ABSTRACT

Triggering processes for the rapidly intensifying phase of a tropical cyclone (TC) were investigated on the basis of numerical experiments using a three-dimensional nonhydrostatic model. The results revealed that the rapid intensification of the simulated TC commenced following the formation of a circular cloud, which occurred about 12 h after the TC became essentially axisymmetric. The circular cloud (eyewall) evolved from a cloudy convective cell that was originally generated near the radius of maximum wind speed (RMW). The development of the convective cell in the eyewall was closely related to the radial location of the strong boundary layer convergence of axisymmetric flow. The radius of maximum convergence (RMC) was small relative to the RMW when the TC vortex was weak, which is consistent with the boundary layer theory for a rotating fluid system on a frictional surface. As the TC intensified, the RMC approached the RMW. An eyewall was very likely to form in the simulated TC when the RMC approached the RMW. Because the RMC is theoretically determined by a Rossby number defined by the maximum tangential velocity, RMW, and Coriolis parameter, a series of numerical experiments was conducted by changing the three parameters. The results were consistent with the hypothesis that intensification occurs earlier for larger Rossby numbers. This finding indicates that initial TC vortices with larger Rossby numbers are more likely to experience rapid intensification and, hence, to evolve into strong hurricanes.

摘要

目前使用三維的非淨力模式作為數值實驗基礎，藉此探究熱帶氣旋快速成長時的觸發過程，結果發現，模擬中的熱帶氣旋隨著眼牆的形成快速成長，這情形在熱帶氣旋逐漸以軸心對稱後 12 小時發生，而眼牆的形成源自於最大風速半徑(RMW)產生的對流胞，其在眼牆中的發展，與軸對稱流在邊界層匯流的逕向位置有相當大的關聯。

當熱帶氣旋渦流非常微弱時，依據邊界層理論中旋轉流體在摩擦表面時的解釋，最大匯流半徑(RMC)和最大風速半徑並無太大關係，隨著熱帶氣旋增強，RMC 也會越接近 RMW，此時若為模擬中的熱帶氣旋，將有極大機會形成眼牆，因為理論上 RMC 產自一個改變三個不同參數的數值實驗，參數有：受最大切線速度定義的 Rossby number、RMW、和 Coriolis 參數。

此結果包含一個假設—當 Rossby numbers 越大，開始增強的時間點越早，這項發現顯示了，越大的 Rossby numbers 會使最初的熱帶氣旋渦旋經過越快的增強時間，而進化成強大的颶風。