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Unsteady aerodynamic models for separated flow past a flat plate at Re=100 STEVEN BRUNTON, CLARENCE ROWLEY, Princeton University — This work develops reduced-order models for the unsteady aerodynamic forces on a small wing in response to agile maneuvers and gusts. Models are based on direct numerical simulations performed using the immersed boundary projection method for a flat plate at Reynolds number 100. In particular, we investigate models linearized at various angles of attack, up to the Hopf bifurcation, which occurs around $\alpha_{\text{crit}} = 28°$. A main result is that we present a flexible, low-order representation that includes viscous separated effects as well as added-mass effects, and may be seen as a linearization of a physically motivated nonlinear dynamical system. The performance of models below the Hopf bifurcation are investigated in the frequency domain as well as on large amplitude, rapid pitch maneuvers in the time domain. Additionally, we investigate models and flow field structures in the fully nonlinear vortex shedding regime using force, vorticity, and finite-time Lyapunov exponent field measurements.

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