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Simulation of three dimensional aeronautical flow using the SED-SL algebraic turbulence model.[1] TAN-TAN DU, MENG-JUAN XIAO, WEI-TAO BI, ZHEN-SU SHE, Peking Univ. — The SED-SL model specifies a multilayered stress length (SL) function in the wall-normal direction (which depicts the eddy viscosity), with slowly varying parameters along the streamwise direction simulating the entire turbulent boundary layer (TBL) including transition. After successful simulations of transitional flat-plate (APS meeting, 2016), airfoils (APS meeting, 2017), and 3-D aeronautical flows (APS meeting, 2018), here we report an in-depth study of the SED-SL model in simulating flows over M6 wing and DLR-F4 wing-body. For the M6 wing, intuitive consideration suggests a mildly varying buffer layer thickness in the spanwise direction, yielding a more accurate prediction of the shock locations and their merging above the wing surface, and thus a better prediction of the aerodynamic forces than those of the SA and SST models. A comparison with a large eddy simulation of the flow shows also a superior prediction of the flow structures and Reynolds stress distribution. For the DLR-F4 wing-body, a significant improvement also is obtained with the new model compared to the SA and SST, in the prediction of the flow structures near the wing-body juncture and wing tip. These results demonstrate that the SED-SL model captures the right and simple (multilayer) structure of TBL, and is adaptable to aeronautic flows with not only high accuracy and efficiency for assisting design, but also more knowledge about the flow physics.

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