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学位論文の概要及び要旨

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題　目　A Numerical Simulation of Hydrodynamics and Thermohaline Circulation

学位論文の概要及び要旨

In this study,the development and application of a three-dimensional multi-layer hydrodynamic,and thermohaline structure and circulation model are documented. The governing equations are derived from three-dimensional Navier-Stokes equations for incompressible free surface flows. The algorithm is based on the fractional step(operator splitting)technique. The solution is obtained in subsequent stages treating equations split into parts having well-defined mathematical properties, so that the most adequate methods for a given differential operator type can be used. The fractional step method is combining the finite difference method in the horizontal plane and the finite element method in the vertical plane. The computational domain variability is taken into account by staggered grid structure,which is well suitedto most geophysical applications. This study introduces a three-dimension, time-dependent,hydrodynamic,tidal- and density-currents model that can compute wetting and drying in tidal flats due to tidal motion. The free surface position can be found using height function methods based on the free surface conservative equation. In the numerical solution algorithm the Galerkin FEM and explicit formulation in finite elements were used.

The developed model has been verified using a number of benchmark test cases covering the model application domain in order to investigate the performance of the model.Some of these allowed a formal comparison with an analytical problem solution.They include wind-driven currents,tide-driven currents,and free surface elevation.The numerical solutions are almost identical to the analytical ones.

The hydrostatic model applications to Saigo fishery port and Ariake Sea have targeted carried out at first.Then,the hydrodynamic model has applied to the northern bay of the Ariake Sea to simulate the tidal- and density-currents and thermohaline structure. The hydrostatic model results for Saigo port and Ariake Sea show good agreement with the field observations. In the hydrodynamic model,the tidal- and density-currents behavior including current circulation and time history of sea levels is predicted. The numerically predicted results show good agreement with available field observations of tidal currents and water levels.