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Parametric Instability in Stochastic Shear Flows

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Time-Periodic shear flows can give rise to Parametric Instability (PI), as in the case of the Mathieu equation. This mechanism results from a resonance between the oscillatory basic state and waves that are superimposed on it. Farrell and Ioannou, (1996, J. Atmos. Sci.) explain that the source of PI is that the snap-shots in time of the basic state are susceptible to transient growth. Mathematically, this is due to a linearized system that has a nonorthogonal eigenspace.

Poulin, Flierl and Pedlosky (2003, J. Fluid Mech.) studied a time-periodic barotropic shear flow that exhibited PI, and thereby produced mixing at the interface between Potential Vorticity (PV) fronts. The instability led to the formation of vortices that were stretched. A later study of an oscillatory current in the Cape Cod Bay illustrated that PI can occur in realistic shear flows. These studies assumed that the basic state was periodic with a constant frequency. In this work we study a shear flow similar to that found in Poulin et al., 2003 but now where the frequency is a stochastic variable. This is inspired by the fact that the oscillations exhibited in this model can be generated by a travelling wave packet. If the frequency is constant the associated packet has a uniform frequency. To study the case of a more randomly organized wave packet we assume the frequencies are variable. We determine that in the case of stochastic shear flows the transient growth of perturbations of the snapshots of the basic state still generate PI.