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The role of the vorticity field on the increase of drag forces during impulsive deployment of a rectangular flow actuator inside TBL AMIR ELZAWAWY, Vaughn College of Aeronautics and Technology, YIANNIS ANDREOPOULOS, City College of New York — An experimental Time Resolved PIV data is used to evaluate the significant role of the vorticity field on aerodynamic forces during an impulsive deployment of a 100x100 mm² flow actuator. In this experiment, the flow actuator is placed inside TBL flow, while it is suddenly deployed, $\omega = 17$ rad/s, against the incoming TBL flow with free stream air velocity of 3.7 m/s. The experiments data has shown a significant increase of drag forces during the impulsive deployment compared with the drag of those stationary actuator cases. In this work, a further analysis is carried out using vorticity moments-based relations of forces of finite bodies exerted by incompressible fluid flows (Wu et al. 2006). These formulations, which shown to be suitable for use with TR-PIV data, are used here to identify the role of the generated vorticity field on the increase of the drag. Only three terms out of the seven terms showed significant contribution to the drag forces enhancement. Two of those were dependent on the vorticity field; the first term represents volume integral of rate of change of the first moment of the vorticity. The second term, which showed a negative contribution to the increase of drag, was the volume integral of the Lamb force. The third term represents the inertia effects at the accelerating boundaries. This identification of the role of each term can provide a basic understanding to the role of the vorticity field and may help in flow actuator design process to obtain enhanced aerodynamics forces with impulsive motion.

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