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Modeling of stochastic dynamics of time-dependent flows under high-dimensional random forcing[1] HESSAM BABAEE, MIT, GEORGE KARNIADAKIS, Brown University — In this numerical study the effect of high-dimensional stochastic forcing in time-dependent flows 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 $\mathbf{u}(\mathbf{x},\mathbf{t};\omega) = \overline{\mathbf{u}}(\mathbf{x},\mathbf{t}) + \sum_{\mathbf{i}=\mathbf{1}}^{\mathbf{N}} \mathbf{y_i}(\mathbf{t};\omega)\mathbf{u_i}(\mathbf{x},\mathbf{t})$, in which $\overline{\mathbf{u}}(\mathbf{x},\mathbf{t})$ is the stochastic mean, the set of $\mathbf{u_i}(\mathbf{x},\mathbf{t})$'s is a deterministic orthogonal basis and $\mathbf{y_i}(\mathbf{t};\omega)$'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 $\mathbf{u_i}(\mathbf{x},\mathbf{t})$'s remain orthogonal for all times and they evolve according to the system dynamics to capture the energetically dominant stochastic subspace. We consider two classical fluid dynamics problems: (1) flow over a cylinder, and (2) flow over an airfoil under up to one-hundred dimensional random forcing. We explore the interaction of intrinsic with extrinsic stochasticity in these flows.

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