Minamata Bay, located in the west coast of Kyushu Island, was heavily polluted by mercury-contaminated discharge from a chemical factory. Ever since the Minamata Disease caused by mercury poisoning was publicly recognized, water quality dynamics and residual mercury variation have been the research emphasis in the Minamata Bay and the larger Yatsushiro Sea. The transport and distribution of mercury are related to many factors such as wind, flow, sediment and so on. In addition to periodic in-situ measurements with field survey, numerical simulation model was established to present the dynamics of mercury and other ocean indexes effectively. Coupled with the Princeton Ocean Model, an integrated three dimensional mercury transport model was presented in this thesis to provide some new insights and further understanding of residual mercury variation in Minamata Bay. This model was integrated with the POM and a new precipitation module for providing hydrodynamic environment, and cohesive sediment transport module for reproducing the mercury cycling between water column and sediments, incorporating oxidation, methylation and other reaction processes among different mercury species in different forms. Simulation results indicated that the integrated numerical model was generally feasible to reveal the temporal variations and spatial distributions of residual mercury and other factors. The present study achievements are divided into several chapters in this thesis.

Chapter 1 gives introduction of research background in Minamata Bay firstly, the remediation project and some researches aiming at behavior of mercury and related factors in bay area are presented. After a brief review of mercury researches in global range, the study objectives and thesis outline are given.

Chapter 2 introduces the development of ocean numerical simulation and Princeton Ocean Model. Some common ocean circulation models are presented. After that is a detailed description of the Princeton Ocean Model from basic assumptions and algorithm to numerical scheme and solution procedures.
Chapter 3 shows the simulation results of hydrodynamic model and a new precipitation module. Simulated salinity and temperature on surface by original POM showed deviations with measured data, which was caused by the frequent precipitation during plum rain season and constant setting of surface thermal radiation boundary conditions. A new precipitation module was constructed with new thermal radiation boundary conditions which could change temporally and spatially and integrated into POM, simulation accuracy showed significant improvement with this module. Cooling impact on surface temperature field of precipitation is analyzed, and the influence of river discharge and flow characteristic in research area are also discussed. This study indicates that the precipitation effect on numerical simulation in rainy season should not be neglected.

Chapter 4 performs a current induced cohesive sediment transport model based on the suspended solid distribution and flow magnitude in Minamata Bay. After the description of basic structures of sediment transport module, sensitivity tests are presented to determine the values of critical erosion and deposition shear stresses, and analyze the influence of wind and river discharge. Simulation results of the sediment transport module showed good agreements with measurements on different layers. The relationship between flow field and sediment concentration in bay area is also discussed.

Chapter 5 presents the integrated three-dimensional mercury transport model coupled with the hydrodynamic module and sediment transport module. Three mercury kinds obtained from in-situ measurements were selected for the comparison of simulation results. Simulated dissolved mercury kinds showed acceptable agreements with measurements and the vertical concentration profiles presented a generally consistent distribution trends. Notable deviations occurred in the simulation of bottom particulate mercury, which were probably caused by the existence of abundant coarser particles. While mercury adsorbed by these sediments could barely suspend to upper layers. After the simulation verification part, mercury transport pattern over the large Yatsushiro Yea with mercury source from Minamata Bay is presented and discussed, together with analysis of flow field.

Chapter 6 is the conclusions and recommendations for further studies. Main research achievements of this thesis are summarized in this chapter, some suggestions for improvement and potential directions of the following researches are also presented.