

**Central Weather Administration**  
**Annual Weather Forecast Report, 2023**

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## **I. Introduction**

This annual report includes significant weather events that affected Taiwan in 2023, analysis of major weather incidents, and the weather forecasts and weather warnings and advisories issued. The data source for this report is the Central Weather Bureau (CWB), which was upgraded and restructured into the Central Weather Administration (CWA) on September 15, 2023.

In 2023, Taiwan experienced three cold surge events. Regarding rainfall, there was one large-scale or severe rainfall event. Warnings were issued for six typhoons, three of which brought extremely torrential rain (>500mm/24h) during their warning periods.

## **II. Major Weather Events of 2023**

A summary of the significant weather events affecting Taiwan in 2023 is presented in Table 2.1, while the statistical breakdown of weather system types is illustrated in Figure 2.1. Northeast monsoon and northeasterly winds were the most frequent influences, accounting for 27.84% of the year. Fronts ranked second, comprising 23.71%. South China cloud system and tropical systems accounted for 9.28% and 8.25%, respectively, making them the third and fourth most impactful systems. Southern cloud system influenced Taiwan across different seasons, contributing to 6.19% of the annual impact.

During the Meiyu season, there was no influence from any stationary front in May, while one stationary front affected Taiwan in June. Additionally, from June to September, Taiwan was influenced by 4 occurrences of low pressure troughs, with the combined impact of stationary fronts and low pressure troughs accounting for 5.15% of the year. Although there were no distinct southwesterly flows, southwesterly winds influenced Taiwan in June and August, contributing to 3.09% of the annual impact. Pacific high mainly affected Taiwan in June and July, accounting for 3.09%.

In terms of cold air systems, continental cold air mass and strong continental cold air mass, which occurred mainly from January to March and in November and December, contributed to 6.19% and 4.12%, respectively. Furthermore, Taiwan was affected by 3 cold surge events, with 2 occurring in January and 1 in December, contributing to 3.09% of the annual statistics.

**Table 2.1 Major Weather Events in Taiwan in 2023**

January	Cold surge	In late January, 2 cold surges affected Taiwan. On January 24, 25, 27, and 28, the temperature at Taipei Station reached the cold surge standard. On the 25, Taipei recorded a minimum temperature of 8.5°C, the lowest at the station this year. Matsu recorded a minimum temperature of 2.5°C, the lowest temperature measured at CWA ground-level weather stations this year. On January 29, Tianzhong station recorded a minimum temperature of 6.0°C, the lowest temperature measured at ground-level weather stations in Taiwan Island this year.
February	Warm in the first half, affected by cold air masses in the second half	The first half of February experienced warm weather across the regions. On February 13, Dawu Station recorded a maximum temperature of 36.5°C, setting a new record for February's maximum temperature across Taiwan. On the same day, Hsinchu recorded 30.6°C, Taichung 33.2°C, Chiayi 33.4°C, Su'ao 28.5°C, and Dongjidao 29.8°C, all setting new historical highs for February at the respective stations. In the second half of February, Taiwan was affected by a strong continental cold air mass and two continental cold air masses, resulting in prolonged periods of cold air influence.
March	Cold air masses, first spring thunder	In early March, cold air masses continued to exert influence. On March 23, a front passed, and Matsu Station observed the first spring thunder of the year.

April	Front and northeast monsoon	In April, the weather systems changed rapidly, mainly influenced by fronts and northeast monsoon, with the occasional South China cloud system moving eastward. On April 5, a front approached, causing unstable weather, and hail was observed at Yushan Station. On April 19 and 20, under the influence of a front, rain occurred across Taiwan, with localized torrential rain in Miaoli's mountainous areas.
May	High temperatures, Meiyu fronts, Typhoon Mawar	Early May saw hot weather across the regions. On May 6, Dawu Station recorded a maximum temperature of 39.7°C, breaking the record for May at the station and marking the highest temperature recorded at any CWA station that year. Subsequently, several Meiyu fronts brought weather changes. On May 19, short-duration intense rainfall and localized torrential rain occurred in northern and central Taiwan. At the end of the month, Typhoon Mawar approached, prompting the issuance of the year's first typhoon warning.
June	Typhoon Mawar and stationary front	On June 1, the outer circulation of Typhoon Mawar brought intermittent rain to northern Taiwan. The typhoon moved away on June 2. From June 9 to 16, under the influence of a stationary front and a low pressure trough, unstable weather brought short-duration intense rainfall, with localized heavy rain or extremely heavy rain.

July	Pacific high, Typhoon Talim, Typhoon Doksuri	In early July, The Pacific high brought mostly sunny and hot weather, with localized afternoon thundershowers. In the second half of July, prolonged rainfall occurred due to typhoons and low-pressure systems. On July 15 and 16, the outer cloud systems of Typhoon Talim affected Taitung and the Hengchun Peninsula. From July 25 to 28, Typhoon Doksuri, the year's first Typhoon to invade Taiwan, brought extremely torrential rain to Hualien, Taitung, and the Hengchun Peninsula.
August	Typhoon Khanun, Typhoon Saola	In early August, Typhoon Khanun, southwesterly winds, and a low pressure trough affected Taiwan. From August 1 to 4, under the influence of Typhoon Khanun, combined with enhanced effects of southwesterly wind on August 4, Ren'ai Township in Nantou recorded a maximum hourly precipitation of 141.5 mm, with a daily accumulated precipitation of 748 mm, reaching the threshold for extremely torrential rain. On August 31, Typhoon Saola and its outer circulation brought localized torrential rain to Taitung. Additionally, on August 30th, lee-side subsidence effect associated with typhoon circulation caused widespread high temperatures in Hsinchu and Miaoli.
September	Typhoon Saola, Typhoon Haikui, low pressure trough	In early September, Taiwan was situated within a trough of low pressure and affected by the outer circulations of Typhoon Saola and Typhoon Haikui. Central, southern and southeastern Taiwan experienced above-average precipitation. Typhoon Haikui made landfall in Taitung on September 3,

		<p>marking the first typhoon to make landfall in Taiwan since Typhoon Bailu in 2019. During the impact period from September 2 to 5, localized extremely torrential rain or torrential rain occurred in eastern Taiwan. The total accumulated precipitation over the 4 days reached 1,114 mm in Xiulin Township, Hualien County. On September 10, under the influence of low pressure trough and afternoon convection, significant rainfall occurred in central and southern Taiwan, with short-duration torrential rain in Fanlu Township, Chiayi County.</p>
October	Typhoon Koinu, first autumn front	<p>From October 3 to 6, Typhoon Koinu and its outer circulation brought significant rainfall to Taitung and the Hengchun Peninsula, reaching the torrential rain standard. On October 4, Lanyu Station recorded a maximum gust wind of 95.2 m/s, the highest since the station's establishment. On October 5, localized high temperatures occurred in Nantou due to lee-side subsidence effect. The first autumn front arrived on October 8, with weather gradually influenced by the northeast monsoon.</p>
November	Strong continental cold air mass	<p>This month was primarily influenced by fronts, northeast monsoon, and cold air masses. On November 18, Taipei Station recorded a minimum temperature of 12.4°C, reaching the strong continental cold air mass standard.</p>

December	Cold surge, Yushan's first snow	In early December, northeast monsoon prevailed. Mid- and late December were influenced by strong continental cold air masses and cold surges. On December 21 and 22, the cold air reached the cold surge standard. From December 23 to 25, under the influence of continental cold air mass and Southern cloud system, Yushan Station got its first snow of 2023 winter on December 23.
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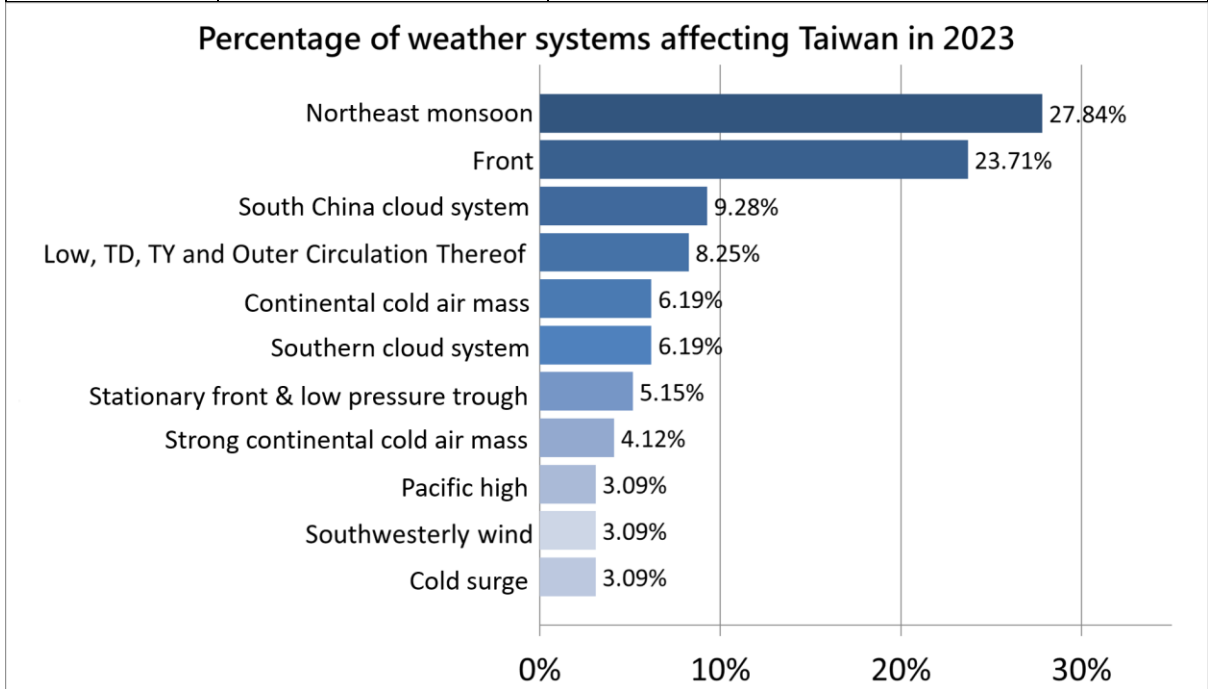


Figure 2.1 Proportion of weather systems affecting Taiwan in 2023

### **III. Analysis of Significant Weather Events**

#### **(1) Low-Temperature Events**

In 2023, Taiwan experienced a total of 12 significant cold air mass events. Among the 9 events in the first half of the year, 2 reached the level of cold surge (January 22–25 and January 27–31), 2 were classified as strong continental cold air masses, and 5 were categorized as continental cold air masses. In the second half of the year, 3 events occurred, including 1 cold surge (December 21–22), 1 strong continental cold air mass, and 1 continental cold air mass. The 3 cold surge events were characterized by distinct features:

First, in late January, intense cold air masses frequently moved southward, and Taiwan was impacted by two consecutive cold surges. During the first cold surge, the daily minimum temperature averaged 9.8°C across 13 lowland weather stations on the main island, setting the year's record and indicating its extensive impact. The second cold surge's strong cold air brought low temperatures, and under the influence of dry air, radiative cooling led to Tianzhong Station recording, on January 29, the island's lowest minimum temperature of the year at 6.0°C. The third cold surge, which occurred in late December (December 20–23), was accompanied by abundant moisture, resulting in wet and cold weather conditions across Taiwan. Some windward areas experienced heavy rain, while mountainous regions observed snow, freezing, and rime. The following sections provide a brief description of these three cold surge low-temperature events.

##### **1. Cold Surge Low-Temperature Event of January 22 to 25**

The weather pattern during this event was characterized by the deepening of the East Asian trough. Following the passage of a front, strong cold air gradually moved southward, causing temperatures to decrease steadily across Taiwan. Most weather stations recorded their lowest minimum temperatures of 2023. The lowest temperature at Taipei Station was 8.5°C, and Su'ao recorded the lowest temperature in lowland areas of the main island at 6.9°C. The daily minimum temperature averaged 9.8°C across 13 CWA-manned weather stations on the island (Figure 3.1.1).

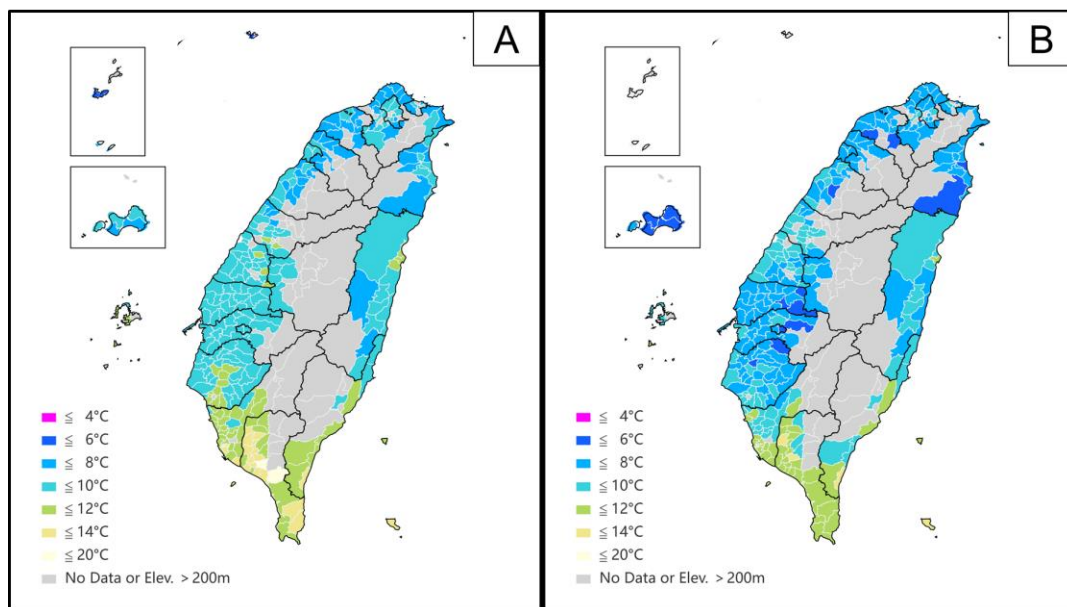
##### **2. Cold Surge Low-Temperature Event of January 27 to 31**

The weather pattern during this event was characterized by the East Asian trough being located over the sea east of Taiwan. As a shortwave trough moved eastward, it replenished the cold air, causing temperatures to continue to drop.

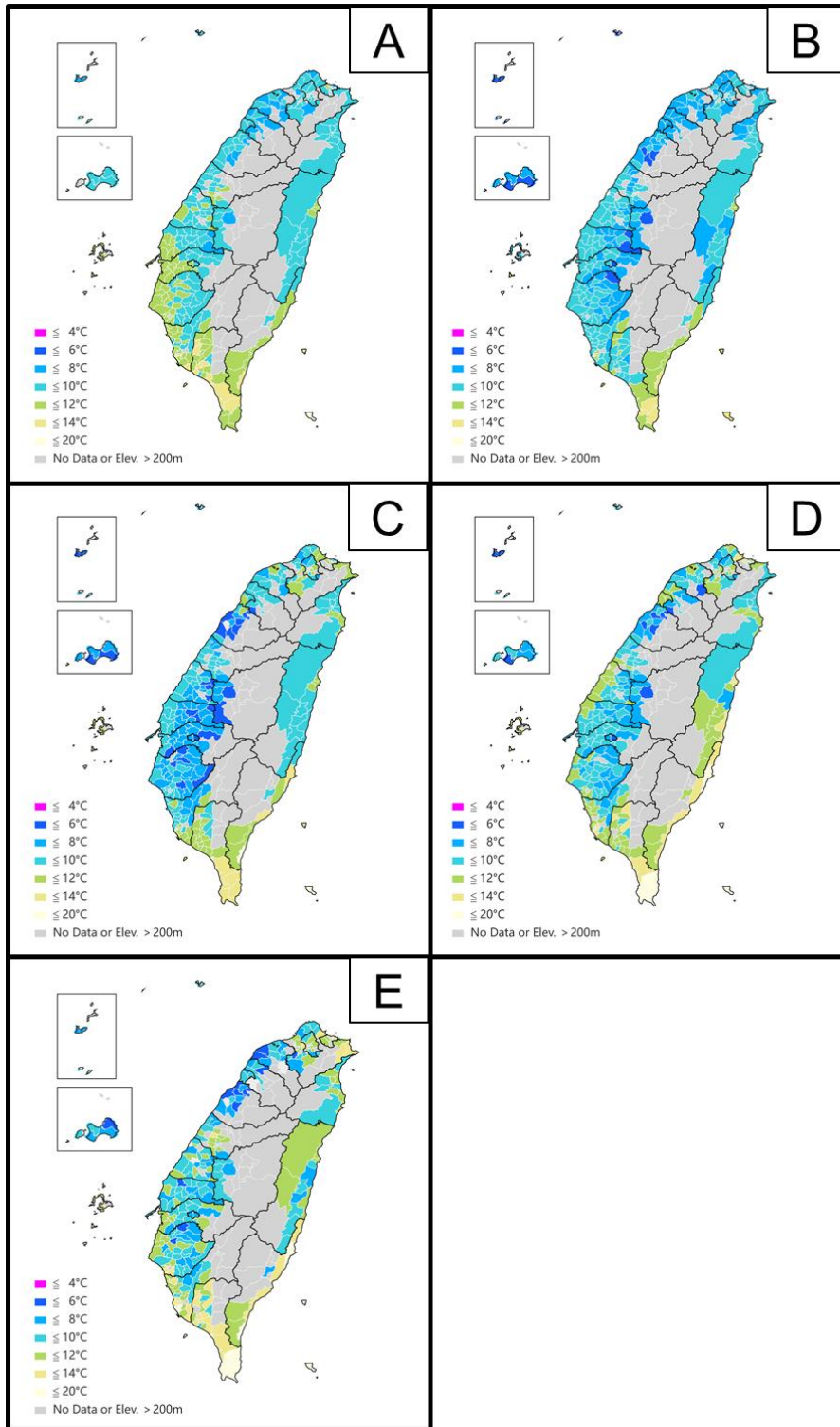
The impact of the cold air lasted longer, and Taiwan, situated in the rear of the trough, experienced a persistently dry environment. Even several days after the cold air weakened, significant radiative cooling still resulted in low temperatures. Some weather stations recorded their lowest temperatures of 2023. The lowest temperature at Taipei Station was 9.3°C, while the lowest temperature in lowland areas of the main island was 6.0°C at Tianzhong. The daily minimum temperature averaged 10.1°C across 13 lowland weather stations on the main island (Figure 3.1.2).

### 3. Cold Surge Low-Temperature Event of December 20 to 23

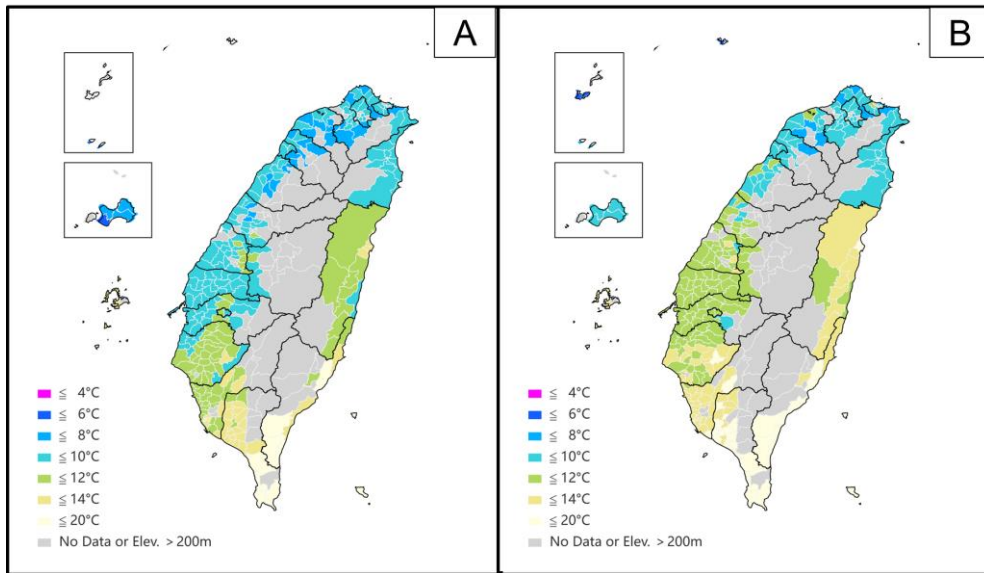
The weather pattern during this event was characterized by the East Asian trough in conjunction with the southern branch trough gradually moving eastward. Waves of split high-pressure systems originating from Mongolia moved southward, bringing an impact. Due to the northward movement of the southern cloud system, wet and cold weather conditions prevailed across Taiwan. Temperatures steadily decreased over consecutive days to their lowest levels. The lowest temperature at Taipei Station was 9.6°C, while the lowest temperature in lowland areas of the main island was 8.2°C at Tamsui and New Taipei Stations. The daily average minimum temperature across 13 lowland weather stations on the main island reached its lowest at 11.9°C (Figure 3.1.3).



**Figure 3.1.1:** Distribution of daily township-level minimum temperatures during the low-temperature event of January 22 to 25, specifically on January 24 (A) and January 25 (B)



**Figure 3.1.2:** Distribution of daily township-level minimum temperatures during the low-temperature event of January 27 to 31, specifically on January 27 (A), January 28 (B), January 29 (C), January 30 (D), and January 31 (E)



**Figure 3.1.3:** Distribution of daily township-level minimum temperatures during the low-temperature event of December 20 to 23, specifically on December 21 (A) and December 22 (B)

## (2) Typhoon and Heavy Rain Events

### 1. Typhoon Mawar (warning period: May 29-31)

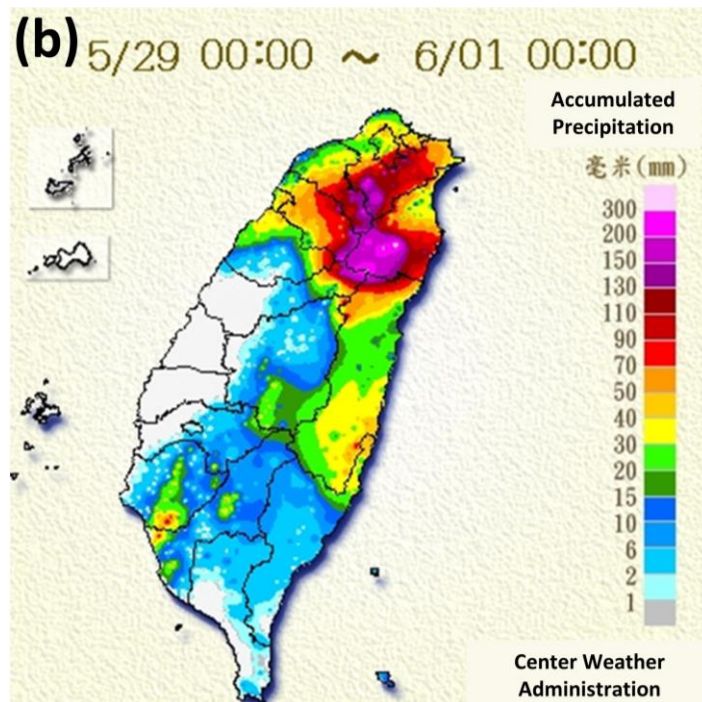
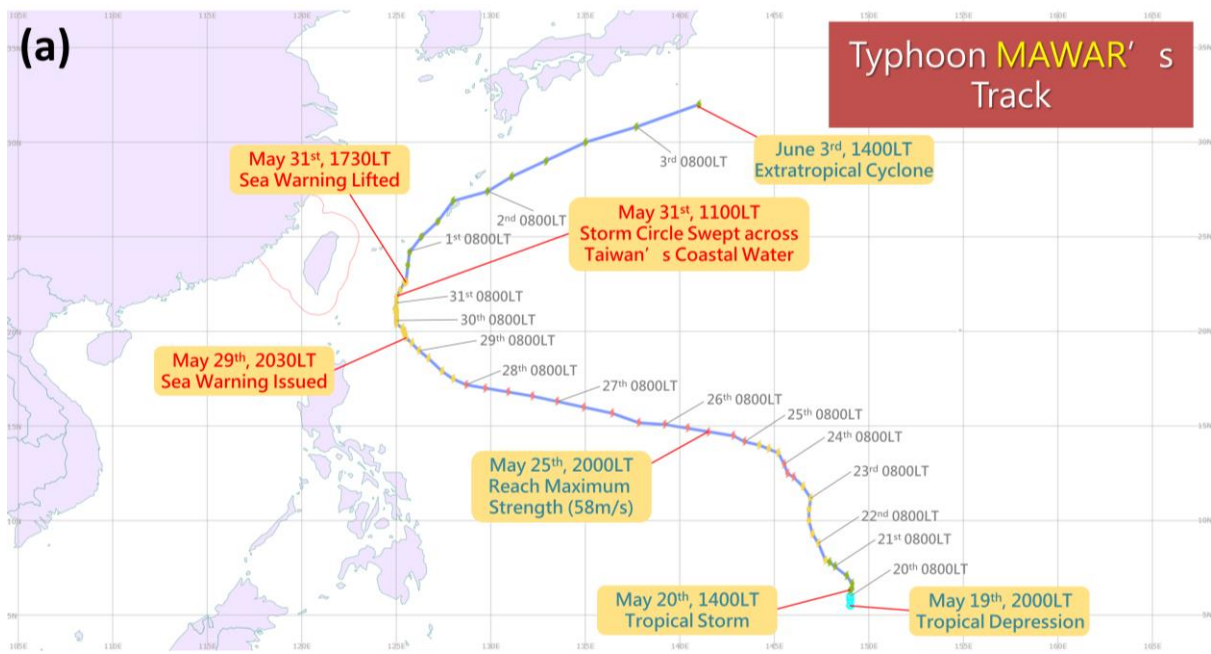
The lifespan of Typhoon Mawar lasted 14 days, during which it intensified twice into a "typhoon (intense intensity)" (see Table 3.1 for CWA's typhoon categorization). The maximum wind speed near its center reached 58 m/s at 20:00 on May 25. The maximum radius of 15 m/s was 300 km, while the radius of 25 m/s was 120 km. The typhoon track map and the timeline of its development and warning issuance are shown in Figure 3.2.1a.

During the period from May 29 to May 31, when the typhoon was affecting Taiwan, precipitation was most significant in the northeastern and northern mountainous regions, followed by eastern Taiwan. Additionally, localized heavy rain occurred in the southern region due to afternoon convection. The total accumulated precipitation distribution is shown in Figure 3.2.1b. Regarding wind, Lanyu and Ludao frequently experienced Beaufort scale 10 gusts. Due to its higher elevation, Lanyu Weather Station recorded a maximum sustained wind of Beaufort scale 11 and a maximum gust wind of Beaufort scale 14. Among CWA-manned weather stations located below 200 meters sea level altitude, Wuqi observed a maximum gust wind of Beaufort scale 10, while Chenggong recorded Beaufort scale 9.

During the Typhoon Mawar warning period, CWA issued a total of 16 typhoon warnings (including 15 typhoon sea warnings and 1 typhoon warning lifted), 15 extremely heavy rain (and heavy rain) advisories, and 1 severe thunderstorm alert.

Table 3.1 Categorization of typhoon intensity

Typhoon intensity	Maximum wind speed near the typhoon's center			
	km / hour	m / sec	mile / hour	Beaufort scale
Tropical storm	62 ~ 117	17.2 ~ 32.6	34 ~ 63	8 ~ 11
Typhoon (moderate intensity)	118 ~ 183	32.7 ~ 50.9	64 ~ 99	12 ~ 15
Typhoon (intense intensity)	above 184	above 51.0	above 100	above 16



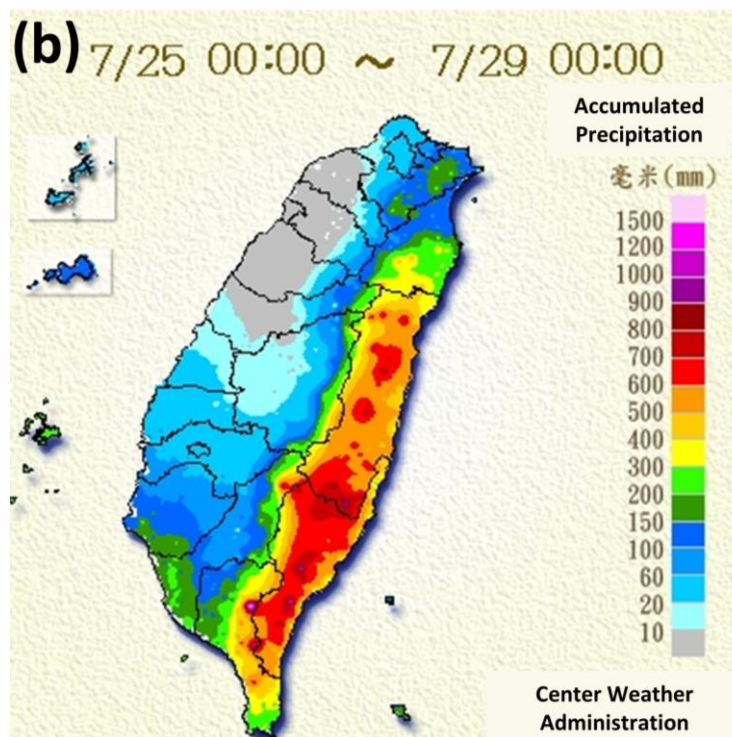
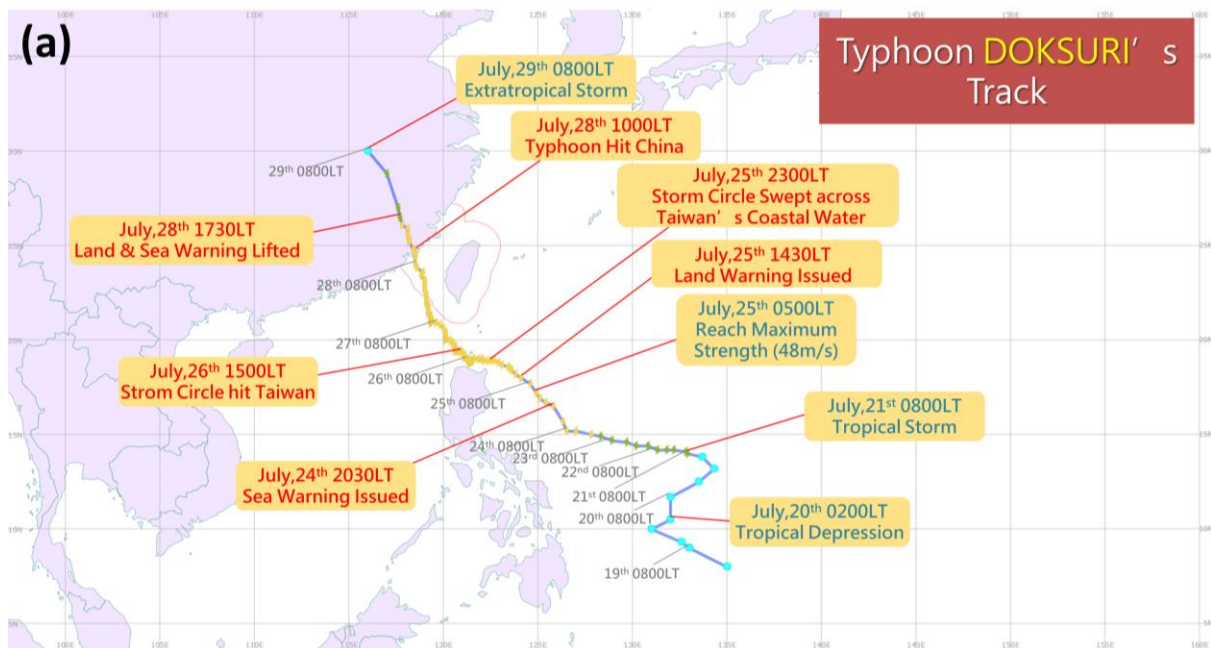
**Figure 3.2.1:** (a) Typhoon track map and timeline for Typhoon Mawar (No. 2, 2023). Color code: blue, tropical depression; green, tropical storm; yellow, typhoon (moderate intensity); red, typhoon (intense intensity). (b) Total accumulated precipitation distribution from May 29 to May 31

## **2. Typhoon Doksuri (warning period: July 24-28)**

Typhoon Doksuri lasted 8 days, maintaining a typhoon (moderate intensity) status for 5 days. The maximum intensity reached 48 m/s, equivalent to the upper limit of typhoon (moderate intensity). The maximum radius of 15 m/s was 300 km, and the maximum radius of 25 m/s was 100 km. The typhoon track map and its development and warning timeline are shown in Figure 3.2.2a.

From July 25 to July 28, the most significant rainfall occurred in the Hualien, Taitung area and Pingtung mountainous regions. The total accumulated precipitation distribution is shown in Figure 3.2.2b. Regarding wind, Dongjidao recorded a maximum gust wind of Beaufort scale 15, Penghu recorded Beaufort scale 13, Kinmen recorded Beaufort scale 12, Pengchiayu recorded Beaufort scale 11, while Lanyu, Dawu, Tainan, and Kaohsiung each recorded Beaufort scale 10.

During the Typhoon Doksuri warning period, CWA issued a total of 32 typhoon warnings (including 6 typhoon sea warnings, 25 typhoon sea and land warnings, and 1 typhoon warning lifted), 26 extremely heavy rain (and heavy rain) advisories, 1 severe thunderstorm alert (cell broadcast), 22 land strong wind advisories, 10 heat information updates, and 2 typhoon destructive strong wind alerts. Additionally, two video conferences with county and city leaders were conducted.



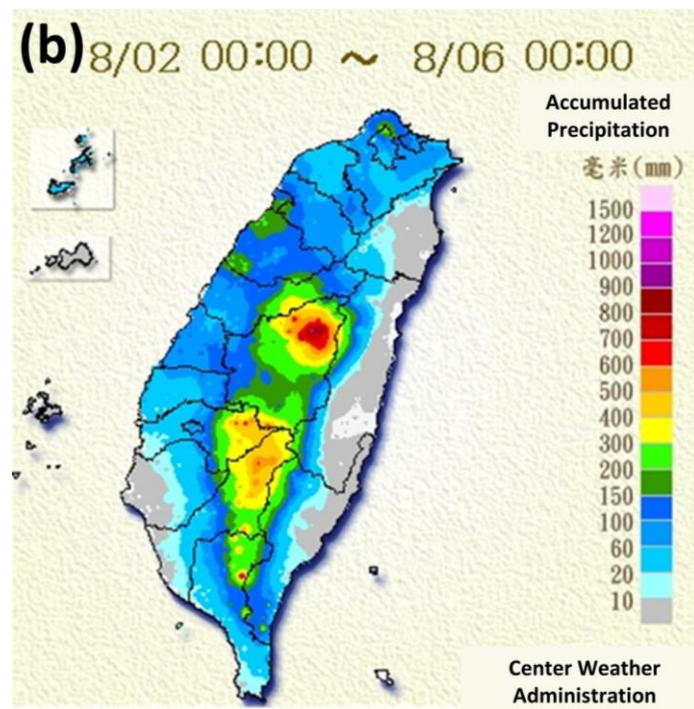
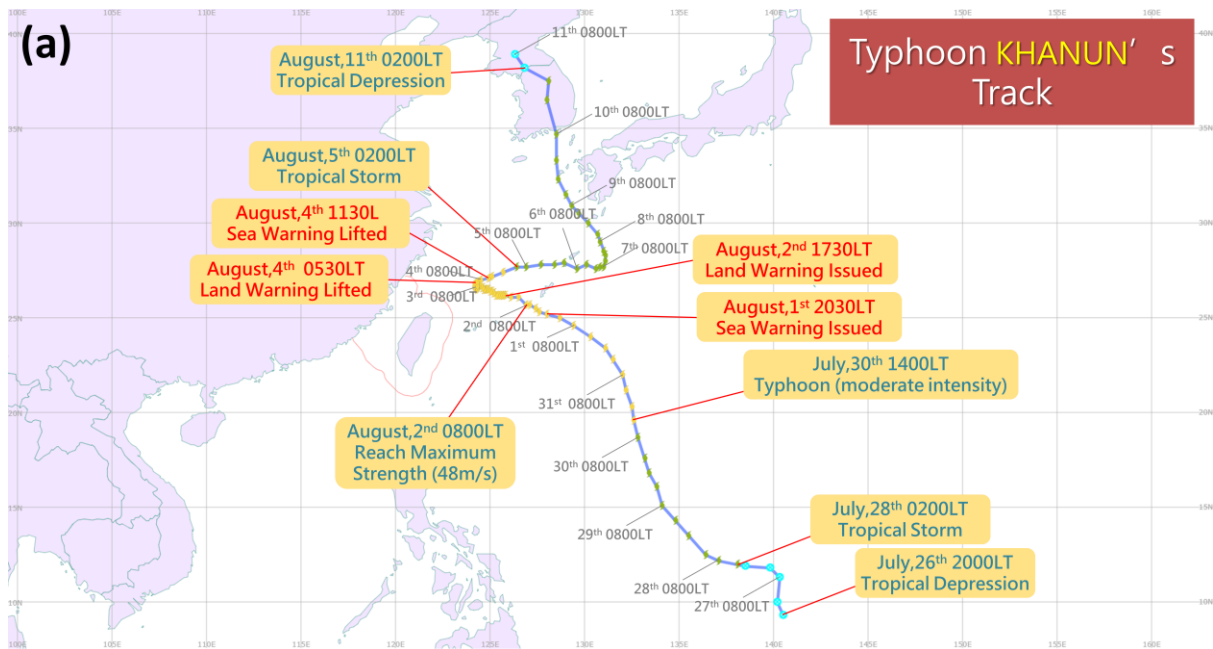
**Figure 3.2.2:** (a) Typhoon track map and timeline for Typhoon Doksuri (No. 5, 2023). Color code: blue, tropical depression; green, tropical storm; yellow, typhoon (moderate intensity); red, typhoon (intense intensity). (b) Total accumulated precipitation distribution during the period from July 25 to July 28.

### **3. Typhoon Khanun (warning period: August 1-4) and Subsequent Heavy Rain Events from Its Outer Circulation (August 4-5)**

Typhoon Khanun had a lifespan of 14 days, with its lowest barometric pressure recorded at 930 hPa. The maximum wind speed near the center reached 48 m/s, classifying it as a typhoon (moderate intensity). The maximum radius of 15 m/s was 280 km, and the maximum radius of 25 m/s was 100 km. The typhoon track map and its development and warning timeline are shown in Figure 3.2.3a.

From August 2 to August 5, during the typhoon's impact and enhanced forecasting operations, the most significant rainfall occurred in the mountainous regions of central and southern Taiwan, Taipei City, Taitung County's mountainous areas, and the coastal areas of Hsinchu and Miaoli Counties. The total accumulated precipitation distribution is shown in Figure 3.2.3b. Regarding wind, the highest gust wind was recorded at Beaufort scale 12 in Pengchiayu and Lanyu. Keelung, Chenggong, and Yushan also experienced Beaufort scale 10 gusts.

During the Typhoon Khanun warning period and the subsequent heavy rain events from its outer circulation, CWA issued a total of 22 typhoon warnings (including 9 typhoon sea warnings, 12 typhoon sea and land warnings, and 1 typhoon warning lifted), 52 extremely heavy rain (and heavy rain) advisories (including 4 extremely torrential rain, 9 torrential rain, 13 extremely heavy rain, and 26 heavy rain), 24 land strong wind advisories, 10 swell alerts, 34 severe thunderstorm alerts (including 7 cell broadcasts), 4 flash flood alerts after heavy rain in mountains, and 37 heat information updates. Additionally, two video conferences with county and city leaders were conducted.



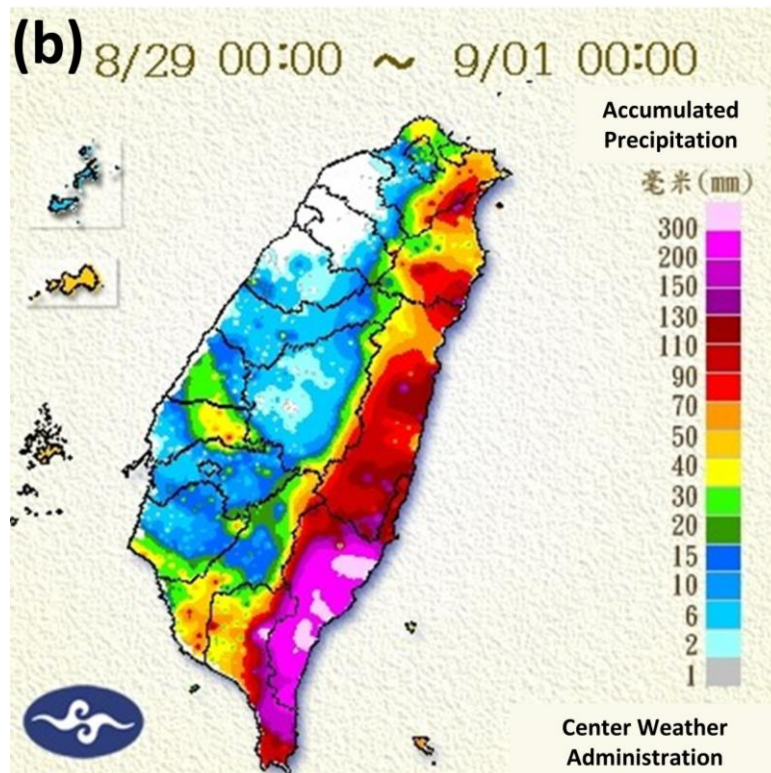
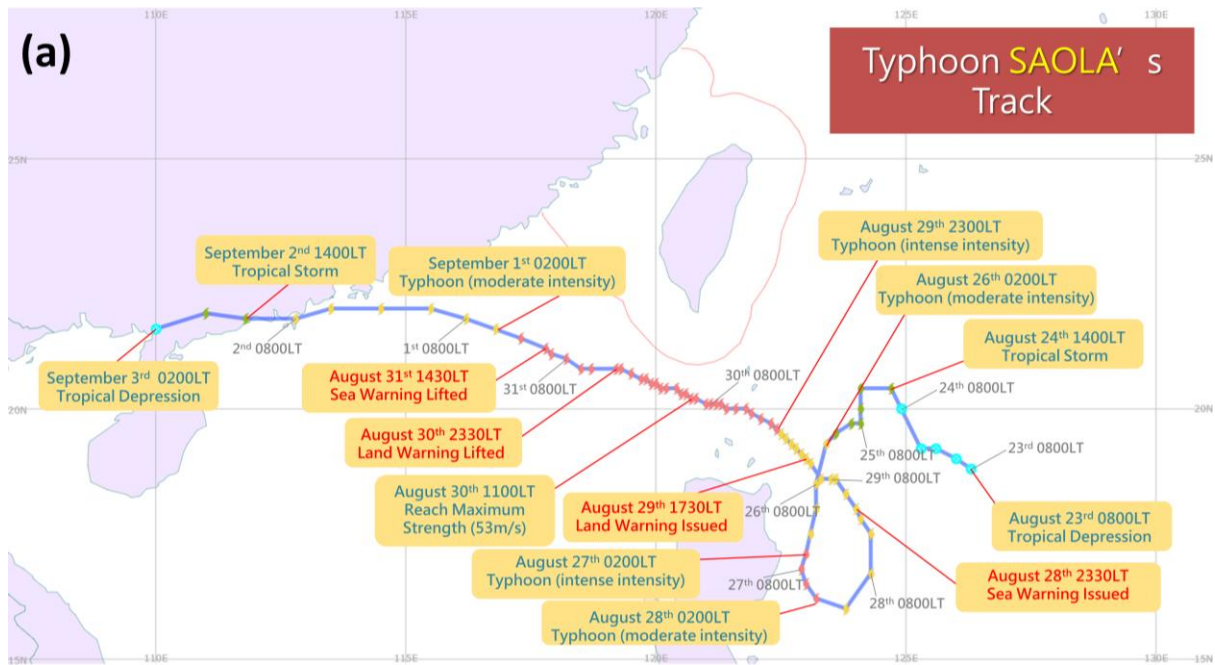
**Figure 3.2.3:** (a) Typhoon track map and timeline for Typhoon Khanun (No. 6, 2023). Color code: blue, tropical depression; green, tropical storm; yellow, typhoon (moderate intensity); red, typhoon (intense intensity). (b) Total accumulated precipitation distribution during the period from August 2 to August 5.

#### **4. Typhoon Saola (warning period: August 28-31)**

The lifespan of Typhoon Saola lasted 9 days and 12 hours, during which it intensified twice into a typhoon (intense intensity). The maximum wind speed near the center reached 53 m/s at 11:00 on August 30. The maximum radius of 15 m/s during its lifespan was 200 km, and the radius of 25 m/s was 80 km. The typhoon track map, formation, development, and the timeline of warning issuance are shown in Figure 3.2.4a.

During the typhoon's impact from August 29 to August 31, the most significant precipitation was observed in eastern Taiwan, Hengchun Peninsula, and mountainous areas in Pingtung. The distribution of total accumulated precipitation is shown in Figure 3.2.4b. Regarding wind, the highest average wind observed by CWA-manned weather stations occurred at Lanyu and Xinwu stations, reaching Beaufort scale 7; Pengchiayu and Dongjidao stations recorded Beaufort scale 6. The highest gust wind recorded was Beaufort scale 9 at Lanyu and Xinwu stations, and Beaufort scale 8 at Hengchun, Dawu, and Pengchiayu stations.

From the Typhoon Saola warning period to 2:05 on September 1, when the consecutive extremely heavy rain advisories were downgraded to a heavy rain advisory, CWA issued a total of 22 typhoon warnings (including 10 typhoon sea and land warnings, 11 typhoon sea warnings, and 1 typhoon warning lifted), 20 extremely heavy rain (and heavy rain) advisories, 2 severe thunderstorm alerts (including 1 cell broadcast), and 13 heat information updates. Additionally, 1 video conference with county and city leaders was conducted.



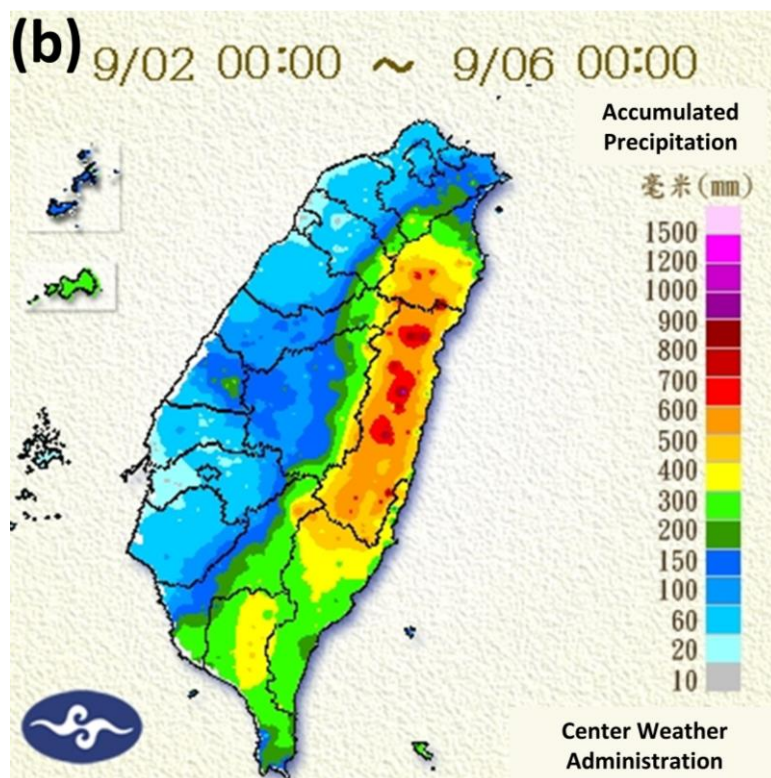
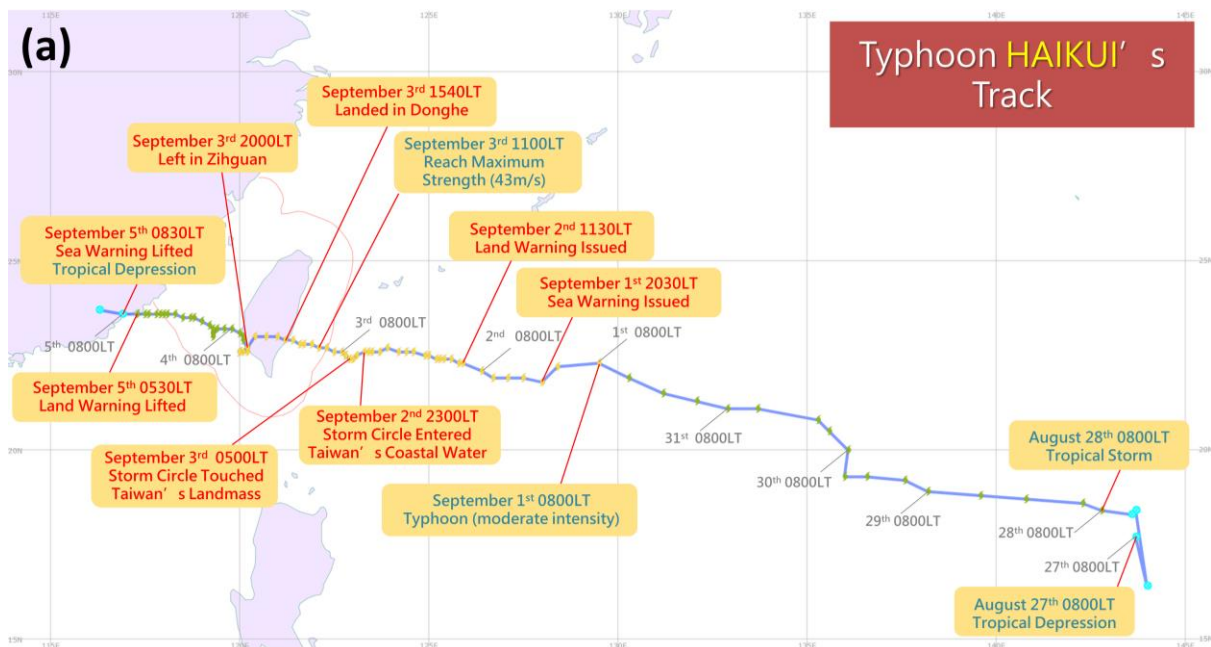
**Figure 3.2.4:** (a) Typhoon Saola (SAOLA), the 9th typhoon of 2023: track map, formation, warning issuance, and major impact timeline during the warning period. (b) Total accumulated precipitation distribution map during the impact of Typhoon Saola from August 29 to August 30 (2 days).

## **5. Typhoon Haikui (Warning period: September 1-5)**

The lifespan of Typhoon Haikui lasted a total of 8 days, with a maximum intensity of 43 m/s, equivalent to a typhoon (moderate intensity). The maximum radius of 15 m/s was 180 km, and the radius of 25 m/s was 60 km. The typhoon track map, formation, development, and the timeline of warning issuance are shown in Figure 3.2.5a.

During the typhoon's impact from September 2 to September 5, the most significant precipitation occurred in eastern Taiwan and the adjacent mountain ranges in western Taiwan. The distribution of total accumulated precipitation is shown in Figure 3.2.5b. Regarding wind, the strongest gust wind recorded at CWA-manned weather stations located below 200 meters sea level altitude occurred at Chenggong Station, reaching Beaufort scale 15; Lanyu and Dongjidao recorded Beaufort scale 12, Taitung recorded Beaufort scale 11, and Xinwu recorded Beaufort scale 10.

During the Typhoon Haikui warning period of 2023, CWA issued a total of 29 typhoon warnings (including 6 typhoon sea warnings, 22 typhoon sea and land warnings, and 1 typhoon warning lifted), 28 extremely heavy rain (and heavy rain) advisories, 6 severe thunderstorm alerts (cell broadcast), 19 land strong wind advisories, and 2 typhoon destructive strong wind alerts (cell broadcast). Additionally, 2 video conferences with county and city leaders were conducted.



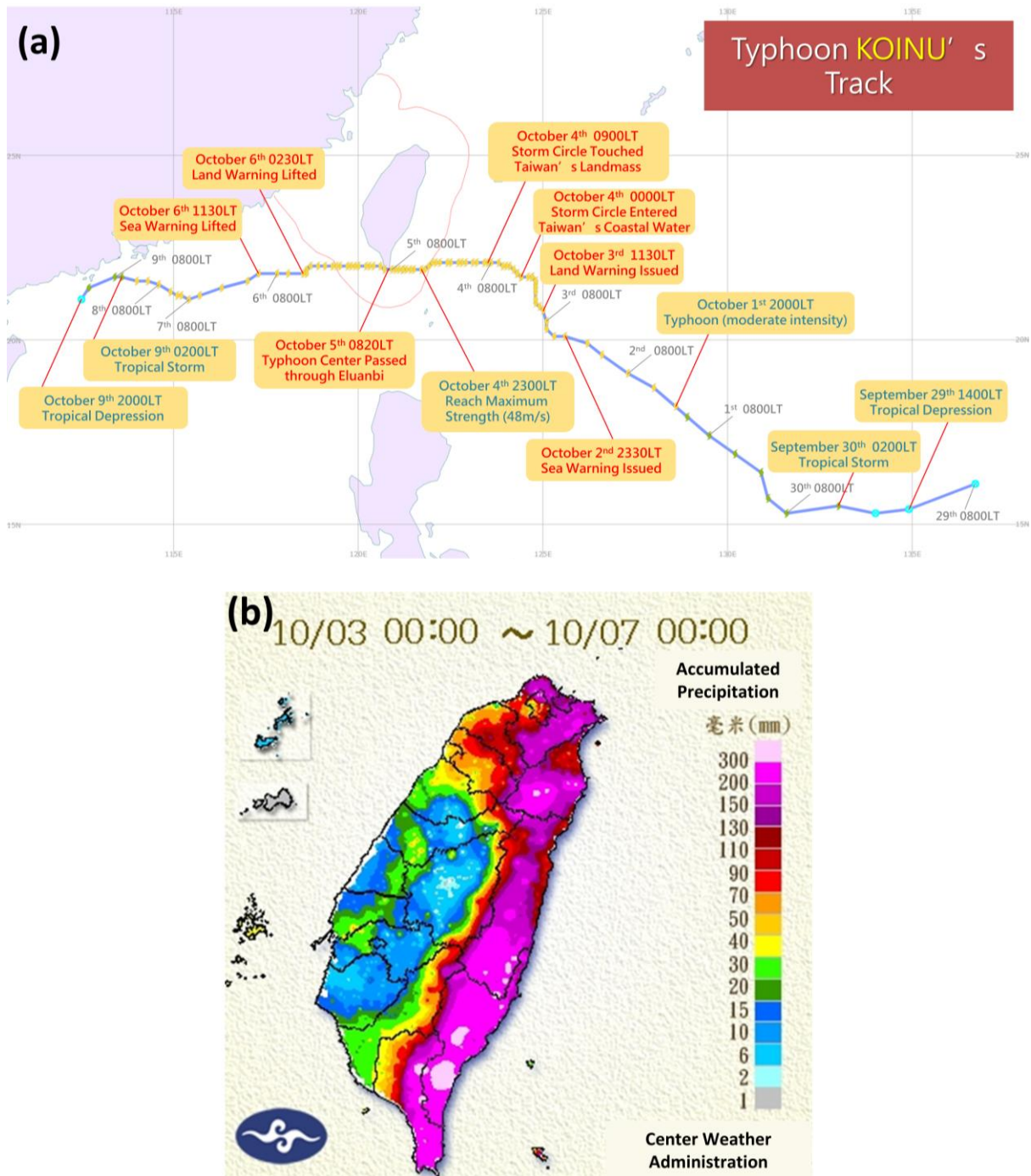
**Figure 3.2.5:** (a) Typhoon Haikui (HAIKUI), the 11th typhoon of 2023: track map, formation, warning issuance, and major impact timeline during the warning period. (b) Total accumulated precipitation distribution map during the impact of Typhoon Haikui from September 2 to September 5 (4 days).

## 6. Typhoon Koinu (Warning period: October 2-6)

The lifespan of Typhoon Koinu lasted 9 days and 18 hours, with a maximum intensity of 48 m/s, equivalent to a typhoon (moderate intensity). The maximum radius of 15 m/s was 250 km, and the radius of 25 m/s was 90 km. The typhoon track map, formation, development, and the timeline of warning issuance are shown in Figure 3.2.6a.

During the typhoon's impact from October 3 to October 6, the most significant precipitation occurred in eastern Taiwan, Hengchun Peninsula, mountainous areas in Pingtung, and the Greater Taipei area. The distribution of total accumulated precipitation is shown in Figure 3.2.6b. Regarding wind, the strongest gust wind recorded at CWA-manned weather stations located below 200 meters sea level altitude occurred at Lanyu, exceeding Beaufort scale 17; Hengchun recorded Beaufort scale 14, Dongjidao recorded Beaufort scale 13, while Dawu, Tainan, and Xinwu recorded Beaufort scale 11, and Chenggong, Penghu, and Pengchiayu recorded Beaufort scale 10.

During the Typhoon Koinu warning period of 2023, CWA issued a total of 29 typhoon warnings (including 7 typhoon sea warnings, 21 typhoon sea and land warnings, and 1 typhoon warning lifted), 19 extremely heavy rain (and heavy rain) advisories, 2 severe thunderstorm alerts (cell broadcast), 20 land strong wind advisories, 4 heat information updates, and 3 typhoon destructive strong wind alerts (cell broadcast). Additionally, 2 video conferences with county and city leaders were conducted.



**Figure 3.2.6:** (a) Typhoon Koinu (KOINU), the 14th typhoon of 2023: track map, formation, warning issuance, and major impact timeline during the warning period. (b) Total accumulated precipitation distribution map during the impact of Typhoon Koinu from October 3 to October 6 (4 days).

## **IV. Future Outlook**

The Weather Forecast Center (WFC) provides not only refined weather services but also ever-enhancing disaster prevention forecasts to help the government and people adapt to the turbulent times of climate change.

In 2023, to improve disaster preparedness and serve the public's needs, five new forecasting information services were introduced. Starting in July, a trial expansion of Flash Flood Alert after Heavy Rain in Mountains messages was conducted in 19 stream areas across 10 counties and cities nationwide.

Township Forecast and Quantitative Precipitation Forecasts (QPF) were extended. In February, the Township Forecast was extended to 3 days with 3-hour intervals, and in May, QPF was extended to provide 48-hour forecasts at 12-hour and 6-hour intervals. During typhoon warnings (sea and land warning or sea warning with significant threats) and periods of enhanced operations for large-scale and severe rainfall, 3-hour QPFs for the next 12 hours were issued. In June, township-level heat signal information was issued. Starting in July, information on typhoon analysis of asymmetric storm radius was issued, and during typhoon warnings, when strong winds were expected on land, a land strong wind advisory for the affected areas was issued and also included in the typhoon warning report.

In 2024, to further refine weather services, inshore and offshore fishery forecasts will be extended to 5 days, and Township Coastal Forecasts will be extended to 72 hours. Regarding disaster prevention forecasts, the formal implementation and issuance of Flash Flood Alert after Heavy Rain in Mountains in high-risk river activity areas will begin. From the typhoon season onwards, in addition to the original "typhoon wind speed probability," new information will include the "most likely/earliest reasonable arrival time of storm-force winds." During typhoon warning periods, a trial provision of wind forecasts for both coastal and non-coastal areas will begin for county and city coordination meetings.

The WFC will continue to participate in CWA's interdisciplinary cooperation endeavors, enhance the application of weather forecasting technologies, and facilitate cross-sector technical exchanges and interactions for the advancement of intelligent weather services in the country.