Abstract Submitted
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Wall-modeled large-eddy simulation of turbulent boundary layers with mean-flow three-dimensionality[1] MINJEONG CHO, Korea Institute of Energy Research, ADRIAN LOZANO-DURAN, PARVIZ MOIN, Stanford University, GEORGE ILHWAN PARK, University of Pennsylvania — We examine the performance of wall-modeled LES (WMLES) to predict turbulent boundary layers (TBLs) with mean-flow three-dimensionality. The analysis is performed for an ordinary-differential-equation-based equilibrium wall model (EQWM) due to its widespread use and ease of implementation. Two test cases are considered: a spatially-developing TBL in a square duct with a 30-degree bend, following the experiment of Schwarz Bradshaw (JFM, 1994), and the flow behind a wall-mounted skewed bump with a 3-D separation bubble, following the experimental study by Ching, Elkins Eaton (Exp. in Fluids, 2018). In the duct simulation, WMLES predicts mean velocity profiles and crossflow angles in the outer region of the flow to within 1–5% accuracy using 10 points per boundary layer thickness. The largest disagreement is observed in the crossflow angles in the bend region, where 3-D effects are the most significant. In the bump simulation, the EQWM with a grid resolution of 40 points across the 3-D separation region predicts mean velocity profiles, separation location to within 1–3% accuracy. The bubble size and vortex structures in the wake are also well predicted. It is demonstrated that capturing the shear layer at the apex of the bump is key for achieving accurate results.

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