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# THE CHARACTERISTICS OF TEMPORAL AND SPATIAL DISTRIBUTION OF TROPICAL CYCLONE FREQUENCIES OVER THE SOUTH CHINA SEA AND ITS AFFECTING OCEANIC FACTORS IN THE PAST 50 YEARS

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**Abstract:** The characteristics of temporal and spatial distribution of tropical cyclone frequencies over the South China Sea areas and its affecting factors in the past 50yrs are analyzed based on typhoon data that provided by CMA and Simple Ocean Data Assimilation (SODA). The results show that the tropical cyclone frequencies from June to October show concentrated geographic distribution, for they mainly distribute over the SCS area from 15 – 20°N. The characteristics present significant interdecadal changes. The impact of oceanic factors on the tropical cyclone frequencies in the SCS area is mainly realized by La Niña and La Niña-like events before 1975 but mainly by El Niño and El Niño-like events after 1975.

**Key words:** South China Sea; tropical cyclone frequencies; temporal and spatial distribution; affecting factors

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## 1 INTRODUCTION

The tropical cyclone is one of the important systems that produce wind and rain. A lot of progress has been made in the climatological study of TC. For instance, periodic and abrupt-changing characteristics of point frequency of the TC location have been studied, large-scale circulation condition for TC to generate over the west Pacific has been summarized and the relationship between Southern Hemisphere circulation and medium-term activity of TC groups has been discussed. Most of them, however, focus on the northwest Pacific, with only general effort on the spatial-temporal distribution of the point frequency of TCs generating over or passing the South China Sea and the effect of oceanic factors (like sea surface temperature, sea surface height and sea surface salinity) for different periods on it. It is with this purpose that the current work attempts to study.

## 2 SEASONAL VARIATION OF TCS

Analyzing with the *Yearbook on Typhoons* (1949 - 1999) compiled by China Meteorological Bureau, it is found that the point frequency is of significant seasonal variation (Fig.1). during the winter (December – February), it concentrates in the area south of 15°N. In spring (March – May), it spreads from south to north. In summer (June – August), it is basically north of 15°N and northernmost in August, showing a tendency of going westward. Such geographic distribution maintains until autumn (September – October). In November, it retreats quickly to the south. It is then known that the point frequency begins to increase significantly in June but starts to decrease dramatically in November.

## 3 SPATIAL-TEMPORAL DISTRIBUTION OF TC

According to the authors' definition, the location points of TCs that generate and pass the area of 105°E

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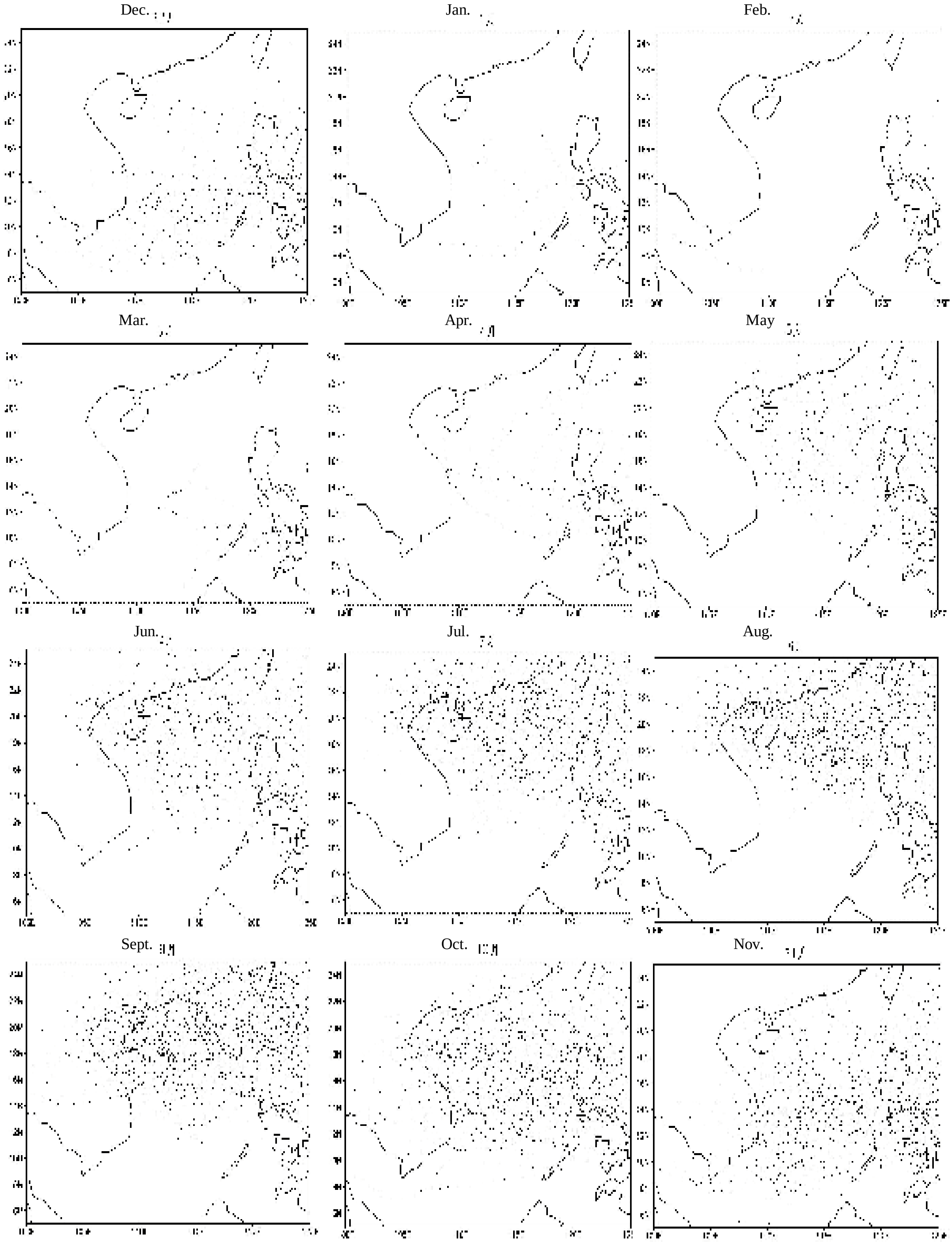


Fig.1 Distribution of point frequency of locations of TCs that generate over or pass the waters of South China Sea (105°E – 120°E, 5°E – 25°E) at 6-h intervals from 1949 to 1999.

– 120°E, 5°N – 25°N in the South China Sea from 1949 to 1999 (51 years) are averaged on a monthly basis in terms of accumulated times of appearance within a 2-degree interval of latitude for the spatial-temporal distribution series of point frequency over the time. Then, monthly point frequency for June – October in the South China Sea is processed with Empirical Orthodontic Function (Fig.2). It is known from the spatial distribution that the TC shows obvious

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geographic concentration from June to October, mainly in the areas of 15°N – 22°N in the South China Sea. It is known from the temporal distribution that the point frequency for the same months experiences four periods alternating with more and less TC, namely in 1950 – 1960, 1965 – 1975, 1980 – 1990 and 1990 – 1999.

The Simple Ocean Data Assimilation (SODA) from 1950 to 1999 are used to determine the distribution of the correlation between the first temporal series of the point frequency for June – October and sea surface temperature (SST) field over the four periods of time (Fig.2). For the periods of 1950 – 1960 and 1990 – 1999, a positively correlated area in the tropical central and eastern Pacific is the key region governing the frequency of TC appearances. By combining the spatial and temporal series of Fig.1, it is known that the temporal coefficient is mainly negative with large point frequency for the former period, showing that it is mainly affected by La Niña or La Niña-like episodes; the temporal coefficient is mainly positive with small point frequency for the latter period, showing that it is mainly influenced by El Niño or El Niño-like episodes. In contrast, cooler (warmer) SST in the tropical central and eastern Pacific is associated with smaller (larger) point frequency for the 1965 – 1975 period but warmer (cooler) SST is linked with smaller (larger) point frequency for the 1980 – 1990 period. In general, the La Niña or La Niña-like episodes played a main role before 1975 but the El Niño or El Niño-like episodes had major effect after it.

The effect of sea surface height on the point frequency is consistent with that of SST, especially for the 1965 – 1975 period when significant positive and negative correlation areas are over the tropical western Pacific and central and eastern Pacific, respectively (figure omitted). The mainly positive coefficient describes a pattern of higher sea surface height and warmer SST in the west than in the east of the ocean, i.e. the conditions of La Niña or La Niña-like episodes, which reduces the point frequency for the period. For the other three periods, however, the characteristics with regard to the effect of the episodes around the year 1975 is also evident, though the sea surface height has less effect on the TC than the period from 1965 to 1975.

In contrast, the sea surface salinity is comparable in terms of the effect on the point frequency for the four periods (figure omitted). In 1950 – 1960, it was low and the point frequency was high in the tropical western Pacific. In 1965 – 1975, areas of significant positive correlation are over the tropical western and central Pacific (figure omitted), indicating that the La Niña or La Niña-like episodes did have major effect on the point frequency. In the two decades with mainly negative and positive temporal coefficients (1980 – 1990 and 1990 – 1999, respectively), areas of significant correlation between the sea surface salinity and TCs are respectively over the areas of negative correlation in the tropical western Pacific, positive correlation in the eastern Pacific and negative correlation in the tropical central and eastern Pacific. The distribution is corresponding to the patterns of El Niño or El Niño-like episodes, i.e. warmer SST versus more precipitation versus low salinity. It also supports the fact that the El Niño or El Niño-like episodes mainly affect the point frequency after the year 1975.

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

## 4 CONCLUSIONS AND DISCUSSIONS

Analyzing the temporal and spatial distribution of the point frequency for June – October over the past 50 years, the current work investigates into the effect of SST, sea surface height and salinity on it and draws the following conclusions.

(1) Showing significant seasonal variation, the point frequency begins to increase significantly in June but starts to decrease substantially in November.

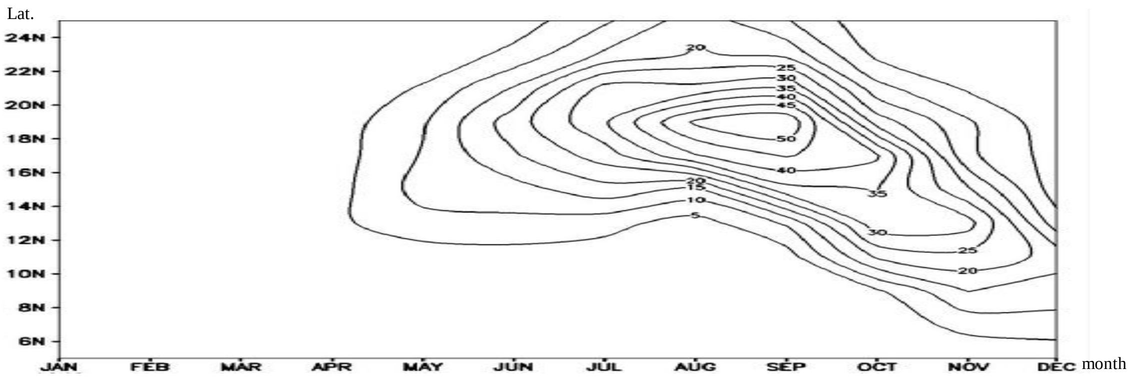


Fig.2 Distribution with the latitude of the point frequency of locations over the waters of South China Sea for TCs generating or appearing in 105°E – 120°E, 5°N –25°N. The contour interval is 5.

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(2) Showing significant concentration in geographic distribution for June – October, the point frequency mainly distributes in the area of 15°N – 22°N in the South China Sea and experiences four periods that alternate with more and less point frequency.

(3) SST, sea surface height and salinity all affect the point frequency, showing that the La Niña or La Niña-like episodes played a main role before 1975 but the El Niño or El Niño-like episodes had the major effect after it. Furthermore, for the periods of 1965 – 1975 and 1980 – 1990, the point frequency had close relationship with the onset and ending time of the ENSO event.

In addition, analysis has also been done of the atmospheric effect on the point frequency. It is found that the atmosphere does not affect it as systematically as the ocean, possibly due to longer memory of the latter, which enables it to remember some significant signals of meteorological phenomena, which affect the frequency of TCs. In contrast, with shorter memory, the atmosphere tends to affect the TC more immediately and on shorter time scales, without a regular pattern. It needs to be studied in more detail.

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