Abstract Submitted
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Sensitivity of hypersonic boundary layers to n-periodic surface roughness-element arrays and finite-rate chemistry[1] ATHANASIOS MARGARITIS, Imperial College London, TARANEH SAYADI, Sorbonne University, OLAF MARXEN, University of Surrey, PETER SCHMID, Imperial College London — Finite-rate thermochemical effects have an order-one influence on the macroscopic behavior of hypersonic boundary layers, hence they have to be accounted for in numerical simulations. Flow stability and heat loads are significantly affected by the modelling approaches in such simulations. Highly-parametrized thermochemical models are commonly used, introducing large amount of uncertainty. Furthermore, the effect of surface roughness and its potential interaction with finite-rate chemistry effects remains unexplored. A mathematical framework for linearized analysis of n-periodic systems of roughness elements is developed, allowing us to extract information about wake synchronization from reduced-cost simulations of a single unit or a triplet of units; this modifies the restrictive assumption of single-unit periodicity. An efficient adjoint-based sensitivity analysis is used to identify critical roughness or chemical model parameters, with respect to their effect on output flow quantities. This framework is applied to generic flat-plate boundary layer configurations for validation; extensions to more complex flow configurations are readily feasible. Preliminary results of an n-periodic system analysis for reacting and non-reacting flows will be presented.

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