Modeling sediment/water interface biogeochemistry changes forced by seasonal anoxia

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Interaction between the seawater and the sediments plays an important role in the global biogeochemical cycling. The benthic fluxes of chemical elements affect directly the acidification characteristics (i.e. pH and carbonate saturation) and also determine the functionality of the benthic and pelagic ecosystems. In many regions redox state of the near bottom layer can oscillate in connection with supply of organic matter (OM), physical regime and coastal discharge influence. The goal of this work was to apply a model for analysis of changes occurring due to seasonal oscillations of redox conditions.

We use a 1-dimensional C-N-P-Si-O-S-Mn-Fe vertical transport-reaction Bottom RedOx Model (BROM) describing transport in the sediments, bottom boundary layers (BBL) and the water column coupled with biogeochemical block simulating changeable redox conditions, and the carbonate system processes block (Yakushev et al., 2014). In BROM we parameterize OM formation and decay, reduction and oxidation of species of nitrogen, sulfur, manganese, iron, and the transformation of phosphorus, silicate and carbon species. BROM includes a simplified ecological model with phytoplankton, heterotrophic organisms, aerobic autotrophic and heterotrophic bacteria, anaerobic autotrophic and heterotrophic bacteria. BROM is coupled to FAMB (Bruggeman, Bolding, 2014) as a transport model and biogeochemical model. The model's domain includes the water column, the BBL and the upper layer of the sediments.

The model shows a possibility of periodic replacement of oxic conditions with anoxic, that leads to changes in the distributions of the parameters and their fluxes. The seasonality in production and destruction of OM together with the mixing seasonality lead to a vertical displacement of the oxic/anoxic interface from the sediments in winter to the water in summer. This affects distribution of sulfur species, nutrients (N and P), redox metals (Mn and Fe) and carbonate system parameters. Bacteria play a significant role in the fate of OM due to chemosynthesis (autotrophs) and consumption of DOM (heterotrophs). In particular, model reproduce a n increase of pH in below the sediment/water interface connected with CO2 consumtion for chemosynthesis.