Abstract View

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A Three-Dimensional Simulation of the Hudson–Raritan Estuary. Part I: Description of the Model and Model Simulations

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ABSTRACT

A time-dependent, three-dimensional, finite difference simulation of the Hudson‐Raritan estuary is presented. The calculation covers July–September 1980. The model estuary is forced by time-dependent observed winds, tidal elevation at open boundaries, and river and sewage discharges. Turbulence mixing coefficients in the estuary are calculated according to a second-moment, turbulence-closure submodel. Horizontal diffusivities are zero in the simulation and small-scale eddies produced by the interaction of unsteady, three-dimensional velocity and salinity fields with coastline and bottom bathymetry were resolved by the model. These eddies are important physical elements in shear dispersion processes in an estuary.

Model results show unstably stratified water columns produced by advection of waters of different densities. These instabilities produce intense mixing with vertical eddy diffusivities reaching 2–3 times their neutral values. They occur most frequently at slack currents, during initial stages of flooding currents and also during up-estuary wind events. These three-dimensional, time-dependent solutions extend previous analytical model results and are consistent with observations in partially mixed and well mixed estuaries.

Model results show large subtidal response of velocity and salinity fields to wind forcing. Wind forcing modifies the density-induced flows in deep channels in the estuary and also the horizontal circulation in Raritan Bay where the average water depth is less than 5 m and tidal currents are weak.

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