A 3-D simulation of the lower trophic ecosystem in the Ise-Mikawa Bay estuary using a coupled physical and biochemical model

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Abstract

A 3-D coupled physical and biochemical model was applied to the Ise-Mikawa Bay estuary to simulate the long-term variation in plankton, nutrients, dissolved oxygen and other ecological constituents during the period from April 1993 to March 1996. The triennial simulation was done under the conditions of dynamic driving forces of the model ecosystem: time-dependent flow field (current velocity, temperature, salinity and coefficients of vertical eddy diffusivity); nutrient loading fluxes that vary daily in response to the river discharges; benthic nutrient regeneration fluxes and meteorological parameters.

The numerical results were compared favorably with the field measurements of water quality indicating the validity and predictive capability of the model, and thus served for a detailed analysis of nutrient and oxygen cycles in the estuary. It turned out from the nutrient flux analysis that primary productivity varied considerably over the three years in relation to water temperature and that the most limiting nutrient to phytoplankton growth was nitrogen. The oxygen field in the bottom layer, on the contrary, did not show any clear year-to-year variation in that the oxygen-depleted water mass regularly appeared in the middle-upper basin from late June, developed to cover the whole middle-upper basin in midsummer, and dissipated by about mid-November.