# Taiwan's Climate in 2024

**Central Weather Administration, Taiwan**

In 2024, the global mean temperature surpassed the 1901-2000 average by 1.29°C, marking as it the warmest year on record since 1880. Taiwan experienced a similar trend, with the annual mean temperature reaching 24.97°C, which is 1.65°C above the average, making 2024 the warmest year on record (FIG. 1). Over the past three decades, Taiwan's temperature has exhibited a consistent upward trend, increasing at an average rate of 0.32°C per decade, which exceeds the global rate of 0.23°C per decade. Additionally, all meteorological stations across the country reported annual mean temperatures that ranked among the top 10 highest in their respective records (FIG. 2).

Taiwan's annual precipitation for 2024 reached 2,135.9 mm, approximately 98.8% of the climatological median for the period from 1991 to 2020. Precipitation levels in northern and southwestern Taiwan were above-normal (FIG. 2), while other regions experienced below-normal precipitation. This increase is primarily attributed to the Southwest Monsoon and typhoons during the summer and autumn (FIG. 3). Due to the concentration of rainfall over a few months, the annual number of rainy days at most weather stations was lower than the climatic average, with only a few stations in the south-central region recording more rainy days (FIG. 2).

## Global and Taiwan's Annual Mean Temperatures 1880-2024

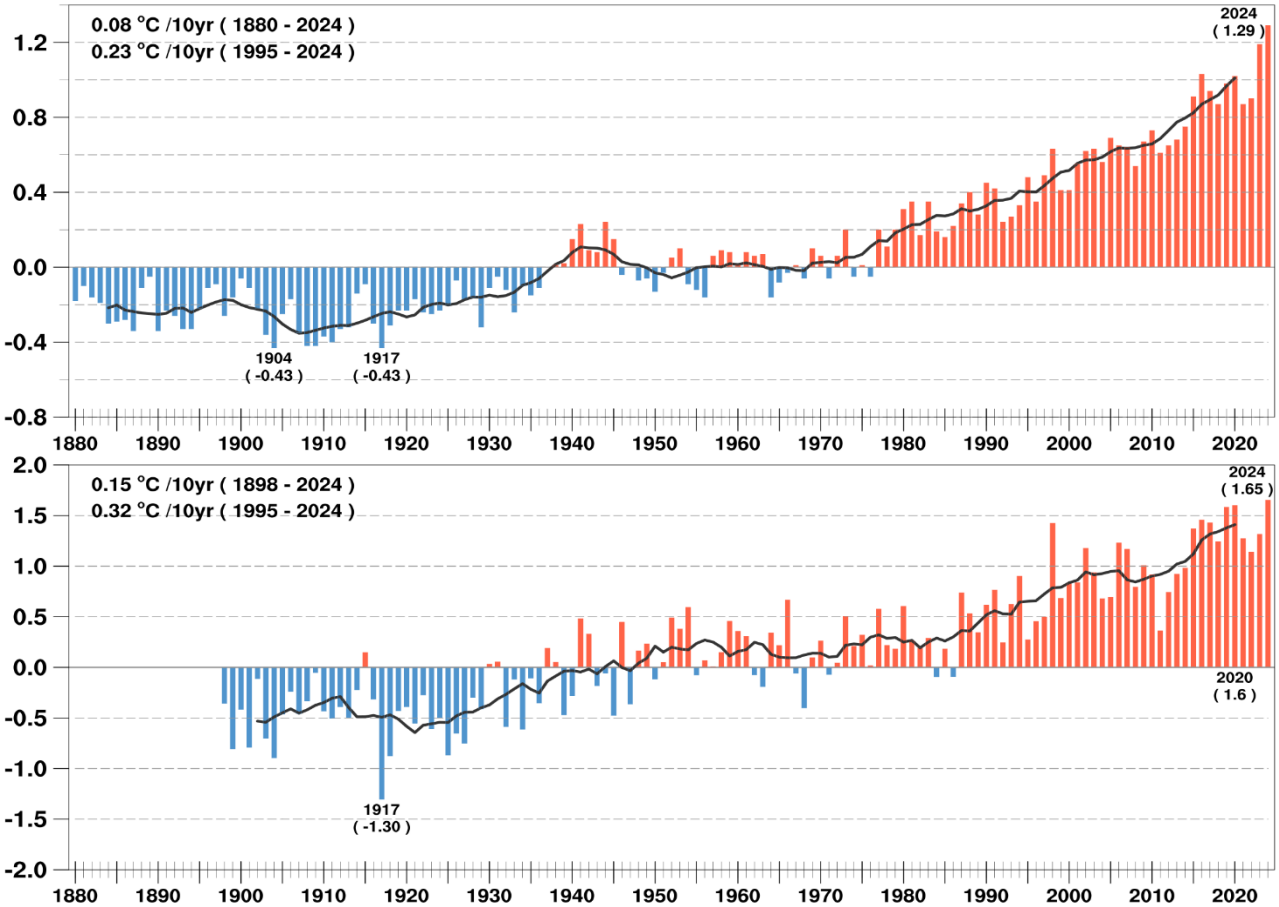


FIG. 1. Global (upper) and Taiwan (lower) long-term annual mean temperature anomalies time series (compared to 1901-2000 average). The solid line shows the 9-year running mean. Taiwan's annual mean temperature is calculated from the average of 6 centennial stations (Taipei, Taichung, Tainan, Hengchun, Hualien, and Taitung).

## Annual Mean Temperature and Total Precipitation of Taiwan in 2024

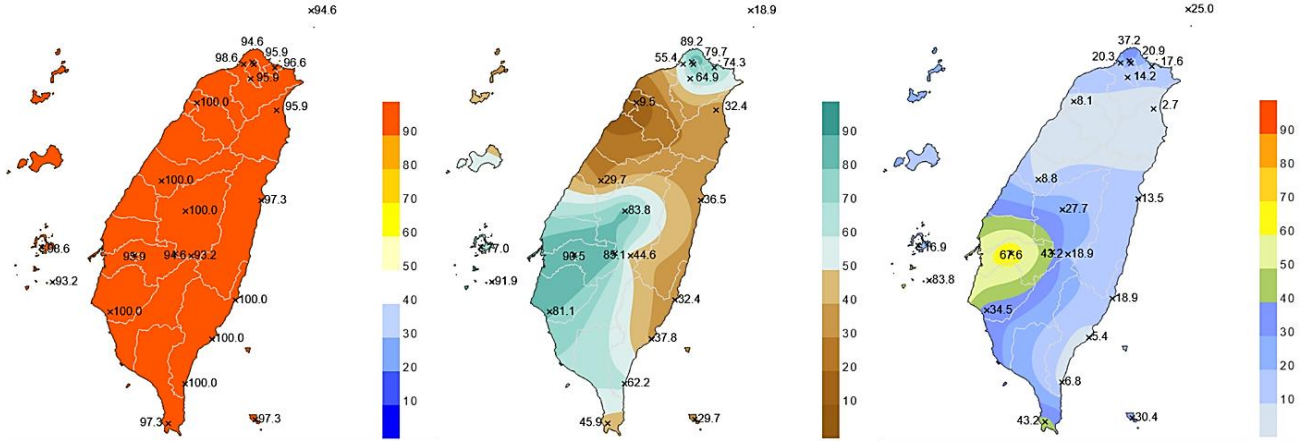

FIG. 2. Left to right: annual mean temperature percentile, precipitation percentile, and rainy days percentile in Taiwan since 1951.

## Monthly Mean Temperature and Precipitation of Taiwan in 2024

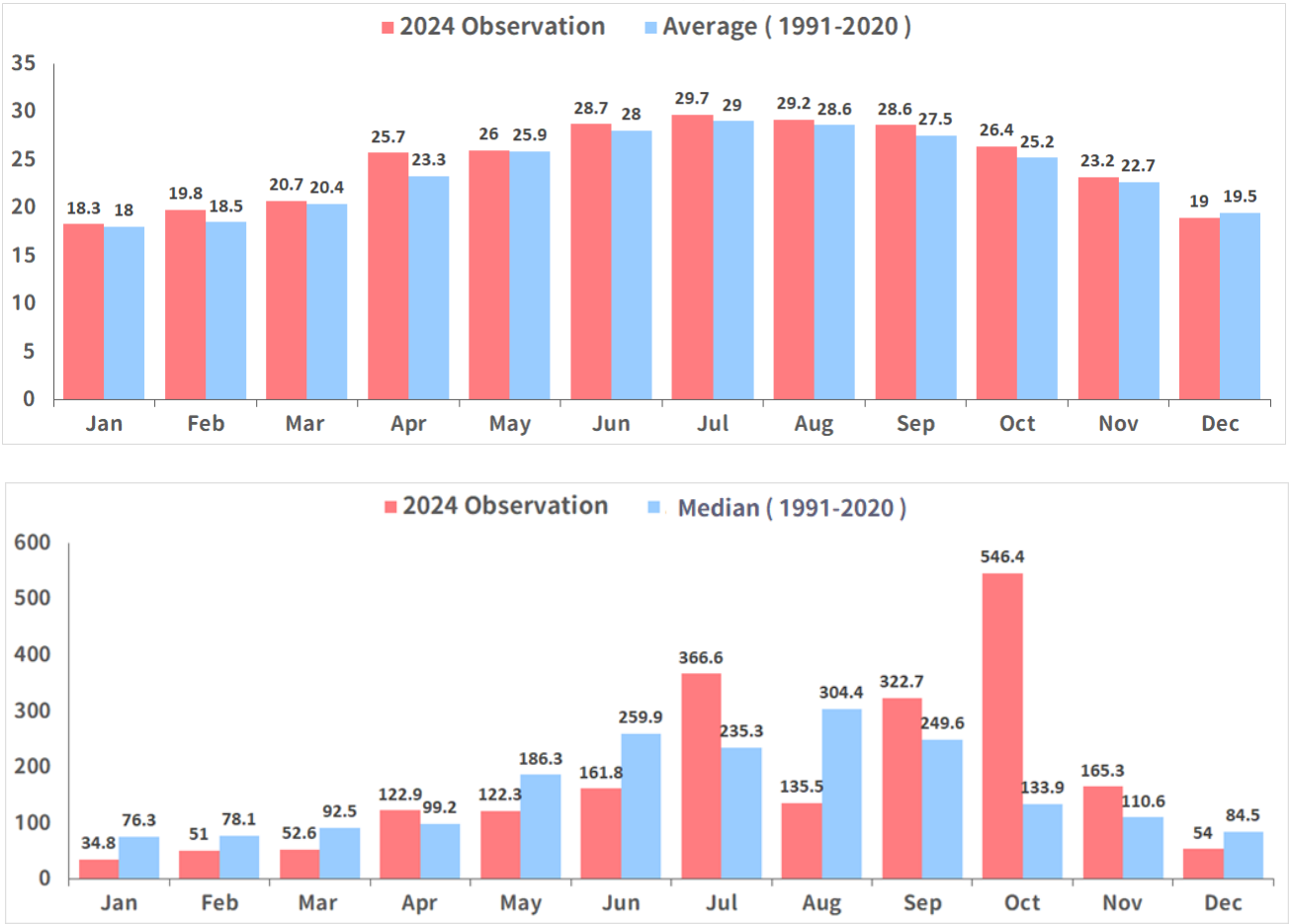


FIG. 3. Monthly mean temperature (upper) and total precipitation (lower) of 2024.

# Significant Climate Anomalies and Events in 2024

## Record High Annual Mean Temperature

The hottest year, 0.7°C above Taiwan's climatological normal. Annual rainfall was near normal but unevenly distributed.

## 3 Typhoons Made Landfall This Year

3 typhoons (GAEMI, KRATHON, and KONG-REY) made a landfall in Taiwan, which was close to the climatological normal.

## 2nd Warmest Spring (Feb.-Apr.)

The 2nd warmest spring, and even April broke its respective highest temperature on record.

## Below Normal Rainfall in Meiyu Season (May-Jun.)

The 3rd lowest rainfall on record for this season.

## High Temperature in Summer (Jul.-Aug.)

## Typhoon GAMEI Landfall

Dominated by the Pacific subtropical high, resulting in hot weather.

Typhoon GAMEI made landfall in late July, bringing heavy rain to eastern, central and southern Taiwan, while other times saw strong afternoons convection.

## 2nd Warmest Autumn (Sep.-Nov.)

## Above Normal Rainfall Due to Consecutive Typhoon Impacts

## More Tropical Cyclogenesis in Western North Pacific in Autumn

The 2nd warmest autumn on record. For all of the 22 stations of Taiwan saw their respective top 10 highest temperature.

In early and late October, typhoon KRATHON and KONG-REY made landfall and caused heavy rainfall in Taiwan in succession.

15 tropical cyclones formed in the Western North Pacific during autumn 2024, marking the 3rd highest number since 1958.

# Tropical Cyclones

In 2024, a total of 26 tropical cyclones (TCs) formed over the Western North Pacific, close to the long-term annual average (1991-2020) of 25.4. Warnings were issued for 4 typhoons, and 3 of them (GAEMI, KRATHON, and KONG-REY) caused significant damage to Taiwan. In addition, the number of TCs formed in Autumn (September to November) was obviously above normal (FIG. 4). The total number of TCs approaching Taiwan in 2024 was also close to the normal value (3.2) (FIG. 5).

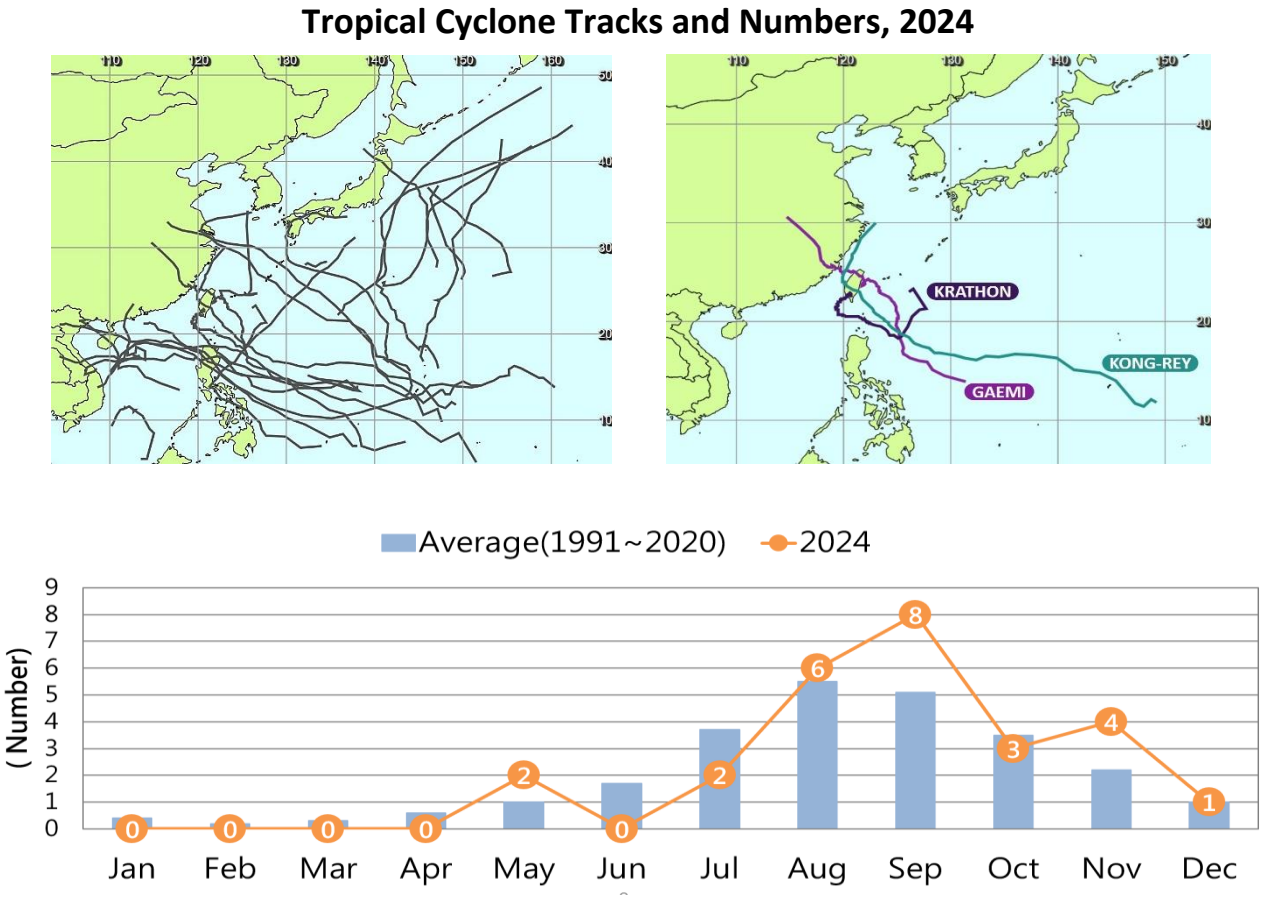


FIG. 4. 26 named TCs tracks over the Western North Pacific in 2024 (top left) and 3 for which approached Taiwan (top right). Monthly number of named TC formation for 2024 and monthly average calculated over 1991-2020 (bottom).

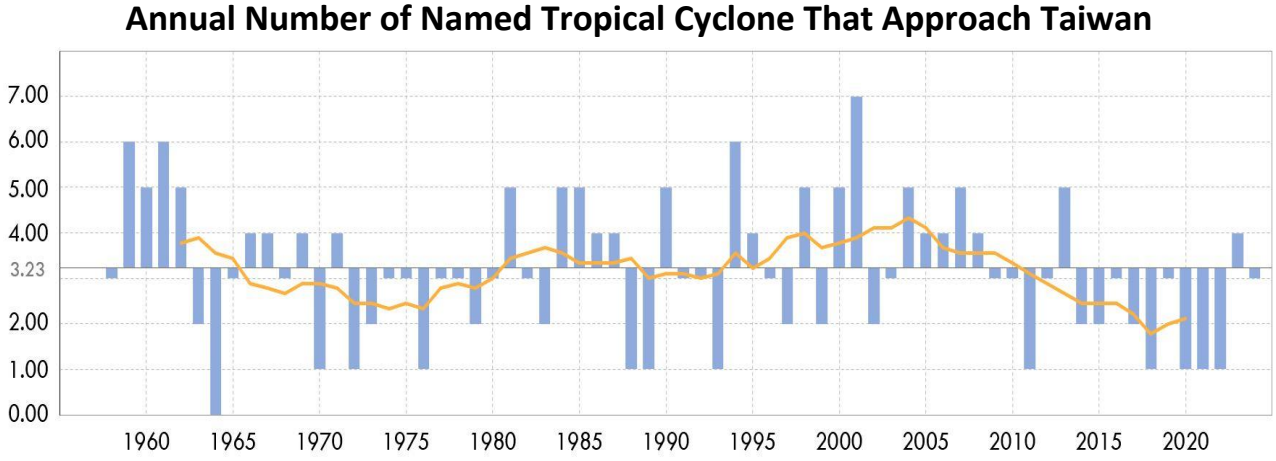


FIG. 5. Annual number of named TCs that approach Taiwan (bar chart) and its 9-year running mean (line graph) since 1958 compared to 1991 -2020 average (3.2).

# Exploring the Factors Behind the Surge of Typhoons in Autumn 2024

The total number of typhoons generated in the Western North Pacific in 2024 was 26, which is similar to the climatological average of 25.4, but these typhoons were mostly concentrated after August, with a particularly high number occurring in autumn. Notably, two typhoons made landfall in Taiwan in October and November, marking the first occurrence of such an event in recorded history. Looking back over the past decade, there has been a slight upward trend in the number of typhoons generated in the Western North Pacific during autumn, though the number of typhoons making landfall in Taiwan has been relatively low. However, this autumn's typhoon activity was abnormally intense, with many typhoons taking paths toward the west or northwest, leading to a higher frequency of landfalls in Taiwan.

According to climatology, it is common for 3 to 4 typhoons to make landfall in Taiwan each year. However, over the past decade, the number of typhoons making landfall in Taiwan has not exceeded 2 annually, with a record of no typhoons making landfall for three consecutive years between 2020 and 2022. Compared to the long-term average, there has been a noticeable decline in the number of typhoons making landfall in recent years. However, this year saw three typhoons make landfall in Taiwan, the highest number since 2008.

From June 2023 to August 2024, the global monthly average temperature almost set a new historical record every month (FIG. 6). In addition to higher land temperatures, sea surface temperatures in the Atlantic Ocean, Indian Ocean, and North Pacific remained unusually high. Similarly, sea surface temperatures in the Western Pacific also showed a distinct warming trend, which has persisted for several months. So, why did typhoon genesis increase only after August? The possible reasons are outlined below:

1. After August, sea surface temperatures and atmospheric conditions indicated the development of a La Niña event, with the range of warm sea temperatures expanding in the Western Pacific. During the development of La Niña, sea temperatures in the equatorial Western Pacific are warmer, while those in the Eastern Pacific are cooler. This autumn, the area of warm sea surface temperatures in the equatorial Western Pacific expanded further, extending from 150°E to the International Date Line. The northwestern edge of this unusually warm sea surface temperature zone created an environment favorable to typhoon genesis, which aligns with the typical typhoon genesis locations this autumn. At the same time, because the typhoon formation area shifted eastward to between 140°E and 150°E, farther from Taiwan, typhoons had more time to intensify as they traveled, resulting in stronger and more destructive storms.

2. In addition to the expansion of warm sea surface temperatures in the equatorial Western Pacific, tropical wave activity this autumn was notably more active than usual. When these tropical waves moved into the Western North Pacific, they created more favorable conditions for typhoon genesis. Furthermore, the subtropical high this autumn was positioned farther north and expanded westward, causing typhoons to follow the guiding air currents of the subtropical high, moving westward or northwestward, thus increasing the potential threat to Taiwan and surrounding areas.

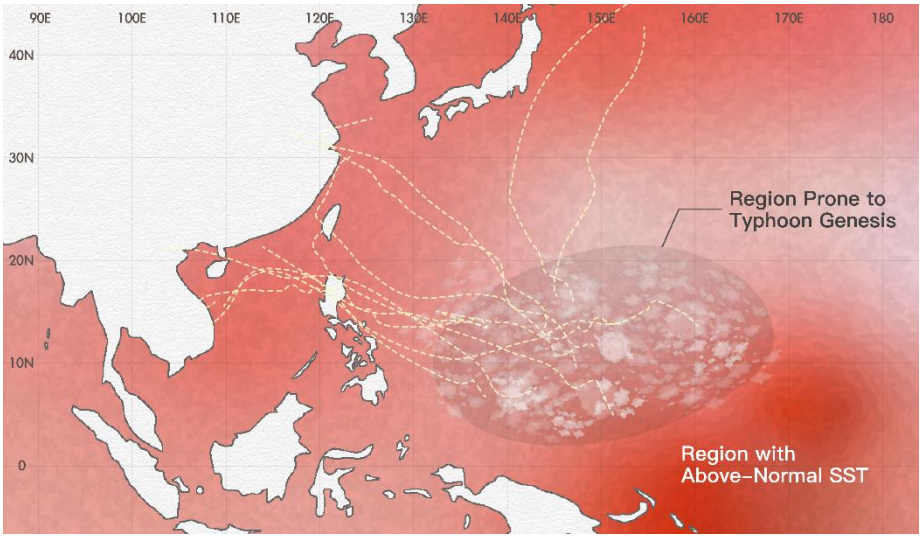


FIG. 6. Schematic diagram of typhoon genesis locations and tracks in the Western North Pacific in autumn 2024

According to future projections, sea surface temperatures in the Western Pacific are expected to rise. While warm sea water helps with the formation and intensification of typhoons, the factors influencing typhoon genesis are still affected by other atmospheric and oceanic conditions. However, the unusual expansion of warmer sea temperatures in the Western Pacific this autumn may indicate potential changes in La Niña development under global warming. Additionally, the increased activity of tropical waves, which may be a characteristic influenced by warming, still requires further research and scientific validation.