A numerical analysis of strongly nonlinear baroclinic instability

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Received 15-APR-94
in revised form 12-NOV-94

To gain a better understanding of the general circulation in our atmosphere and of many other geophysical fluid dynamics phenomena, a stability analysis of strongly nonlinear baroclinic flow in a rotating annulus has been performed. A dynamic model of baroclinic waves with single or wave-wave interactions is developed using an Eady-type basic state modified by two Ekman layers of different strengths. The mathematical model is developed in terms of the nondimensional stream function and is solved using a truncated spectral expansion. The expansion coefficients are computed from a set of evolution equations. The influences of the imposed temperature contrast, the Ekman layer dissipation, and the rotation rate on the main characteristics of the flow have been explored by solving the evolution equations for sequences of Ekman dissipation rate, $\delta$, and Stratification parameter, $S$. The current model not only produced the regimes observed in the annulus experiments: axisymmetric zonal flow, steady waves, and amplitude vacillation, but also predicted the phenomena of wave number transition.

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