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The turbulent equilibration of an unstable baroclinic jet

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The evolution of an unstable baroclinic jet, subject to a small perturbation, is examined numerically in a quasi-geostrophic two-layer channel model. After a period of initial wave growth, wave breaking leads to two-dimensional turbulence within each layer, and to the eventual equilibration of the flow. The equilibrated flow must satisfy certain constraints; its total momentum is conserved, its total energy is bounded and the flow must be realisable via some area preserving (diffusive) rearrangement of the potential vorticity field of the initial flow. A theory is introduced that predicts the equilibrated flow in terms of the initial flow parameters, which are the jet width and criticality of the flow. The idea is that the final state minimizes available potential energy, subject to constraints on the total momentum and total energy, and the further constraint that the potential vorticity changes through a process of complete homogenization within well-delineated regions in each layer. Within a large region of parameter space, the theory is found to accurately predict the cross-channel structure and strength of the equilibrated jet, the regions where potential vorticity mixing takes place, and total eddy mass (temperature) fluxes.