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STUDY ON THE CAUSE OF HEAVY RAIN 200506 (HR200506) IN GUANGDONG

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Abstract: A continuous heavy rain visited Guangdong province during June 18-25, 2005 (named Heavy Rain 200506, HR200506) and had resulted in enormous economic loss. The ageostropic Q vectors, θ_{se}, meridional circulation, computed from the NCEP reanalysis, and TBB are used to study the rainfall processes. The results indicated that a convective system moved northwards from the South China Sea (SCS) and stayed in Guangdong for several days, which was a direct cause of HR200506. The process is a result of the activity of the South China Sea summer monsoon. There were two rainbands of HR200506 in Guangdong. One laid in the north of Guangdong that produced frontal rainfall; another situated on the south of Guangdong which produced monsoon rainfall.

Key words: Guangdong heavy Rain; ageostropic Q vector; South China Sea Summer Monsoon

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1 INTRODUCTION

The amount of precipitation during pre-rainy season has the closest relationship to the drought and flood in Guangdong. Previous studies have shown that rainfall during the annually first rainy season is caused by different physical processes in different periods[1-4]. In the early stage of the first rainy season, frontal rainfall is dominant. Whereas the second peak of the precipitation is almost completely controlled by the southwest monsoon in the SCS. Late in the first rainy season, rainfall processes are complex. But previous studies always focused on single processes such as precipitation from fronts or tropical monsoon [5,6] while ignoring their combined effects. Guangdong province locates in low latitudes, so ageostropic Q vectors [7] can be used to analyze the processes in Heavy Rain 200506 (HR200506). In this paper, the moving path of associated convective systems is found through analysis of ageostropic Q vector divergence and TBB. To understand the processes of HR200506, we investigated the SCS summer monsoon (SCSSM) activities and then explored the rainfall characteristics. Four times of daily NCEP reanalysis are used in this study with 7 pressure levels (1000, 850, 700, 500, 300, 200, and 100 hPa). Other data include hourly TBB from NCEP and daily precipitation from surface stations, which have been interpolated into grids of 0.5˚ latitude by 0.5˚ longitude. All the data used cover the period throughout the whole month of June, 2005.

2 MOVING PATH OF CONVECTIVE SYSTEM

HR200506 is composed of two main rainbands. The northward one centering around Longmen was active during 18 – 25 June. Another center located southward in Yangjiang and was maintained from 21 to 24 June. 1000 – 500 hPa averaged ageostropic Q vector divergence and TBB are combined to determine the moving path of convective systems associated with HR200506. Fig.1 shows that the associated convection first moved northwestwards from the north of SCS, then passed through Guangdong and turned northeastward to leave the continent. It is noticeable that the convective system stayed in Guangdong in the

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period of 18 – 22 when HR200506 occurred. As the system shifted into the ocean during 23 – 25 HR200506 began to be weakened and die out.

Does the northward movement of the convection relate to the SCSSM activities? Fig.2 illustrates the activities of the SCSSM in June (the SCS region is 105˚-120˚E, 5˚-20˚N in this paper). Increased westerly and enhanced convection (corresponding to decreased TBB) on 18 – 25 of June indicate that the SCSSM is developing into an active period from a break. In general, the developing SCSSM intrudes northward and simultaneously controls the weather in relatively higher latitudes. In fact, there are strong vapor transports into South China after the fourth pentad of June when HR200506 began. So the strengthening of vapor transport and convection due to the developing SCSSM provide essential conditions for HR200506.

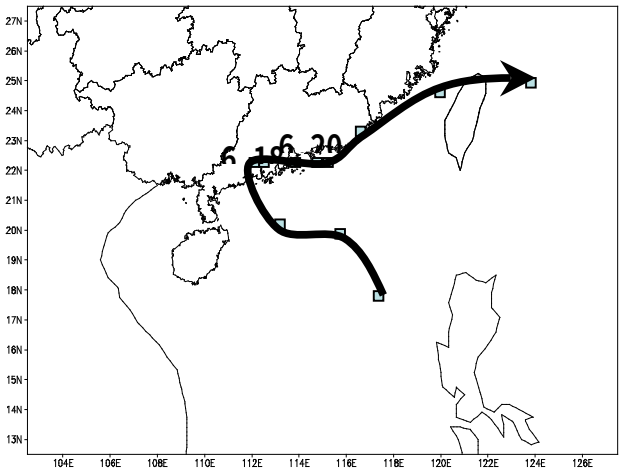

Fig.1 Moving path of the convective system associated with the Heavy Rain 200506.

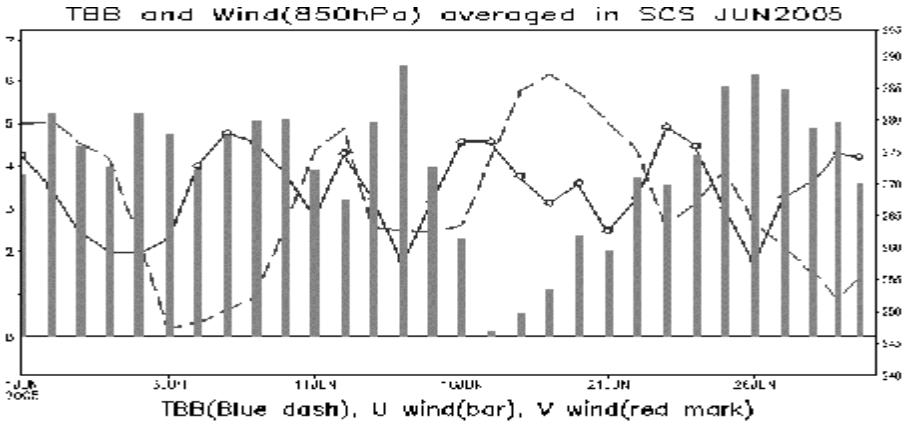

Fig.2 850hPa horizontal winds (m/s) and TBB (K) in the SCS in June, 2005 (from ①)

3 TYPES OF RAINFALL IN HR200506

When the first rainy season in Guangdong comes in April, frontal rainfall is dominant. As SCSSM breaks out and moves northward the frontal rainfall gradually retreats from Guangdong and is replaced by monsoon rainfall [4,8]. What type of rainfall does the HR200506 actually belong to?

Fig.3a displays the meridional circulation and θ_{se} averaged from 18 – 25 June, 2005. It can be seen that more streamlines concentrate between 22.5º and 27.5ºN where θ_{se} gradients are much greater than elsewhere, which indicates that there is a frontal region. According to the meridional variation of θ_{se} in Fig.3a, the maximum surface gradients locate on about 30ºN where the surface front situates. Furthermore, near 30ºN, Fig.3b also displays the gradients of maximum surface θ_{se} and significant horizontal wind shear that confirm the existence of the surface frontal region near 30ºN. On the other hand, the lower troposphere over 17.5 – 22.5˚N is featured as a strong instability that is sometimes increased in HR200506. There are two cloud bands shown by TBB in Fig.4. Since the northern cloud band extends to the subtropics the northern rainband has a linkage to subtropical rainfall. On the contrary, the southern cloud band connects to those in tropics, so the southern rainband relates to tropical rainfall. Based on the works of Chen et al.[8], we can classify the northern rainband into frontal rainfall and the southern one into monsoon rainfall.

For analyses of other aspects, refer to the Chinese edition of the journal.

4 CONCLUSIONS

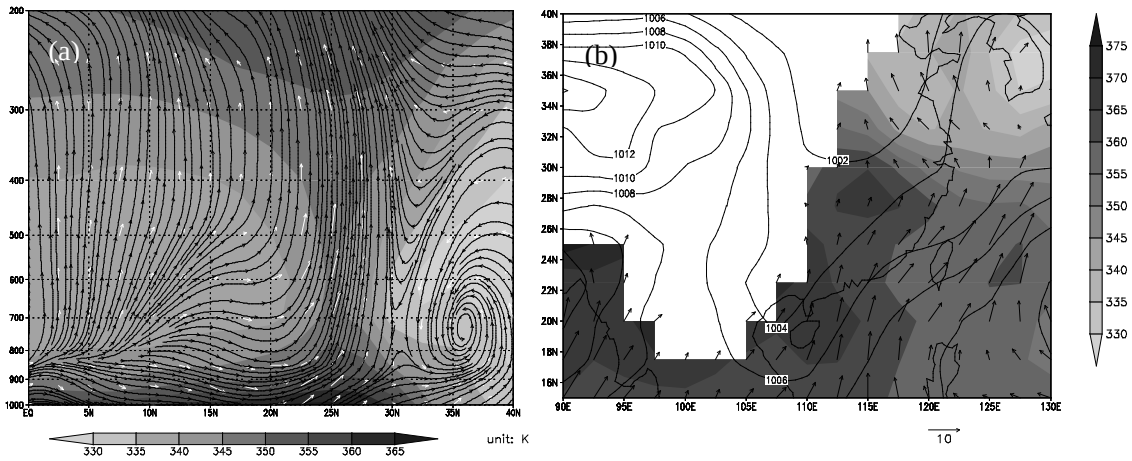

Fig.3 a) 105˚-120˚E averaged θ_{se} (K) and meridional circulation (b) 1000 hPa θ_{se} (the shadow), horizontal winds (m/s) and sea level pressure (contour in unit of hPa) on 18 – 25 June, 2005.

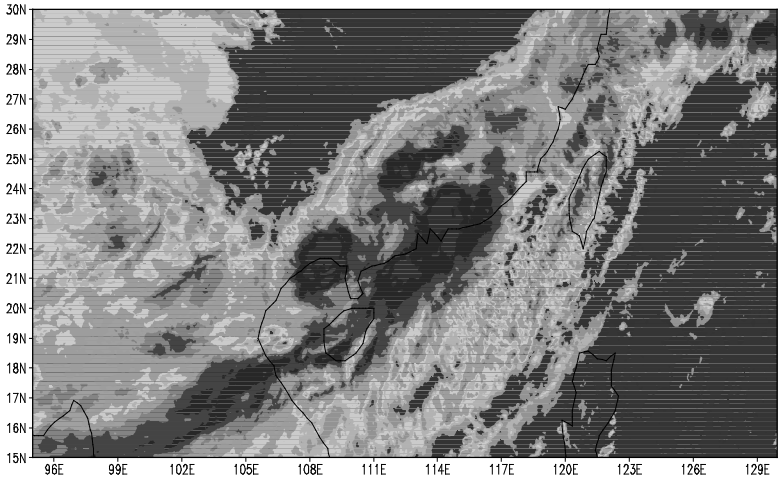

Fig.4 TBB (K) at 04UTC, 22 June, 2005 with the bright gray area denoting cloud bands.

Q vector divergence, TBB, θ_{se}, and meridional circulation are used in this paper to investigate into the processes of a heavy rain taking place during 18 – 25 June, 2005 in Guangdong Province (HR200506), and some conclusions are drawn as follow:

(1) The moving path of convection associated with HR200506 is isolated. The system moves northwestward from the north of the South China Sea (SCS), through Guangdong where it turns northeastward, before moving out into the ocean.

(2) There are two rainbands in HR200506. The northern rainband corresponds to frontal rainfall and the southern one belongs to monsoon rainfall.

(3) The SCS summer monsoon (SCSSM) transited from a break to become active during the HR200506 when the SCSSM was not strong enough to completely control rainfall in Guangdong, so both frontal rainfall and monsoon rainfall maintained in Guangdong to contribute to HR200506. As the SCSSM became active, the rainbands shifted northward and eastward along with the SCSSM and HR200506 finished with it.

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