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On the Unexpected Longevity of the Great Red Spot, Oceanic Eddies, and other Baroclinic Vortices PEDRAM HASSANZADEH, Harvard University, PHILIP MARCUS, UC Berkeley — Vortices in the ocean and atmosphere dissipate via various mechanisms such as wave emission, turbulence, and thermal radiation. However, these vortices are observed to live much longer than the time scales of the dissipation processes. Here we model these processes as either Rayleigh drag or Newtonian cooling with time scale τ, and use simulations of the 3D non-hydrostatic Boussinesq equations. Our results show that vortices in fact do NOT decay at the imposed time scale τ; they decay much slower, sometimes by a factor of 100. The slow decay is due to a meridional circulation, which converts the potential energy to the kinetic energy and vice versa and slows down the decay. In the presence of horizontal shear, the circulation can extract the shear energy and further energize the vortex. We explain the existence of the meridional circulation, the slow decay, and the resulting cyclone-anticyclone asymmetry using the numerical results, a physical model, and simplified equations. Our results suggest that the observed longevity of some vortices can be explained without a forcing mechanism. For very long-lived vortices, such as the Great Red Spot, our results imply that much weaker forcing, compared to what originally thought, is needed to maintain the vortices.

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