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The Interplay of Acceleration and Vorticity Fields in the Tip Region of Massively-Separated Flows DAVID RIVAL, JOCHEN KRIEGSEIS, University of Calgary — The influence of seemingly analogous plate kinematics (plunge vs. tow) on instantaneous forces has been investigated. Simultaneous measurements by means of three-dimensional particle tracking velocimetry (3D-PTV) and a six-component force/moment sensor have been performed. Despite identical effective shear-layer velocities and effective angles of attack, the force histories vary between the two cases (plunge and tow). To uncover this discrepancy, a combined analysis of vorticity, Lagrangian (total) fluid acceleration and vortex-force contribution (Lamb vector) has been performed. It is found that leading-edge vortex (LEV) and tip vortex (TV) formation are nearly identical during the acceleration phase for both cases. However, at the end of acceleration the tow LEV rolls off the plate. As such, the development of vortex force also ceases once this roll-off process begins. Also TV strength as well as its relative positioning to the plate surface influences the instantaneous force. Based on a Lamb-vector analysis of the TV, the present work provides insight into the underlying cause-effect relation. Particularly, it is demonstrated that the sensitivity of the resulting vortex-force formation is dependent on the interplay between streamwise vorticity and spanwise (inboard) velocity.

David Rival
University of Calgary

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