# Abstract View

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# Nonlinear Waves and Coherent Vortex Structures in Barotropic β-plane Jets

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ABSTRACT

We examine the nonlinear evolution of barotropic β-plane jets on a periodic domain with a pseudospectral. A calculation of the linear growth rate yields an infected U-shaped curve on the β versus $k_0$ plane which separates regions of stability and instability. This curve aids in clarifying the morphology of the nonlinear structures which evolve from monochromatic small-amplitude perturbations of wavenumber $k_0$. At very small or zero β, we recover and further quantify previously obtained results, including formation of: dipolar vortex structures or bound pools of opposite-signed vortex regions at small $k_0$; staggered streets isolated vortex pools at intermediate $k_0$; and "cat-eyes" or staggered connected pools of vorticity at large but still unstable $k_0$.

As β is increased, the jet exhibits quite different evolutionary patterns. At low $k_0$, where the laminar jet may be stable, we find a multistage instability. First, neutrally stable long-wavelength modes of small amplitude interact nonlinearly to produce harmonics in the linear unstable band. These grow at an exponential rate until a near-steady wake appears. However, the wake is unstable to the initial long wavelength modes and a rapid merger (i.e., backward energy cascade) occurs.

At an intermediate $k_0$, the presence of β causes a "reversal" of vortex pools in the meridional direction of the near-steady vortex street. That is for a west-to-east flowing jet the Positive pools of vorticity are south of the negative pools causing a decrease in the near-steady velocity of the jet. Retrograde Rossby radiation is observed and weak "shingles" or cast-away vortex pools are observed. The meander amplitude pulsates, pumping Rossby radiation into the far field. The merger and binding processes also occur on a jet excited by many harmonics, with an ensuing

chaos that is very sensitive to initial conditions.

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