Biogeosciences Discuss.,
doi:10.5194/bg-2016-350-RC1, 2016

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.

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Received and published: 1 November 2016

Morales-Williams Bg-2016-350 Morales-Williams et al have assembled an isotopic data base on aquatic plankton and ambient water, and relate this to carbon concentrating mechanisms (CCMs) in cyanobacteria. CCMs are like cosmological "dark energy". One might doubt their existence, except that many smart people confidently attest to them. It is nevertheless ironic that CCMs are reported mainly from very small algae. Small size makes CCMs less necessary, and harder to operate. Biological lipid membranes just don't retain CO2. They retain HCO3- much better, but 1000-fold accumulation factors (Line 72: Raven et al., 2008) make even an acolyte squirm. (Some papers suggest even higher accumulation ratios.) Is this necessary? Isn't it expensive? 1000x

also brings internal DIC levels nearly to the molar range. Wouldn't that create high osmotic pressures, and pop those little bugs? Morales-Williams et al attribute high 13C levels in phytoplankton to CCMs. Do the isotopes really require a CCM? What sorts of CCM would or wouldn't explain the isotopic results, and what can be inferred about the CCM? For example, what does the isotopic data say about internal carbon concentration factors? Leakage rates? Title: "Carbon concentrating mechanisms maintain bloom biomass and CO2 depletion in eutrophic lake ecosystems" doesn't mention cyanobacteria or isotopic measurements, which are the focus of the paper.

Shallow surface water systems are rife with isotopic complications. Wintertime decomposition of organic matter brings springtime high CO2, low pH, low 13C-DIC. Even methane production (line 245) and methane oxidation might alter the 13C of DIC. Hydrology and groundwater inputs can be important (line 244). Carbonate rocks in the soils, like the glacial tills in Iowa, can add isotopically heavy DIC to the system. The present data is further complicated by many different ponds, with individual depths, presence or absence of macrophyte beds, farm water inputs, surface algal scums, different species of algae, blooms at different times, etc. With all this heterogeneity, focus on summertime algal bloom conditions. In the graphs, use larger or darker symbols for bloom conditions. In the table, give separate values typical of bloom conditions, and include representative pH, alkalinity, and chlorophyll. In text, please summarize chemical conditions during algal blooms.

Line 96: "decreased carbon efflux". Carbon efflux may be key to the isotopic balance. Carbon balance models for cyanobacterial CCMs (like Manger and Brennon 2014) sometimes call for large carbon effluxes, sometimes much larger than photosynthetic fluxes. CO2 efflux might leave internal HCO3- relatively enriched in C13, leading to C13 enrichment of photosynthetic products.

159: Phytoplankton samples fumed in HCl to remove inorganic carbon. This procedure would mainly be useful if the samples contained lots of it. Its quantity and isotopic composition would be very nice to know. Could you possibly make such measure-

ments? Could CaCO3 or other solid phases account for some of this internal C? Many cyanobacteria do calcify. Calcification is most likely in alkaline waters with significant calcium. Please list ambient pH and alkalinity levels in table 1, and discuss this possibility. Calcification can also act as a CO2 generator (McConnaughey 2012, Mar Ecol Prog Ser doi: 10.3354/meps09776).

163 “appropriate isotopic scale?”

191 fractionation of biomass compared to external CO2. (Eq 4 line 173): εp =(δ13CCO2 - δ13Cphyto) / (1 + (δ13Cphyto / 1000)). Text line 191 (as is figure 2 caption) should specify that you are talking about fractionation of biomass relative to ambient CO2 to prevent confusion (for example, confusion with ambient DIC, internal DIC pool, or internal CO2.) Note that this fractionation factor is a result of the cumulative fractionations that have occurred as the plankton grew. It is not an instantaneous fractionation that occurs at the time of harvest, during the bloom. Can you estimate an instantaneous fractionation?

23, 204: “Harmful” and HCB: This may be true from a human or fish perspective, but this study doesn’t address harm.

234, 252: Isotopically light aquatic DIC often comes from decomposition of organic matter, especially in early spring, accompanied by high total DIC and low pH. However, CO2 invasion from air and hydroxylation in alkaline waters during summertime bloom, accompanied by kinetic isotope fractionations, might also cause isotopic enlightenment of DIC.

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-350, 2016.