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Reynolds-constrained large-eddy simulation of compressible flow over a compression ramp ZUOLI XIAO, LIANG CHEN, Peking University — A novel large-eddy simulation (LES) method is introduced for numerical simulation of wall-bounded compressible turbulent flows. The subgrid-scale (SGS) model in this method is designed to be composed of two parts depending on the distance to the nearest wall. In the near-wall region, both the mean SGS stress and heat flux are constrained by external Reynolds stress and heat flux to ensure the total target quantities, while the fluctuating SGS stress and heat flux are closed in a traditional fashion but using residual model parameterizations. In the far-wall region, the conventional SGS model is directly employed with necessary smoothing operation in the neighborhood of the constrained-unconstrained interface, which might be different for the stress and heat flux depending on the flow configuration. Compressible flow over a compression ramp is numerically studied using the new LES technique. The results are compared with the available experimental and direct numerical simulation (DNS) data, and those from traditional LES and detached-eddy simulation (DES). It turns out that the Reynolds-constrained large-eddy simulation (RCLES) method can predict the size of the separation bubble, mean flow profile, and friction force, etc. more accurately than traditional LES and DES techniques. Moreover, the RCLES method proves to be much less sensitive to the grid resolution than traditional LES method, and makes pure LES of flows of engineering interest feasible with moderate grids.

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