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The ecohydrodynamic model of the Baltic Sea

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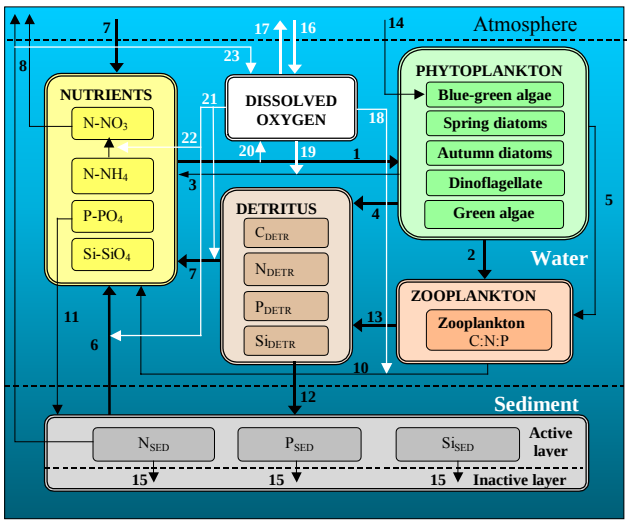
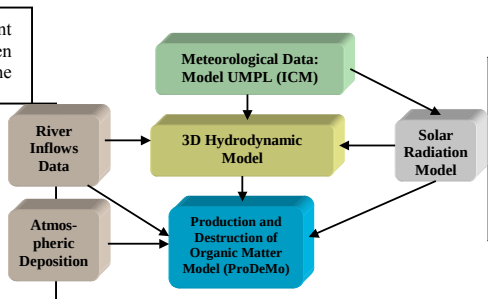
The ProDeMo model describes the nutrients (phosphorus, nitrogen, silicon) cycles through the food web including water-sediment interactions and oxygen condition. Five groups of phytoplankton: spring and autumn diatoms, dinoflagellates, green algae, blue-green algae as well as zooplankton biomass has been considered in the present version. Totally, 18 state variables has been included in the model. The following processes are included in the ProDeMo:

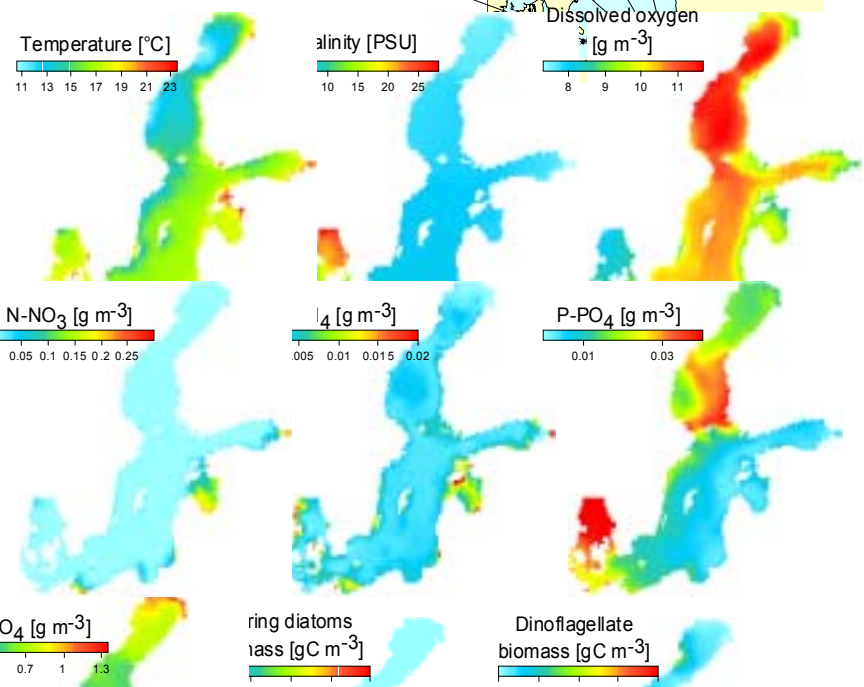


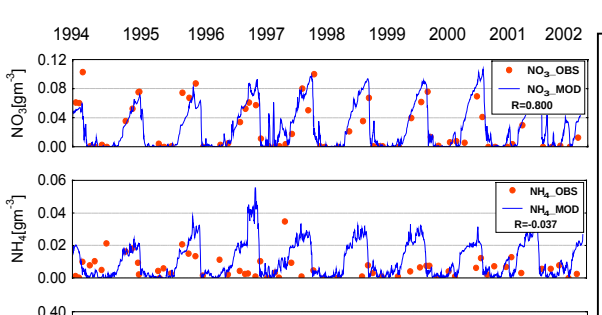
1) nutrient uptake by phytoplankton,
2) phytoplankton grazing by zooplankton,
3) phytoplankton respiration,
4) phytoplankton decay,
5) sedimentation,
6) nutrients release from sediment,
7) atmospheric deposition,
8) denitrification,
9) mineralization,
10) zooplankton respiration,
11) sedimentation of phosphorus adsorbed on particles,
12) detritus sedimentation,
13) zooplankton decay
14) nitrogen fixation
15) nutrient deposition.

The model also describes processes influenced the dissolved oxygen:

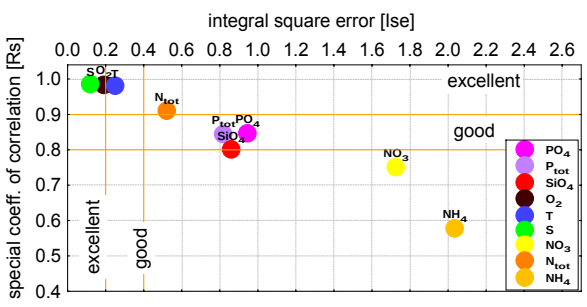
16) reaeration,
17) flux to atmosphere due to the over saturated conditions,
18) zooplankton respiration,
19) phytoplankton respiration,
20) assimilation,
21) mineralization,
22) nitrification,
23) denitrification







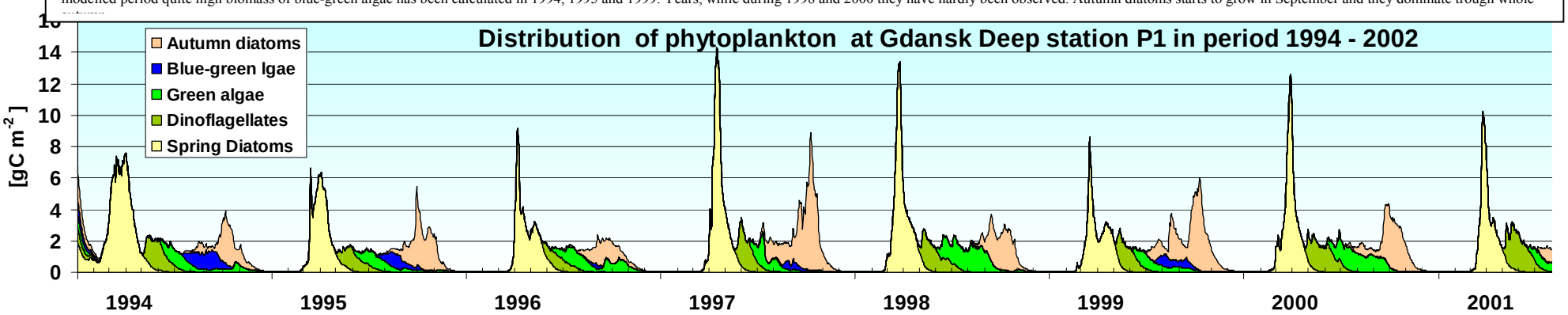
In order to get the proper agreement between modelled simulations and observed data, the calibration procedure has been done by comparing results of the model with measured nutrient concentrations (monitoring stations on the map) for 9 years period 1994-2002 period. The example of the calibration results are presented for the P1 monitoring station representing the Gdańsk Deep. The model has properly described the seasonal distribution of nutrients, temperature and dissolved oxygen. However, too high ammonium concentrations during the winter months have been obtained.



The strong variation in biomass and structure of phytoplankton can be also observed in the spatial distributions (see maps: mean concentrations of the modelled parameters for June 1999). The highest primary production rates (mean daily rates for July 1999) during the summer are observed along the coastal waters, especially in surrounding of river outlets. Very high primary production is observed in the western parts of the Gulf of Gdańsk and the Gulf of Riga as the likely consequence of upwelling process appearing along the coasts. During the summer the green algae dominates in phytoplankton biomass of the majority Baltic waters, however there are regions with appearance of dinoflagelletes and blue-green algae (highest water temperature). The autumn diatoms appear in the regions of upweling even during the summer season. This phenomena is caused by cooler water conditions in upwelling regions favourable by autumn diatoms.

Correlation coefficient versus total quadratic error diagram calculated for all measurements at stations P1, P110, ZN2 has showed an excellent agreement for salinity, dissolved oxygen and very good for temperature. Other compared parameters lie in the good range except nitrate nitrogen as acceptable and ammonium nitrogen low satisfactory.

The ProDeMo model has been applied to study the dynamics of the different groups of phytoplankton through the seasons. The biomass distribution of the five phytoplankton varies in time following different reactions on the water temperature, solar radiation and nutrient availability. The vegetation seasons start with the high blooms of diatoms during the spring. During the summer dinoflagellates and green algae dominates in the phytoplankton biomass. The blue-green algae are able to assimilate the nitrogen from the atmosphere, therefore they can grow even during the nitrogen limitation summer conditions. The blue-green algae appearance varies from year to year since they prefer higher water temperature and solar radiation. During the modelled period quite high biomass of blue-green algae has been calculated in 1994, 1995 and 1999. Years, while during 1998 and 2000 they have hardly been observed. Autumn diatoms starts to grow in September and they dominate trough whole



Ref. 1: Ołdakowski B., Renk H., 1997, The conception and structure of the Production-Destruction of Organic Matter Model; verification tests for the Gulf of Gdańsk, *Oceanol. Stud., 26 (4), 99-122*
Ref. 2: *Kowalewski M.,1997,* A three-dimensional, hydrodynamic model of the Gulf of Gdańsk,*Oceanol. Stud., 26 (4), 77–98*

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