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Seven years CO_2 partial pressure measurements on a cargo ship in the Baltic Sea What have we learnt about biogeochemistry?

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Continuous measurements of the surface water CO_2 partial pressure were performed since 2003 on a cargo ship that commutes at 2 – 3 day intervals between the Mecklenburg Bight in the southwest and the Gulf of Finland in the northeast of the Baltic Sea. In 2006 the fully automated measurement system was complemented by a module for recording the oxygen concentrations. The data were exploited under different aspects:
1.) Determination of the net biomass production: The decrease of the pCO_2 after the onset of the spring bloom was used to calculate changes in total CO_2. To determine the loss of total CO_2 due to the formation of organic carbon, a mass balance was established that included the CO_2 gas exchange. Taking into account the formation of dissolved organic carbon yielded the net production of particulate organic that represents the total biomass. It was shown that con-ventional production estimates based on the nutrient availability may underestimate the bio-mass production by a factor of more than two.
2.) Determination of the nitrogen fixation: Nitrogen fixation rates were calculated by combin-ing the organic carbon production with a DIN (dissolved inorganic nitrogen compounds) budget. The obtained N_2 fixation rates exceeded previous estimates and indicated the impor-tant role of this process for the eutrophication of the Baltic Sea.
3.) The Baltic Sea – sink/source for atmospheric CO_2: The pCO_2 data were used to calculate the CO_2 gas exchange. On an average the flux balances indicated that the Baltic Sea is a weak sink (< 1 mol/m^2 yr) for atmospheric CO_2. However, the regional and interannual variability was large and mainly caused by the variability of the convective mixing during winter.
4.) Ocean acidification: The pH is directly related to the pCO_2, hence, pCO_2 time series are a potential tool to identify long-term changes in the surface water acid/base system. However, due to the large interannual and seasonal variability a trend in pCO_2 was not yet detectable.

Our studies of the marine CO_2 system in connection with the use of an automated measure-ment systems deployed on a cargo ship have proven to be an efficient (and economical) tool for biogeochemical studies in the Baltic Sea. Considerable progress has been achieved with regard to the characterization of important processes whereas at the same time new interesting questions emerged.