STUDY ON RAINBAND STRUCTURE OF SUPER TYPHOON WIPHA OBSERVED BY DUAL-DOPPLER RADAR

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(Dated: 15 September 2009)

I. INTRODUCTION

Doppler weather radar is one of the powerful tools for study the severe weather (Dotzek et al., 2005, 2007). Dual-Doppler radar extends the capability of radars to obtain the horizontal and vertical components of the wind. Since 1980's, scientists have investigated the structure of the eyewall and the spiral rainband of the typhoon with ground-based dual-radar (Tabata, et al., 1992) and airborne Doppler radar (Bousquet and Chong, 1998). The super typhoon Wipha (0713) is the strongest typhoon in 2007 that landed on China mainland. It caused heavy precipitation in Zhejiang province. The three-dimensional wind fields of two outer spiral rainbands were retrieved by dual-Doppler radar data. The 3D structure of the rainbands is analyzed with the retrieval wind.

II. DATA

The dual-Doppler radar network is composed by the radars located in Ningbo and Zhoushan city in Zhejiang province in South China. The two radars are S-band (10cm wavelength) radars with approximately 1°beamwidths. The technique parameters and operate modes are same with Weather Surveillance Radar-1988's (WSR-88D). The raw data quality control is processed to the radar raw data firstly, and then the 3D wind fields are retrieved by MUSCAT technique. MUSCAT technique was proposed to retrieved the 3D wind from the airborne radars (Bousquet and Chong, 1998) firstly. Zhou improved this method to ground-based dual-radar and studied the 3D wind structure of the heavy rainfall on Meiyu front with this method (2009).

III. PRESENTATION OF RESEARCH

There are two spiral rainbands that passed through the south region of the dual-Doppler radar baseline. The 3D wind structure of the rainbands retrieved by the dual-radar was analyzed.

Firstly, the spiral rainband at 1121LST 18th Septembe 2007 was analyzed. At 2km level, the wind was cyclonic shear. The maximum reflectivity was located in the center of the rainband. There was a strong wind region which was correspond with the strong reflectivity in the rainband.

Fig. 1a shows the pattern of the radial component of the relative flow (*Vr*). The convective at the centre of the rainband is very active. The reflectivity core in the rainband centre exceeded 45dBZ and tilted outwards with height. Below 2km level, positive flow (flow toward the storm center) was seen outside the rainband. It also shows that the positive flow was accelerated in the outer of the rainband, and decelerated near the reflectivity core. Negative flow (flow away from the storm centre) was shown on the inner side, and the maximum negative value is about 11m/s at 3km level. The negative flow was shown in the middle and high level of the rainband. The negative and the positive air flows at the low level of the rainband cause the convergence in the rainband centre.

Fig. 1b presents the vertical velocity (*w*). A updraft zone was found in the centre of the rainband. A weak downdraft less than -1m/s exists outside the updraft. The location of the downdraft is on the outside edge of the maximum reflectivity zone within the rainband. As we known, the raindrops are produced in the updraft, displaced outward by the radial flow, and finally decend in the downdraft zone.

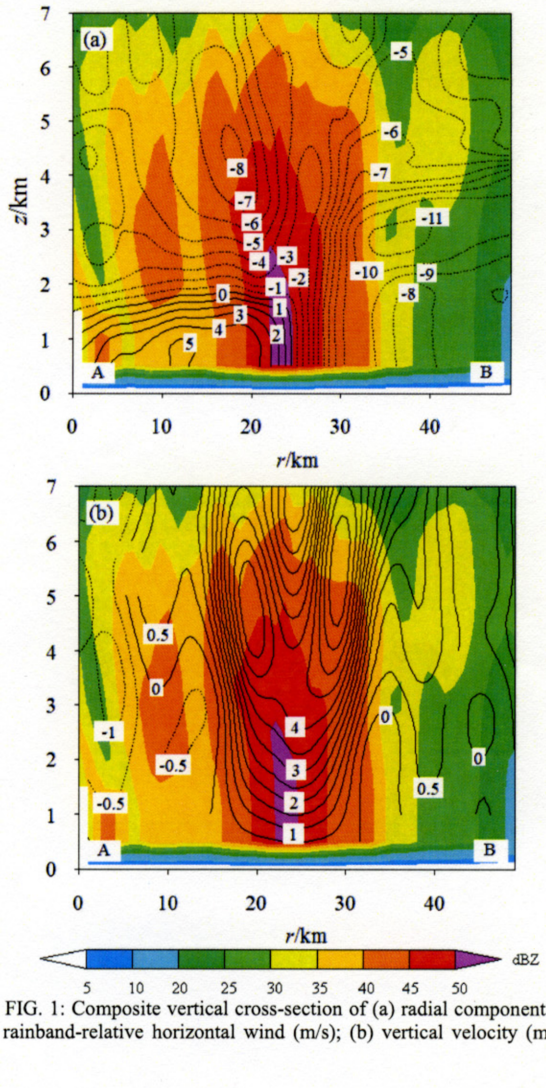

FIG. 1: Composite vertical cross-section of (a) radial component of rainband-relative horizontal wind (m/s); (b) vertical velocity (m/s)

contour at 1121LST 18th September 2007. B is near the storm centre.

After typhoon landing on 0230LST 19th September, another spiral rainband passed through the dual-Doppler domain.

Fig. 2a shows the radial component of the relative flow (*Vr*) at 0535 LST. The reflectivity core in the rainband centre was about 40dBZ with 3.8km height that was weeker. Below 2km level, negative flow (flow toward the storm centre) was shown in the rainband. It shows that the negative flow was accelerated in the outer of the rainband, and decelerated in the inside of the inner reflectivity core. In the middle and high level of the rainband, the positive flow (flow away from the storm centre) was shown.

Fig. 2b shows the vertical velocity (*w*). A updraft zone was found in the inner side of the rainband, and tilted with height. The maximum updraft is more then 5.5m/s at 5km height. A downdraft exists outside the updraft. The location of the downdraft is on the outside edge of the maximum reflectivity zone.

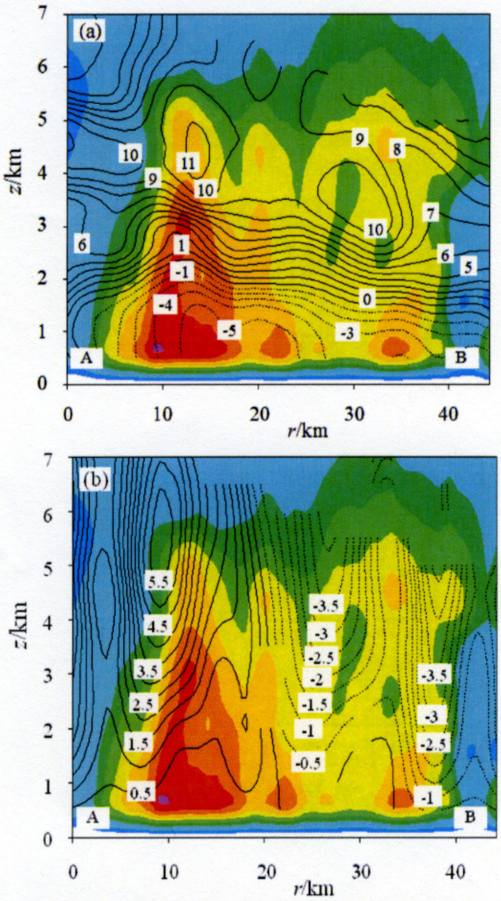

FIG. 2: Composite vertical cross-section of (a) radial component (m/s) of rainband-relative horizontal wind (m/s); (b) vertical velocity contour (m/s) at 0535LST 19th September 2007. A is near the storm centre.

IV. RESULTS AND CONCLUSIONS

In this, the 3D structure of the rainbands is analyzed by the dual-radar retrieval wind.

It shows clearly that the two rainbands have some similar characteristics. There are some strong reflectivity zones in the low level of the spiral rainbands, and the strong horizontal wind speed zones were correspond with strong reflectivity zones. There are some strong updrafts in the low and middle level of the stronger reflectivity band that some convergence centres are found in these areas. There are downdrafts in the both outer sides of the rainbands. In the vertical-cross section in the radial direction from the typhoon center, the reflectivity core in the spiral rainband tilts outside with height. There is strong inflow toward the typhoon center blow 2km level at the outer side and outer edge of the rainband that the maximum value is 5m/s. There is strong outflow away from the typhoon center in the inner side and the inside of the rainband. The outflow and the inflow at the low level cause the convergence above the center of the rainband. The maximum tangential speed exists at the low level of the rainband.

On the other hand, there are some differences between the two spiral rainbands. The convergence at the low level of the first rainband is more stronger than the second one's. In the vertical-cross section, the convergence maximum is more than -15×10^{-4}/s in magnitude at the low level of the first rainband. Due the stronger convergence and abundance water vapour at the low level, the convective of the first spiral rainband is more active than the second one's. The reflectivity core of the first spiral rainband greater than 45dBZ is 4.8km height, on the other hand, the reflectivity core of the second spiral rainband is 3.2km height.

V. AKNOWLEDGMENTS

The work was supported by the Grant Agency of the National Science Foundation of China (grant 40605014 and 40975015), the Grant Agency of research on theories and methods of monitoring and predicting of heavy rainfall in South China (grant 2004CB418305) that was supported by the National Key Basic Research and Development Project of China and the foundation of state key laboratory of severe weather (grant 2008LASWZI01).

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