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Resolvent analysis of laminar separation bubble over an airfoil at high Reynolds number using discounting and randomized linear algebra¹ CHI-AN YEH, University of California, Los Angeles, STUART BENTON, Air Force Research Laboratory, Wright-Patterson Air Force Base, KUNIHIKO TAIRA, University of California, Los Angeles, DANIEL GARMANN, Air Force Research Laboratory, Wright-Patterson Air Force Base — We perform resolvent analysis to examine the perturbation dynamics over the laminar separation bubble (LSB) that forms near the leading edge of an airfoil at Re=5E5. While we focus on the LSB residing over 6% of the chord, the resolvent operator is constructed about the global mean flow over the airfoil, avoiding issues due to domain truncation. Moreover, randomized SVD is adopted in the analysis to relieve the computational cost for the high-Re global baseflow. To examine the local physics over the LSB, we consider the use of exponential discounting to limit the time horizon that allows for the instability to advect along the baseflow. In addition to discounting, we also examine the use of a spatial mask that highlights the LSB in the analysis. We find that discounting is required to reveal the stability characteristics of the LSB due to the unstable baseflow, regardless of the use of the mask. With discounting, the gain distribution over frequency accurately captures the spectral content over the LSB obtained from LES. The peak frequency also agrees with previous flow control results on suppressing dynamic stall. We show that discounted analysis is the appropriate approach for unstable baseflow and that randomized approach can expand global resolvent analysis to high-Re flows.

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