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Numerical investigation on the aerodynamics of high-lift and bird-like low Reynolds number airfoils
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Abstract
The current study numerically investigated the accuracy of turbulent models in predicting the aerodynamic performance of man-made, bird-like high-lift low Reynolds number airfoils. S1223, Seagull, and two Merganser airfoils were the main airfoils considered for analysis. The research included both 2D and 3D simulations. Spalart-Almaras (SA), shear stress transport (SST), SST K-ω, and SST γ-Reθ models were used for 2D simulation whereas SST was used for 3D simulation. The numerical solution was verified against Xfoil and the experimental data for airfoils such as S1223 and FX63-137. The study results revealed that fully turbulent models failed in the accurate prediction of critical physical phenomena of the flow, owing to high unsteadiness near stall conditions. SST γ-Reθt model demonstrated better flow prediction abilities. The airfoils of all the three tested birds showed similar stalling behaviour. In terms of drag coefficient, Seagull airfoil exhibited a favourable response in terms of increase in the angle of attack than Merganser airfoil.

Author Keywords
bird-aerodynamics; laminar separation bubble; low Reynolds number flow; transition modelling

Index Keywords
Angle of attack, Birds, Forecasting, Laminar flow, Lift, Oceanography, Reynolds number, Shear stress; 2D simulations, 3D simulations, Bird-aerodynamic, High lifts, Laminar separation bubble, Low Reynolds number airfoils, Low Reynolds number flow, Shear-stress transport, Transition model, Turbulent models; Airfoils

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