Abstract

An alternative non-linear eddy viscosity formulation based on Reynolds stress anisotropy is presented in this thesis for the purpose of capturing turbulence in numerical ocean models. The present state-of-the-art three-dimensional numerical ocean models like Princeton Ocean Model (POM) which is very widely used depends on stability functions for the calculation of eddy viscosity. In contrast, the eddy viscosity formulation presented here is free from the stability functions. Instead, it depends on the second invariant of Reynolds stress anisotropy which is a function of shear and vorticity. The applicability of the present formulation has been tested for simple channel flows with the aid of one-dimensional water column model (GOTM). Further, it is calibrated using different mixed layer entrainment scenarios forced by stress and buoyancy gradient at the surface for different two-equation turbulence models like the $k - kl$ model of Mellor and Yamada (1982) and $k - \varepsilon$ model of Rodi (1987). Validation of turbulent parameter such as dissipation rate of turbulent kinetic energy has been done for the Liverpool Bay in the Irish Sea and for NNS seasonal in the North Sea. The formulation has also been validated for realistic oceanographic situations like a weather station located in the Pacific Ocean (OWS Papa) and a storm scenario (FLEX' 76) in the northern part of North Sea. A new set up of GOTM for the Bay of Bengal incorporating the present formulation has been developed for the location 15^{o}N, 90^{o}E for investigating the cyclone 'Nargis'. The simulated SST and temperature evolution shows the strength of applicability of the present formulation during extreme events like cyclone. Finally, the present formulation has been incorporated in a more robust state-of-the-art three-dimensional ocean model POM in order to test its performance. Simulations have been carried out for the cyclone 'Nargis' to validate the intense mixing produced due to the cyclone through detailed analysis of temperature and mixed layer depth (MLD). It has been noticed that the present model captures the sea surface cooling and the enhanced mixing due to the cyclone very effectively.

Key words: *Eddy viscosity; Stability function; Anisotropy; General Ocean Turbulence Model; Princeton Ocean Model.*