Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Randomized Resolvent Analysis of Turbulent Separated Flow over a NACA0012 Airfoil[1] JEAN HELDER MARQUES RIBEIRO, CHI-AN YEH, KUNIHIKO TAIRA, University of California, Los Angeles — Singular value decomposition of a large resolvent operator for high-Reynolds number fluid flow is computationally and memory intensive. For this reason, the applications of resolvent analysis has generally been limited to 1D or laminar flow problems. We consider randomized analysis for fast computation of the dominant resolvent modes by passing a tall and skinny random test matrix to sketch the large resolvent operator. The operator is then projected onto the low-dimensional subspace spanned by the sketch. By performing SVD on this reduced resolvent matrix, we achieve significant reduction in computational and memory requirements compared to traditional techniques. We apply this randomized approach for a bi-global resolvent analysis on a turbulent mean flow over a NACA0012 airfoil at chord-based Reynolds number of 23,000. While the full resolvent operator is projected using only 10 out of the 750,000 bases, the leading gain, forcing and response modes are accurately captured. We also provide discussions on incorporating physical insights into the randomized algorithm for further computational alleviation.

[1]This work was supported by ONR (N00014-16-1-2443), AFOSR (FA9550-18-1-0040), and ARO (W911NF-17-1-0118). We also thank the DoD HPC Modernization Program.

Jean Helder Marques Ribeiro
University of California, Los Angeles

Date submitted: 23 Jul 2019 Electronic form version 1.4