OBSERVATIONS OF A TROPICAL INSTABILITY VORTEX

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ABSTRACT

Observations of an upper ocean vortex associated with tropical instabilities in the tropical Pacific were made in the vicinity of the South Equatorial Current and North Equatorial Counter Current (SEC-NECC) shear at 140°W during November-December of 1990. The dynamic and thermohaline structure of the observed vortex is mapped in three dimensions using a suite of measurements from shipboard, hydrographic, and satellite sensors and drifting buoys. Evidence that the sampled flow field is steady in a frame of reference moving with the disturbance is used to study the underlying dynamical balances and the effects on heat, fresh water, and eddy energy fluxes in the region.

The vortex translated westward at 30 cm/s (0.24°/day), less than half the speed of westward propagating meridional oscillations of the Equatorial Undercurrent (EUC) and SEC system. The associated flow deformed the North Equatorial Front through northward advection of cold equatorial water and southward entrainment of warmer tropical water, giving the surface temperature field the cusp-like pattern which is commonly associated with tropical instabilities.

A dipole of convergence and divergence had magnitudes comparable to the local inertial frequency and confirms predictions by various numerical models. Relative vorticity advection balanced convergence at the front, allowing northward moving cold water to subduct beneath the warmer tropical water. The growth of the vortex appears to have been limited by the inertial frequency via a vortex instability mechanism. The same features are present in shear vortices in a general circulation model.

The vortex transported heat and fresh water equatorward at rates of about 0.2 MW/m^2 and 5 $g/(m^2s)$, respectively. The heat flux agrees with previous estimates from observations and models. The region from 2-5°N gained heat and fresh water at 2-5 W/m^3 and 0.1 $\mu g/(m^3 s)$.

Eddy kinetic energy increased via barotropic instability at a rate of 0.15 mW/m^3 and via baroclinic conversion at 0.05 mW/m^3. The mean to eddy conversion took place in between the frontal convergence and central upwelling in the mixed layer and was coincident with a critical layer, consistent with a wave overreflection interpretation of barotropic shear instability.