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A mixed LES model based on the residual-based variational multiscale formulation ZHEN WANG, ASSAD OBERAI, Resselaer Polytechnic Institute — In the residual-based variational multiscale (VMS) formulation of large eddy simulation (LES) a projection operator is used to separate the solution of the Navier-Stokes equations into coarse and fine scales. The coarse scale equations are solved numerically while the fine scale equations are solved analytically. In particular, an algebraic approximation for the fine scale velocities is derived wherein they are expressed in terms of the residual of the Navier Stokes operator applied to the coarse scale solution. In this talk we analyze the residual-based VMS model in wavenumber space and conclude that while it accurately models the cross-stress term, it under-estimates the contribution from the Reynolds-stress term. To remedy this we add to it a Smagorinsky eddy viscosity which provides a good approximation to the Reynolds-stress term. This leads us to a mixed model capable of accurately modeling all components of the subgrid stress. We implement the mixed model in a Fourier-spectral method and use it to predict the decay of homogeneous isotropic turbulence. We determine the two unknown parameters in this model dynamically using the variational counterpart of the Germano identity. We note that the mixed model yields better agreement with direct numerical simulation than either of its components: the dynamic Smagorinsky model and the dynamic version of the residual-based VMS model.

Zhen Wang
Resselaer Polytechnic Institute

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