Use of Çinlar Velocity Fields as a Subgrid Model

Rukiye Kara
Mimar Sinan Fine Arts University, Istanbul, Turkey rkara@msgsu.edu.tr

Mine Çağlar*
Koç University, Istanbul, Turkey mcaglar@ku.edu.tr

Large eddy simulation (LES) of the ocean flows is based on the numerical solution of larger eddies by filtered Navier-Stokes equations while modeling smaller ones. Çinlar velocity field which is inspired by eddies detected from Lagrangian studies of the ocean can efficiently represent the continuous change of eddy sizes from medium to smallest as a stochastic flow. The eddy parameters have been estimated from high-frequency radar observations verifying the model to be capable of generating mesoscale eddies up to 5-10km in radius. Therefore, it has been put forward as a subgrid model for LES. As a related model, the strained spiral vortex of Lundgren for turbulent fine structures in the ocean has already been demonstrated as a subgrid model. We use Çinlar velocity field composed of eddies of rotational form in two dimensions as it is verified to represent real data features. For the generalized version where the temporal decay depends on spatial variable, we have computed the energy spectrum using Gamma distribution for the eddy radius and shown that the data behavior in the wave number space is reflected as well. As for LES, typically the subgrid stress is modeled. From a statistical point of view, the covariance of the subgrid velocity with the resolved velocity in each step of LES can be estimated to represent the subgrid stress. Pursuing this idea, we have developed a numerical algorithm in OPENFOAM software taking into account the subgrid fluctuations modeled by our random velocity field. We report our first findings in this regard.

Key Words: Ocean modeling, subgrid scale, stochastic flow, random velocity field.