

This study investigates the predictability of the aerodynamic performance of some numerical methods at low Reynolds numbers and their dependency on the geometric shape of airfoil. We conducted three-dimensional large-eddy simulations (3-D LES), two-dimensional laminar simulations (2-D Lam), and Reynolds-averaged Navier–Stokes simulations with Baldwin–Lomax (2-D RANS(BL)) and Spalart–Allmaras (2-D RANS(SA)) turbulence models. Although there is little discrepancy between the 3-D LES, 2-D Lam, and 2-D RANS(SA) results in terms of the lift and drag characteristics, significant differences are observed in the predictability of the separation and reattachment points. The predicted lift, separation, and reattachment points of the 2-D Lam are qualitatively similar to those of the 3-D LES, except for high angles of attack at which a massive separation occurs. The 2-D RANS(SA) shows good predictability of the lift and separation points, but it does not estimate reattachment points accurately. The 2-D RANS(BL) fails to predict the precise separation points, which results in a poor lift predictability. These characteristics appear regardless of the airfoil geometry shapes. The results suggest that a 2-D Lam without any turbulence models can be used to estimate qualitative airfoil aerodynamic characteristics at the low Reynolds numbers.