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# What controls the nitrogen fixation in the Baltic Sea? - Solar radiation versus phosphorus -

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Records of the surface water $CO_2$ partial pressure along a VOS (voluntary observation ship) line crossing the entire central Baltic Sea were performed since 2003. The overall seasonality of the $pCO_2$ was characterized by two minima which reflected $CO_2$ consumption during the spring bloom and during the mid-summer cyanobacteria bloom. Furthermore, the high temporal resolution of the measurements facilitated the identification of short-term production events that lasted typically one to two weeks. For a quantitative analysis of these events, the corresponding changes in total $CO_2$ (CT) were calculated from the decrease in $pCO_2$. This was possible because internal alkalinity changes were negligible due to the absence of calcifying plankton in the central Baltic Sea.
Regarding the mid-summer biomass production fuelled by nitrogen fixation, several pulses of decreasing CT and thus of increasing production were observed and coincided with a rapid increase of the sea surface temperature (SST). In contrast to the current believe, the inferred production rates and thus the underlying nitrogen fixation did not increase with SST as such, but were positively correlated with the SST increase rate. It is suspected that nitrogen fixation requires a minimum exposure to solar radiation which is provided at low mixing due to calm weather conditions and which generates simultaneously a rapid increase of SST.
Whenever a production pulse was observed, the CT decrease continued as long as SST increased and was stopped only by a wind-driven mixing event. This questions the view that the phosphate availability controls and limits the nitrogen fixation based mid-summer production. The phosphate excess that still exists after the spring bloom, is widely consumed at the onset of the mid-summer production and the remaining concentrations are by far too low to explain the observed biomass production on the basis of Redfield C/P ratios. This refers also to the input of phosphate by mixing with deeper water layers. Possibly, the existing low phosphate concentration were sufficient to initialize a bloom of cyanobacteria, which in the absence of further phosphate, but at favourable radiation conditions, perpetuate nitrogen fixation and produce in excess proteins. This hypothesis is supported by relative conservative C/N ratios in the particulate organic matter ($\sim 7$) whereas the C/P ratios exceeded the Redfield value by a factor of 4 – 5.