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A Lagrangian approach to study flow topology around a flapping flat-plate wing SWATHI KRISHNA, Syracuse University, KAREN MULLENERS, EPFL, MELISSA GREEN, Syracuse University — The incredible flight performance of insects can be attributed in part to the generation and maintenance of stable regions of vorticity, which is achieved by manipulating the wing kinematics. Along with the prolonged attachment of the leading edge vortex during translation of the wing, the rotational motion at the end of the stroke is critical as it generates large amounts of lift required for the insect to remain air-borne while hovering. The wing reversal entails a change in the flow-field around the wing which is closely tied to variations in force production. Based on phase-averaged particle image velocimetry data we analyze the effect of a shift in the rotational phase of a flapping wing on the flow characteristics. A topological study is conducted using Lagrangian vortex detection techniques in order to characterize the shear layer formation, vortex interactions and flow separation. The Lagrangian analysis includes the calculation of Finite Time Lyapunov Exponents based on particle trajectories. An objective approach is employed to trace the location of separation or attachment points as an indication for changes in the strength, stability and shedding frequencies of vortices. These trajectories are correlated with fluctuations in aerodynamic force coefficients.

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