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Evaluation of Turbulence Models Through Predictions of a Simple 3D Boundary Layer. A. JAMMALAMADAKA, K. CHAUHAN, H. NAGIB, IIT, USA — Although a number of popular turbulence models are now commonly used to predict complex 3D flows, in particular for industrial applications, very limited full evaluation of their performance has been carried out using thoroughly documented experiments. One such experiment is that of Bruns, Fernholz and Monkewitz (JFM, vol. 393; 1999) in a boundary layer on the wall of an S-shaped duct, where the wall shear stress was measured accurately and independently in the original work and more recently with oil-film interferometry by Reudi et al. (Exp Fluids vol. 35; 2003). Results from various models including $k-\varepsilon$, Spalart-Alamaras, $k-\omega$, Menter's SST, and RSM are compared with the experimental results to extract better understanding of strengths and limitations of the various models. In addition to the various pressure distributions along the S-duct and the shear stress development on the test surface, the various normal stresses are compared for all the models with some surprising results in reference to the difficulty in predicting even such a simple 3D turbulent flow. Comparisons of other Reynolds stresses with models that predict them directly also reveal interesting results. In general the predictions of models are more in agreement with each other than with the experiment, suggesting that they suffer from common shortcomings. Also, the deviations of the predictions from the experiment grow to significant levels just beyond the development of the cross-over transverse velocity profile.

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