Seasonal Tropical Cyclone Activity Forecast
Northwest Pacific Ocean and South China Sea
August 2024 Update

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I. Forecasting Results

- Fewer tropical storms (TS) are forecasted to form in the Northwest Pacific Basin (NWP) and the South China Sea (SCS) in 2024, with a total number of around 22-24. Meanwhile, the number of strong typhoons (STY) is expected to be slightly below the long-term climatic average (LTCA). 6-8 TSs are forecasted to make landfall in China, which is close to LTCA.
- The number of tropical cyclones (TC) expected to impact overall China and South China in 2024 are forecasted to reach 13-15 and 9-11 respectively, slightly higher than the LTCA. East China and Shanghai are expecting a normal year, with the total number of TC forecasted to reach around 9-11 and 2 respectively. The subtropical high is expected to remain stronger than average during summer before gradually weakening and retreating eastward in late summer and early autumn. It is important to pay close attention to potential autumn typhoons.

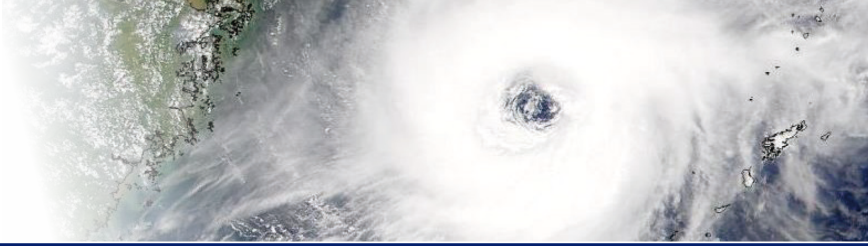
	TS or above formation	STY or above formation	TS or above landfall	TC impacting China (Notes 1-2).			
				China Overall	South	East	Shanghai
1991-2020 EV ± SD	25±4.5	9.5±3.6	7±1.9	13.0±3.6	9.0±3.5	9.5±3.3	2.0±1.5
2024 Forecast (March)	22–24	Less	6–8	13–15	9–10	8–10	~2
2024 Forecast (June)	22–24	Normal Less	6–8	13–15	9–11	9–11	~2

Table 1. Seasonal forecast of TC activity in 2024

II. Basis for forecasting

1. Tropical cyclone activity year-to-date

As shown in Figure 1, two tropical cyclones formed in the Philippines and the northern part of the South China Sea respectively in late May: Typhoon Ewini No. 2401 and Tropical Storm Mali No. 2402. Compared to the LTCA of 5.5 from January to May, the number of TCs generated in the area was lower and mainly concentrated in late May. This was due to the suppression of convective activities in the South China Sea and the Philippine Sea area earlier this year (Refer to the first issue of



2024 Seasonal Tropical Cyclone Activity Forecast Report). In late May, the Madden–Julian oscillation (MJO) signal strengthened over the oceanic continent, and negative Outgoing Longwave Radiation (OLR) anomalies (Figure 2) were observed in the South China Sea and the northern part of the Philippine Islands, providing favorable conditions for active convective activities and tropical cyclone formations.

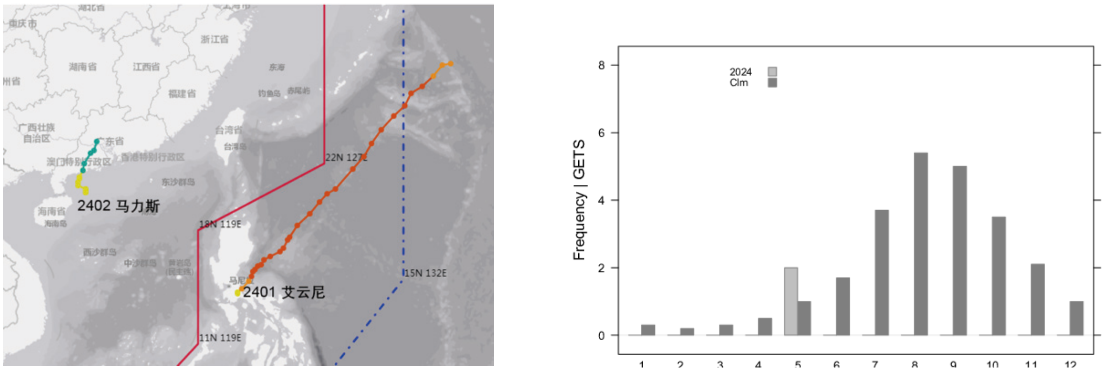


Figure 1. Left: Paths of Typhoon Ewini 2401 (formed on 26 May 2024) and Tropical Storm Mali (formed on 31 May 2024)
Right: The monthly tropical cyclone numbers year-to-date vs. the LTCA

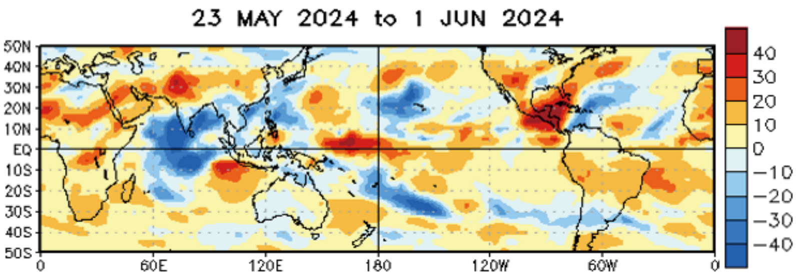
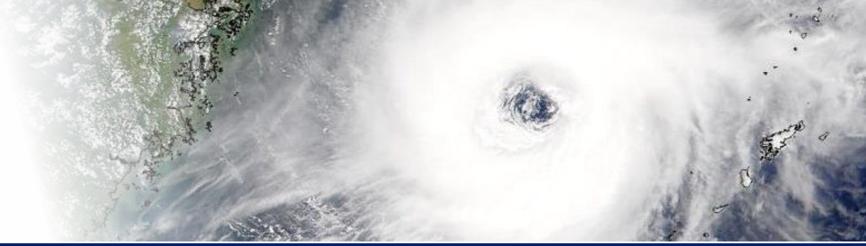


Figure 2. The distribution of OLR anomalies (23 May - 1 June 2024)

2. Ocean Atmosphere Conditions and Outlook

According to recent monitoring results of sea surface temperatures (SST), the 2023/24 El Niño event has ended in May, and the tropical Pacific Ocean has returned to the ENSO neutral status (Figure 3). Compared to the 2023/24 winter, the positive SST anomaly weakened in Tropical Pacific, India Ocean and most of the Atlantic Ocean, and a negative SST anomaly was observed in equatorial East Pacific during this spring (Figure 3). Negative OLR anomalies emerged in the equatorial India Ocean, the Arabian Sea and the Oceanic Continent (Figure 4). However, the southern part of the South China Sea and the Philippine Sea were still under the control of positive OLR anomalies. A negative anomaly of the sea level pressure (SLP) was observed over the South China Sea and the Indochina Peninsula, while a positive anomaly was present over the Philippine Sea. The flow field at 850 hPa over the South China Sea became a junction of an anomalous cyclonic circulation and an anomalous anticyclonic circulation. Meanwhile, the Philippine Sea and the eastern coast of China (excluding the Yangtze River Delta area) were affected by an anomalous anticyclonic circulation (Figure 4). The combination of these conditions was not favorable for tropical cyclones to evolve into large-scale circulations over the open ocean.



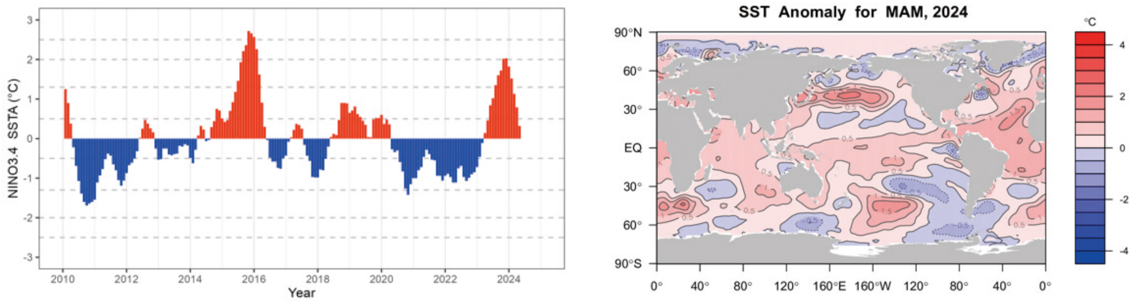


Figure 3. Left: Evolution of the Nino3.4 SST index
Right: Distribution of SST anomalies, spring 2023/24 (March-May, MAM)

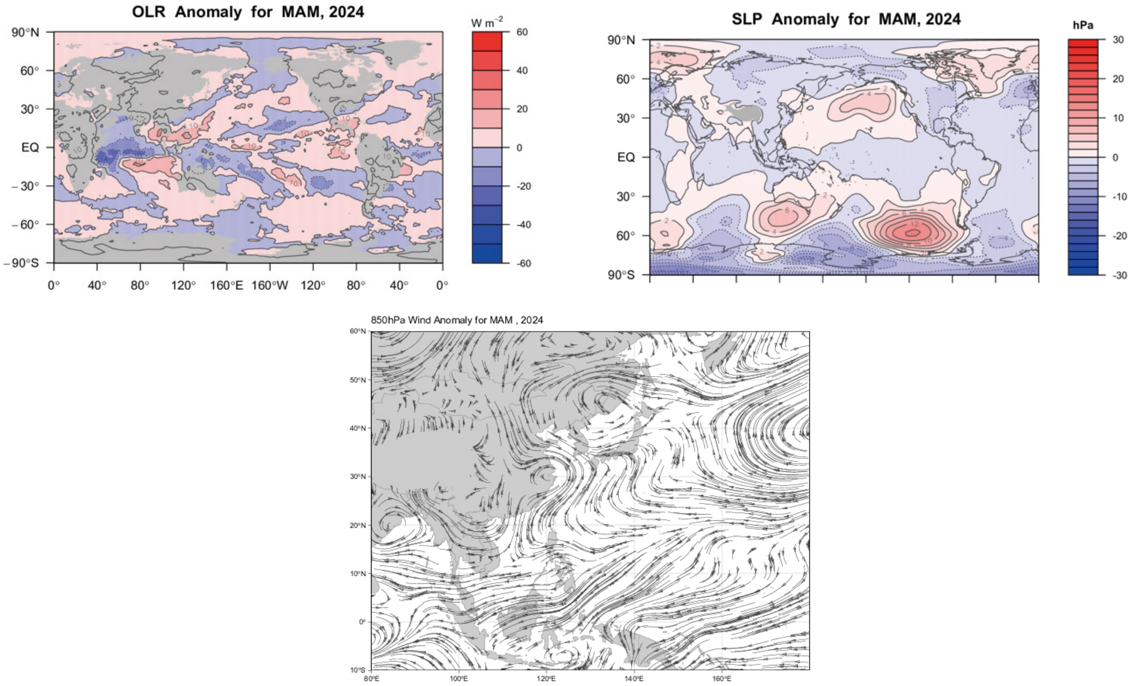
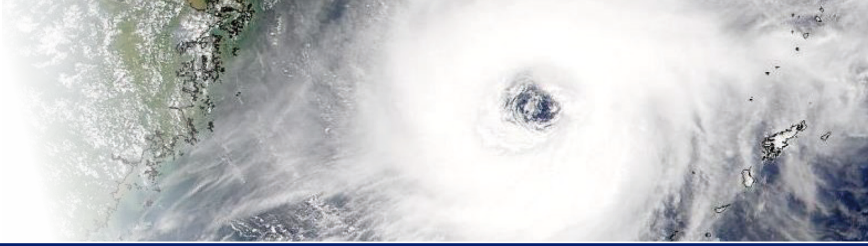


Figure 4. Left top: OLR Anomaly, spring 2023/24
Right top: SLP Anomaly
Bottom: Distribution of anomalous flow field at 850 hPa

In March, major climate centers at home and abroad reached a consensus that the probability of the ENSO status evolving into a La Niña event was high. While a few experts predicted a late onset of La Niña, with the event starting in autumn or winter, most expected an early kick-off this summer (Refer to the first issue of 2024 Seasonal Tropical Cyclone Activity Forecast Report). The latest forecasts on the evolution trend of the ENSO system are generally in line with those made in March: it remains highly likely for the ENSO status to transition into a La Niña event later this year. Yet, some experts have revised their forecasts on the timing of the La Niña event, with many postponing the expected onset. In summary, it is highly possible to witness a La Niña event in the late summer and early autumn this year.

According to the latest forecast results of the dynamic model, the western Pacific subtropical high is stronger during the summer and autumn seasons, consistent with the March projections. The eastward retreat of the anomalous height anomaly over the South China Sea and the east Philippine Sea is expected to be delayed. This



suggests that the tropical cyclone activities may be affected by the anomalous subtropical high in late summer and early autumn, which is the main flood season caused by tropical cyclones. As a result, the number of tropical cyclones forecasted to generate in the northwest Pacific and the South China Sea in 2024 may be lower than the LTCA, based on the anticipated ocean-atmosphere conditions.

We conducted an analysis of four Niño region indices from June 2023 to May 2024, and found that 1958, 1973,1988, 2010 and 2016 were similar years in terms of SST in the early stage. Among them, 2010 replaced 1998 in our March analysis (Refer to the first issue of 2024 Seasonal Tropical Cyclone Activity Forecast Report). Figure 5 shows the changes in the Nino 3.4 region indices over the past few years. Evolution trends of ENSO and tropical cyclone activities are shown in Table 2. It can be seen from Table 2 that 2010 experienced the earliest onset of a La Niña event as an El Niño ends among all similar years. In 2010, only 14 TS (same as 1998) and 5 STY (two more than 1998) were generated, with 7 TS making landfall (1 more than 1998) in China. Overall, the number of TS affecting China, South China and East China were all at normal levels, with four of them impacting Shanghai and nearby areas. From the summer to autumn of 2010, the northwest tropical Pacific and the southeast coast of China were both under the control of anomalous anticyclonic circulations, while the southern China provinces and their coastal waters were affected by anomalous cyclonic circulations during the autumn. The summer anomalous circulations were similar to those observed in 1998, even though the autumn circulations were different from the those experienced along the southeast coast of China in 1998. In short, the summer-autumn circulations in 1973, 1988 and 2010 were similar to the March forecasts of 1973, 1988 and 1998. It also bears resemblance to the circulation evolution predicted by the CFSv2 dynamic model.

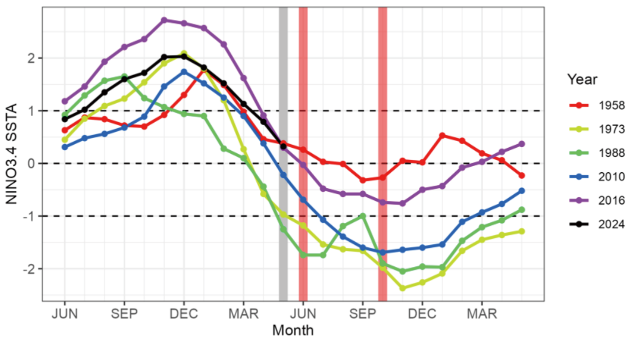
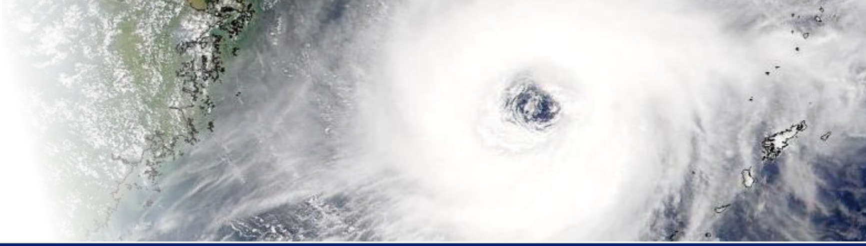


Figure 5. Evolution trends of SST indices in Nino3.4 region in similar years (1958, 1973, 1988, 2010 and 2016).

ENSO evolution	Similar years	EN ends	Subsequent LN	TS formation	STY	TS landing	Impact overall China	Impact South China	Impact East China	Impact Shanghai
Evolves into NE	1958	May	The following Jul	33	17	7	12	11	7	2
Evolves into LN	1973	Mar	May	24	5	9	17	14	10	0
	1988	Feb	Apr	26	7	6	14	11	8	1
	2010	Apr	Jun	14	5	7	13	9	10	4
	2016	May	Aug - Dec	26	12	8	16	12	10	4
			TC activity EV ± SD:	25±4.5	9.5±3.6	7±1.9	13.0±3.6	9.0±3.5	9.5±3.3	2.0±1.5

Table 2. Tropical Cyclone Activity in ENSO Similar Years (EN: El Niño, LN: La Niña NE: Neutral)



3. Objective Methodologies and Regional Model Forecast Results

3.1 Deterministic Forecasting with Statistical Model

The objective methodologies include two methods: the first is the mean generating function based on time series data, and the second is the regression model based on correlative climate-oceanic environment elements. Results of the first method aligns with the March forecasts (Refer to the first issue of 2024 Seasonal Tropical Cyclone Activity Forecast Report). Table 3 shows the results of the regression model applying the spring forecast factors, where TS generation, landfalls and the number of TC affecting China, South China and East China all increase compared to the March forecast. In general, the number of TS are forecasted to stay at a normal level, though less than the LTCA in 2024. Among them, the number of TS expected to make landfalls in China is close to average. However, more TC are expected to impact overall China, South China and East China. Shanghai will expect an average number of TC this year.

	TS formation	TS landfall	TC impacting China (Notes 1-2).			
			China Overall	South China	East China	Shanghai
1991-2020 EV ± SD	25±4.5	7±1.9	13.0±3.6	9.0±3.5	9.5±3.3	2.0±1.5
2024 forecast (mean generating function / Regression model)	25.5/ 24.4 / 23.4	8.0/ 7.1 / 7.6	14.7/ 15.4	8.8/ 11.1	8.7/ 13.1	1.1/ 2.1

Table 3. Annual tropical cyclone forecast results of the statistical models in 2024

3.2 Mixed Dynamic-Statistical Model

Mixed Dynamic-Statistical Model is based on the statistical relationship between observation results of TS activity and key zone variables, SST anomalies during the 2024 spring and summer, vertical wind shear change and lower layer vorticity produced by the NCEP/CFS dynamic model. With the data samples reported by CFSv2 in April, May and June, the model produces frequency and probability forecasts on TS and STY formation shown in Table 4. The numbers of TS and STY are both expected to be lower than the LTCA, though STY formation stays at a normal level. Probability results (Figure 6) suggest a similar conclusion: the probability of fewer TS is higher, while the probability of average STY formation is higher.

2024 forecast \ Reporting month		April	May	June	1991-2020 EV ± SD
TS formation	Whole year	14.0	15.4	17.4	25±4.5
	Jul - Dec	12.0	13.4	15.4	21±4.3
STY formation	Whole year	2.4	8.4	8.7	9.5±3.5
	Jul - Dec	2.4	8.4	8.7	8.3±3.4

Table 4. Forecast results of mixed dynamic-statistical model

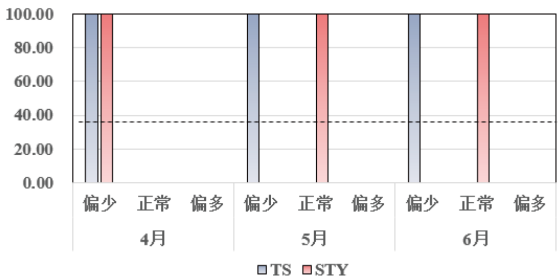
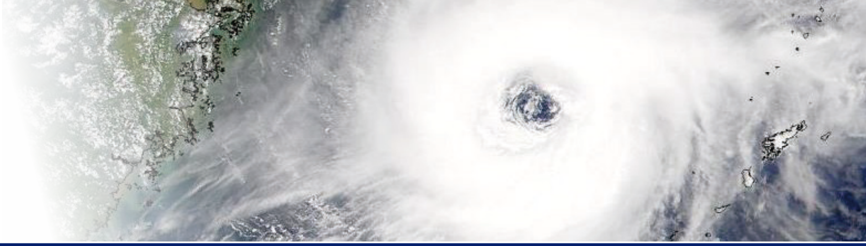


Figure 6. Probability forecast on TS (blue) and STY (red) formation over the NWP and SCS from Jul to Dec 2024 with mixed dynamic-statistical model
The horizontal ordinate represents the reporting month; the dotted line represents the probability value of 33.3%.



3.3 Forecast Results of Regional Model (iRAM2)

Regional model iRAM2 makes forecasts with five output data points (marked E1 to E5) from CFSv2 as the drive (00:00 on Jun 1, 3, 5, 7, and 9, 2024). The forecast begins at 00:00 on Jun 14, 2024, and the results of each data point and the mean are shown in Table 5: 19.6 TS are expected to form from July to December, which is slightly lower than the LTCA (21).

Data point	E1	E2	E3	E4	E5	Mean	LTCA
TS formation	11	22	20	23	22	19.6	21

Table 5. Forecast results of TS formation (Jul to Dec) with the regional model (iRAM2)

4. Tropical Cyclone Induced Natural Disaster and Risk Assessment

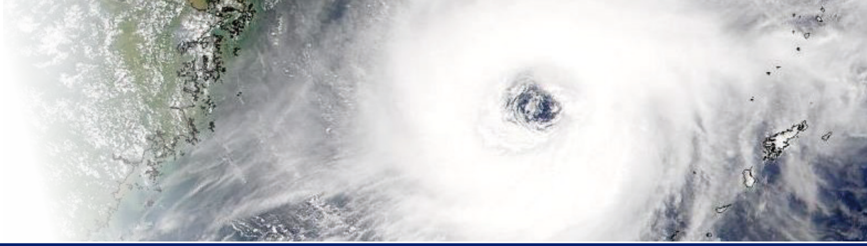
As mentioned above, the years 1958, 1973, 1988, 2010 and 2016 are similar in terms of ENSO's impact on tropical cyclone activities. The summer and autumn of 1958, 1973, 1988 and 2010 were especially similar, while the prevailing circulation in 2016 was the opposite of these four years.

The TC potential risk index indicates relative disaster-induced risks. As shown in Figure 7, the annual average of the TC potential risk index from 1958 to 2018 reflects that the disaster-induced risk in 1958, 1973, 1988 and 2010 is lower than average, in contrast to the higher-than-average risk in 2016. Typical adverse weather conditions in these similar years include heavy precipitation and strong winds. Statistics show that there were 21 disaster-causing typhoons in the aforementioned five similar years. Notably, 10 of them made landfalls on the coast of South China, with 9 in Fujian and 1 in northern Zhejiang.

Among the four similar years with lower disaster-induced risks, an average of two typhoons caused relatively severe disasters each year. For example, in 1958, Typhoon Winnie (No. 5810) flooded 82,700 hectares of crops in Fujian Province, killed 56 people, and caused over-one-meter flood in Tong'an County. The strong, fast-moving and destructive Typhoon Marge (No. 7314) destroyed 80% of the buildings in Qionghai County, killed 903 people on Hainan Island, and led to direct economic loss of about RMB 1 billion. After sweeping through Zhejiang and Anhui provinces, Typhoon Bill (No. 8807) reached Hubei, where it killed 162 people, demolished 53,900 houses, and caused serious damage to 80% of the power transmission cables in Hangzhou. Typhoon Megi, the strongest typhoon formed in 2010, caused significant damage to Guangdong and Fujian provinces, with direct economic loss amounting to RMB 2,808.24 million.

In 2016, a similar year with a higher disaster-induced risk, a total of 10 tropical cyclones triggered various disasters. The death toll reached 174, with 20,235,000 hectares of crops affected, 145.1 thousand hectares of crops destroyed, 37,000 houses collapsed, and 49,000 houses seriously damaged. The direct economic loss was as high as RMB 76.64 billion. Among the typhoons that year, Nepartak (No. 1601) and Meranti (No. 1614) were particularly destructive.

Based on similar historical precedents, we expect the overall risks of typhoon-induced natural disasters to be lower than average in 2024, with Southeast China and most of South China being the most vulnerable areas.



However, it will still be necessary to closely monitor for potential extreme scenarios, such as extreme winds and storm surges along the coast, floods and secondary disasters caused by extreme rainstorms and localized sudden heavy rainfall.

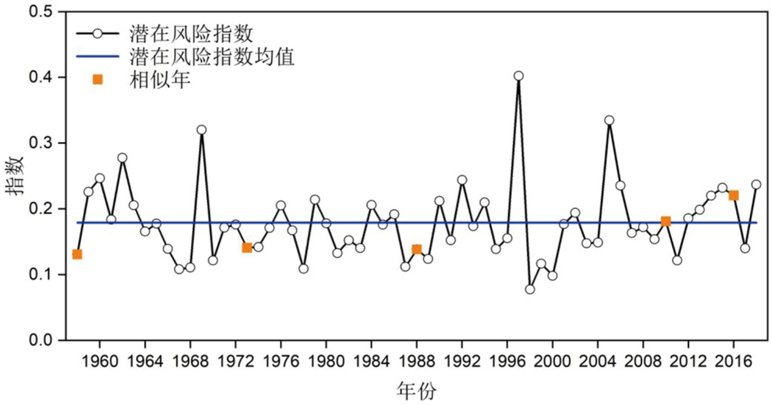


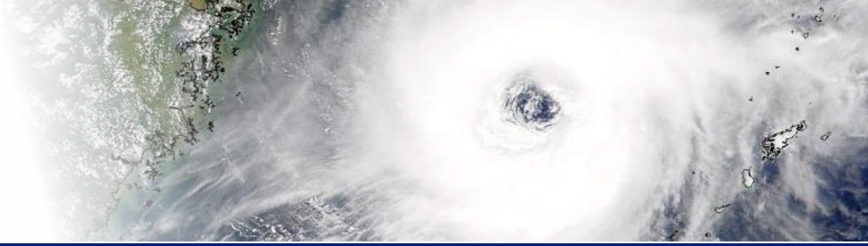
Figure 7. TC Potential Risk Index affecting China from 1960 to 2018

5. Summary

In conclusion, the 2023/24 El Niño event has ended in May and has a high possibility of evolving into a La Niña event in autumn and winter. The forecast results of the dynamic model shows that the western Pacific subtropical high is likely to be strong this summer, which is not favorable for tropical cyclone activities. The anomalous anticyclonic circulation is expected to retreat eastward in late summer and early autumn, leaving room for tropical cyclone activities during the typhoon flood season and the subsequent period. This is similar to the results derived from the Nino index. Based on the subjective analysis and the results from objective methodologies and regional model iRAM2, we expect that less TS and STY to form over the NWP and the SCS, and the number of TS to make landfalls in China to be in line with the LTCA. More TC are expected to impact overall China and South China, while the number of TC to impact East China and Shanghai is expected to be in line with the LTCA. We expect the overall risks of typhoon-induced natural disasters to be lower than average in 2024, with Southeast China and most of South China being the most vulnerable areas. However, it will still be necessary to closely monitor for potential extreme scenarios, such as extreme winds and storm surges along the coast, floods and secondary disasters caused by extreme rainstorms and localized sudden heavy rainfall.

Notes:

1. A TC with major impact should satisfy at least one of the three following conditions: (1)aggregate precipitation in the given area is over 50 mm; or (2)average wind level ≥ 7 (or a gust ≥ 8) in the given area; or (3)aggregate precipitation is over 30 mm and an average wind scale ≥ 6 (or a gust ≥ 7) in the given area.
2. South China includes Guangdong, Guangxi and Hainan provinces; East China includes Fujian, Jiangxi, Zhejiang, Anhui, Jiangsu and Shandong provinces and Shanghai.



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1. S&P Global Ratings Top 40 Global Reinsurers And Reinsurers By Country: 2022, S&P Global, 2022

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Shanghai Typhoon Institute (STI) is a state-level institution founded with the approval of the Ministry of Science and Technology, the Ministry of Finance and the State Commission Office for Public Sector Reform. Its mission is to undertake basic and applied research related to tropical cyclones. As one of the research units providing the best route predication for tropical cyclones in East Asia, STI has developed and maintained a database of meteorological information specific to cyclone activities in China. Since 2015, Peak Re has partnered with the Shanghai Typhoon Institute (STI) on research projects related to North-West Pacific basin and South China Sea tropical cyclones.

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