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Biogeosciences Discussions

Interactive comment on "Carbon concentrating mechanisms maintain bloom biomass and CO_2 depletion in eutrophic lake ecosystems" *by* Ana M. Morales-Williams et al.

Anonymous Referee #3

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Review of Morales-Williams – CCMs maintain bloom biomass and CO2 depletion in eutrophic lake systems

The MS by Morales-Williams et al shows carbon isotope data from 16 different lakes (eutrophic and hypereutrophic). The carbon fractionation factors were calculated and correlated to the CO2 concentration available. The authors suggest that the decrease in fractionation is due to the use of HCO3-, indicating CCM activity, which would allow the phytoplankton community to thrive in the lakes even when CO2 becomes limited.

I have several major concerns with the data presentation:

- A simple correlation of d13C values with Chl a concentration cannot be used in this

study to predict CCM activity. The authors describe the function of the CCM and how this could potentially change the isotopic signature of the cells (see line 91). Recent papers by Eichner et al 2015 and Raven and Beardal 2015 include internal cycling and loss terms of CO2. These two paper directly affect the interpretation of the data in this MS and should be introduced and discussed. Additional, a paper by Kranz et al 2015 showed the change in epsilon 13C during a bloom of diatoms. These authors also measured CCM parameters directly, seeing a switch from CO2 to HCO3- uptake at low CO2 conditions. However, this study used a model (Hopkinson) to predict the changes in d13C POC due to the switch to HCO3- uptake. The authors could contribute less than 0.5 permill change in the d13C signal to the switch in the inorganic carbon source-. Together with the findings by Eichner et al 2015 and Raven and Beardall (2015) I feel that the authors have be aware that isotopic signal of organic matter are not necessarily driven by the uptake of different carbon species, but largely are affected by other cellular processes such as leakage as well as the external d13C DIC. Additionally, different species have different isotopic compositions – do the authors know if the lakes have similar phytoplankton communities?

- In the method section the authors do not specifically mention how they obtained the biomass measured. Please be more precise in this and also mention how much of the organic material might have been detritus from other sources.

- The authors have to include the data of TA, DIC, d13C DIC, pH into Table 1 for the reader to understand the dataset and the correlations given.

- The title of the MS is a little farfetched. Neither does the study proof that CCMs maintain biomass in the lakes not did the authors show actual CCM activity. Please revise.

Specific comments:

Line 113: What are the criteria for which the lakes have been chosen? Wouldn't it be sufficient to just mention that 16 lakes were sampled and then briefly describe their

properties?

Line 127,132: I don't understand the expression – "measurements were increased" do the authors mean that data was corrected/adjusted for pressure and temperature? Please revise.

Line 143-145. I feel that this short paragraph should move behind line 160.

Line 171 and 172: describe what alpha a and alpha b means (Temperature-dependent fractionation factors between CO2 and HCO3 (a) as well as $HCO3^-$ and $CO32^-$ (b).

Add additional info on the sampling of the phytoplankton organic matter

Fig 1: Despite being significant, the predictive power of the dataset is relatively low! How would the dataset look like, if you use epsilon vs. Chl a. I feel that this would be more appropriate especially after reading how d13C seems to change in the different lakes.

Discussion:

Line 220: Please rephrase: "This mechanism likely provides a competitive. . ." The authors refer to decreased fractionation as a mechanism, yet the fractionation calculated is the result of cellular mechanisms such as enhanced HCO3- uptake and/or enhanced CO2 leakage. Maybe rephrase to: "The cellular mechanisms which led to the decrease in fractionation under low pCO2 likely provide. . ."

Please explain the paragraph starting line 234 better.

References:

Eichner M Thoms S Kranz SA Rost B . 2015. Cellular inorganic carbon fluxes in Trichodesmium: a combined approach using measurements and modelling. Journal of Experimental Botany 66, 749–759.

Kranz S Young JN Goldman J Tortell PD Bender M Morel FMM . 2015. Low tem-

perature reduces the energetic requirement for the CO2 concentrating mechanism in diatoms. New Phytologist 205, 192–201.

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