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ANALYSIS OF AMBIENT FIELDS AND SATELLITE IMAGERY CHARACTERISTICS OF EFFECT OF BAY OF BENGAL STORMS ON LOW-LATITUDE PLATEAU

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Abstract: Based on the composite analysis method, 12 rainstorms triggered by Bay of Bengal storms (shortened as B-storms hereafter) across the whole province of Yunnan were studied, and some interesting results of rain and circulation characteristics influenced by the storms were obtained for low-latitude plateau. Usually, when a rainstorm weather occurs in low-latitude plateau, the B-storm center locates in the central, east or north parts of the Bay of Bengal. At the same time, the subtropical high ridge moves to 15°N – 20°N and the west ridge point moves to the Indo-china Peninsula from the South China Sea and the low-latitude plateau is controlled by southwest air streams coming from the front of the trough and the periphery of the subtropical high. The southwest low-level jet stream from the east side of the bay storm has great effect on heavy rains. On the one hand, the southwest low-level jet stream is playing the role of transporting water vapor and energy. On the other hand, the southwest low-level jet stream is helpful to keep essential dynamical condition. From the analysis of the satellite cloud imagery, it is found that mesoscale convection cloud clusters will keep growing and moving into the low-latitude plateau to cause heavy rains when a storm forms in the Bay of Bengal.

Key words: Bay of Bengal storms; low-latitude plateau; large-scale circulation; satellite cloud imagery

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1 INTRODUCTION

The B-storms are tropical cyclones taking place over the waters of the Bay of Bengal, which are among the main weather systems that affect the low-latitude plateau in early summer and autumn[1]. Over the years, Chinese meteorologists have spent much effort and achieved a lot in studying the genesis, evolution, strengthening and movement of typhoons in the west Pacific as well as the physical causation, evolution patterns and forecasting methods of typhoon-triggered heavy rains[2 - 6]. There has been not much work, however, on the research on the common characteristics of the B-storm-related heavy rain over low-latitude plateaus, though the focus is mainly on case study and diagnosis of some physical quantities. In this work, the characteristics of composite analysis are performed of the B-storm cases for the 30-year period from 1975 to 2004 and 12 cases of heavy rains over extended areas of the Yunnan province caused by the B-storms are examined. Common characteristics are revealed of the effect of the B-storms on low-latitude plateau in the hope that they can be better monitored and pre-warned of.

2 CHARACTERISTICS OF B-STORMS

There are 104 B-storms over the 30 years from 1975 to 2004, or an annual average of 3.47. Their life cycle is 6.4 days on average. They show two seasonal peaks of activity, one in May and the other in October and November. There are rarely any B-storms in February, March, July and August. As shown in the statistics, 56% of the heavy rain days and 71% of the usually heavy rain days in May are associated with the B-storms, and the percentages are 33% and 68% for October and 56% and 57% for November, respectively.

3 EFFECT OF B-STORMS ON LOW-

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LATITUDE PLATEAU

3.1 *Distribution of precipitation*

Fig.1a shows the accumulated rainfall for 124 weather stations in the province, which are the results of 19 B-storms. It is seen that there is more precipitation in the south and west than in the north and east of Yunnan. The least precipitation (108 mm) occurs in the northeast of the province and the most precipitation (1063 mm) in the south of it. The inhomogeneous distribution of rainfall may be attributed to the special terrain of the low-latitude plateau. In Yunnan, the mean altitude above sea level is mostly more than 1500 m, being higher in the north and west than in the south and east and having two mountain ranges in the western and southern parts of the province, respectively. When the B-storms move near the plateau, the southwesterly or southerly flows to its east increase the ascending motion due to the lifting effect of terrain on the windward slope of the mountain ranges and cause intense precipitation.

3.2 *Flow field at 500 hPa*

The 500-hPa circulation field is studied with the 19 B-storms that caused unusually heavy rain in Yunnan (Fig.2). There are roughly three types of circulation, specifically, the pattern of a shear associated with an east-west trough (I), the pattern of a southward-extending trough (II) and the pattern of the west Pacific subtropical high (III). Pattern I takes up the majority of all cases, about 53%, followed by Pattern II (about 26%) and Pattern III (about 21%).

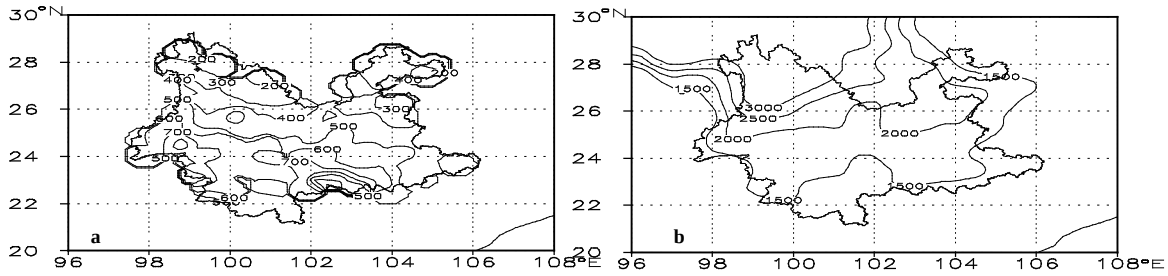

Fig.1 Accumulated rainfall (a) with unusually heavy rains for individual weather stations under the influence of 19 B-storms and (b) the terrain height.

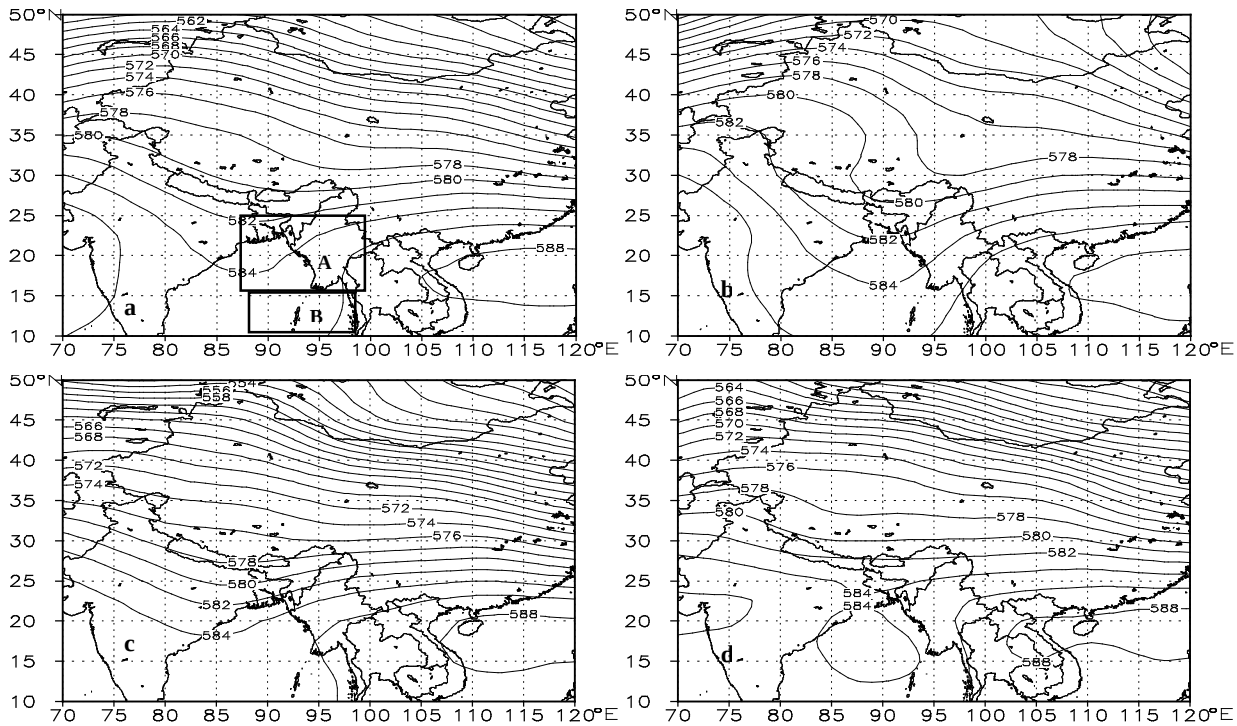

Fig.2 The pattern of an east-west trough with shear at 700 hPa (a) and 500 hPa (b), the pattern of a southerly trough (c) and the pattern of the west Pacific subtropical high (d), which are accompanied with the beginning of unusually heavy rains caused by the B-storms.

3.3 *Southwest jet stream*

As shown in the analysis (Fig.3), the northeast movement of the cloud system of the B-storms is mostly related with the southwesterly wind over the low-latitude plateau. When the airflow is straight or coming from the northwest from the Bay of Bengal to the plateau, it is usually unfavorable for such movement. The southwesterly jet stream is always with the beginning of unusually heavy rain in the province. Heavy rain usually occurs to the left, front side of the southwesterly jet stream, where there are intense converging center and positive vorticity, indicating that the southwesterly jet stream in the front of the B-storm is playing an important role in the formation of severe precipitation. It transports water vapor and energy on the one hand and helps maintain necessary dynamic condition on the other.

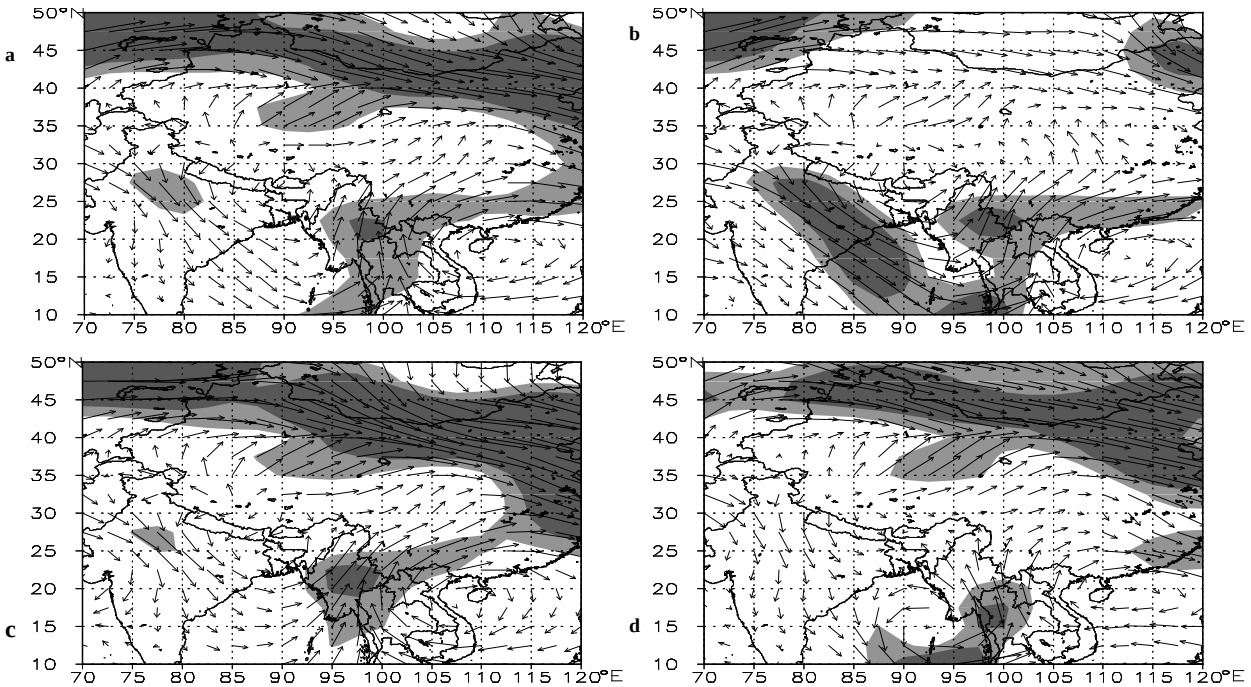

Fig.3 Wind field and composite maximum wind speed for the pattern of an east-west trough with shear at 700 hPa (a) and 500 hPa (b), the pattern of southerly trough (c) and the west Pacific subtropical high (d) in association with the beginning of unusually heavy rains caused by the B-storms. The solid line is the contour for wind speed, the dark and light shades are for wind speed of ≥8 m/s and 12 m/s respectively.

3.4 *Satellite imagery*

As shown in routine forecast, mesoscale convective cloud clusters play a major role in the formation of severe precipitation related to the B-storms. Take for example 12 of the unusually heavy rains across the province. Digital hourly TBB data are used to study the characteristic activity of mesoscale convective cloud clusters and their interrelationship with the heavy rain. The convective cloud clusters are defined to be on mesoscale if their shorter axis is less than the distance of two latitudes in a cold tongue of – 32°C and they last more than 5 hours. Over the area of 20°N – 30°N, 97°E – 110°E, 56 mesoscale convective cloud clusters appeared successively, with minimum temperature between – 44°C and – 52°C at the center and an extreme of – 72°C and a life cycle of 5 – 21 hours. The mesoscale convective cloud clusters from the B-storms over Yunnan can generally summarize the unusually heavy rains for the same period of time. It is then shown that mesoscale convective cloud clusters are the main system through which the B-storms cause unusually heavy rains in Yunnan.

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

4 DISCUSSIONS

In this work, only the circulation and satellite imagery with the B-storm affecting the low-latitude plateau are analyzed. How does the B-storm interact with circulation systems on different latitudes and scales? What effect does the interaction have on the formation and development of unusually heavy rains? More work needs to be done and in greater detail to study the formation, development and movement of the B-storm and the physical causation and forecasting methods for the unusually heavy rain it causes.

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