4: it may be interesting to compare SO4 fluxes at the SWI.

13. Page 15, line 30-31 “Thus, sediments deposited during the pre-eutrophication, early and mid eutrophication periods have similar RRtotal today. . .”: it’s not clear how this conclusion is reached?

14. Page 16, line 20-22 “Yet, even though water column P concentrations in most lakes have decreased close to pre- eutrophication levels since the ∼1970s, TOC burial and accumulation rates in eutrophic lakes remain significantly higher than before the eutrophication era (Figs. 3 and 4).”: This is an interesting observation, and also agree with studies that show persisting high primary productivity after P reduction.

15. Page 16, line 23-25: “Despite the increase in TOC burial, lake sediments are not a static sink for OC. Increases in TOC accumulation and burial increase remineralization by stimulating microbial respiration (Fig. 6).”: this is an interesting statement, however,

quantitative estimation is needed. With increasing TOC deposition (sedimentation), the net burial of TOC (long-term burial) may still be higher compared to pre-eutrophication period, even though microbial respiration increase.

16. Page 18, line 25-26 “Despite the observed decreases in TOC accumulations in two of the three eutrophic lakes, our calculated TOC accumulation rates for the period after peak eutrophication have remained well above those during pre-eutrophication times (Fig. 3).”: Does primary productivity also decrease to pre-eutrophication times?

17. Page 19 Zonation and rates of dominant respiration processes: Rates were not quantified, and comparing zones in different sediments are less meaningful. I don’t quite understand what the authors mean by “zonation”. I suggest removing this part of the discussion.

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