



Taiwan's Climate in 2021

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In 2021, the global mean temperature was 0.84°C above average, the sixth warmest on record since 1880. The situation was similar in Taiwan, where the annual mean temperature was 24.25°C (1.22°C above average), making 2021 the seventh warmest year on record (FIG. 1). For the last 30 years, Taiwan's temperature has been increasing at a rate of 0.30°C per decade, higher than the global rate of 0.21°C per decade, and the mean temperature of 2021 was above the climatological normal (1991-2020) for Taiwan as a whole (FIG. 2). The annual total precipitation was 1997.4mm, 165.2mm less than the 1991-2020 average, about 92% of the climate mean. Precipitation was below normal in most parts of Taiwan (FIG. 2) except in the southwest, which saw above-normal precipitation that mainly came from the Meiyu in June and typhoons in August (FIG. 3). Under the extended influence of severe to extreme drought conditions between June 2020 and May 2021, more than two-thirds of the meteorological weather stations around the country reported annual rainy days that ranked among the lowest 10 on their respective record (FIG. 2).

Global and Taiwan's Annual Mean Temperatures 1880-2021

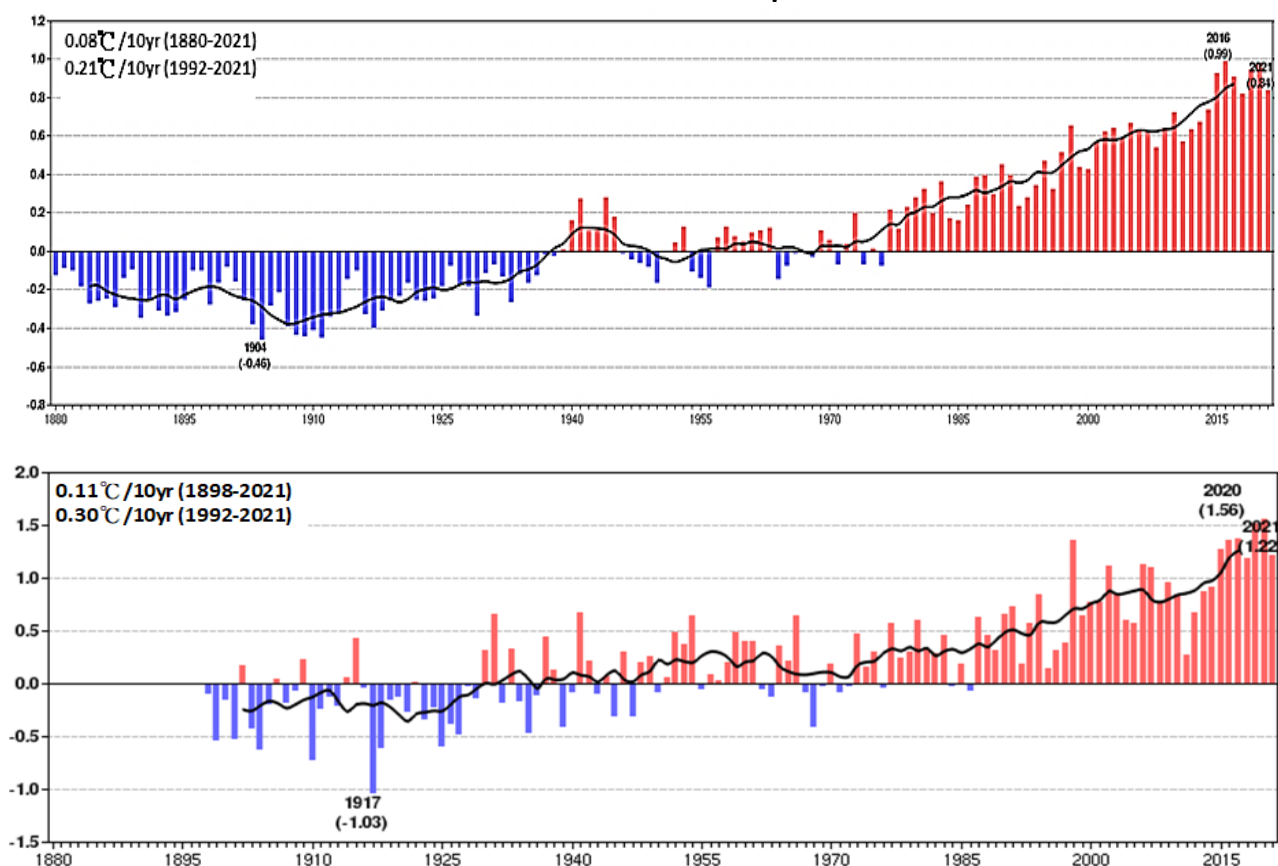


FIG. 1 Global (upper) and Taiwan (lower) long-term annual mean temperature anomalies time series (compared to 1901-2000 average). The solid line shows the 9-year running mean.

Annual Mean Temperature and Total Precipitation of Taiwan in 2021

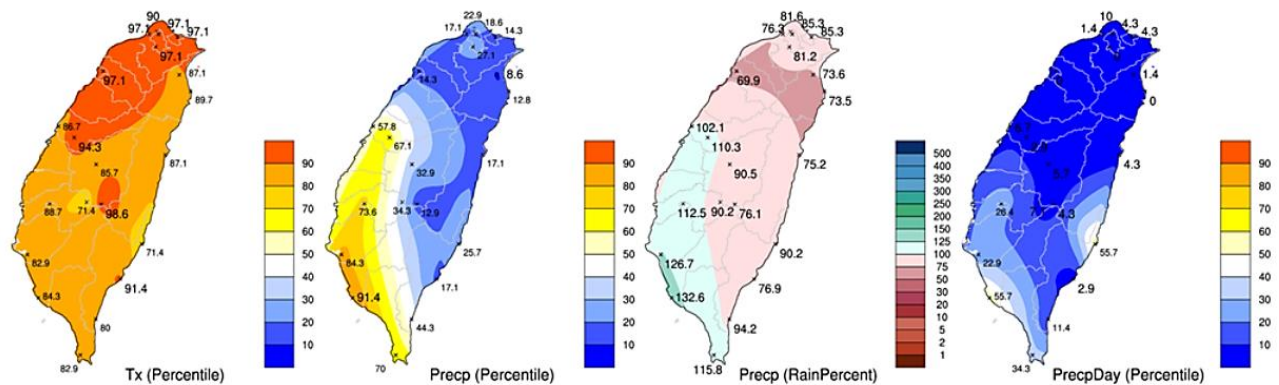


FIG. 2 Left to right: annual mean temperature percentile, precipitation percentile, rain percent and rainy days percentile in Taiwan since 1951

Monthly Mean Temperature and Precipitation of Taiwan

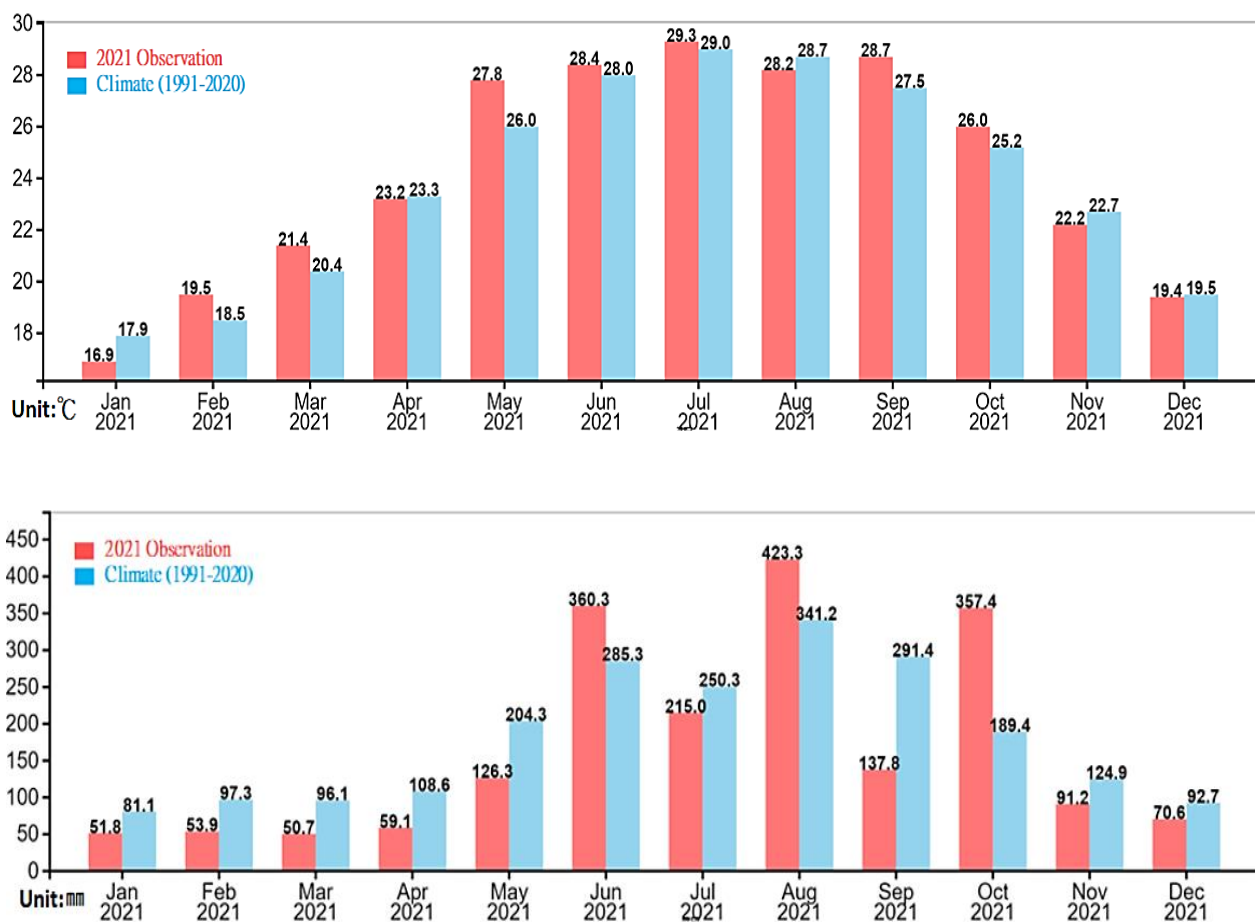


FIG. 3 Monthly mean temperature (upper) and total precipitation (lower) of 2021

Selected Significant Climate Anomalies and Events in 2021



Below normal rainfall and temperature in January



In January, temperature was below normal under the influence of two cold surges and two strong continental cold air masses.

Most weather stations recorded near normal or below normal rainfall.



Heavy rain in summer (Jul.-Aug.)

Typhoon INFA's outer circulation brought heavy rain to northern Taiwan on July 21-24.

Typhoon LUPIT and its cloud system caused extremely torrential rain in southern Taiwan on August 5-7.



High temperature and little rain in spring (Feb.-Apr.)

The temperature at Yushan station in spring was the highest on record for the season.

Spring rainfall was below normal and the mean rainfall of 13 ground-level stations was the fifth lowest on record.



Fewer typhoons

22 typhoons generated over the West Northern Pacific, less than the average of 25.4.

Only CHANTHU made landfall over Taiwan in September. The number of typhoons that make landfall has been less than average in the last 8 years.



Extremely high temperature in the Meiyu season (May-Jun.)

Mean temperature of 13 ground-level stations was the second highest on record, with 5 stations reaching their respective highest.

Meiyu (plum rain) season started in late May and ended at the end of June, bringing relief from the meteorological drought since 2020.



Early arrival of autumn cold air (Sep.-Nov.)

On November 11, continental cold air mass arrived (minimum temperature $\leq 14^{\circ}\text{C}$ at Taipei station), which was the earliest since 1982.



High annual mean temperature

Annual mean temperature was the seventh warmest on record.

Typhoons

In 2021, a total of 22 named typhoons generated over the western North Pacific, less than the long-term annual average (1991-2020) of 25.43. While warnings were issued for 5 typhoons, only 1 (CHANTHU, in September) made landfall over Taiwan (FIG. 4), which was below the normal of 3.23. The number of typhoons that make landfall has been below average for 8 years (FIG. 5).

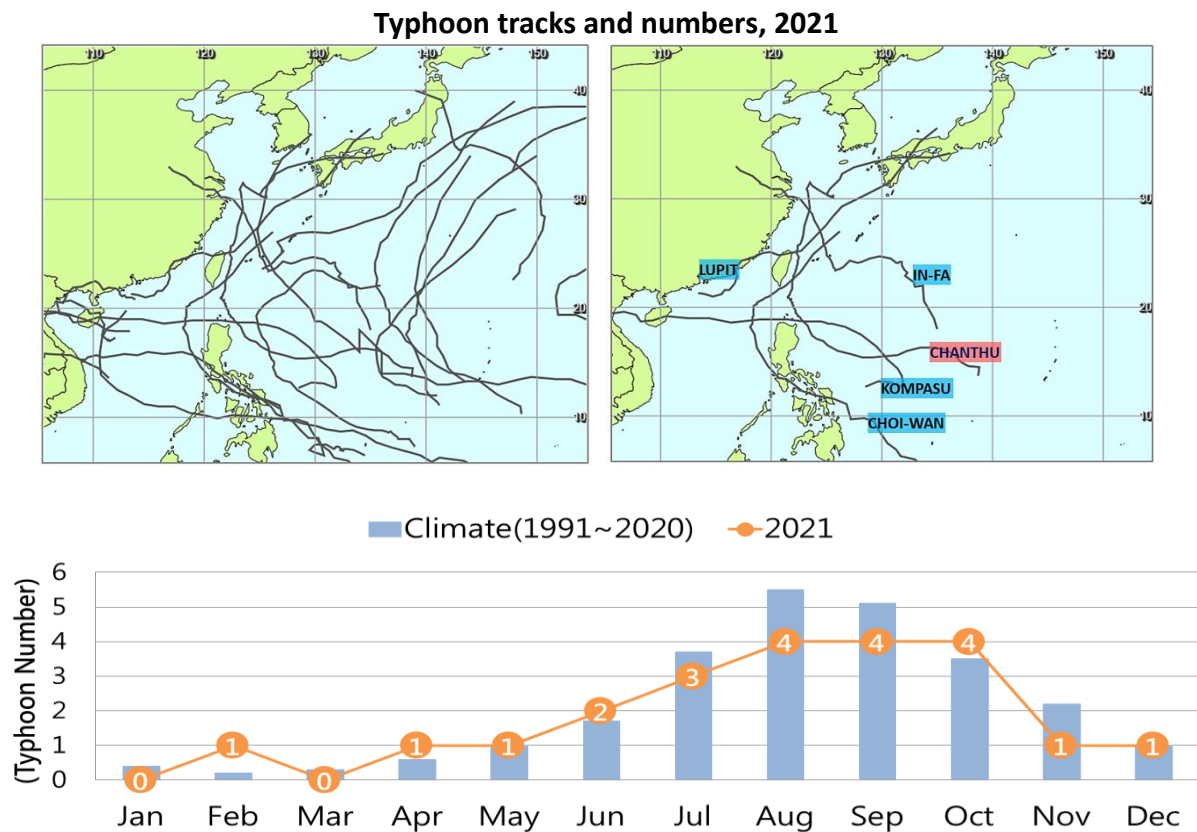


FIG. 4 Tracks of 22 typhoons over the western North Pacific (upper left) and 5 for which warnings were issued (upper right). Monthly typhoon numbers of 2021 and monthly average as calculate over 1991-2020 (lower)

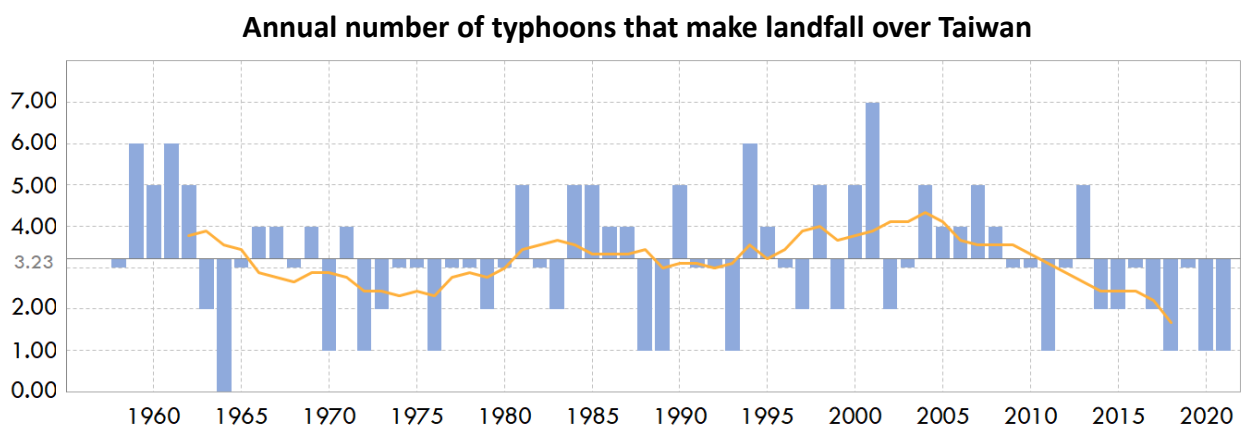


FIG. 5 Annual number of typhoons that make landfall over Taiwan (bar chart) and smoothed annual number by 9-year running mean (line graph) since 1958 as compared to 1991 -2020 average (climate =3.23)

Most serious drought event on record

Taiwan experienced the most serious drought event in June 2020 to May 2021, when the accumulated rainfall average from 6 stations (Taipei, Taichung, Tainan, Hualien, Taitung and Hengchun) was the lowest since 1910, with anomaly of -876.5 mm and standard deviation of -2.66 (FIG. 6).

There are several possible causes of the drought event. First, the duration and strength of subtropical high over the western North Pacific reached the strongest in June to September 2020 (FIG. 7a), resulting in the hottest weather and lowest rainfall in Taiwan. Then, the warmest sea surface temperature (SST) in the Philippines Sea through October 2020 to March 2021, with concurred La Niña, generated a significant zonal SST gradient over the tropical Pacific, resulting in a cyclonic anomaly in the South China Sea to the Philippines Sea (FIG. 7b). The cyclonic anomaly in turn brought north-eastern wind anomaly and dry conditions to Taiwan.

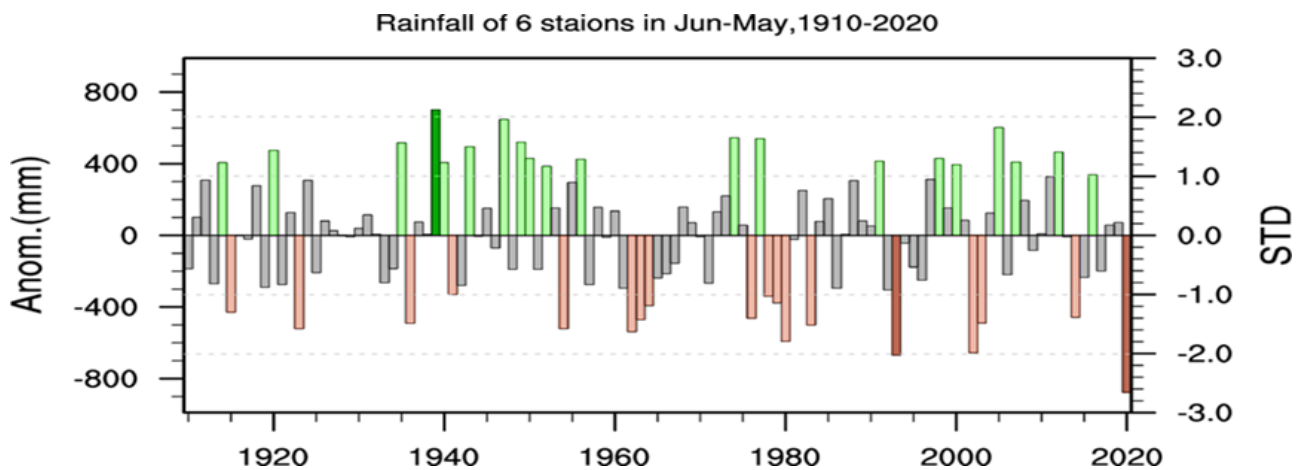


FIG. 6 Taiwan (6 stations' average) accumulated rainfall of June to the next May in 1910 to 2020, the left and right axis of ordinate representing anomaly and standard deviation, respectively

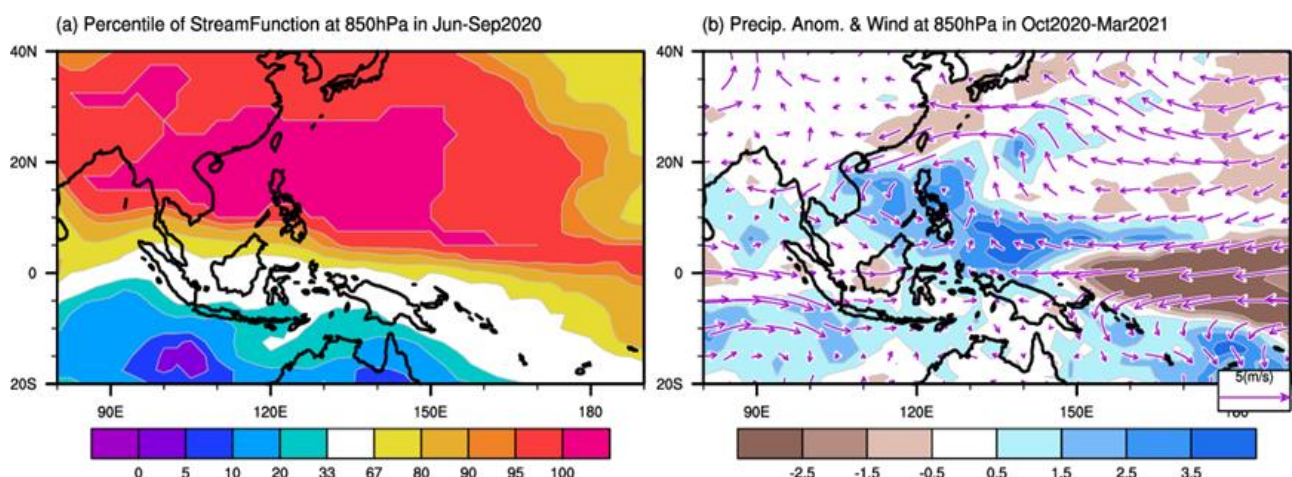


FIG. 7 (a) Percentile of 850hPa stream function in June to September 2020, and (b) precipitation and 850hPa wind anomaly in October 2020 to March 2021