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Modeling vortical flows using linear eddy viscosity closures K. DURAISAMY, University of Maryland, G. IACCARINO, Stanford University — An inherent shortcoming of linear eddy viscosity (LEV) RANS closures is their inability to correctly account for the effects of flow rotation and streamline curvature. Several corrections and modifications have been devised to improve LEV models - these typically involve either a change in the dissipation rate equation or the introduction of coefficients in the turbulence production that depend on the mean velocity gradients. In this work, a modification to LEV models is introduced to improve the predictions of flows dominated by strong vortices. Following the approach of Petterson Reif et al., a correction is devised to mimic the behavior of SMC models in their response to rotation. In particular, a constraint is devised to bound the turbulent production to realizable states in the original SMC closure. Analyses are reported for SMC solutions obtained for homogeneous rotating turbulence and for a free vortex. The correction is used in combination with the $v^2 - f$ turbulence model, although, in general, it can be applied to any of the conventional LEV models. An example of its application to a 1 eqn. LEV model is presented. An assessment of the proposed modification on modeling trailing vortex flow-fields is performed. Reference data include DNS of an isolated axisymmetric vortex at a moderate vortex Reynolds number (Re) (≈ 16500) and experimental measurements in the wake of a wing at a high Re ($\approx 2 \times 10^6$). The level of agreement achieved with the reference data confirms the viability of the approach.

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