Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Nonequilibrium energy spectrum in subgrid-scale one-equation model in LES KIYOSI HORIUTI, TAKAHIRO TAMAKI, Tokyo Institute of Technology — The subgrid-scale (SGS) modeling in LES which accounts for effect of unsteadiness and nonequilibrium state is considered by employing the transport equation for the SGS energy (one-equation model). Perturbation expansion about the Kolmogorov -5/3 energy spectrum which constitutes a base equilibrium state in the inertial subrange yields -7/3 spectrum. These spectra are extracted in the DNS data, and their roles in generation of energy cascade have been revealed. The SGS energy spectrum which governs one-equation model is sought in a perturbative manner. Besides the base -5/3 spectrum assumed in the Smagorinsky model, -7/3 power component is derived, which is induced by temporal variations of SGS energy. We propose the nonequilibrium Smagorinsky model in which estimate of the SGS energy based on the -7/3 spectrum is added to the Smagorinsky model. Assessment in forced homogeneous isotropic turbulence showed that performance of the Smagorinsky and one-equation models for prediction of temporal variations of turbulence energy is not satisfactory, whereas improvement is achieved in the new model. This occurred because natural continuation of grid-scale spectrum, which contains both -5/3 and -7/3 components, into the SGS and associated energy transfer is established in the new model.

Kiyosi Horiuti
Tokyo Institute of Technology

Date submitted: 03 Aug 2012 Electronic form version 1.4