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A Subgrid Scale Estimation Model for Large Eddy Simulation[1]

KRISHNAN MAHESH, RAJES SAU, University of Minnesota — We propose a novel estimation procedure to model the subgrid velocity for Large Eddy Simulation (LES). The subgrid stress is obtained directly from the estimated subgrid velocity. The subgrid velocity is modeled as a function of resolved velocity ($\overline{u}_i$) and resolved strain–rate tensor ($\overline{S}_{ij}$). Using tensor invariants, we obtain an expression for subgrid velocity that is linear in $\overline{u}_i$ and quadratic in $\overline{S}_{ij}$ with three undetermined coefficients. These three coefficients are obtained by imposing the following constraints: (i)Galilean invariance, (ii)ensemble- averaged subgrid dissipation and (iii)local subgrid kinetic energy. The subgrid dissipation may be obtained through either eddy–viscosity models or a new dynamic model for dissipation. The subgrid kinetic energy may be obtained either from the dynamic Yoshizawa model or a modeled transport equation. The estimation model is applied to isotropic turbulence and good results are obtained. Realistic backscatter is also predicted. We also extend the estimation procedure to LES of passive scalar transport and propose an estimation model for subgrid scale scalar concentration. The model is applied to decaying isotropic turbulence with an uniform mean scalar gradient and good results are obtained.

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