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The influence of biogeochemical processes on the pH dynamics in the seasonally hypoxic saline Lake Grevelingen, The Netherlands

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Coastal areas experience more pronounced short-term fluctuations in pH than the open ocean due to higher rates of biogeochemical processes such as primary production, respiration and nitrification. These processes and changes therein can mask or amplify the ocean acidification signal induced by increasing atmospheric pCO_2. Coastal acidification can be enhanced when eutrophication-induced hypoxia develops. This is because the carbon dioxide produced during respiration leads to a decrease in the buffering capacity of the hypoxic bottom water. Saline Lake Grevelingen (SW Netherlands) has limited water exchange with the North Sea and experiences seasonal bottom water hypoxia, which differs in severity interannually. Hence this lake provides an ideal site to study how coastal acidification is affected by seasonal hypoxia.

We examined the annual cycle of the carbonate system in Lake Grevelingen in 2012 and how biogeochemical processes in the water column impact it. Monthly measurements of all carbonate system parameters (DIC, pH, fCO_2 and TA), suspended matter, oxygen and nutrients were accompanied by measurements of primary production and respiration using O_2 light-dark incubations. Primary production was also estimated every season using ^{14}C-incubations and monthly via ^{13}C-labeling of phospholipid-derived fatty acids (PLFA). Finally, incubations to estimate nitrification and NH_4 uptake using ^{15}N-enriched ammonium were carried out seasonally.

Preliminary results show that the hypoxic period was rather short in 2012. During stratification and hypoxia, pH varied by up to 0.75 units between the oxic surface water and the hypoxic bottom water. Consistency calculations of the carbonate system reveal that pH is best computed using DIC and TA and that there is no significant difference between TA measured on filtered (0.45 μm) and unfiltered samples. Primary production rates were highest in summer and range up to 800 mmol C/m^2/d. Nitrification rates varied between 73-2702 nmol/L/h and did not vary much with depth in winter (March) but increased with depth in spring (May) due to a lack of NH_4 in the surface water. Further calculations are necessary to estimate a proton budget for Lake Grevelingen and will reveal whether on an annual scale this saline lake is currently a source or sink for atmospheric CO_2.