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Objective detection of vortices in massively-separated flow[1]
YANGZI HUANG, Syracuse Univ, ALIREZA HADJIGHASEM, ETH Zurich, MELISSA GREEN, Syracuse Univ, GEORGE HALLER, ETH Zurich — We study the formation and shedding of vortices in two vortex-dominated flows around a pitching panel in order to detect coherent structures objectively (i.e., in a frame invariant fashion) in massively-separated flow. We employ a recently developed objective definition and extraction technique for rotationally coherent Lagrangian vortices. This methods renders material vortex boundaries as outermost convex level surfaces of the Lagrangian-Averaged Vorticity Deviation (LAVD), i.e., the trajectory integral of the normed deviation of the vorticity from its spatial mean. We also employ the derivative of the LAVD, the Instantaneous Vorticity Deviation (IVD), to uncover instantaneous Eulerian vortex boundaries in an objective fashion. These Eulerian vortex boundaries, therefore, remain the same in all possible rotating and translating unsteady frames. The multiple methods we use identify and track both leading edge and trailing edge vortices as they form and shed. This helps in describing the relationship between the vortex dynamics and the loss of lift during dynamic stall on a 2D flat plate undergoing a 45 degree pitch-up maneuver.

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