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Acoustically coupled jet resonance in a finite-length duct VICTOR TOPALIAN, ARNAB SAMANTA, JONATHAN FREUND, University of Illinois at Urbana-Champaign — Remarkably high amplitude fluctuations have been observed in jet engine test cells, which most simplistically are a jet confined in a finite-length outer duct. The dominant frequencies correspond well with the acoustic modes of the outer duct, which suggests that the resonance involves strong acoustic coupling, but the mechanism's details remain unclear, which hampers mitigation efforts. We investigate the coupling through a specially designed direct numerical simulation code that uses a high-order staggered finite difference formulation. The current focus is on a parametric study in two space dimensions. The acoustic modes of the finite duct are excited by the jet but not to the degree anticipated unless the configuration is carefully tuned to match the natural instability frequencies supported by the confined jet. The basic mechanism of receptivity at the nozzle lip is reasonably well understood, but the acoustic reaction of the duct to an outgoing hydrodynamic instability is not. For a jet engine test cell, the instability wavelength is comparable to the duct diameter, so a constant pressure boundary condition is inappropriate. This part of the feedback mechanism is investigated analytically, in conjunction with the simulation, using a vortex sheet model.

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