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Modelling the dynamics of copepods in the southern Baltic Sea (Gdansk Deep)

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A 1D-Coupled Ecosystem Model is used to make a numerical investigation of the seasonal dynamics copepods in the southern Baltic Sea. This model consists of three submodels: a meteorological submodel for the physics of the upper layer and a biological submodel, which also is driven by output from the physical submodel. The biological submodel with a high-resolution mesozooplankton module consists of six nonlinearly coupled partial differential equations of second order for nutrient, phytoplankton, mesozooplankton, and early juvenile of herring and one ordinary differential equation of first order for benthic detritus. In this model the mesozooplankton - herbivorous copepods is represented by two taxa (*Pseudocalanus elongatus* and *Acartia* spp.). The aim is a description of a numerical investigation of herbivorous copepods in one example of a model. The temporal changes in distributions of a nutrients (inorganic nitrogen, and phosphate), phytoplankton, microzooplankton, mesozooplankton for *Pseudocalanus elongates* and Acartia spp. and early juvenile of herring *Clupea harengus* are necessary outputs from the biological model. The flow field and water temperature used as the inputs of the biological submodel were reproduced by the physical submodel. The calculations were made for 1999 for the station at the Gdansk Deep in the southern Baltic Sea. The simulations of annual cycles of copepods contain one complete generation of *Pseudocalanus* for 1 cohort in the upper 30 m layer, and two and one generation of *Acartia* for 6 cohorts, respectively, in the upper 30 m and lower 40 m layer, and indicate the importance of growth of older stages of 6 cohorts each species to total population biomass. The peaks of copepods biomass, main, at the turn of June and July for *Pseudocalanus* and smaller in July for *Acartia* lag that phytoplankton by ca. two mouths due to growth of cohorts in successive stages and egg production by females. The variability in space and time of zooplankton is usu-

ally so great that any model that has the right orders of magnitude in its outputs will fit the data. Thus even with models treating herbivores in some detail, the testing of these models may rest primarily upon the nutrient and phytoplankton levels, which can be measured with greater accuracy. The results of the numerical simulations described here are in accordance with the in situ observations. The differences in the phytoplankton biomass between the modelled and mean observed values is equal to 5 - 20% in the 10m upper layer and to 30% at the surface sea and depend on the month for which the calculations were made as well as depend on mainly C$//$Chl ratio for converting the simulated carbon contents to chlorophyll-a. Comparing the nutrient concentration from the calculated and mean experimental data the present results indicate that the difference is to ca. 30%. However, the difference in the 15m upper layer in the winter time is to 1mmol m^{-3} for inorganic nitrogen and to 0.1 mmol m^{-3} for phosphate, i.e. ca. 20%; however, in the summer time, ca. 5%. However, the obtained depth integrated biomass of copepods is different in relation to mean value of observation data. This difference is from 20 to 50%. After all, the $1D$ - Coupled Ecosystem Model can be utilized for numerical investigations of the seasonal variability of copepods for *Pseudocalanus elongates* and *Acartia* spp. as well as nutrient (total inorganic nitrogen and phosphate) distributions, phytoplankton, microzooplankton and early juvenile herring biomass. This research was carried out as part of statutory programme of the Institute of Oceanology in Sopot, Poland (No. II.1) and was supported by the Polish State Committee of Scientific Research (grant No 2PO4F 075 27, 2004-2006)