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Interactions and energy transfers among symmetric and asymmetric hurricane circulations and its background mean flows

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To investigate the interactions among symmetric and asymmetric circulations of hurricane and its background flows, nonlinear baroclinic two-layer models in the cylindrical and cartesian coordinates are constructed. Wind and geopotential height fields have been decomposed into barotropic and baroclinic components for both the basic state and vortex perturbations. To study the dependence of asymmetric perturbation growth on symmetric vortex structure, two types of symmetric hurricane tangential wind profiles are specified. The first one is a standard profile in which vorticity decreases monotonously with radius so that vorticity gradient does not change sign. The second one is a barotropic instability profile in which vorticity gradient of tangential wind does change sign. Our results show that for the given standard vortex profile, the wave number one develops, but the wave number two is stable. For the barotropic instability vortex profile, both wave number one and wave number two develop. When an initial symmetric barotropic hurricane vortex is specified under a horizontal cyclonic shear mean flow, the wave number two perturbations develop. In the presence of a symmetric baroclinic hurricane with strong cyclone at lower level and weak cyclone at upper level, an initial perturbation with baroclinic wave number one or two structure may lead to the generation of barotropic wave number one or two perturbation, and vice versa. The relationship between the hurricane intensity change and energy transfer among symmetric and asymmetric circulations of hurricane and its background mean flows are also examined.