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

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

Anonymous Referee #1 Received and published: 18 April 2019

General comments: This ms deals with the impact of eutrophication on sediment TOC burial and mineralization in 5 temperate lakes. I find the topic interesting and the study and analyses are thoroughly performed and described.

Answer: The authors thank the anonymous referee for the positive assessment and constructive suggestions. Below are our answers to the detailed comments of the referee. All changes to the ms in response to the referee comments are highlighted in

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blue in the main document (please see link to the supplement below).

However, I found that the introduction lacks some background information. First, the potential reasons for the increase of TOC burial in case of eutrophication appear too late and too briefly in the ms (p18 L10-15) and should be detailed in the introduction.

Answer: We would like to refer the reviewer to the paragraph on page 3, lines 9-17, in which we explain the link between TOC burial and eutrophication.

The authors mostly assume that TOC accumulation/burial increased because of an increase of OC deposited on the sediment (e.g. p10 L25, P8 L1-2, p21 L8). Other potential reasons could be mentioned. For example, in some cases OC could be better preserved because of anoxic conditions due to low sediment mixing and low bioturbation (so not necessarily related to an increase in NPP)?

Answer: Thank you for this comment. We discuss oxygen exposure as a possibility on p. 18, L. 24 to p. 19, L. 2, as well as p. 19, L. 15-31. In this context we also discuss the apparent lack of a strong influence of bioturbation on C burial in eutrophic Lake Baldegg. Our analyses indicate that, although oxygen exposure may play a role, other variables appear to be more important drivers of OC burial.

Secondly, besides the influence of mitigation strategies on OC burial (p3 L20), the novelty of the study regarding the relationships between eutrophication, TOC burial in general and respiration could be more detailed in the introduction. The authors mention respiration in the hypotheses p3 L28 but cite very few references on this aspect before that.

Answer: We have changed the section introducing microbial respiration in the beginning of the Introduction (P. 2, L. 21-26) and added two more references. We have also rewritten the end of the introduction (p. 3 L. 24 – p. 4, L. 4) to more clearly highlight the novelty of the study.

I think the authors should better justify the use of only one decay constant k for their

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calculations of OC burial and accumulation rates. The decomposition rate of TOC can strongly vary and the authors show in this ms that the respiration rates and ratios (RR DIC/ RR CH4) differ between sites.

Answer: We have tried to explain this more clearly in the Material and Methods (p. 8, L. 9 – p. 9, L. 4). Please note that – in the power model - the decay constant k changes as a function of time (it is not simply one constant). Furthermore, despite using the same k for TOC of comparable ages from different stations or lakes, the TOC decomposition rates differ greatly as a function of TOC content. We use the power model, which has been empirically shown to describe the relationships between TOC profiles and time across many sedimentary environments, as a reference, in order to identify the effects of eutrophication on TOC and TOC burial. We could have used different models to describe the TOC-time relationship, but inevitably these would have also failed to describe the observed subsurface peaks in TOC, as – same as in the power model - the common assumption is constant TOC deposition and burial. This assumption is wrong for lake sediments that have experienced eutrophication, as shown by this study and a small number of previous studies. With respect to the respiration rates, we would like to point out that we observe higher respiration rates in sediments of eutrophic lakes, where TOC is higher, compared to meso-/oligotrophic lakes (Figure 7). This is consistent with inferences regarding TOC that are based on the power model.

Detailed comments: P3 L30: I find strange to already give the results here

Answer: we use this to attune readers to the scientific trajectory of the following manuscript. This is a common practice.

P4 L21: repetitive with L7-8 Answer: Thank you, the repetition in L21 was removed as suggested.

P4 L32: “The porewater was then sampled under strictly anoxic conditions” how? Because the syringe was rinced?

Answer: a half sentence was added for clarification (p. 5, L. 4).

P7 L21: Punctuation missing

Answer: Punctuation was added.

P8 L1-2: it can also mean that the decay constant is in reality slower (higher)?

Answer: see answer to previous comment on the use of the decay constant.

P9 please provide more details on the flux (unit, the flux is from what to what...) L14 what is the unit of RR DIC and RR CH4? Please provide more details on how RR DIC and RR CH4 are calculated (i.e. write explicitly the relation between the flux, RR DIC and RR CH4).

Answer: a formula was added (Eq. 12) describing the calculations we made to calculate respiration rates from flux including units (P9 L16-18 and P10 L1-4). We furthermore added units to all equations.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2019-108/bg-2019-108-AC1-supplement.pdf

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