

**Model assessment of annual C, N, P budgets for the Baltic Proper**

The distinction between biogenic nitrogen (N) and phosphorous (P) cycling is critical in the Baltic Proper and eastern Arkona basin, as it is hypothesized that the bioavailability of N and P largely regulates the occurrence and intensity of N<sub>2</sub>-fixing cyanobacteria blooms. Depending on the intensity of these blooms during summer months, surface partial pressure of carbon dioxide (pCO<sub>2</sub>) is affected and thus the physical air-sea CO<sub>2</sub> exchange rate is altered. In order to assess possible effects of ocean acidification on primary- and secondary production we must better constrain the biogeochemical cycling of N and P within the upper layers. Central questions address the limiting factors for cyanobacterial growth and how much of CO<sub>2</sub> uptake from the atmosphere is mediated by nitrogen-fixing diazotrophs. Furthermore, does the observed CO<sub>2</sub> sensitivity of nitrogen fixation affect element (C, N, P) cycling.

To address these questions I've refined the ecosystem model described by Schartau et al., (2007) to account for variations of carbon-, nitrogen-, and phosphorus (C:N:P) fluxes within in the plankton community. The model extension includes diazotrophs and a formulation of algal growth that is regulated by intracellular C:N:P quota. The model's cell quotas vary due to physiological acclimation to environmental conditions (e.g. temperature, availability of light and nutrients). The model component has been implemented to the General Ocean Turbulence Model (GOTM, Burchard et al, 2006), providing the physical and numerical framework.

A first data-model assessment at the HELCOM (Helsinki Commission) monitoring station #BY15 reveal good agreement of model results with observations. Our model results are in support of the hypothesis, that the sequential DIN and DIP drawdown observed during spring can be explained by luxury (excessive) P uptake of algae. In this context, variations in cellular N:P-quota are similar to observations by Larsson et al. (2001). While considering CO<sub>2</sub> effects on nitrogen fixation, as published by Czerny et al. (2008), model induced variations in pCO<sub>2</sub> that are in the order of magnitude equivalent to uncertainties in model parameters. Finally, model estimates of annual C, N, P budgets are provided, which will be compared with available literature values.

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**Czerny, J., Barcelos e Ramos, J., and Riebesell, U. (2009):** Influence of elevated CO<sub>2</sub> concentrations on cell division and nitrogen fixation rates in the bloom-forming cyanobacterium *Nodularia spumigena*, *Biogeosciences*, 6, 1865-1875, doi:10.5194/bg-6-1865-2009.

**Larsson, U., Hajdu, S., Walve, J. & Elmgren, R. (2001):** Baltic Sea nitrogen fixation estimated from the summer increase in upper mixed layer total nitrogen. *Limnol Oceanogr* 46: 811–820.

**Schartau, M., Engel, A., Schröter, J., Thoms, S., Völker, C., and Wolf-Gladrow, D. (2007):** Modelling carbon overconsumption and the formation of extracellular particulate organic carbon, *Biogeosciences Discuss.*, 4, 13-67, doi:10.5194/bgd-4-13-2007.

## Posters and talks:

- 1st Annual SOPRAN Meeting, IOW, Warnemünde, 11/12 March 2008: "Model sensitivity analysis of interdependencies between nitrogen fixation and bacterial activity"
- BIOCAT Summer School, IFM-GEOMAR, Kiel, 15-19 September 2008: "Model sensitivity analysis of interdependencies between pCO<sub>2</sub> and plankton growth"
- 2nd Annual SOPRAN Meeting, IFM-GEOMAR, Kiel, 19/20 March 2009: "1D-ecosystem-biogeochemical modelling and synthesis of data from the Gotland Deep monitoring site (of the Leibniz Institute for Baltic Sea Research, IOW)"
- ICES Annual Science Conference 2010, Nantes, France, 20-24 September 2010: "Seasonal zooplankton dynamics in the southern and northern North Sea captured by ecosystem and stage-structured models"
- EGU General Assembly /2008/. Vienna, Austria, 13 – 18 April //2008: "Combining FerryBox Data and Lagrangian Transport Modelling" (Kreis, Callies and Petersen)

3rd Annual SOPRAN Meeting, ZMAW Hamburg, 23/24 March 2010:

"Biogeochemical modelling and data synthesis at the Gotland Deep monitoring site"