

# 2023 WESTERN NORTH PACIFIC TROPICAL CYCLONE PREDICTION

## Executive Summary

- The La Niña conditions that have existed since 2020 have now ended, and 2023 is a transition to an El Niño year.
- Based on the regional climate model prediction, and past observations, we expect the number of tropical cyclone **formations** in the Western North Pacific will likely be **above-normal**.
- However, the number of **landfalls** across East Asia will likely be **below-normal**, except for the Philippines, where the number of tropical cyclone **landfalls** is predicted to be **near-normal**.
- A review of our 2022 forecast shows a good match with what occurred during the typhoon season.

**Table 1:** Forecast number of landfalling tropical cyclones in 2023, in a transition to an El Niño year.

Country	Regulator	Guidelines
Japan and Korea	4.8	1-3 (Below-Normal) *
Eastern Mainland China and Taiwan	3.6	1-3 (Below-Normal)
Southern Mainland China and Vietnam	5.1	2-4 (Below-Normal)
Philippines	2.7	2-4 (Near-Normal)

\* The Japan and Korea region showed a systematic low bias in the past few years compared to the Japan Meteorological Agency (JMA) observations.

Source: Guy Carpenter

## The Guy Carpenter Climate Centre Forecast

For more than 10 years, Guy Carpenter has worked closely with our academic partners in Hong Kong and China via the Guy Carpenter GCAT Climate Centre to provide insights regarding climate-related science for our clients, and to help create innovative solutions in the increasingly complex risk landscape in Asia.

As part of our ongoing commitment, we produce an annual tropical cyclone seasonal forecast that takes into account current El Niño/La Niña conditions (known as the El Niño Southern Oscillation, or ENSO), and provides insight into tropical cyclone frequency and landfall rates for the Western North Pacific basin.

### Our Forecast Model

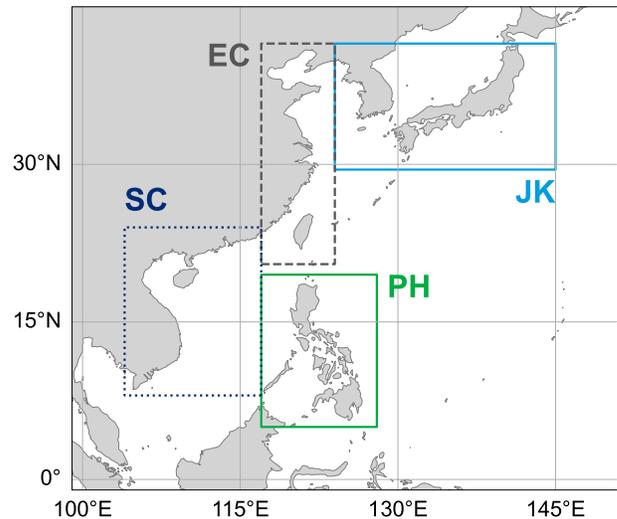
*Our forecast approach is based on a 2014 study by Judy W.R. Huang of National Taiwan Normal University and Johnny C.L. Chan of the City University of Hong Kong. The study showed that using a regional climate model on top of a global climate model can more accurately predict tropical cyclone activity than the global model alone. Here, the regional climate model is the Regional Climate Model version 3 (RegCM3) from the International Centre for Theoretical Physics, and the global climate model is the Climate Forecast System version 2 (CFSv2) from the US National Centers for Environmental Prediction (NCEP).*

*RegCM3 uses the forecasts produced by CFSv2 as initial and boundary conditions for dynamical downscaling to predict tropical cyclone activity with a lead time of 1 to 6 months. The regional model is run for 8 times, each using slightly different initial conditions dated on April 1 to April 2 of the year, so that the predicted numbers are the averages of the 8 runs.*

Tropical cyclone landfall predictions are made for the 4 regions listed below and shown in Figure 1:

- JK: Japan and the Korean peninsula
- EC: Eastern mainland China and Taiwan
- SC: Southern mainland China and Vietnam
- PH: Philippines.

**Figure 1:** The 4 regions in which the number of tropical cyclone landfalls is predicted.



Source: naturalearthdata.com

### How Did We Do in 2022?

The La Niña conditions that have occurred since 2020 have resulted in 3 consecutive years of below-normal tropical cyclone activity in the Western North Pacific, while bringing heavy rains to Australia. As a result, Asian typhoons have not contributed significantly to major global losses (Table 2).

**Table 2:** Global insured natural catastrophe losses during the recent La Niña phase versus typhoon losses in the forecast areas. Values in USD billions.

Year	Global Total Catastrophe Losses	Global Tropical Cyclone Losses	Typhoon Losses
2020	132.3	23.2	0.9
2021	108.1	31.8	0.8
2022	118.0	54.8	2.9

Source: Guy Carpenter

Our 2022 annual forecast prediction matched well with actual tropical cyclone activity, compared with total numbers and number of landfalls. Significant typhoons that made landfall in the basin last year included

Nanmadol (Japan), Hinnamnor (Korea), Noru (Philippines and Vietnam) and Muifa (China). Detailed comparisons of RegCM3 prediction and JMA’s tropical cyclone analysis are shown in Table 3.

**Table 3:** Observed and predicted tropical cyclone landfalls from May to October in 2022.

Landfall Regions	2022 Observed (JMA)	2022 Prediction (RegCM3)
Japan & Korea	6	3.8
Eastern Mainland China & Taiwan	1	3.6
Southern Mainland China & Vietnam	5	6.4
Philippines	4	4.3
<b>Total Landfalls *</b>	<b>14</b>	<b>14.1</b>

*\* Tropical cyclones may pass through multiple regions. As a result, a single event can be counted several times as it makes landfall in different territories. When compiling the total numbers, each cyclone is counted as a single event only.*

Source: Guy Carpenter

## 2023 Forecast

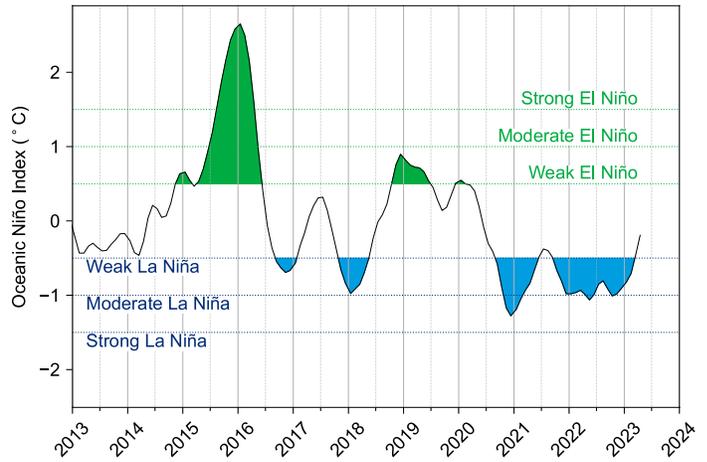
2023 is a transition to an El Niño year, shifting from a previous La Niña winter to a predicted El Niño winter.

El Niño and La Niña are the 2 opposite phases of El Niño–Southern Oscillation (ENSO). ENSO is an irregular periodic variation in winds and sea surface temperatures over the tropical Pacific, and it is a major driver of seasonal changes in the global atmospheric and oceanic circulations.

The long-lasting La Niña event active since 2020 ended in March 2023 (Figure 2). The US National Oceanic and Atmospheric Administration has declared that El Niño conditions are present, while the Australian Bureau of Meteorology is predicting a 70% chance of El Niño this year.

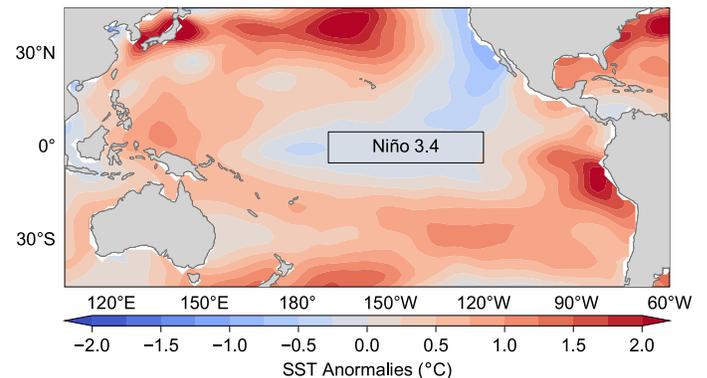
The warming near coastal South America (Figure 3) signifies that El Niño is expected to form and strengthen in the next few months. Most climate models predict monthly sea surface temperature (SST) in the central tropical Pacific are very likely to meet or exceed the El Niño thresholds (+0.5°C) in July and continue through the Northern Hemisphere winter of 2023-24.

**Figure 2:** Oceanic Niño Index (ONI) from 2013.



Source: NOAA Climate Prediction Center/Graphic: Guy Carpenter

**Figure 3:** 3-month average sea surface temperature anomalies (February to April 2023). The Niño 3.4 region (black box) is commonly used to assess ENSO phases.



Source: NOAA Climate Prediction Center/Graphic: Guy Carpenter

As we have seen in the past 3 years, there is typically less tropical cyclone activity in La Niña years. They are more likely to form closer to the coast of East Asia and move toward the regions of South China and the Philippines. In contrast, during typical El Niño years there are more tropical cyclones, and they are more active in the seas east of Guam, recurving toward the seas near Japan. For this upcoming transition year, we may see tropical cyclone activity shifting toward El Niño patterns.

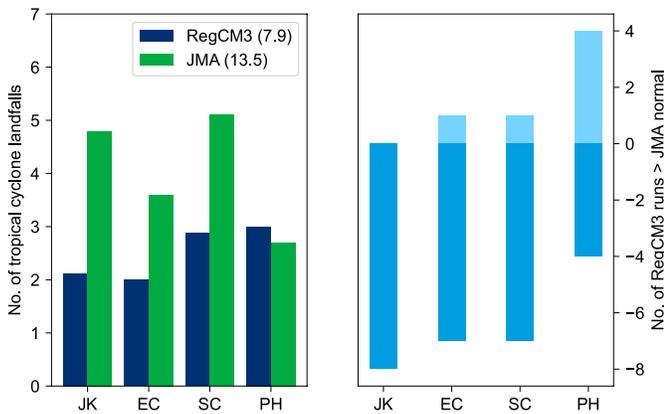
Our model predicts the number of tropical cyclones in the 2023 season is 25.4, which is above-normal (20.5). However, less than one-third of them (7.9) are predicted to make

landfall in East Asia. Tropical cyclone landfalls in the JK, EC and SC regions are all predicted to be below-normal, supported by the vast majority of the 8 model runs. The PH region, on the other hand, is predicted to be near-normal.

The full model prediction is shown in Figure 4.

**Figure 4:**

**Left**—The number of tropical cyclone landfalls in each region from the JMA normal (green) and RegCM3 2023 prediction (blue).  
**Right**—The number of RegCM3 runs in which the number of landfalls is above (light blue) or below (blue) JMA normal.



**Notes:** Bracketed numbers are the total landfalls, where a tropical cyclone passing through multiple regions is counted as a single event.

Source: Guy Carpenter / JMA

## Historical Tropical Cyclone Activity During ENSO Transition to El Niño Years

Tropical cyclone data from JMA, the Regional Specialized Meteorological Centre delegated by the World Meteorological Organization, is used to analyze past tropical cyclone activity during transition years.

Oceanic Niño Index (ONI) is a principle measure for ENSO. ONI is defined as the 3-month running average SST anomalies in the central and eastern tropical Pacific (the Niño 3.4 region in Figure 3), and is calculated with respect to the “Normal” conditions, which are defined as the long-term average of the most recent 30-year period finishing in a year ending with zero (conditions in 2023 will be compared to the period 1991-2020).

If ONI is  $-0.5^{\circ}\text{C}$  or less, then it is in a La Niña phase, while values of  $+0.5^{\circ}\text{C}$  or higher signify an El Niño phase. ONI values between  $-0.5$  and  $+0.5^{\circ}\text{C}$  are considered neutral.

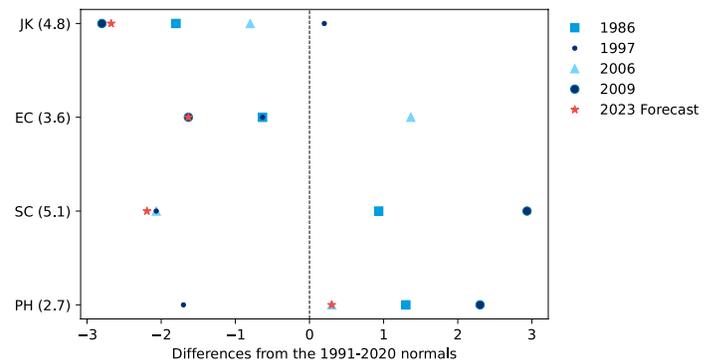
To compare the current conditions with historic seasons, we identified other transition years of 1986, 1997, 2006 and 2009 where ONI was in the La Niña phase in February, became neutral in May and switched to the El Niño phase by November.

In these 4 transitions to El Niño years, the numbers of tropical cyclones varied between -2 and +3 from the normal. On the other hand, the numbers of tropical cyclone landfalls were often below-normal.

Across the regions of East Asia, the PH region often experienced above-normal tropical cyclone landfalls, while in the EC and JK regions below-normal activity is more common. For the SC region, no distinctive pattern can be identified.

While the past observations can be seen as a reference of what to expect for 2023, these characteristics are not guaranteed because each ENSO event is unique, and our model prediction also has some deviations from these 4 years. Nevertheless, it is fair to expect a below-normal activity for this year in general.

**Figure 5:** Differences in tropical cyclone activity between the 1991-2020 JMA normal and transition to El Niño years. Numbers in parentheses brackets are the JMA normals.



Source: Guy Carpenter / JMA



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