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Bifurcation scenario for the low-frequency oscillations of the turbulent flow over an airfoil near stalling conditions. OLIVIER MARQUET, DENIS BUSQUET, FRANCOIS RICHEZ, DENIS SIPP, ONERA, MATTHEW JUNIPER, University of Cambridge — In addition to the sudden drop of lift, two phenomena appear around an airfoil near stalling conditions: hysteresis and low-frequency oscillations. They are investigated here numerically for an OA209 airfoil at low Mach number M=0.2 and high Reynolds number Re=1.8 10^6. A combination of various numerical and theoretical approaches is performed in the framework of RANS equations. Steady computations show the co-existence of three branches of solutions: high-lift and low-lift solutions, connected by a branch of intermediate-lift solutions. Their global stability analysis then reveals the destabilization of low-frequency modes on the low-lift and high-lift steady branches. The low-frequency oscillations emerging from the Hopf bifurcation points are captured with unsteady RANS computations in a narrow range of angles of attack. They are characterized by Strouhal number St =0.02 an order of magnitude lower than those associated to vortex-shedding. A one-equation model is finally proposed to show that the onset of these low-frequency oscillations is related to a subcritical bifurcation while their disappearance occurs via a homoclinic bifurcation.

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