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A Non-Linear Eddy Viscosity Model for Turbulent Natural Convection in Geophysical Flows

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Abstract : Eddy viscosity models in turbulence modeling can be mainly classified as linear and nonlinear models. Linear formulations are simple and require less computational resources but have the disadvantage that they cannot predict actual flow pattern in complex geophysical flows where streamline curvature and swirling motion are predominant. A constitutive equation of Reynolds stress anisotropy is adopted for the formulation of eddy viscosity including all the possible higher order terms quadratic in the mean velocity gradients, and a simplified model is developed for actual oceanic flows where only the vertical velocity gradients are important. The new model is incorporated into the one dimensional General Ocean Turbulence Model (GOTM). Two realistic oceanic test cases (OWS Papa and FLEX' 76) have been investigated. The new model predictions match well with the observational data and are better in comparison to the predictions of the two equation k-epsilon model. The proposed model can be easily incorporated in the three dimensional Princeton Ocean Model (POM) to simulate a wide range of oceanic processes. Practically, this model can be implemented in the coastal regions where trasverse shear induces higher vorticity, and for prediction of flow in estuaries and lakes, where depth is comparatively less. The model predictions of marine turbulence and other related data (e.g. Sea surface temperature, Surface heat flux and vertical temperature profile) can be utilized in short term ocean and climate forecasting and warning systems.

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