

Interactive comment on “Photochemical mineralisation in a humic boreal lake: temporal variability and contribution to carbon dioxide production” by M. M. Groeneveld et al.

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Response to A. Amado (Referee #3)

General comments:

This manuscript by Groeneveld et al. describes a seasonal study of the photochemical degradation rates of dissolved organic matter (DOM) in a humic northern (Boreal) lake in Sweden by looking at “in situ” photochemical dissolved inorganic carbon (DIC) production estimated rates and modeled estimated rates. Also, the manuscript focused on the apparent quantum yields (AQY) over a temporal scale. The study is well de-

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signed and developed and bring interesting data that might contribute to the general current knowledge of the DOM photochemistry dynamics in lakes and also points out that it is reliable to evaluate the photochemical contribution to lakes carbon budget using modeling methods. Thus, in my opinion the manuscript is suitable for publication in Biogeosciences.

Response: We are pleased by the overall positive reception of our manuscript “Photochemical mineralisation in a humic boreal lake: temporal variability and contribution to carbon dioxide production”, and greatly value the suggestions and comments given by Dr. Amado. Below, we provide detail on how the manuscript has been revised in response to the comments.

I acknowledge here that reviewer # 1 did a great job reviewing the manuscript raising questions and pointing out really relevant issues (regarding technical aspects of the research) to be addressed before acceptance and I totally agree with all these comments. Also, I noticed that the authors already addressed these concerns, which I believe have greatly improved the manuscript quality.

Response: We agree that the comments provided by reviewer # 1 were very helpful in improving the manuscript.

On the other hand, in my opinion it is necessary to better explore the main message of the manuscript regarding the title and the discussion structure. Thus, I'll recommend the manuscript for publication after the consideration of the aspects that will be detailed below.

Aspects of the general message to be addressed: 1. The title describes what the study aimed, but does not bring the message of the manuscript. As I understand, the photochemical mineralization contribution to the total carbon dioxide (CO₂) production in the lake is minimal and that was the expected from the literature (e.g. Jonsson et al. 2001) and thus, the authors may feel that it does not call great attention to the paper. However, this study brings this confirmation in a very consistent way due to a

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more complete time-scale approach because it considers the seasonal variation of the photochemical DOM degradation and total CO₂ production. On the other hand, this work also highlights the relevance of considering the temporal (seasonal) variation to estimate the AQY rather than time-limited observation/estimates. That brings a reliable modeling approach (demonstrated through the comparison with the “in situ” measurements) to study the photochemical contribution to CO₂ production in lakes for broader time and spatial scales. Raised these aspects, the authors should pick what they believe as being the most relevant aspect of the work as the main take-home message to acknowledge in the title (and make it more attractive and informative).

Response: In response to this comment, and to similar comment by reviewer #2, we revised the manuscript title to “Photochemical mineralisation in a boreal brownwater lake: Considerable temporal variability and minor contribution to carbon dioxide production”, highlighting both main findings of the study.

2. The discussion of the manuscript does a great job in presenting the patterns found in the research, adding the data in the literature results perspective and discussing it altogether. However, in my opinion it is not clear in the discussion what is the main message of the work, following the thoughts line in my previous comment. Thus, my suggestions to the authors are: a) Think through the paper and considering the literature (state of art of the research topic) to clearly recognize what should be the take-home message of the paper: either the confirmation of the low contribution of the photochemically produced CO₂ to the whole lake carbon budget in the humic boreal lakes considering the seasonal variation or the possibility of using modeling tools to study this photochemical contribution in lakes with good confidence. In my opinion, the first one should be adopted as the main message and better exploited in the title of the paper and the second one should be clearly stated in the discussion;

Response: We revised the manuscript title, which now states that the contribution of photochemical mineralization to carbon dioxide production in the studied boreal brownwater lake was minor (see also response to comment above above).

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b) In the discussion, write an introductory paragraph where the authors would clearly state the main message and secondary messages of the paper so the reader can be better guided in the discussion to what is the contributions of the paper. As I mentioned in the previous comment (A), the low contribution of photochemical degradation to the total CO₂ in the humic lake is an important finding and could be the pointed as the main message. Also the possibility of other studies be carried out in different lakes from different regions (such as tropical lakes with high sunlight incidence all over the year) to evaluate the AQY and CO₂ photochemical production through modeling estimates should be stimulated as this paper shows that it is an important and reliable approach.

Response: We agree with the reviewer, and have included a new introductory paragraph in the discussion section where we stress the main message of the manuscript and aim to facilitate the understanding of the reader: “The apparent quantum yield (AQY) spectra for photochemical DIC production, measured monthly between June and November 2014 in a boreal brownwater lake, showed considerable seasonal variability, with the slope of the spectrum decreasing over the open-water season. Photochemical DIC production, simulated using photochemical rate modelling, made a minor contribution to the total CO₂ emissions observed from the same lake (Fig. 5). Hence, similar results from earlier studies in boreal Sweden (Jonsson et al., 2001; Koehler et al., 2014; Chmiel et al., 2016) were corroborated when considering temporal variability in photochemical reactivity as well as in total lake CO₂ emissions. Moreover, the good match between photochemical DIC production observed in situ and simulated rates (Fig. 2) supported that photochemical rate modelling is a suitable approach to investigate photochemical DOM mineralisation in lakes and its contribution to carbon cycling on broader temporal and spatial scales. This highlights the potential to use a similar method for studying this process also in other climate zones, e.g. for tropical lakes, where the role of photochemical mineralisation for lake carbon cycling remains even less constrained than in boreal and temperate systems.”

By considering these aspects, I believe that the paper will turn into an even more

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interesting paper and will reach a broader audience.

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