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On the role of turbulent mixing for North Sea lower trophic level dynamics and its inter-annual variability

C. Schrum (1), I. Alekseeva (2), M. St. John (2)

1. Danish Institute of Fisheries Research, Copenhagen, Denmark (schrum@dkrz.de)
2. Centre of Marine and Atmospheric Sciences, University Hamburg, Germany

A 3-D coupled biological-physical model ECOSMO (ECOSystem MOdel) has been developed to simulate ecosystem dynamics in the North Sea and the Baltic Sea. The biological module of ECOSMO is based on lower trophic level interactions between two phyto- and two zooplankton components. The non-linear dynamics of the different phytoplankton components are governed by the availability of the macro nutrients nitrogen, phosphate and silicate as well as light. Zooplankton production is simulated based on the consumption of the different phytoplankton groups and detritus.

ECOSMO was used to study the regional and temporal variability of primary and secondary production in the North Sea. Numerical hindcasting was performed for the period of 25 years (1980-2004). Simulated fields were used to investigate the annual spatial distribution of phytoplankton and zooplankton biomass and their production in the North Sea in relation to different turbulence characteristics. In contrast to earlier model approaches ECOSMO was able to identify frontal environments as zones of high primary productivity and the simulations characterized the dynamics of different zooplankton feeding environments with special emphasis on the role of frontal production.

From production and biomass anomalies basic modes of variability were identified. For a couple of modes related physical forcing mechanisms were identified. Different characteristic periods could be identified to be dominated by either stratification induced variability (1980-1998) and Atlantic inflow induced variability (1996-2002). Within these identified periods, physical parameter like the depth of the thermocline, turbulence and nutrient transports were found to be hydrodynamic indicators for ecosystem variability.