Diagnosis on the characteristics of the mesoscale potential vorticity in intensity-maintaining Tropical Cyclone

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The distribution of Potential Vorticity (PV) in the intensity-maintaining of Tropical Cyclone (TC) Fitow (2013) at different stages are investigated by using the high-resolution data. Results show that the high value PV band and its change in the inner core are associated with the intensity change of TC. The high value PV area is not only corresponded with the convective bursts in the inner core, but also well consistent with the maintaing intensity period (Fig.1). Moreover, the highest radial PV gradient occurs in the eyewall.

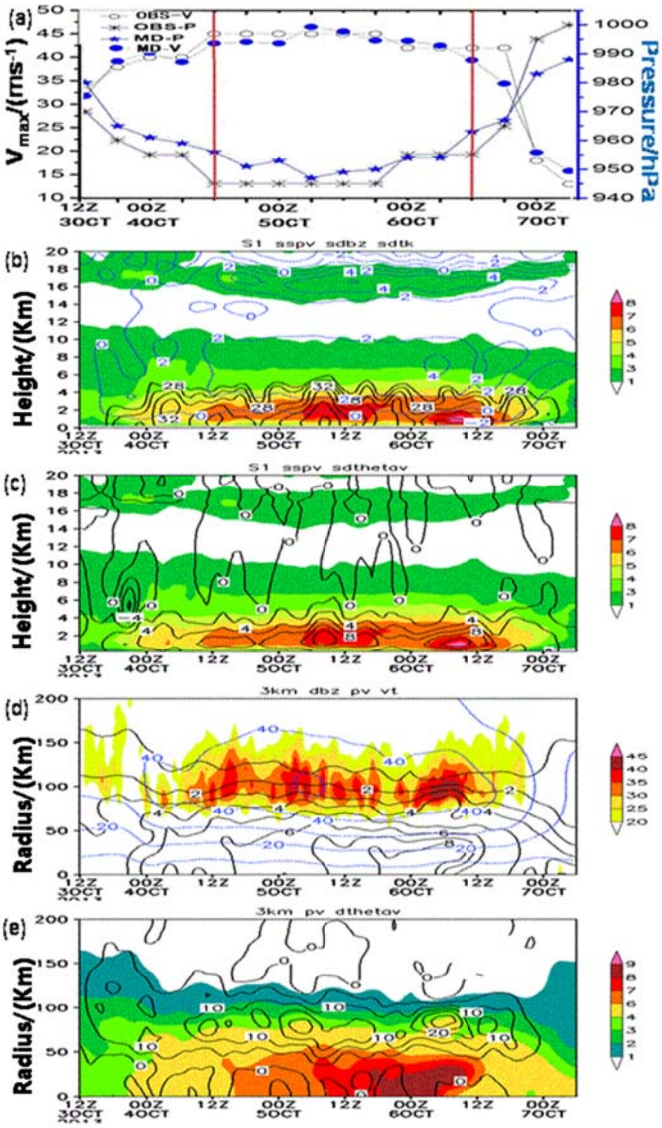

Fig.1 Time-height cross section of PV, Radar reflectivity, condensation heating rate, tangential velocity and temperature difference.

In (a): open/closed circle represents the observed/simulated maximum wind speed; thin asterisk/bold asterisk represents the observed/simulated minimum surface pressure; two vertical lines are starting and ending time of continuous intensifying. In(b),(c): Time-height cross section of area-averaged PV(shaded, PVU) , Radar reflectivity(black solid line, interval=2dBz, in(b)), temperature difference(blue dotted line, interval=2K, in(b)) and condensation heating rate(black solid line, interval=2Kh^{-1}, in(c)) in a subdomain of 100KmX100Km. In(d)(e): Axisymmetric Radar reflectivity(shaded, dBz, in(d)), PV(black solid line, interval=1PVU, In (d)), tangential velocity(blue dotted line, interval=10ms^{-1}, in(d)), PV(shaded, PVU, In(e)) and condensation heating rate(black solid line, interval=5Kh^{-1}, in(e)) at 3km height

The changes of the mesoscale high value PV are analyzed both in time and in space. It is found that the vertical cross-section of high value PV transfers from a monopole (in the development period of TC, Fig.2(a)) to a hollow pole pattern (in the intensity-maintaining phase, Fig.2(b,c)), while the monopole structure with a smaller PV value is re-formed in the rapid decay period of TC,Fig.2(d). The horizontal distribution of PV presents an annular ring of high vlaue PV during the intensification of TC Fitow.

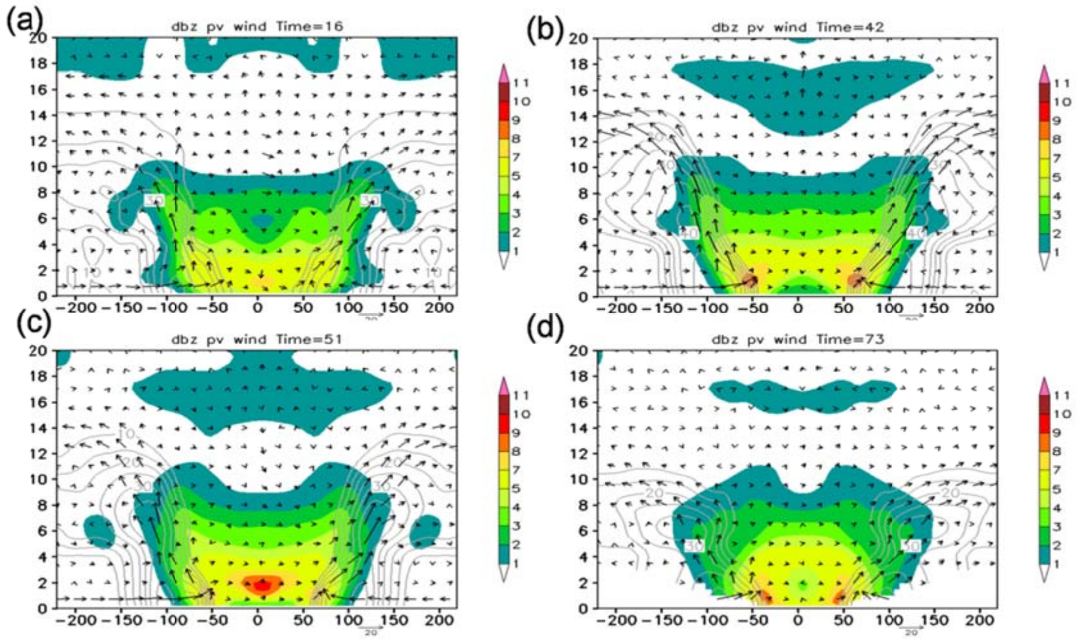

Fig. 2 Vertical cross section of axisymmetric PV(shaded, PVU) , Radar reflectivity(gray solid line, interval=5dBz) and wind vectors(ms^{-1}) at (a) 03Z Oct 04, (b) 05Z Oct 05, (c) 14Z Oct 05, (d) 12Z Oct 06. The values of vertical velocity all multiplied by 15.

The PV budget is diagnosed and the results show that the horizontal and vertical advection of PV, as well as the initial enhancement of condensation heating in the inner core play an important role in the mesoscale high PV distribution(Fig. 3.1).In addition, it is indicated that the condenstion heating has an important effect on developing the hollow structure of PV at the intensity-maintaing stage, while the horizontal advection has a positive contribution on PV tower in the upper-middle level and the vertical advection plays an intermediary role in the redistribution of high value PV(Fig. 3.2).

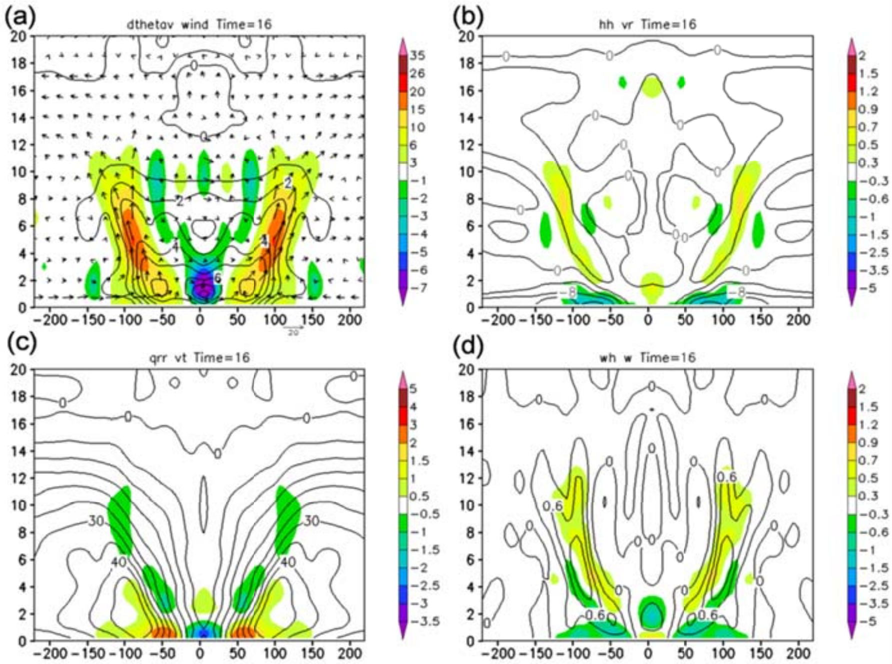

Fig. 3.1 Vertical cross section of axisymmetric PV (black solid line, interval=1PVU), at 03Z Oct 04. The values of vertical velocity all multiplied by 15.

(a): condensation heating rate (shaded, Kh^{-1}) and wind vector; (b):horizontal advection (shaded, 10^{-3}PVU) and radial velocity (black solid line, interval=$4ms^{-1}$)); (c):condensation heating (shaded, 10^{-3}PVU) and tangential velocity (black solid line, interval=$5ms^{-1}$); (d):vertical advection (shaded, 10^{-3}PVU) and verticall velocity (black solid line, interval=$0.3ms^{-1}$)

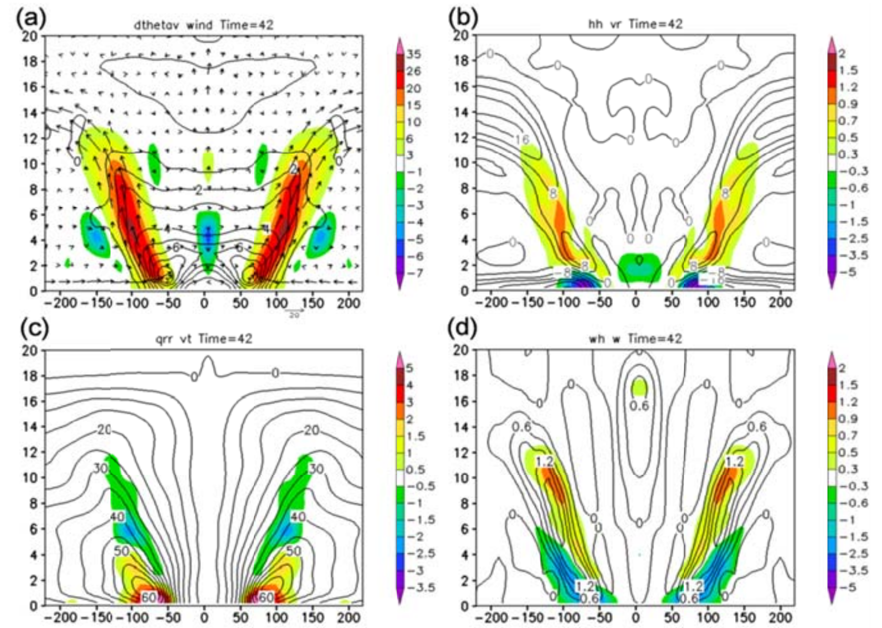

Fig. 3.2.same as Fig. 3.1, but at 05Z Oct 05.

(a):condensation heating rate (shaded, Kh^{-1}) and wind vector; (b):horizontal advection (shaded, 10^{-3}PVU) and radial velocity (black solid line, interval=$4ms^{-1}$); (c): condensation heating (shaded, 10^{-3}PVU) and tangential velocity (black solid line, interval=$5ms^{-1}$); (d) :vertical advection (shaded, 10^{-3}PVU) and vertical velocity (black solid line, interval=$0.3ms^{-1}$)

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