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Hybrid Two-Level and Large-Eddy Simulations of High Reynolds Number Turbulent Wall-Bounded and Free Shear Flows

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We present application of hybrid two-level and large-eddy simulation (TLES) method [1-3] to very high Reynolds number wall bounded and shear flows. TLES employs a multi-time, multi-scale simulation approach to turbulent flows at high Reynolds number that combines scale decomposition to separate large and small scales and then uses appropriate closure for the small-scales in the regions of interest. Simulation employs a two-grid system that can be overset or contiguous depending on the application, and the transition is dynamically simulated between the conventional subgrid eddy viscosity closure (in regions where LES is applicable) to a subgrid simulation model that resolves in both local space and time the fluctuations in the smaller scales without assuming isotropy. The two methods are coupled with an appropriate dynamic closure in the transition regions where new hybrid terms are present and require additional layer of closure. Past applications to wall bounded flows is now generalized for both wall bounded and free shear layer flows, as in wakes past cylinders and pitching wings or hydrofoils. Hybrid algorithms that combine MPI and OpenMP are used to efficiently simulate various application problems and results are compared with available data.

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