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

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Introduction
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 pCO2 [1-2]. Coastal acidification can be enhanced when eutrophication-induced hypoxia develops [3]. This is because the carbon dioxide produced during respiration leads to a decrease in the buffering capacity of the hypoxic bottom water.

Research questions
- What is the contribution of primary production, nitrification and CO2 exchange with the atmosphere to the total rate of change in pH?
- Is Lake Grevelingen a source or a sink for CO2 on a yearly basis?

Lake Grevelingen
Saline Lake Grevelingen (SW Netherlands) has limited water exchange with the North Sea and experiences seasonal bottom water hypoxia. In our sampling year 2012, the hypoxic period was rather short but severe.

Process rates
Rates of primary production, determined monthly by light-dark O2 bottle incubations, peak in May and July, while respiration is more constant during the year. Nitrification rates, determined seasonally by incubations using 15N-NH4, show highest values in May as a result of high [NH4] at depth.

Effect of biogeochemical processes on pH
We estimated the outgassing of CO2 based on the difference between surface water (1m) and atmospheric pCO2. The change in proton concentration due to primary production, respiration and nitrification was calculated according to eq.2 [4]. Here, νH+ represents the stoichiometric change in [H+] in the absence of buffering. It is noticeable that [H+] changes due to net production are mainly driven by high primary production rates, while in August the effect of nitrification on [H+] is mostly driven by the low buffer factor.

Carbonate system
During stratification and hypoxia in August, pH differed by 0.75 units between the oxic surface water and the hypoxic bottom water. The buffering capacity, determined by calculating the buffer factor as in eq.1 [4], varied a factor 2 with season and up to a factor 5 with depth.

Main conclusions
- Lake Grevelingen carbonate dynamics are mainly driven by production and respiration. Nitrification plays a role in the deeper water in summer.
- Hypoxia influences pH in summer by weakening the buffering capacity.
- Overall, Lake Grevelingen was a sink for atmospheric CO2 in 2012.