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A new algebraic turbulence model for accurate description of airfoil flows. MENG-JUAN XIAO, ZHEN-SU SHE, SKLTCS, COE, Peking Univ. — We report a new algebraic turbulence model (SED-SL) based on the SED theory, a symmetry-based approach to quantifying wall turbulence. The model specifies a multi-layer profile of a stress length (SL) function in both the streamwise and wall-normal directions, which thus define the eddy viscosity in the RANS equation (e.g. a zero-equation model). After a successful simulation of flat plate flow (APS meeting, 2016), we report here further applications of the model to the flow around airfoil, with significant improvement of the prediction accuracy of the lift (C_L) and drag (C_D) coefficients compared to other popular models (e.g. BL, SA, etc.). Two airfoils, namely RAE2822 airfoil and NACA0012 airfoil, are computed for over 50 cases. The results are compared to experimental data from AGARD report, which shows deviations of C_L bounded within 2%, and C_D within 2 counts (10^{-4}) for RAE2822 and 6 counts for NACA0012 respectively (under a systematic adjustment of the flow conditions). In all these calculations, only one parameter (proportional to the Karmen constant) shows slight variation with Mach number. The most remarkable outcome is, for the first time, the accurate prediction of the drag coefficient. The other interesting outcome is the physical interpretation of the multi-layer parameters: they specify the corresponding multi-layer structure of turbulent boundary layer; when used together with simulation data, the SED-SL enables one to extract physical information from empirical data, and to understand the variation of the turbulent boundary layer.

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