Dynamics of cyclones and anticyclones under background rotation

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Abstract

The evolution of localized cyclonic and anticyclonic vortices in a quiescent, rotating fluid is investigated. When the Rossby number, $Ro \ll 1$, the vortices evolve into columnar structures via inertial wave propagation, regardless of their sense of rotation. When $Ro \gg 1$, the dynamics is nonlinear, governed by the stretching and advection of vorticity. The blobs burst radially outward forming a thin annular vortex sheet. However, cyclones and anticyclones behave differently in the intermediate regime of $Ro \sim 1$: unstable regions of fluid develop at lower values of $Ro$ for anticyclones than cyclones; hence, the transition from columnar vortex formation to radial bursting happens for lower values of $Ro$ for anticyclones. This idealized problem could have implications for rapidly rotating turbulence at $Ro \sim 1$, where there are more cyclones than anticyclones, in the sense that the long-lived sign of $\omega_z$ (the vorticity component parallel to the axis of rotation) is positive.

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