Rainband Characteristics by the Radar Observation under the Influence of Typhoon-induced Southwest Flow

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Abstract

The analysis on the data collected by the Central Weather Bureau's Chiku weather radar and automatic rainfall rate measurement is to identify the characteristics of rainbands under the influence of typhoon-induced southwest flow. There are 2 case studies, including Sepat (2007) and Kalmaegi(2008), for recognizing the pattern of convective rainbands associated with typhoon-induced southwest flow. The preliminary result shows The rainbands evolve into linear convections with north-south orientation after propagating inland. The line echoes in the case of Typhoon Sepat are well organized, which are similar to the squall line and oriented to northwest-southeast. Severe convections associated with typhoon Kalmaegi develop on the upslope over the southwestern Taiwan. Later on they extend to central Taiwan and elongate over 9 hr.

Keywords: southwest flow, radar echoes

Introduction

Typhoons mainly contribute flash floods, landslides, flooding and other disasters, accidents and other casualties over the Taiwan Area. In addition to the strong wind damage, the abundant rainfall brought by typhoon itself is also one of the reasons for the formation of disasters. Due to the steep high mountains of Taiwan, the rainfall distribution in space is a complicate topic. The typhoon caused severe precipitation usually induces the worst disasters than the other weather system. Therefore, many studies focus on the typhoon moving path to investigate the distribution of precipitation (Chang et al. 1993). Recent years studies on the flood phenomenon caused by the typhoon indicate that the lifting on the windward side of terrain will initiate lifting condensation and increase the amount of rain at the same area (Wu and kou. 1999, Yu and Cheng 2008). It is interesting to mark, however, from past experience, the typhoon-induced southwesterly flow brings more severe precipitation sometimes than the typhoon itself. The southwesterly flow associated with typhoon Kalmaegi (2008) bring heavy rainfall which make a historic record high. This study tries to use the reflectivity observed by weather radar to investigate the characteristics of rainband embedded within the typhoon-induced southwesterly flow and tries to have a preliminary understanding for the issue.

Data sources and Analysis

The present study use the reflectivity of low-pulse repetition frequency (460 km) scan collected by Central Weather Bureau's Chiku Doppler weather radar The scan strategy is set up on every 10 minutes or 7 and a half minutes and two elevations, including such as 0.5 and 1.4 degrees. The radar echo interpolated to the latitude and longitude grid, which apply Cressman (1959) method with horizontal resolution of 1 km, after data editing.

Typhoon Sepat

During the impact of southwesterly induced by Typhoon Sepat (fig. 1), the maximum accumulated rainfall were located at the mountainous area of southwest Taiwan and central Taiwan coast, respectively. The distribution of reflectivity illustrated by latitude-averaging Hovmöller diagram (fig. 2a and b) depicts that the intense echoes enhance and develop while propagating to the west of 120.1° E. The precipitation systems move inland from west to east wave by wave. There has existed echoes in the region between 120.6 and 120.7° E. And the pronounced systems dissipate in the area. The analysis indicates that the heavy rainfall occurs on the southwestern slope of Central Mountain Range from100 to 500 m above sea level. The migrating precipitation system from west and terrain induced convection are the mechanisms to bring the severe rainfall in this area.

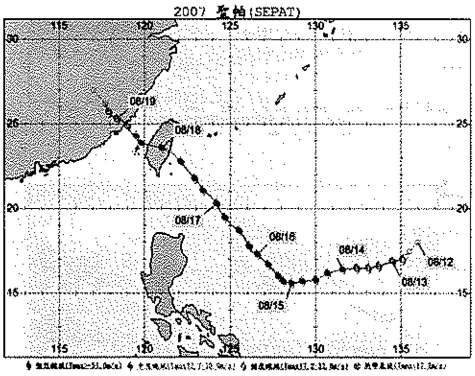

Fig. 1 The diagram for the movement of Typhoon Sepat (2007) (Adapted from CWB website: http://www.cwb.gov.tw)

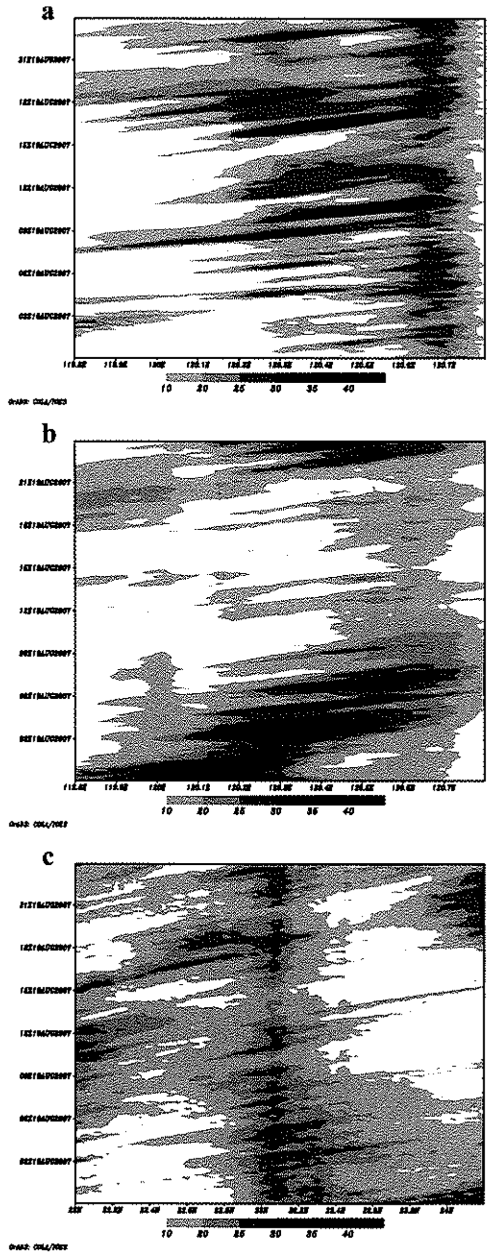

Fig. 2 The Hovmöller diagram of radar reflectivity from 0000 UTC, Aug. 19 to 0000 UTC, Aug. 20 2007. (a) 22 to 23° N latitude-averaging, (b) 23 to 24° N latitude-averaging, (c)119.8 to 120.8 ° E longitude-averaging

The intense echoes propagate into the central Taiwan from the west before 0800 UTC, Aug. 19 2007 wave by wave. The intensive migrating precipitation systems seem to be the prominent factor bringing torrential rainfall along coastal area. The longitude-averaging Hovmöller diagram (fig. 2c) illustrates that the intense echoes at the area between 23 and 23.2 °N. The development of precipitation systems reveals a wave pattern. Additionally, the northern component of propagation is significant, suggesting that the systems move from the south.

Typhoon Kalmaegi

The location of maximum accumulated rainfall shifted from southwestern Taiwan to central Taiwan accompanying with the movement of typhoon (fig. 3).

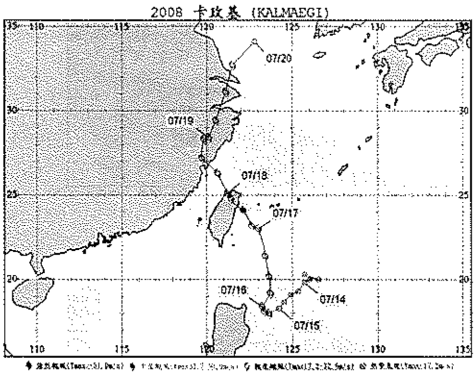

Fig. 3 The diagram for the movement of Typhoon Kalmaegi (2008) (Adapted from CWB website: http://www.cwb.gov.tw)

Therefore the analysis of latitude-averaging Hovmöller diagram is separated into two portions accordingly. The averaging pattern of reflectivity for typhoon Kalmaegi is different from that for typhoon Sepat. Its wave-like signal is hard to be identified, suggesting that the precipitation systems develop and strengthen locally (fig. 4a and b). The intense echoes (> 30 dBZ) sustain more than 12 hrs over the central Taiwan area and 9 hrs in the southwestern Taiwan. The longitude-averaging Hovmöller diagram (fig. 4c) depicts two periodic echoes. One is located between 23 and 23.2 ° N and another is located between 23.4 and 23.5 ° N. Additionally, the wave-like pattern of reflectivity appears in the north of 22.8 ° N between 1500 UTC and 2100 UTC, July 17 2008. These precipitation systems propagate southward after formation.

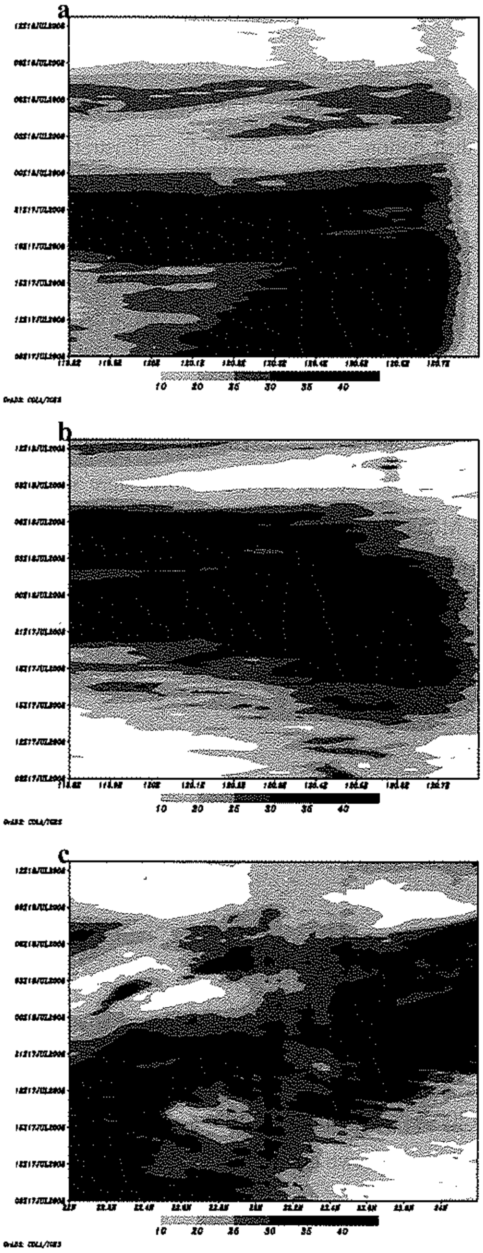

Fig. 4 The Hovmöller diagram of radar reflectivity from 0900 UTC, Jul. 17 to 1300 UTC, Jul 18 2008. (a) 22 to 23° N latitude-averaging, (b) 23 to 24° N latitude-averaging, (c)119.8 to 120.8 ° E longitude-averaging

Discussion and Conclusion

The pattern of longitude and latitude averaging reflectivity for typhoon Sepat and kalmaegi are quite different though the precipitation systems associated with typhoons are induced by southwesterly flow. The way that the systems affect the land is also different. Most of rainbands propagate into southwestern Taiwan area from the ocean after Typhoon Sepat pass by. However, the precipitation systems enhance after the landfall of Typhoon Kalmaegi. The preliminary result describes that the characteristics of rainbands associated with the southwesterly flow induced by both typhoons are distinctive. Furthermore, the precipitation systems over land are initiated by the interaction of the southwesterly flow and the typhoon's circulation in typhoon Kalmaegi case. The characteristic of rainbands associated with typhoon induced southwesterly is a complicate issue and need further discussions in the future.

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