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Global mode and frequency response analysis of low-density jets[1]

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We present a global stability analysis of a low-density jet, where the wavepacket structures are temporal eigenmodes of the linearized equations of motion in a 2D domain. As a base state we employ a numerical solution of the low-Mach number Navier-Stokes equations. The jet is characterized through the jet-to-ambient density ratio, the Reynolds number, and the momentum thickness of the velocity profile at the jet exit plane. The linear global mode analysis shows that for certain combinations of the control parameters, an isolated eigenmode dominates the eigenvalue spectrum. Its associated growth rate can be used to construct a neutral curve in the parameter space that agrees well with the experimentally observed onset of self-sustained oscillations (Hallberg & Strykowski, JFM, 2006). However, for high values of the Reynolds number, the construction of a neutral curve based on the spectrum loses validity, since for these cases the spectrum is dominated by a continuous branch of eigenvalues, sensitive to changes in domain length and grid refinement. Finally, the flow response to external forcing in a globally stable setting is investigated through the computation of the pseudospectrum, and is found to be dominated by a resonance of the stable eigenmode.

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