Abnormal anti-cyclone in ocean atmosphere and sports swimming strength training based on target tracking algorithm

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Abstract
Using the best tropical cyclone path data set provided by the Shanghai Typhoon of the China Meteorological Administration, the 2474 site data provided by the CMA, and the China ground precipitation daily value grid data set (V2.0), based on objective weather analysis techniques, this paper first conducts TC precipitation Separate and propose a decomposition method for TC precipitation influencing factors to analyze the climate characteristics of continental tropical cyclone precipitation and its influencing factors, then use ERSSTv5 sea temperature data to study the characteristics of TC precipitation in the four phases of ENSO through synthetic analysis methods, and use the abnormal cause diagnosis method analyzes its possible causes. From the point of view of the magnitude, the EPW and CPC phases show an abnormal decrease, while the CPW and EPC phases show an abnormal increase; from the perspective of the spatial distribution characteristics of abnormal TC precipitation, the spatial distribution of EP-type ENSO presents a southwest-northeast distribution, while the CP-type ENSO presents uniformity throughout the region. At the same time, in order to improve the special physical abilities of swimmers, the physical strength training of swimmers should be adjusted according to different swimming styles and closely coordinated with special techniques. At present, the physical training methods of swimmers cannot fully meet the functional requirements of various special swimmers. Therefore, in various swimming events, how to carry out the highly combined design of physical training methods under different swimming postures is a problem worthy of discussion. Based on this, this article simulates the athlete’s physical training through the target tracking algorithm, which can improve the athlete’s professionalism.

Keywords Target tracking algorithm; Ocean atmosphere; Abnormal anticyclone; Swimming strength training

Introduction
Tropical cyclone (TC) is a strong cyclonic vortex with a warm central structure that occurs in the tropical ocean. It is often accompanied by strong winds and heavy rains, causing serious disasters in the areas within its influence. China is located on the northwestern edge of the Northwest Pacific Ocean (WNP) and is one of the countries most affected by the TC disaster in the world (Balla 1961). At the same time, the precipitation caused by TC is an important part of the precipitation in the summer of China. In the southeast coast of China, TC precipitation accounts for 20–40% of the total precipitation, and it can reach more than 40% locally. It has a certain effect on alleviating drought (Clemence and Veesaert 1977). The impact on agriculture outweighs the disadvantages. ENSO is a global-scale climate oscillation phenomenon, which plays an important role in East Asian climate change. TC precipitation is of great significance to China. ENSO has an important modulating effect on the climate of East Asia, especially TC activities. Studies have also shown that ENSO has an indicative effect on China’s TC precipitation in the second summer, but it only affects typical ENSO and Chinese TC (Mo et al. 2014). Precipitation studies, when diagnosing the causes of TC precipitation, the predecessors thought that TC precipitation is closely related to the frequency of TC paths. However, in the process of research, it is found that the abnormal frequency of TC paths does not always explain the abnormality of TC precipitation (Ouyang et al. 2019).
Therefore, this paper takes the precipitation of landfall tropical cyclones in China as the main research object, and proposes a decomposition method of TC precipitation influencing factors. The TC precipitation is divided into three direct influencing factors, two indirect influencing factors, and non-linear terms. Precipitation and its influencing factors are analyzed for climatic characteristics; then ENSO is divided into four phases, and the characteristics of the precipitation of tropical cyclones landing in China under the two types of ENSO phases are studied through the method of synthetic analysis, and the different phases are preliminarily analyzed by the abnormal cause diagnosis method (Paton et al. 2010). The reason for the abnormal TC precipitation in the lower TC; finally, taking the EPW phase as an example, an attempt is made to analyze the mechanism of ENSO’s influence on TC precipitation from the perspective of the large-scale circulation field. Scientific physical training has always been one of the hot topics in the field of sports training in our country. Scientific physical training during swimming training can not only improve the special performance of swimmers, but also prevent sports injuries and prolong careers. Most swimming coaches adopt a unified training method in the selection of physical training methods, but they are not carried out according to the special requirements of swimmers, so scientific training methods are relatively lacking. Because the difficulty of high-level training methods and the combined effect of training play an important role, for swimmers, physical strength training methods are very valuable for research.

Materials and methods

Data source

For TCs affecting China, data from the Shanghai Typhoon Research Institute of the China Meteorological Administration is more representative (Ritts et al. 2001). This article selects the best path data set provided by CMA-STI (tcdata.typhoon.org.cn), covering the WNP sea area (including the South China Sea, north of the equator, west of east longitude 180°), with a time resolution of every 6 h. TC has an extremely fine structure, and the study of its precipitation requires data with higher spatial resolution. The monthly data in this paper uses the grid data set V2.0 provided by the National Meteorological Administration, with a spatial resolution of 0.25°×0.25°.

Station data processing

During the 57 years from 1964 to 2020, the CMA Meteorological Information Center has 2474 national meteorological observation stations with historical meteorological data records. Since the establishment of the station, many stations across the country have undergone operational reforms, and the meteorological data has been broken. In order to select the starting time of this study, the number of general national meteorological stations in China was plotted over the years (Fig. 1). It can be seen that the number of general national meteorological stations has experienced a period of rapid growth from the 1960s to the 1980s. During the 20 years, the number of stations increased rapidly from 2050 in 1964 to 2,361 in 1984; the number of stations began to increase in the 1980s. It tends to be slow until 2020, increasing to 2403 stations. Tropical cyclones are a mesoscale or synoptic scale system, and the study of the precipitation requires finer station distribution. In order to ensure that the distribution of precipitation stations is dense enough and the data is valid for a long enough time, this paper selects 1984 as the starting time.

The number of national meteorological stations reached 2,361 in 1981, but of these stations, some were later removed, and some were missing for a long time. Therefore, these 2361 stations need to be screened, and the stations with missing data for more than 2 consecutive months from 1981 to 2017 are eliminated, leaving 1896 stations in the end. Figure 2 shows the spatial distribution of 2,474 national-level weather stations (black dots) across the country and 1896 stations (blue dots) after screening. It can be seen that the distribution of meteorological stations is uneven, and the distribution of stations in the XZ Autonomous Region is sparse. As the most severely affected area by tropical cyclones, South China has a relatively even distribution of meteorological stations. (As shown in picture 2)
Design of target tracking algorithm

In the random finite set theory, the measurement and state of the target are modeled through the random finite set. In the forehead tracking system of this article, the generated state vector $\chi_k$ and measurement vector $\tilde{Z}_k$ are as follows:

$$
\chi_k = [x_k, y_k, w_k, h_k, \dot{x}_k, \dot{y}_k]^T
$$

$$
\tilde{Z}_k = [x_k, y_k, w_k, h_k]^T
$$

The Gaussian mixture probability proposes a linear Gaussian hypothesis, which is calculated as follows:

$$
f(x_k | x_{k-1}) = N(x_k; F_{k-1} x_{k-1}, Q_{k-1})
$$

$$
g(z_k | x_k) = N(z_k; H_k x_k, R_k)
$$

In the prediction step, the intensity of GM-PHD is modeled between Gaussian groups and is calculated as follows:

$$
v_{k|k-1}(x) = \sum_{i=1}^{J_{x_k}} w_{i,x_k}^{k-1}N(x; m_{i,k-1}, S_{i,k-1})
$$

In the summary of the update steps, the intensity of GM-PHD is modeled as a Gaussian mixture function:

$$
v_k(x) = \sum_{i=1}^{J_x} w_{i,x_k}^{k}N(x; m_{i,k}^{k}, S_{i,k}^{k}) + (1-P_{D,k})v_{k|k-1}(x)
$$

The diagnosis method of the cause of abnormal anticyclone in the ocean atmosphere

For any variable $\text{var}$, if the other impact factors $a$ and $b$ have the following relationship:

$$
\text{var} = a \cdot b
$$

And each variable can be decomposed into event average item and instantaneous change item:

$$
\text{var} = \text{var}^{a-\text{var}} + a^\prime \cdot b
$$

Incorporating formula (8) into formula (7), we have

$$
\text{var} = \left( (a + a^\prime) \cdot (b + b^\prime) \right) = a \cdot b + a \cdot b^\prime + a^\prime \cdot b + a^\prime \cdot b^\prime
$$

Bringing $a = a^\prime = 0, b = b, b^\prime = 0$ into (9), we get:

$$
\text{var} a^\prime \cdot b^\prime
$$

Equation (10) shows that for any variable $\text{var}$, the time average value is not only determined by the time average value of the influence factors $a$ and $b$, but also determined by the time average value of the product of the instantaneous changes of the two influence factors.

The time abnormal value of any variable $\text{var}$ is:

$$
\text{var}^\prime = \text{var} - \text{var}
$$

$$
= a \cdot b + a \cdot b^\prime + a^\prime \cdot b + a^\prime \cdot b^\prime - (a \cdot b + a^\prime \cdot b)
$$

$$
= a \cdot b + a^\prime \cdot b + (a^\prime \cdot b - a \cdot b^\prime)
$$

It is worth mentioning that this type of cause diagnosis method can not only be applied to the diagnosis of variable time abnormalities, but also can derive the cause diagnosis...
formulas such as critical abnormalities and meridional abnormalities in the same way.

Research and design of sports swimming strength training

The experimental equipment required for this research is shown in Table 1.

The intervention in this study will last for 8 weeks. These 12 athletes will have 5 days of water training every week, with an average of about 2 h of training time per day. While not affecting the daily normal water training of 12 athletes, additional interventions will be added to 12 athletes. Among them, the experimental group will have 3 core training sessions a week, namely Swiss ball training, static balance training and waist and abdominal muscle training. Then cooperate with each regular water training. The 3 core training sessions were all controlled at 30 min, and they were carried out simultaneously with the water training in the control group.

The intervention method used is to consult the domestic and foreign literature and implement it after being approved by experts Sun Jiawei (former national team coach), Zheng Minsheng (former national team scientific researcher), and David Lyles (former national team coach).

Statistical analysis

In this study, SPSS20.0 software (IBM SPSS Inc., Chicago, USA) was used for statistical analysis of the data. First use the K-S test to test whether the data is normally distributed.

1. The independent sample t test is used to judge whether there is a difference between the demographic data of the two groups.
2. The independent sample t test is used to judge whether there is a difference between the test index groups before and after the intervention of the two groups.

Results

Responses of atmospheric circulation to sea temperature anomalies in different phases of ENSO

The sea temperature index can reflect the distribution of sea surface temperature. The Nino3 and Nino3.4 indexes can be used to distinguish the meridian position of the center of the equatorial eastern Pacific sea temperature anomaly, and the EMI index can be used to determine whether the equatorial central Pacific sea temperature exists in the meridian direction. When the Nino3 index is greater than (less than) the Nino3.4 index and both are greater than 0 (less than), it means that the equatorial eastern Pacific Ocean is anomalously warmer (cold) and the greater the anomaly value eastward; when the Nino3 index is greater than (less than) 0 and the Nino3.4 index is less than (greater than) 0, it indicates that the gradient of the sea temperature change from east to west in the equatorial eastern Pacific is negative (positive), the EPW (EPC) phase is developing or the cold (warm) center moves westward. When the EMI index is greater than (less than) 0, it means that the sea temperature in the central equatorial Pacific is higher (lower) than the average sea temperature in the east and west, and there is an average negative (positive) sea temperature gradient outside the central equatorial Pacific in the meridional direction. Figure 3 shows the year-by-year changes in the EMI, Nino3 and Nino3.4 indices, and selects the year in which each phase occurs according to the definition (Table 2).

As shown in Fig. 3, EMI index (blue line), Nino3 index (yellow line), and Nino3.4 index (brown line) from 1984 to July–September 2020 in line chart (unit: °C). The solid line represents the value of the index, the dashed line is the reference line, which represents the magnitude of plus or minus one standard deviation of the respective index average, and the black dashed line is the reference line with y=0.

As shown in Fig. 4, EPW (a), CPW (b), EPC (c), and CPC (d) during the period 1984–2020 SST anomalies (shaded, unit: °C) and precipitation anomalies with 90% confidence (Isoline, unit: mm, the green solid line is a positive anomaly, the magenta dashed line is a negative anomaly), the black solid line is the key area, from east to west are the east area, Nino1+2 area (located in the east area), Nino3 area, Nino3.4 area, central area and west area.

Table 1

| Laboratory apparatus       | Model                                       |
|---------------------------|---------------------------------------------|
| Height meter              | Holtain,Crymych,Dyfed,UnitedKingdom         |
| Electronic weight scale   | TanitaTFB-543,Tokyo,Japan                   |
| Underwater camera         | GoProHERO4,USA                              |
| Stopwatch                 | CASIOHS-80TW-1JH,Japan                      |

Table 2

| Phase | Years                  |
|-------|------------------------|
| EPW   | 1985, 1990, 2000, 2018 |
| WPC   | 1988, 1991, 2010       |
| CPW   | 1993, 1997, 2005, 2007 |
| CPC   | 1986, 2001, 2002, 2013, 2013 |
On the equatorial Pacific, the westernmost SST anomaly does not exceed 160°E, the central SST anomaly is about 40° smaller than the eastern zonal range, and the center of the anomaly is westward and weaker in intensity. From the perspective of air-sea interaction, the strongest is on the northwest side of the anomalous sea temperature center, and significant precipitation anomalies are produced above it. EPW has the strongest signal of sea temperature anomaly, and its air-sea interaction is also the most intense.

The air-sea interaction in the equatorial Pacific is dominated by the ocean, so the atmospheric circulation in the Pacific responds differently to different ENSO phases.

The gray line in the figure represents the sea temperature anomaly with an absolute value greater than 0.3 in this phase, the solid line represents the positive anomaly, and the dashed line represents the negative anomaly, and the unit is °C. (as shown in Fig. 5).

Assuming that there is no divergence in the atmosphere, the spatial distribution of anomalous flow functions under different phases is drawn as shown in Fig. 6.

To sum up, in the warm (cold) phase, the airflow in the low-latitude abnormally warm (cold) sea area rotates in the low-level abnormally cyclonic (anticyclonic) mode, and in the upper-level abnormally anticyclonic (cyclonic) mode, and it is located in the northern hemisphere. The strong rotation center of the lower layer is westward, and the southern hemisphere, and the higher layer rotation center is westward. The sea temperature in the central equatorial Pacific has an abnormal phase, and the airflow over the eastern equatorial Pacific rotates abnormally. The extreme value of the abnormal center of the downflow function in the EPW phase is larger, which indicates that the airflow rotation is strong and the sea-vapor interaction is strong, which is the same as the previous analysis.

Figures 5 and 6 discuss the response of the atmosphere to different ENSO phases from the perspectives of non-swirling and potential-free flow, while the actual atmospheric cyclone is potentially compressible. Figure 7 shows the actual response of the lower atmosphere to sea temperature.

As shown in Fig. 7, the shadow is the distribution map of the sea temperature anomaly in this phase. Among them, A
represents an anticyclonic vortex, and C represents a cyclonic vortex in the EPW phase (Fig. 7(a)). There is an abnormal westerly wind at the equator, and the airflow at low latitudes in the northern hemisphere presents an abnormal cyclonic rotation at 15°N, 135°E. The cyclonic curvature near E reaches the maximum, and there is an anticyclone-cyclonic circulation on its northwest side. The center of the anomalous anticyclone is at 25°N, near 140°E, and the center of the anomalous cyclone is in the Sea of Japan. In the CPW phase (Fig. 7(b)), the equatorial Pacific air currents depart from the east and west, converge over the warmer zone of the equatorial central Pacific, and form a cyclonic (anticyclonic) vortex in the west (east) Pacific. There is a cyclone-anticyclone-cyclonic circulation in the western Pacific from south to north. There is a cyclone vortex center near 20°N and 140°E, and an anticyclone vortex center exists east of Japan. Under the EPC phase (Fig. 7(c)), the easterly wind is anomalous in the equatorial region, and it shows anticyclonic rotation; under the CPC phase (Fig. 7(d)), the cold sea temperature zone in the central equatorial Pacific appears anomalous east (west) wind.
The analysis of the anomalous characteristics of precipitation of tropical cyclones landing on the Chinese mainland under different phases of ENSO is shown in Figs. 8, 9, 10, and 11.

Table 3 shows the statistics of the anomalous characteristics of TC precipitation in different phases of ENSO.

It can be seen from Table 3 that the abnormal precipitation of landed TC and the number of abnormal landed TC under the two warm phases have a proportional relationship, while the two cold phases have an inverse relationship between the two. This shows that in the warm phase, the number of landed TC anomalies has a positive contribution to the anomalous TC precipitation, which explains the anomaly of TC precipitation; but in the cold phase, the number of landed TC anomalies is not the main factor affecting the abnormal TC precipitation. It may be related to the abnormal rainfall intensity of the landed TC or other factors.

It can be seen from Table 4 that under the EPW phase, the most important factor affecting TC precipitation is the TC...
impact frequency term, which makes a significant positive contribution to the TC precipitation, followed by the daily TC precipitation intensity term, the TC impact duration term, and the nonlinear term make a negative contribution. From the perspective of the cold and warm phases, under the two warm phases, the TC influence frequency term is the main influencing factor, the daily TC precipitation intensity term decreases, the nonlinear term increases, and the influence duration term makes a negative contribution; in the cold phase, the length of impact term is the main influencing factor, the frequency of TC impact is reduced, the daily TC precipitation intensity term all make positive contributions, and the nonlinear terms all make negative contributions. Analyzed from the perspective of different ENSOs, under EP ENSO phases, the TC influence frequency terms are all reduced, while the influence time terms are increased, while the daily TC precipitation intensity terms all make positive contributions, and the non-linear terms all make negative contributions; under CP ENSO phases, the daily TC precipitation intensity term and the impact duration term both decrease, while the nonlinear... 

Fig. 7 The spatial distribution of 700hPa anomalous streamlines in the Pacific region under the EPW (a), CPW (b), EPC (c), and CPC (d) phases from July to September 1984–2020 (unit: m/s)

Fig. 8 The EPW phase from 1984 to 2020 landed in China from July to September (a) Tropical cyclone abnormal precipitation (unit: mm), (b) its anomalous contribution to precipitation (unit: %), and (c) abnormal precipitation over the same period Spatial distribution (filled circles indicate that the reliability test of 0.1 is passed)
term increases, and the TC impact frequency term makes a positive contribution.

**Causes of abnormal precipitation of tropical cyclones landed in China in South China under EPW phase**

As shown in Fig. 12, the effects of (a) tropical cyclone precipitation days, (b) tropical cyclone daily precipitation intensity, and (c) non-linear terms on the precipitation of tropical cyclones landed in China from July to September during the EPW phase from 1984 to 2020; (d) is the contribution of the above three items to the precipitation of abnormal tropical cyclones in South China (unit: mm). Among them, the solid dots in (a) (c) and the dotted area in (d) indicate that they pass the 0.1 significance test.

As shown in Fig. 13, from July to September in the EPW phase from 1984 to 2020 (a) the number of tropical cyclones affected each station each year, (b) the duration of each tropical cyclone’s impact on each station each year, and (c) the influence of non-linear term on the number of rainy days for tropical cyclones landed in China; (d) the contribution of the above three items to the number of rainy days for tropical cyclones in South China (unit: day). Among them, the solid dots in (a)-(c) and the dotted area in (d) indicate that they pass the 0.1 significance test.

From the analysis, it can be seen that the factors that directly affect the TC precipitation in mainland China can be divided into daily TC rainfall intensity, TC impact frequency, impact duration of each TC, and nonlinear terms. There is a good correlation between the decrease of TC path frequency in South China and the decrease of TC influence frequency.

![Fig. 9](image-url) Same as Fig. 8, but in CPW phase

![Fig. 10](image-url) Figure 8, but in EPC phase
The TC path frequency is a direct influencing factor of the TC influence frequency of each station, and it can affect the landing TC precipitation in mainland China by affecting the TC influence frequency of each station (as shown in Fig. 14).

From July to September, the TC generated at each grid point in the Northwest Pacific: (a) the number of anomalies passing through South China under the climate standard state, (b) the number of anomalies passing through South China under the EPW phase; (c) under the EPW phase Spatial distribution of TC anomalies in the Northwest Pacific. Among them, the dotted area means that it passes the 0.1 reliability test (as shown in Fig. 15).

The vertical shear of the zonal wind at 200hPa and 850hPa is anomalous, the shade represents the anomaly size, and the contour represents the size of the climatic average; (d) Outward long wave radiation (OLR) anomaly; (e) 600hPa specific humidity anomaly 1984–2020 July-September EPW phase (a) 850hPa relative vorticity abnormality; (b) vertical motion abnormality; (c) the vertical shear of the zonal wind at 200hPa and 850hPa is anomalous, the shadow indicates the size of the anomaly, and the contour indicates the size of the climatic average; (d) outward longwave radiation (OLR) anomaly; (e) 600hPa specific humidity anomaly. Among them, the dotted area indicates that the physical quantity passes the significance test of 0.1 (as shown in Fig. 16).

Under the climatic average for many years (Fig. 17(a)), the probability of TC generated in the South China Sea through South China is the largest, reaching 58.14%, followed by the ocean to the east (21.2%) and west (29.41%) of the Philippines, with the least being In Southeastern Japan, only 8.00% (as shown in Fig. 17).

Figure 18 shows the spatial distribution of the abnormal velocity of the average guided airflow at 300-850hPa in the EPW phase. There is an abnormal cyclonic vortex on the Korean Peninsula and an abnormal anticyclonic circulation in the Beibu Gulf. Under the influence of these two anomalous airflows, the zonal component of the airflow guided by the southeast coast of China (northeast) is dominated by anomalous westerly winds (east winds). And the ridgeline of the subtropical high is roughly around 25°N in the background state. Under the action of such anomalous guiding airflow, the westerly wind from the north of 25°N to the south of the transverse trough of the abnormal cyclone is strengthened.

As shown in Fig. 19, the spatial distribution map of horizontal shear anomalies of zonal wind from high to low from July to September in the EPW phase from 1984 to 2020.

### Table 3 Abnormal precipitation of TC under different phases of ENSO

| Characteristic                | EPW   | CPW   | EPC   | CPC   |
|------------------------------|-------|-------|-------|-------|
| Abnormal precipitation       | -5.34* | +4.66 | +4.64 | -4.29 |
| Precipitation anomaly         | -1.97  | +1.93 | +1.32 | -5.26 |
| Abnormal precipitation        | Southwest-Northeast “+” distribution | Region-wide consistency | Southwest-Northeast “++” distribution | Region-wide consistency |
| Number                        | -1.74** | +1.53 | -0.72 | +0.08 |

Note: * and ** indicate that the two-sided t-test with reliability of 0.1 and 0.05 passed respectively.
Among them, (a)–(h) represent vertical cross-sectional views of 200, 300, 400, 500, 600, 700, 850, and 925 hPa, respectively.

**Analysis of the effect of sports swimming strength training**

Before and after the 8-week intervention, the changes in the 100-m breaststroke performance of the two groups of subjects are shown in Table 5.

The results showed that there was no significant difference in the 100-m breaststroke performance ($p=0.868, 95\%\text{CI} -4.42\text{--}5.15$) between the two groups before the 8-week intervention. After 8 weeks of intervention, there was no significant difference in the 100-m breaststroke performance between the two groups ($p=0.704, 95\%\text{CI} -5.57\text{--}3.91$). However, there was a significant difference in the difference between the two groups before and after the intervention ($p=0.045, 95\%\text{CI} 0.03\text{--}2.35$). Compared with the control group, the experimental group has a greater improvement in 100-m breaststroke performance.

### Table 4 The contribution of various influencing factors to abnormal TC precipitation under different phases of ENSO

| Influence Item                              | EPW     | CPW     | EPC     | CPC     |
|---------------------------------------------|---------|---------|---------|---------|
| TC influence frequency item                 | 135.68% | 113.92% | -144.92%| 39.91%  |
| Daily TC precipitation intensity item       | 26.18%  | -16.08% | 217.22% | 17.39%  |
| Impact duration item                        | -41.56% | -38.12% | 243.53% | 51.01%**|
| Nonlinear term                              | -20.33% | 40.28%  | -215.81%| -8.30%  |

Note: * and ** indicate that the two-sided $t$-test with reliability of 0.1 and 0.05 passed respectively.

![Fig. 12](image_url)  
**Fig. 12** (a) Tropical cyclone precipitation days item, (b) tropical cyclone daily precipitation intensity item, and (c) non-linear item impact on the precipitation of tropical cyclones landed in China during the EPW phase during 1984-2020 from July to September; (d) is the contribution of the above three items to the precipitation of abnormal tropical cyclones in South China (unit: mm)
Table 6 shows the changes in the 100-m breaststroke performance of the two groups of subjects before and after the intervention.

The results showed that there was no significant difference in the 100-m breaststroke performance of the control group before and after the intervention ($p=0.057$). However, there were significant differences in the 100-m breaststroke performance of the experimental group before and after the intervention ($p=0.012$). Compared with before the intervention, the experimental group had a greater improvement in 100-m breaststroke performance after the intervention.

**Discussion**

**Analysis of strength training methods in sports swimming**

How many support points

The support point refers to the part that can support the athlete's completion of the action. Generally speaking, the more
support points, the more conducive to the completion of the action; conversely, when the support points are continuously reduced, the difficulty for the athlete to complete the action will gradually increase. The purpose of increasing the number of support points is to reduce the difficulty of completion of the action, which is mainly suitable for the initial training or athletes with insufficient athletic ability.

Adjustment of torque

The adjustment of torque refers to the fact that the distance between the support point and the support point changes from long to short (from short to long) or the center of gravity of the body changes when the athlete completes the action.

Increase load to increase resistance

The so-called resistance training refers to the removal of artificial resistance from the outside world after the athlete undergoes systematic training, so that it produces a greater load and reaction in the direction of movement, and the athlete can withstand greater training stimulation, thereby making the athlete more capable. Effectively improve. In the resistance training process, the consistency and standardization of the training movements of the athletes when they are hindered by resistance must be emphasized. Under the interference of resistance, they will not cause movement deformation and incoordination. The physical training is similar to their special purpose. The point is, the anatomical form of sports, the speed and type of muscle contraction, so the strength of muscle contraction must be utilized to the maximum. By combining the characteristics of resistance training and sports, the conversion rate of resistance training can be effectively improved.

Exercise intensity is the intensity of specific strength in the practice of a specific technique. Because every competitive sport has its own characteristics, the required intensity is different. Special strength exercise is a kind of exercise that imitates the joint movement related to special skills, and has a strong particularity to mechanical devices and speed. Because competition training is due to the environment, the resistance in the water is very different from that on the land. When doing physical training, you can simulate the resistance in the water, and design physical training methods in the original special movement mode to increase resistance training.
Fig. 16 1984–2020 July-September EPW phase: (a) 850hPa relative vorticity anomaly; (b) vertical motion abnormality; (c)

Fig. 17 Tropical cyclones in the Northwest Pacific from July to September generated from various grid points and landed in South China (a) Climate average. (b) The probability distribution of anomalies under EPW phase

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Increase the range of motion

The range of motion refers to the increase in the movable range of the athlete during exercise. The expansion of the movable range is mainly achieved by the expansion of the movable range of the joints. The wider the movable range of the joints, the larger the movable range of the body. For example, in the squat stage, the squat is mainly done by bending the hip joint and bending the knee. If the curvature of the hip and knee joints is small, the depth of squat is small, and the range of motion is small, and the stimulation to the body will increase accordingly. On the contrary, if the curvature of the hip and knee joints continues to deepen within the physiological range, as the bending limit range increases, the amplitude of the movement will become larger, and the stimulation to the body will become greater and more difficult. From shallow squatting to deep squatting, the increase in the range of motion increases the stimulation of related muscle groups, and the exercise effect is more obvious. Therefore, by expanding the scope of activities, the difficulty can be further increased to meet the needs of athletes’ special skills.

Comparison of the effect of sports swimming strength training

This study found that after the end of the 8-week intervention, the experimental group and the control group had no significant changes in the number of strokes in the first 50 m and the number of strokes in the last 50 m. However, in the 100-m breaststroke performance, the experimental group had a significant improvement, and the effect is significantly better than the control group (Santosh 2010). In a previous study, core training was also used to improve the expressiveness of youth breaststroke, and this study mainly used the Swiss ball as the main training aid. By using the instability of the Swiss ball to simulate the balance required by the body in the water, the relationship between core training and breaststroke technique is more effectively combined (Tao 2003). In addition to the balance training of the Swiss ball, this research also added some static body position training to better fit some of the core abilities required for the water breaststroke. The results of this study and the previous study are the same. Core training can significantly improve the 100-m breaststroke performance of teenagers.

As the final indicator comparison, in previous studies, researchers usually only used a single performance indicator, or subjective technical evaluation analysis (Wang and Guo 2017). This study also increased the number of strokes and the measurement of the angle between the body position and the water surface (Wang et al. 2001). The stroke cycle of breaststroke is long. In training or competition, the difference of one action cycle will affect the time of the whole stroke (Wang et al. 2012). In this study, core training is used to improve the position of the body in the breaststroke. Small resistance and high efficiency will have a certain impact on the stroke, so the number of strokes is also included in the final indicator. It can be seen from the results that the experimental group has a certain downward trend of strokes, but it is not yet significant, which may have a certain relationship with the small sample size. However, it can be found from the results of the study that changes in technical movements in breaststroke can affect the number of strokes, and a reasonable number of strokes is an important part of the competition for breaststroke athletes (Wang et al. 2017).

Strategies for strength training in sports swimming

From the perspective of the need to supplement the proportion of physical fitness training in competitive swimming training,
it is imperative to strengthen the theoretical knowledge study of first-line children’s swimming coaches, improve the communication mechanism between various training units, and establish a professional for coaches and provincial and municipal sports schools. A platform for teams to communicate and learn together to discuss theoretical knowledge and practical experience of physical training (Wu et al. 2006). To achieve this goal, training courses or conference forums can

![Fig. 19](image-url)

**Table 5** Changes in the 100-m breaststroke performance of the two groups of subjects before and after intervention (seconds)

| Index                              | test group | Control group | P value | 95% CI     |
|------------------------------------|------------|---------------|---------|------------|
| Before intervention                | 75.58±4.55 | 75.21±2.65    | 0.868   | -4.42-5.15 |
| After the intervention             | 73.80±4.70 | 74.63±2.25    | 0.704   | -5.57-3.91 |
| Difference before and after intervention | 1.78±1.14 | 0.58±0.58     | 0.045   | 0.03-2.36  |
be held, and online resources can be vigorously integrated to conduct online learning through online classes. In short, strive to enrich the learning methods of coaches and use learning to make up for the lack of coaches' theory (Xia et al. 2006). Listening at the same time is clear, partial belief is dark is an important method for children's swimming coaches to learn more professionally, systematically and comprehensively, and use physical training theory and practical experience (Xu and Zhao 2005).

Athletes have different characteristics in their physical and mental development at different ages, and the sensitive periods of the development of various physical qualities are also different (Xu et al. 2011). The daily training of young swimmers must be planned, implemented, safe, and able to improve. In physical training, attention must be paid to the physical and mental development of children and the law of growth, so as to avoid the excessive training intensity that violates the law of growth and causes damage to the athletes (Xu et al. 2013). In addition to paying attention to athletes' daily training tests and competition results, coaches must also always pay attention to the physical and psychological changes of athletes, analyze existing problems in time, and adjust appropriate training plans and content.

The lack of physical training facilities has slowed the progress of children's swimming physical training in our province. It has produced boring emotions on a single training facility. To improve the current situation of children's swimming coaches to learn more professionally, systematically and comprehensively, and use physical training theory and practical experience (Xu and Zhao 2005).

Constructing a scientific and reasonable system of physical training mechanism can monitor the dynamics of athletes' physical function and psychological quality in real time, and make appropriate adjustments to athletes' training plans and methods and means of the implementation process, in time to ensure the efficient completion of training. Construct a systematic and scientific physical training system to improve the effectiveness of physical training and competitive sports capabilities of young swimmers.

### Table 6 Changes in the performance of the rear 100-m breaststroke within the subject group before and after intervention (seconds)

| Grouping   | Before intervention | After the intervention | T value | P value |
|------------|---------------------|------------------------|---------|---------|
| Test group | 75.58±4.55          | 73.80±4.70             | 3.823   | 0.012   |
| Control group | 75.21±2.65       | 74.63±2.25             | 2.459   | 0.057   |

Conclusion

This paper proposes a decomposition method of TC precipitation influencing factors. The response of the atmosphere to sea temperature is different under different phases of ENSO. In the EPW (EPC) phase, the equator is dominated by cyclonic (anticyclonic) rotation, there is an abnormal anticyclonic (cyclonic) center in the Northwest Pacific, and there is an abnormal cyclonic center (anticyclonic circulation) in the Sea of Japan. The TC anomalous volume precipitation and the contribution of TC precipitation anomalies under different phases of ENSO present asymmetric characteristics. In terms of magnitude, both EPW and CPC phases showed an abnormal decrease, while CPW and CPC phases showed an abnormal increase. Among them, only the EPW phase had a significant change in TC precipitation that landed in mainland China, and the other phases were not significant; In terms of the spatial distribution characteristics of abnormal TC precipitation, the spatial distribution of EP-type ENSO presents a southwest-northeast distribution, while the CP-type ENSO presents uniformity throughout the region. From the perspective of the number of TCs landing in mainland China, the number of EP ENSO landing TCs has decreased, while the number of CP ENSO landings has increased. The main influencing factor of TC anomalous precipitation in the two warm phases is the TC influence frequency term, while in the cold phase, it is the TC influence duration term.

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**Declarations**

**Conflict of interest** The author declares no competing interests.

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