Geophysical Research Abstracts
Vol. 16, EGU2014-12131, 2014
EGU General Assembly 2014

Quantifying the importance of sediment resuspension for the North Sea and Baltic Sea ecosystem

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Including sedimentary processes such as resuspension in marine coupled bio-physical models is crucial to realistically simulate the dynamics of biologically important chemical variables (e.g oxygen and the macro-nutrients nitrate, phosphate and silicate).

These comprise diffusive release of dissolved nutrients and resuspension of particulate organic material, which occurs when a critical bottom shear stress (τ_{crit}) acting on the sediment particles is exceeded.

In global and regional modelling approaches sediment-water exchange is often parametrized by sedimentation and constant release rates and dynamic resuspension resolving the tidal cycle is often neglected in coupled physical-biological ecosystem models.

During resuspension, sediment particles get transported back into the water column. Thereby, both the turbidity of the water and nutrient availability by releasing dissolved nutrients from the pore-water are changed. Since both light and nutrients are limiting factors in primary production, it is near by hand to suspect resuspension to play an important role in the growth of phytoplankton.

Here, we assess the role of resuspension and its dynamic consideration for the modelled productivity and CO_2 air-sea exchange in the North Sea and Baltic Sea using the coupled 3D physical-biological model ECOSMO.

ECOSMO is a coupled hydrodynamic-sea ice-NPZD-carbonate-system model and is implemented for the North Sea and Baltic Sea. Its ecosystem module includes interactions between three functional groups of phytoplankton, two of zooplankton, detritus, oxygen, three nutrient cycles (nitrogen, phosphorus, silicate) and sediment pools.

In the North Sea, wind forcing and strong tides lead to a frequent exceedance of the critical bottom shear stress and therefore, resuspension events take place regularly, especially in the shallow coastal areas where the tidal range is largest. Here, the model results indicate a clear increase in estimated primary production when dynamical resuspension is considered. In contrast, resuspension only plays a minor role in large parts of the Baltic Sea which is generally characterized by weak tides and deep basins where the sediment is decoupled from surface wind stress.

The results of the sensitivity analysis in ECOSMO are presented which quantify and illustrate the impact of resuspension on primary production and state variables of the carbonate system.