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MIXED MODELING FOR LARGE-EDDY SIMULATION: THE MINIMUM-DISSIPATION-BARDINA MODEL

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The Navier-Stokes equations describe the motion of viscous fluids. In order to predict turbulent flows with reasonable computational time and accuracy, these equations are spatially filtered, resulting in the large-eddy simulation equations, which are not closed. The closure of these equations is carried out by modeling. The subgrid-scale stress tensor, which represents the forward and backward turbulent kinetic energy cascades, as well as the interaction between the large and small scales, is modeled according to a mixed approach. This linearly combines functional and structural models [1]. The minimum-dissipation model proposed by Rozema et al. [2] is applied in conjunction with the scale similarity model proposed by Bardina et al. [3]. The former is an eddy viscosity approach that correctly takes into account the energy transfer between the resolved and the subgrid modes even for anisotropic grids, while the latter consistently predicts the structure of the subgrid-scale stress tensor, being able to capture anisotropic and out-of-equilibrium effects as well as backscatter [1].

The developed model is applied to a turbulent channel flow, whose computational domain is discretized on an anisotropic grid. This is characterized by uniform grid spacings in the span-wise and stream-wise directions. The mesh is stretched near the wall in order to accurately solve the boundary layer. Simulations are carried out using the mixed model as well as solely the minimum-dissipation [2] and the Bardina et al. [3] models. The results are compared to the literature and the mixed model quality is evaluated.

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