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Stochastic modeling of jet in crossflow using dynamically orthogonal decomposition HESSAM BABAEE, THEMISTOKLIS SAPSIS, Massachusetts Institute of Technology, GEORGE KARNIADAKIS, Brown University
— In this numerical study the effect of stochastic perturbation on jet in crossflow is investigated. To efficiently quantify the evolution of stochasticity in such a system, the dynamically orthogonal method is used. In this methodology, the solution is approximated by a *generalized* Karhunen-Loeve (KL) expansion in the form of $\mathbf{u}(\mathbf{x},t;\omega) = \overline{\mathbf{u}}(\mathbf{x},t) + \sum_{i=1}^{N} \mathbf{y}_i(t;\omega)\mathbf{u}_i(\mathbf{x},t)$, in which $\overline{\mathbf{u}}(\mathbf{x},t)$ is the stochastic mean, the set of $\mathbf{u}_i(\mathbf{x},t)$'s is a deterministic orthogonal basis and $\mathbf{y}_i(t;\omega)$'s are the stochastic coefficients. Explicit evolution equations for $\overline{\mathbf{u}}$, $\mathbf{u}_i$ and $\mathbf{y}_i$ are formulated. The elements of the basis $\mathbf{u}_i(\mathbf{x},t)$'s remain orthogonal for all times and they evolve according to the system dynamics to capture the energetically dominant stochastic subspace. In this study, the stochasticity is introduced at the crossflow boundary condition and, in particular, the effect of different time and length scales of the stochastic perturbation on the jet dynamics is investigated. The energy cascades and correlation between stochastic energy levels in the statistical sense are also analyzed. The relationship between the dynamic stochastic modes and the coherent structures present in jet in crossflow is discussed.

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