

Abstract

“The nonlinear, downstream development of unstable baroclinic waves. Chaos and scale.”

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The downstream development in both space and time of baroclinic instability is studied in a nonlinear channel model on the f – plane. The model allows the development of the instability to be expressed on space and time scales that are long compared to the growth rates and wavelengths of the unstable wave. The unstable system is forced by time varying boundary conditions at the origin of the channel and so serves as a conceptual model for the development of fluctuations in currents like the Gulf Stream and Kuroshio downstream of their separation points from their respective western boundaries.

The theory is developed for both substantially dissipative systems as well as weakly dissipative systems for which the viscous decay time is of the order of the advective time in the former case and the growth time in the latter case. In the first case a first order equation in time leads to a hyperbolic system for which exact solutions are found in the case of monochromatic forcing. When the dissipation is small a third order system of partial differential equations is obtained. For steady states the system supports chaotic behavior along the characteristics. This produces for the time dependent problem new features, principally a strong focusing of amplitude in the regions behind the advancing front and the appearance of what might be called “chaotic shocks”.