Experimental verification of lift enhancement of laminar flow airfoil RG15 in low Reynolds number boundary layers

ABSTRACT

Dynamic soaring is a cyclic manoeuvre practiced by RC glider pilots and marine avian species which utilises wind gradients on the leeward side of geophysical features to increase flight speed. The technique has been characterized by extraordinary lift during the climbing phase and tremendous gain of speed during the descent phase of the manoeuvres. The phenomenon experienced by these aircraft with laminar flow airfoils has previously been falsely attributed to the conservation of energy within each cycle. Many manoeuvre optimisation techniques have been developed based on that assumption as well as other simplifying assumptions. However, that theory fails to explain the increase in speed with every revolution. Additionally there has been no experimental aerodynamic verification of the heuristics, lift and drag forces experienced during dynamic soaring maneuvers. This paper presents the preliminary results of wind tunnel tests of a laminar flow airfoil within a uniform boundary layer, or wind gradient for a fixed geophysical feature geometry. Parameters varied are angle of attack and free flow Reynolds number. The lift enhancement results obtained disprove the theory that dynamic soaring is only due to potential to kinetic energy exchange without any total increase in flight speed per cycle. However, the phenomenon is observed consistently in only a specific range of Reynolds number and angle of attack combinations. Outside these ranges, the performance of the aircraft is normal and speed gains are not exhibited. The novelty of this paper is that it specifically studies the aerodynamics in question experimentally rather than numerically or theoretically. It presents preliminary results of that study. Future work involves the experimental flow visualization, drag reduction studies and the impact of the contour of the geophysical feature which forms the wind gradient. Only after that can a complete optimization for dynamic soaring maneuvers be carried out.

Keyword: Laminar flow airfoil; Lift; Laminar boundary layer; Aerodynamics; Reynolds number