Abstract

Some effects of tropical cyclone structure on the vortex motion are examined in a nondivergent, barotropic numerical model with no basic current. As suggested earlier by DeMaria, the initial maximum wind speed has little effect on the track. Vortex translation associated with the beta effect depends sensitively on the strength of the flow between 300 and 1000 km from the center. If the flow in this annulus is made more cyclonic, the track will turn cyclonically and move more toward the west in the Northern Hemisphere. The dynamics of this beta-drift is studied via a decomposition into symmetric and asymmetric circulations. The symmetric flow experiences a slight weakening of the maximum wind speed and an anticyclonic circulation is induced beyond 600 km. The asymmetric circulation is dominated by an azimuthal wavenumber one circulation with an anticyclonic gyre east of the center, a cyclonic gyre to the west and a nearly uniform, broad-scale ventilation flow between the gyres. The vortex translation speed and direction are almost equal to the average of this ventilation flow over the area of significant cyclonic circulation in the vortex. Analysis of the model streamfunction tendency equation demonstrates that the linear beta term is responsible for the initial formation of the asymmetric gyres. Nonlinear advection of the asymmetric circulation by the symmetric vortex flow twists the interior region between the gyres and orients the ventilation flow toward the northwest rather than toward the north. Because this term nearly balances the linear beta forcing, the streamfunction time tendency (and storm motion) is predominantly due to the advection of the symmetric vortex by the ventilation flow between the gyres

摘要

排除洋流影響，使用非輻散的正壓數值模式，檢測熱帶氣旋結構在渦漩運動中的影響，先前 DeMaria 指出，最初的最大風速對路徑造成些微的影響，而與 beta effect 相關的渦度傳遞，在距離中心 300~1000 公里的位置，對氣流強度相當敏感，如果氣流在這環狀範圍氣旋增強，在北半球，其路徑將會偏西且呈氣旋式旋轉。此 beta-drift 的動量可以分成對稱和非對稱環流進行分析。在 600km 外的地方，對稱的環流被最大風速削弱，且倒置反渦漩環流生成；非對稱的環流可被方未的波數決定，其中，在中心東側有一反渦漩的環流，而西側的渦漩環流近乎一致，在這兩個環流間，有一尺度就大的通量。在渦漩中，渦漩的傳遞速度和方向，幾乎等於主要氣旋環流範圍的氣流通量，對此模式的氣流方程公式的分析中顯示，線性的 beta 項可以反映最初的非對稱環流組成；因對稱渦漩產生的非線性非對稱環流之平流項，改變了環流間的內部區域，且讓氣流通量從西北向轉至正北向，因為此項與線性 beta 的力近乎平衡，而氣流方程和其趨勢(&對流運動)之間，主要因為環流間通量造成的對稱渦漩的平流項。