Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Application of the One-Way Navier-Stokes (OWNS) equations to hypersonic boundary layers OMAR KAMAL, GEORGIOS RIGAS, California Institute of Technology , MATTHEW T. LAKEBRINK, The Boeing Company, TIM COLONIUS, California Institute of Technology — Prediction of linear instability and amplification of disturbances in hypersonic boundary layers is challenging due to the presence and interactions of Tollmien-Schlichting, Mack, and entropic modes. While DNS and global analysis can be used, the large grids required make the computation of optimal transient and forced responses very expensive, particularly when a large parameter space is required. At the same time, parabolized stability equations (PSE) are unreliable for multi-modal interactions. In this work, we instead apply a newly developed technique, the One-Way Navier-Stokes (OWNS) equations, which are based on a rigorous parabolization of the full equations of motion. OWNS removes disturbances with upstream group velocity using a high-order recursive filter. We extend the original algorithm by considering body-fitted curvilinear coordinates incorporating full compressibility and real gas effects. We validate the results by comparison with DNS. We present preliminary results for the optimal growth of disturbances in flat-plate and conical boundary layers. This work has been supported by the Boeing Company through a Strategic Research and Development Relationship Agreement CT-BA-GTA-1.

Omar Kamal
California Institute of Technology

Date submitted: 30 Jul 2019 Electronic form version 1.4