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DNS of Turbulent Boundary Layers with/without External Pressure Gradient Based on a Multi-Scale, Dynamic Recycle Inflow Condition Approach LUCIANO CASTILLO, Rensselaer Polytechnic Institute, JUAN G. ARAYA, Swansea University Swansea, CHARLES MENEVEAU, The Johns Hopkins University, KENNETH JANSEN, Rensselaer Polytechnic Institute — A method for prescribing realistic turbulent velocity inlet boundary conditions is presented for simulations of spatially evolving turbulent boundary layers. The standard rescaling process requires prior knowledge about how the appropriate velocity and length scales are related between the inlet and recycle stations. In the present study the scales for the inner and outer regions are determined from the multi-scale approach based on the original equilibrium similarity method developed by Castillo and George (2001) (for PG flows). In addition, a new dynamic approach is proposed in which power law ratios of inner/outer scales are used with scaling exponents that may depend on flow conditions and are deduced dynamically by involving an additional plane, a "test plane". This improvement, as well as the use of multiple velocity scales, permits the simulations of turbulent boundary layers subjected to arbitrary pressure gradients. DNS for zero (ZPG), and pressure gradient flows (APG and FPG) are discussed with special emphasis on adverse pressure gradient flows. In addition, new simulations at about $R_\theta \simeq 3{,}000$ will be shown and compared with experimental data.

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