Abstract

Turbulence has been called the last unsolved problem in classical mechanics and in it, a complete closure for eddy viscosity (and diffusivity) is the most daunting feature. Many types of turbulence models have been formulated starting from mixing length hypothesis going up to the most complicated Direct Numerical Simulations. The present modeling technique in state-of-the-art ocean models like the Princeton Ocean Model (POM) calculates eddy viscosity as a function of stability parameters (C_μ) which are very complicated in nature. Hence a lot of research is and has been carried out in this topic and is the motivation behind the present thesis work. In this thesis, we provide a solution for eddy viscosity along the lines of Reynolds stress anisotropy. A transport equation for II or second invariant of anisotropy is developed which takes into account a new and improved model for the slow pressure strain rate. The new formulation for the slow pressure strain rate uses the anisotropy of the dissipation tensor which is not negligible compared to the anisotropy of the turbulent kinetic energy. The improved slow pressure strain rate model performs well when compared with the established Reynolds stress model of Speziale, Sarkar and Gatski (abbreviated as SSG model). The new formulation for II and its transport equation has been successfully incorporated in one dimensional numerical ocean model like GOTM, and in the more complicated three dimensional POM. The anisotropy model so developed is also used to simulate a naturally occurring dynamic event, like cyclone, and has been compared with turbulence model existing in the three dimensional model POM. The formulation so implemented is advantageous in that it is simpler and more complete than the existing eddy viscosity models and retains the accuracy of the existing Mellor Yamada two equation model.

Keywords : Eddy viscosity, Stability function, Anisotropy, Slow pressure strain rate, Princeton Ocean Model