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

**M. M. Groeneveld et al.**

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Response to Anonymous Referee #2

General Comments: The role of photochemical oxidation of DOM in natural waters in releasing CO2 has been studied since the 1980s. However, many questions remain regarding the nature of the process and it rates – the latter of which the present study addresses. Their study reports valuable findings on the high seasonal variability of the apparent quantum yield (AQY) that is an integrated index of wavelength-specific photochchemical reactivity of DOM. By making monthly experimental measurements of AQY in a humic Swedish lake and running photochemical rate modeling exercises,



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they conclude that the photochemical production of CO2 is a minor fraction of the overall CO2 production in humic Swedish lakes that is presumably dominated by biological respiration. Advancing the discussion of these findings to low-latitude lakes with less seasonality and including considerations of loading of CDOM with variable reactivities based on the nature of the different biogeochemical backgrounds of their watersheds would enrich this study.

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 the reviewer. Below, we provide detail on how the manuscript has been revised in response to the comments.

Details: 1. Title: The title describes the subject well, but reveals nothing of the findings. Suggest changing the later part of the title as follows: “large temporal seasonal variability with minor contribution to CO2 production”. Response: We agree that the title could be more informative concerning the main findings of the study. We revised the title to: “Photochemical mineralisation in aÂăboreal brownwater lake: Considerable temporal variability and minor contribution to carbon dioxide production”.

2. Abstract: Good.

3. Introduction: Nice introduction to the problem.

4. Methods: Sufficient detail is given.

5. Results: Results are well presented, and I have no suggestions to make here.

Response: We are pleased about the positive comments concerning these manuscript parts.

6. Discussion: Nice discussion points. Advancing the discussion of these findings to low-latitude lakes with less seasonality and including considerations of loading of CDOM with variable reactivities based on the nature of the different biogeochemical



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backgrounds of their watersheds would enrich this study.

Response: Although no study has yet measured AQY spectra in low-latitude lakes, we acknowledge that a few studies have investigated seasonal variability in photochemical DOC mineralisation. We now include a paragraph in the discussion devoted to a comparison between the effect of seasonality in high-latitude and low-latitude systems, referring to a recently published article by Vachon et al. (2016) on temporal variability in temperate and boreal systems and articles by Amado et al. (2006) and Suhett et al. (2007) on tropical systems, specifically: "Similarly, rainfall and input of fresh terrestrial material increased CDOM photoreactivity in tropical lakes (Amado et al., 2006; Suhett et al., 2007). For tropical systems, which receive an even dose of sunlight throughout the year, the importance of photochemical reactivity in regulating temporal variability in photochemical DIC production may be expected to be higher than in boreal lakes, where temporal changes in photochemical reactivity interact with the pronounced seasonality in irradiance. Accordingly, CDOM photoreactivity and irradiance explained a similar amount of variability in photochemical mineralisation across seasons for three boreal and northern temperate lakes (Vachon et al., 2016)."

7. Furthermore, a simultaneous study of both ecosystem respiration and photochemical oxidation rates would have been very helpful. The authors should at least attempt a literature review – perhaps in the shape of a Table and discuss the take home message and how it relates to the current study.

Response: During June to October 2012 and April to November 2013, total CO2 emissions were measured from the same lake using floating chambers (Natchimuthu et al., unpublished data). In the originally submitted manuscript, we had compared the mean simulated DIC photoproduction to the mean observed CO2 emissions (P17140, L22-29 and P17141, L1). Moreover, we compare the simulated DIC photoproduction from our study to four more studies from boreal Sweden (Jonsson et al., 2001, Humborg et al., 2010, Koehler et al., 2014, Chmiel et al., 2016; P17141, L1-10). To address this reviewers comment, and a similar comment by reviewer #1, we placed more emphasis



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on relating our study to the total CO2 flux measurements. Specifically, we included the methods for the total CO2 flux measurements, and prepared a boxplot comparing the mean total CO2 emissions to the simulated photochemical DIC production (new Fig. 5), illustrating that simulated photochemical DIC production made just a minor contribution to the total observed CO2 emissions from this boreal brownwater lake. Given that we use the total CO2 emissions fluxes more extensively we extended the author list, including S. Natchimuthu. The take-home message is discussed on original P17141, L15-20, and revised P16, L30 - P17, L4.

8. Refs: O.K. I consider this work to be of considerable interest to the readership of BG. The overall approach has merit, and these experimental measurements covering seasonal variability and modeling of photochemical mineralization of DOM reveal lower than expected rates of photomineralization of carbon, help advance our understanding of photochemical reactivity of DOM in natural waters and brings better context to its diminished but still important role in the carbon cycle of Earth's watersheds. I suggest revision including a more robust Discussion of the findings as noted above.

Response: We revised the discussion section of the manuscript according to the reviewers suggestion, as detailed above.

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Interactive comment on Biogeosciences Discuss., 12, 17125, 2015.