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Multiple space-scale global analysis for hydrodynamic/thermoacoustic instability in low Mach number combustion chambers LUCA MAGRI, OUTI TAMMISOLA, University of Cambridge, YEE CHEE SEE, MATTHIAS IHME, Stanford University, MATTHEW JUNIPER, University of Cambridge — We propose a method to reduce the complexity of the reacting compressible Navier-Stokes equations for global/sensitivity analyses of thermo-acoustic systems. We use multiple space-scale analysis and consider a low Mach number. We assume that reacting hydrodynamic phenomena evolve at small space scales whereas acoustics evolve at larger space scales, a common situation in thermo-acoustics. The reacting hydrodynamics (RH) is governed by the reacting low Mach number equations, and the acoustics (AC) by the reacting Euler equations. The RH feeds into the AC via the heat release by the flame and the AC, in turn, feed back into the RH via the acoustic-pressure gradient (Klein's limit). These two coupling terms enable the thermo-acoustic system to be linearized around time-averaged LES flows and studied as an eigenproblem. We perform global, adjoint and sensitivity analyses, investigating the reciprocal influence of RH/AC interactions and suggest strategies for open-loop control. The analysis is applied to a dump combustor and a complex industrial combustor (Meier's).

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