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CLIMATOLOGICAL VARIATION FEATURES OF TYPHOON PRECIPITATION INFLUENCING FUJIAN FOR THE PAST 46 YEARS

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Abstract: The results of an analysis of the temporal and spatial distribution of typhoon precipitation influencing Fujian from 1960 to 2005 show that typhoon precipitation in Fujian province occurs from May to November, with the most in August. There has been a decreasing trend since 1960. Typhoon precipitation gradually decreases from the coastal region to the northwestern mainland of Fujian and the maximum typhoon precipitation occurs in the northeast and the south of Fujian. Typhoon torrential rain is one of the extreme rainfall events in Fujian. High frequencies of typhoon torrential rain occur in the coastal and southwest regions of the province. With the impact of Fujian's terrain, typhoon precipitation occurs more easily to the east of the mountains than to the west. Atmospheric circulation at 500 hPa over Asia and sea surface temperature anomalies of the equatorial eastern Pacific are analyzed, with the finding that they are closely connected with the anomaly of typhoon precipitation influencing Fujian, possibly mainly by modulating the northbound track of typhoons via changing the atmosphere circulation to lead to the anomaly of typhoon precipitation over the province

Key words: typhoon precipitation; temporal and spatial features; climate change; Fujian

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1 INTRODUCTION

More and more emphasis is being put on the climatological variation of typhoon precipitation both at home and abroad [1-5]. Little effort, however, has been spent on probing into the regional characteristics of typhoon precipitation across different parts of China or the similarity of regional climatological variations to the national ones. They seem all the more important for provinces like Fujian, which are subjected to frequent typhoons. Up till now, case study is the main tool in the research on typhoon precipitation affecting the province [6-8].

In view of it, this study will look into the basic characteristics of relevant typhoon precipitation climotologically, based on the latest data of typhoon and national precipitation as well as Fujian's rainfall records from its basic stations.

2 DATA AND METHODS

The typhoon datasets used in this study are from the *Tropical Cyclones Year Book* by China Meteorological Administration for western North Pacific in 1949 – 2005 while the precipitation datasets are from the daily measurements by China Meteorological Information Center and Fujian Weather Observatory for 724 Chinese stations in 1951 – 2005. The length of the data is 46 years (from 1960 to 2005) in the analysis.

An Objective Synoptic Analysis Technique (OSAT) is used to separate the typhoon precipitation obtained [9]. With this technique, the precipitation field is divided into different rain belts. Added to the 677 station across China are 47 basic stations in the province [5]. For the separation of rain belts, a parameter used for depicting the distance between adjacent stations is set

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at 80 km. With an improved version of OSAT, this study first isolates the measurements of precipitation that influences the whole nation and then identifies those that have effects on Fujian only. For this study, all affecting typhoons are those that bring about precipitation in the province and the time when such influence sets in is defined as the starting day of a period in which the typhoon causes rain in Fujian.

The data used to analyze the causation of precipitation anomalies are from the NCEP reanalysis: the monthly mean geopotential heights at 500 hPa (with grid intervals at 2.5 °× 2.5°) and the global monthly mean SST gridpoint data (with intervals at 2° × 2°). Also used in this study are the methods of linear tendency estimation, Morlet wavelet, contrast analysis and composite analysis [10].

3 ANALYSIS

3.1 *Spatial distribution of typhoon precipitation*

As shown in a multi-year mean of typhoon precipitation (Fig.1a), precipitation generally decreases from the coast in the south to inland areas in the northwest, with an annual average typhoon rainfall of more than 80 m. The areas with the largest typhoon precipitation are over the south and northeast of the province with an annual amount between 350 mm and 500 mm. Fig.1b gives the distribution of the percentage of annual average typhoon rainfall in total precipitation. Similar to the distribution of annual average typhoon precipitation, the contribution rate by typhoon precipitation is also gradually decreasing from the southern coast to the northwestern inland.

3.2 *Temporal variation of typhoon precipitation*

The typhoon volumetric precipitation [5] is used to depict the annual and monthly totals of the typhoon precipitation. The monthly total accumulated for the 46 years is used to describe the seasonal change in typhoon precipitation, which shows well-defined unimodal seasonal variations (Fig.2). The typhoon begins to affect Fujian in April and most seriously from July to September, which takes up 81.1% of the multi-year total of typhoon volumetric precipitation, with August at the peak, while having no effect on the province in January – March. Typhoon precipitation is positively correlated significantly with the number of affecting typhoons --- the larger the number of the affecting typhoons, the more the precipitation will be that affects the province; otherwise is true.

For Fujian province, the general tendency of typhoon volumetric precipitation is decreasing over the time 1960 – 2005 (Fig.3) at a rate of -0.22 km^3 / yr, passing a 0.01 significance test and being consistent with a decreasing national trend. The amount of typhoon precipitation is dependent on the frequency of typhoons affecting the province, whose decrease is mainly attributed to the reduction of typhoon precipitation affecting it.

In order to understand the variations for individual time scales, standardized series of anomalies are calculated for the typhoon volumetric precipitation to determine the distribution of isolines for the coefficient of Morlet wavelet (figure omitted). Fig.4 gives the distribution of differences in 500-hPa geopotential heights averaged over July – September by subtracting four years of anomalously more typhoon precipitation from four years of anomalously less typhoon precipitation.

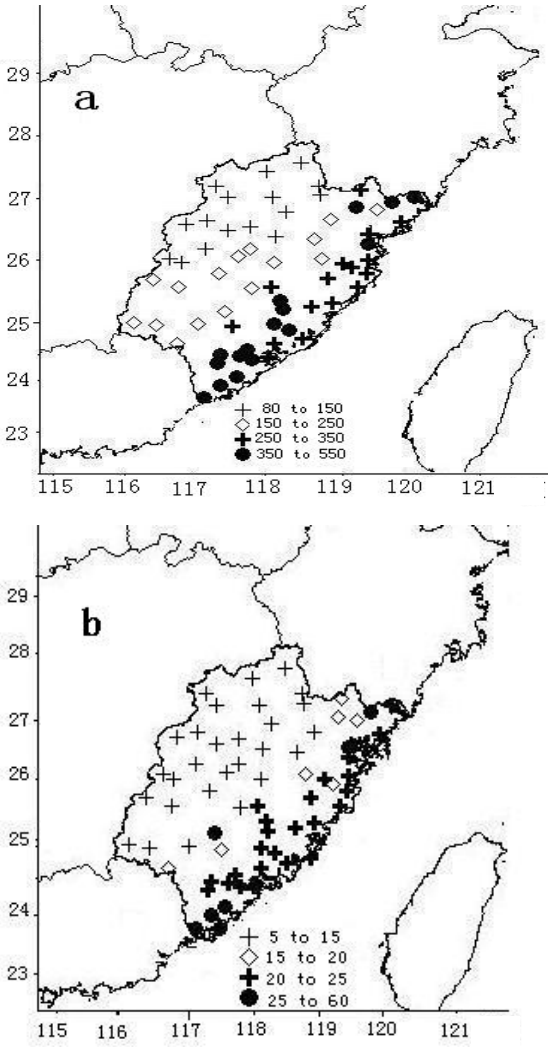

Fig.1 Annual average typhoon rainfall (a, unit: mm) and its percentage in total rainfall (b, unit: %). The abscissa is the latitude and the ordinate the latitude.

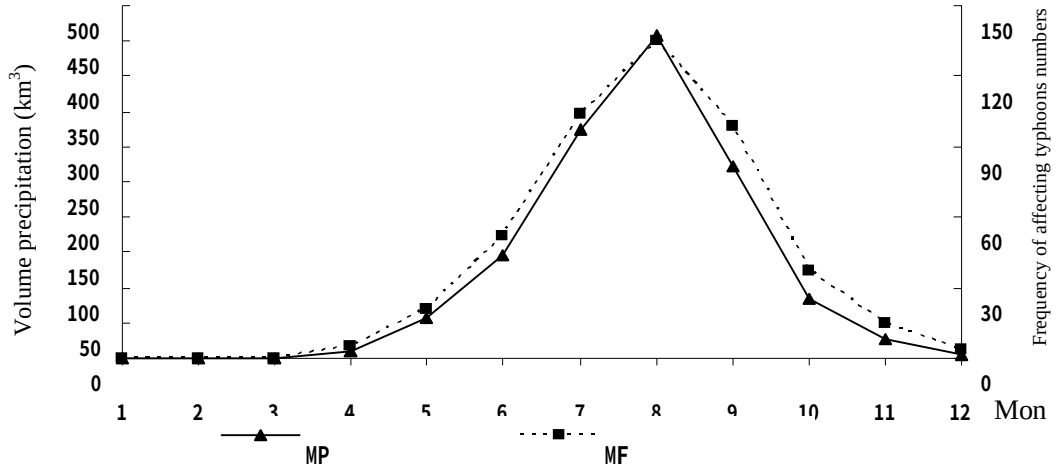

Fig.2 Monthly total of typhoon volume precipitation affecting Fujian (MP) and seasonal variation of monthly total frequency of affecting typhoons (MF) over the time from 1960 to 2005.

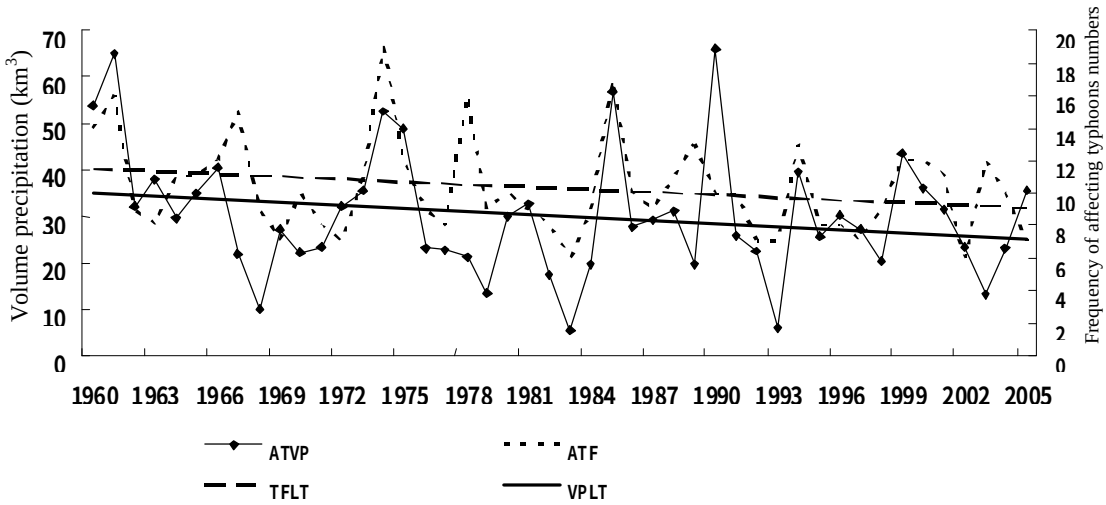

Fig.3 Interannual evolutions of annual total of typhoon volume precipitation affecting Fujian and annual frequency of typhoons affecting it. ATVP stands for annual typhoon volume precipitation, ATF for affecting typhoon frequency, TFLT for typhoon frequency linear trend and VPLT for volume precipitation linear trend.

See the Chinese edition of the journal for more details.

4 SUMMARIES

(1) For Fujian, consistency is found between typhoon precipitation and typhoon frequencies. It takes place mainly from May to November and July, August and September are the three months that have the most typhoon precipitation with August having the maximum amount.

(2) The amount of typhoon precipitation has been decreasing since 1960. Coastal and southwestern parts of Fujian are the two areas with the highest frequencies of occurrence.

(3) High spatial consistency is found between the extreme value of diurnal typhoon precipitation, accumulated number of days with typhoon torrential rain and processes of maximum typhoon precipitation; rainfall decreases from the coast to the inland area. The latter indicates that coastal Fujian suffers more seriously from typhoons than its inland areas and it is more likely for areas to the east of its main mountain ranges to experience typhoon precipitation than those to the west of them.

(4) There are close links between the anomalous typhoon precipitation affecting the province and the 500-hPa general circulation over Asia. When the western Pacific subtropical high is relatively weak and located northward, it is more likely for the typhoon to

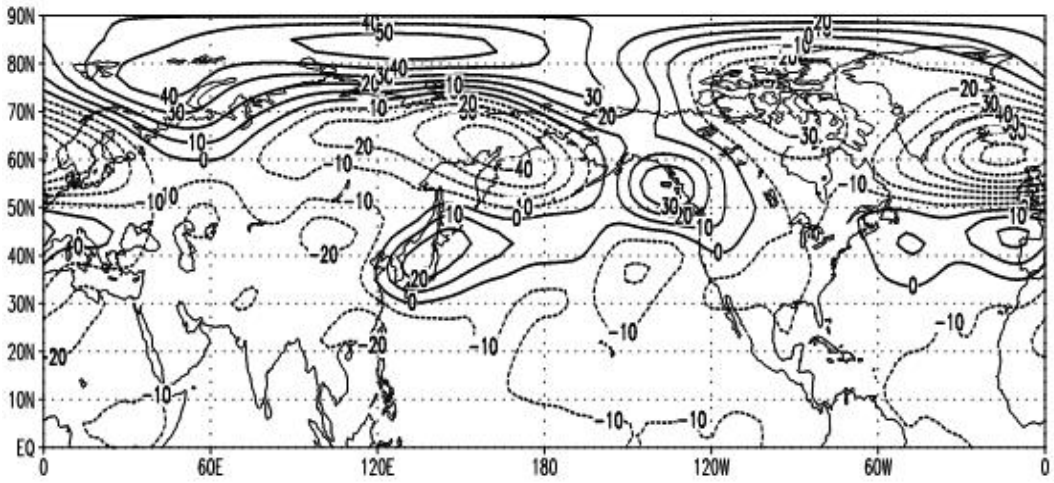

Fig.4 The distribution of differences in 500-hPa geopotential heights averaged over July – September for the years of anomalously more typhoon precipitation versus the years of anomalously less typhoon precipitation over Fujian.

be active and move northward, providing favorable background for the appearance of anomalously more typhoon precipitation in Fujian; otherwise is true.

(5) The equatorial eastern Pacific is the key area of anomalous typhoon precipitation for the province. A lower SST there is favorable for the west Pacific typhoon to remain active and move northward to result in anomalously more typhoon precipitation over the province; otherwise is true.

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