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Resolvent analysis of shear flows using One-Way Navier-Stokes equations[1] GEORGIOS RIGAS, OLIVER SCHMIDT, California Institute of Technology, AARON TOWNE, Stanford University, TIM COLONIUS, California Institute of Technology — For three-dimensional flows, questions of stability, receptivity, secondary flows, and coherent structures require the solution of large partial-derivative eigenvalue problems. Reduced-order approximations are thus required for engineering prediction since these problems are often computationally intractable or prohibitively expensive. For spatially slowly evolving flows, such as jets and boundary layers, the One-Way Navier-Stokes (OWNS) equations permit a fast spatial marching procedure that results in a huge reduction in computational cost. Here, an adjoint-based optimization framework is proposed and demonstrated for calculating optimal boundary conditions and optimal volumetric forcing. The corresponding optimal response modes are validated against modes obtained in terms of global resolvent analysis. For laminar base flows, the optimal modes reveal modal and non-modal transition mechanisms. For turbulent base flows, they predict the evolution of coherent structures in a statistical sense. Results from the application of the method to three-dimensional laminar wall-bounded flows and turbulent jets will be presented.

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Georgios Rigas
California Institute of Technology

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