**APPENDIX V**

**Review of the 2023 Typhoon Season**

Over the western North Pacific and the South China Sea, 17 named tropical cyclones (TCs) formed in 2023, which was below the 30-year average of 25.1 (1991 – 2020) (see Table 1). Ten of these reached typhoon (TY) intensity, which was below the 30-year average of 13.3. A total of five formed after September, which was the fewest since records began (average: 11.6) (see Figure 1). The lower number of formations during the peak period may have contributed to the reduced annual total. This may be partially attributable to the monsoon trough (an area of low atmospheric pressure that extending from the South China Sea to the Philippines in autumn) being weaker than normal and convective activity in the area being relatively inactive. However, further investigation is needed.

The 2023 typhoon season started with Sanvu (2301), which formed over the sea southwest of the Marshall Islands on 19 April. The last-named tropical cyclone of the year was Jelawat (2317), which formed in December 2023 over the sea east of the Philippines and dissipated west of Mindanao.

The mean genesis point of named TCs was 15.1°N and 137.9°E, representing a south-eastward deviation from the 30-year average (16.3°N and 135.9°E) (see Figure 2). The coordinates were 17.0°N and 138.2°E for summer (June to August), representing a east-southeastward deviation from the 30-year summer average (18.5°N and 134.2°E), and 16.3°N and 131.8°E for autumn (September to November), representing a westward deviation from the 30-year autumn average (16.2°N and 137.0°E). The south-eastward shift of the mean genesis point in summer is presumed to be partly associated with the El Niño event that started in spring 2023.

The mean duration of TCs with tropical storm (TS) intensity or higher was 6.1 days, which was longer than the 30-year average of 5.2. The mean duration of TCs with TS intensity or higher in summer was 6.7 days, which was longer than the average of 5.0, and that of TCs with TS intensity or higher in autumn was 5.4 days, which matched the average. The longer-than-average duration in summer is consistent with the results of statistical studies on the prevailing El Niño event.

The only named TC in April was Sanvu (2301, see pink lines in Figure 3), which formed as a tropical depression (TD) over the sea southwest of the Marshall Islands (here, TC locations are expressed as the area of TD formation unless otherwise noted).

The only named TC in May was Mawar (2302, see light blue lines in Figure 3), which formed over the sea around the Caroline Islands and further developed to typhoon (TY) intensity, bringing widespread devastation and flooding to central and northern parts of Guam. It brought heavy rainfall to the Pacific side of western and eastern Japan, caused flooding and landslides. Mawar reached peak intensity with maximum sustained winds of 115 kt and a central pressure of 900 hPa (a record for 2023).

The only named TC in June was Guchol (2303, see yellow lines in Figure 3), which formed over the sea east of the Philippines and reached TY intensity.

Tree named TCs (Talim (2304), Doksuri (2305) and Khanun (2306)) formed in July over the sea east of the Philippines (see light green lines in Figure 3). Talim reached severe tropical storm (STS) intensity before making landfall on the Leizhou Peninsula. It brought rain to parts of China, Macao (China), Hong Kong (China) and Viet Nam. Doksuri reached TY intensity before making landfall on southern China and bringing severe rainfall to wide areas of China and the Philippines. Khanun reached TY intensity before making landfall on Korea and bringing heavy rain and strong wind to Japan, Korea and parts of China. Despite being far from the Philippines, the enhanced Southwest Monsoon brought in prolonged periods of heavy rainfall in the area.

Six named TCs formed in August (see blue lines in Figure 3). The first, Lan (2307), formed over the sea west of Minamitorishima Island and reached TY intensity before making landfall on Shionomisaki in Japan’s Wakayama Prefecture. Dora (2308) crossed longitude 180° east over the sea south of Midways with TY intensity. Saola (2309) formed over the sea east of the Philippines and reached TY intensity, bringing heavy rain, strong wind and storm surges to parts of China, Macao (China), Hong Kong (China) and the Philippines. Damery (2310) formed over the sea south Minamitorishima Island. Haikui (2311) formed over the sea west of the Mariana Islands and crossed Taiwan with TY intensity, bringing torrential rain to parts of China, Macao (China) and Hong Kong (China). Kirogi (2312) formed around the Chuuk Islands.

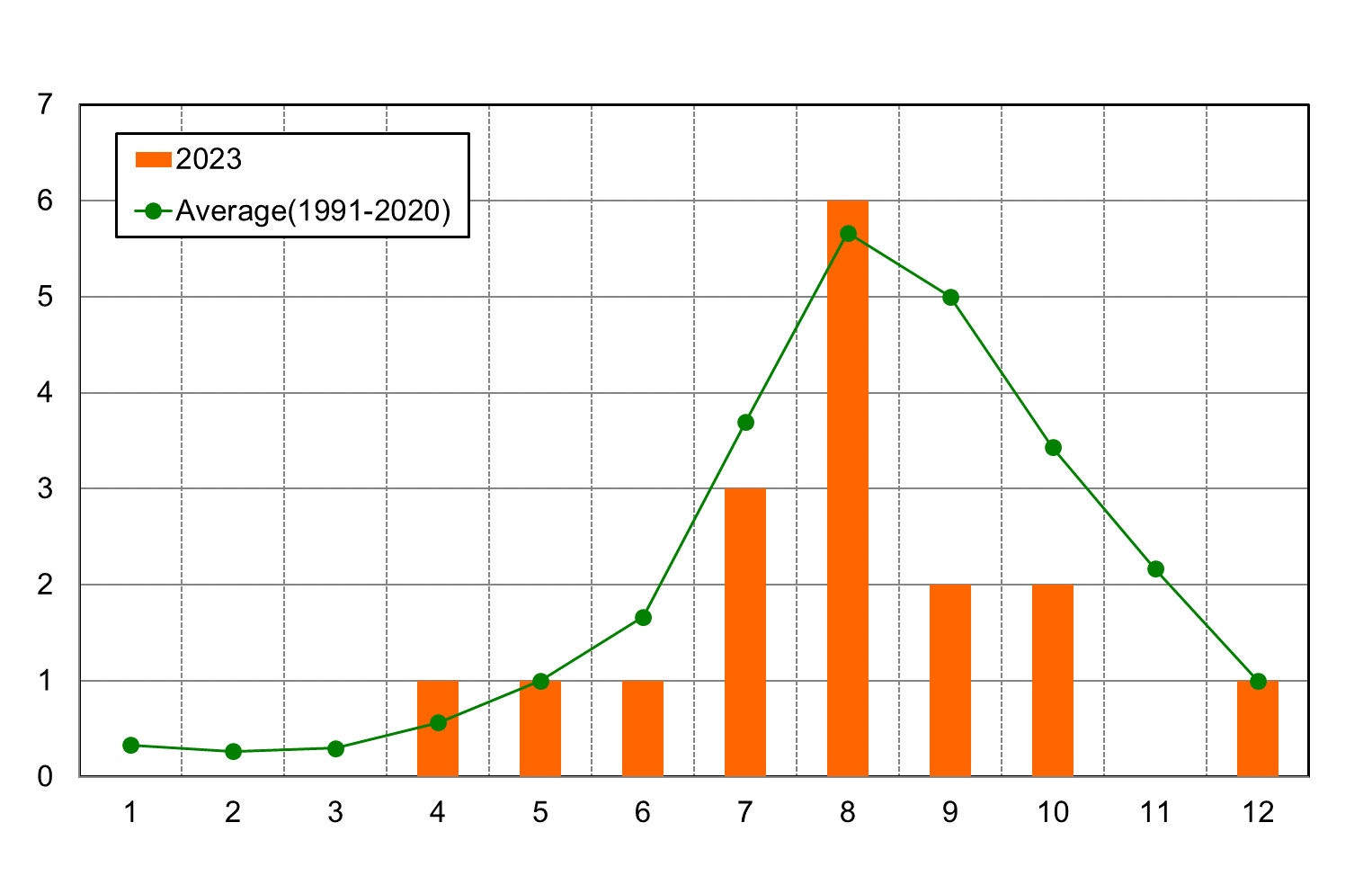
Two named TCs formed in September (see red lines in Figure 3). The first, Yun-yeung (2313), formed over the sea south of Okinawa, bringing heavy rain to Japan. Koinu (2314) formed over the sea east of the Philippines and reached TY intensity, bringing rain and strong wind to parts of China, Macao (China), Hong Kong (China) and the Philippines.

Two named TCs formed in October (see pale green lines in Figure 3). The first, Bolaven (2315), formed over the sea west of the Marshall Islands, and after reaching TY intensity transitioned into an extratropical cyclone and crossed longitude 180°E over the south of Alleutians. Sanba (2316) formed over the South China Sea, bringing rain to parts of China.

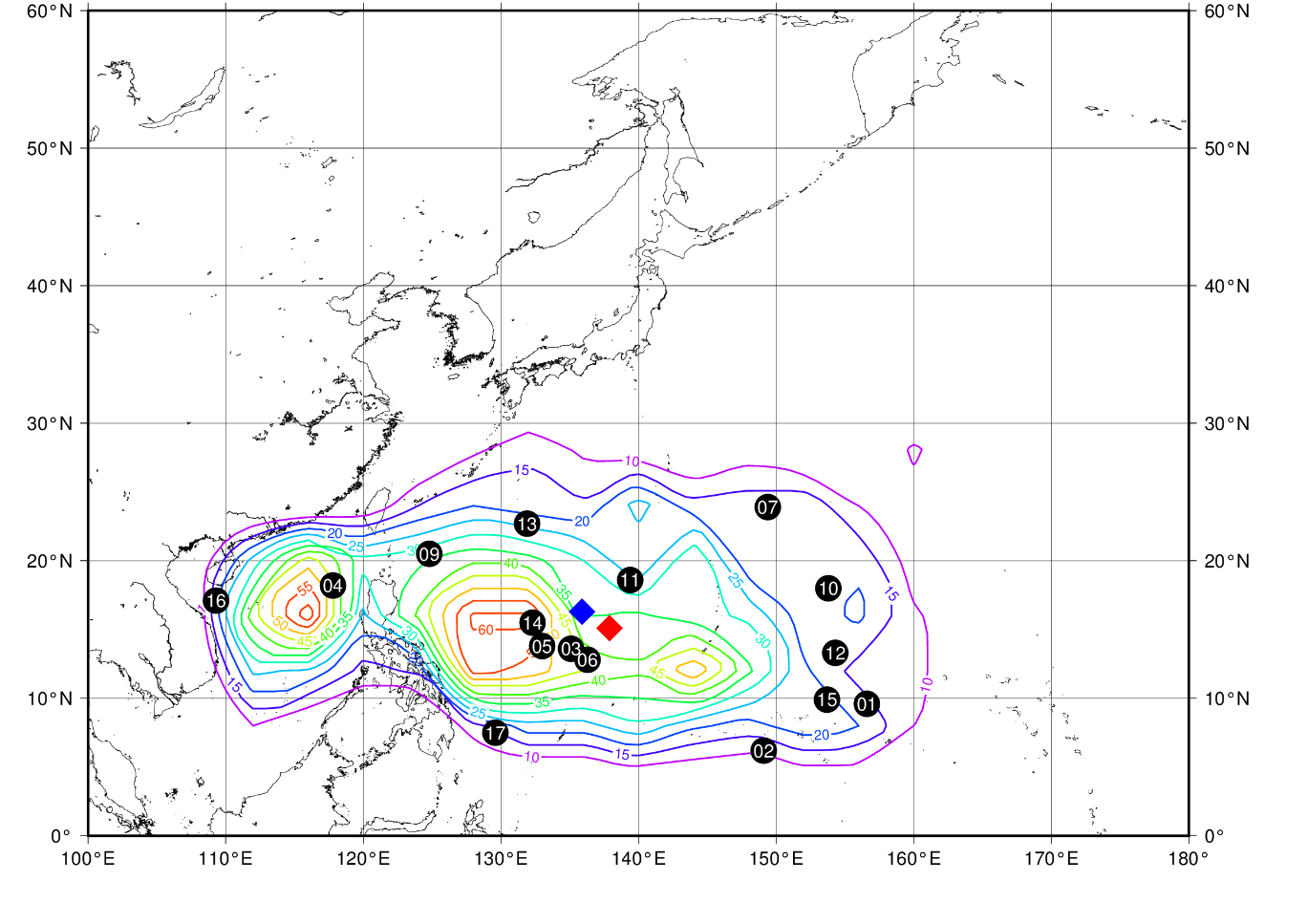
The year’s last-named TC, Jelawat (2317, see the brown line in Figure 3), formed in December around the Caroline Islands. It weakened to TD intensity over the Mindanao Island and dissipated over the island’s southwestern part.

**Table 1 List of named TCs in 2023**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tropical Cyclone | | | Duration (UTC) | | | | | Minimum Central Pressure | | | | Max Wind | |
|  | |  | (TS or higher) | | | | | (UTC) | lat(N) | long(E) | (hPa) | (kt) |  | |
| TS | Sanvu | (2301) | 201200 | Apr | - | 220000 | Apr | 210600 | 10.3 | 155.7 | 996 | 45 |  | |
| TY | Mawar | (2302) | 201200 | May | - | 030000 | Jun | 251200 | 14.8 | 141.5 | 900 | 115 |  | |
| TY | Guchol | (2303) | 061200 | Jun | - | 121200 | Jun | 091800 | 18.5 | 129.9 | 960 | 80 |  | |
| STS | Talim | (2304) | 150600 | Jul | - | 181200 | Jul | 170000 | 20.1 | 113.0 | 970 | 60 |  | |
| TY | Doksuri | (2305) | 210000 | Jul | - | 290000 | Jul | 241800 | 16.9 | 125.1 | 925 | 100 |  | |
| TY | Khanun | (2306) | 280000 | Jul | - | 100600 | Aug | 010000 | 24.6 | 129.4 | 930 | 95 |  | |
| TY | Lan | (2307) | 080000 | Aug | - | 170600 | Aug | 101800 | 26.4 | 142.9 | 940 | 90 |  | |
| TY | Dora | (2308) | 120600 | Aug | - | 150000 | Aug | 120600 | 16.3 | 179.1 | 980 | 75 |  | |
| TY | Saola | (2309) | 240600 | Aug | - | 021800 | Sep | 300000 | 20.1 | 121.0 | 920 | 105 |  | |
| STS | Damrey | (2310) | 241800 | Aug | - | 290600 | Aug | 260600 | 26.1 | 152.9 | 985 | 50 |  | |
| TY | Haikui | (2311) | 281800 | Aug | - | 050000 | Sep | 021800 | 22.7 | 123.1 | 945 | 85 |  | |
| TS | Kirogi | (2312) | 301200 | Aug | - | 030000 | Sep | 310600 | 16.7 | 154.2 | 994 | 45 |  | |
| TS | Yun-yeung | (2313) | 051200 | Sep | - | 081200 | Sep | 060600 | 26.6 | 134.2 | 998 | 40 |  | |
| TY | Koinu | (2314) | 291800 | Sep | - | 090600 | Oct | 021800 | 20.2 | 125.5 | 940 | 90 |  | |
| TY | Bolaven | (2315) | 071200 | Oct | - | 141200 | Oct | 111200 | 18.9 | 143.0 | 905 | 115 |  | |
| TS | Sanba | (2316) | 180000 | Oct | - | 200000 | Oct | 191200 | 21.0 | 109.4 | 1000 | 40 |  | |
| TS | Jelawat | (2317) | 170600 | Dec | - | 180000 | Dec | 170600 | 7.5 | 129.6 | 1002 | 35 |  | |

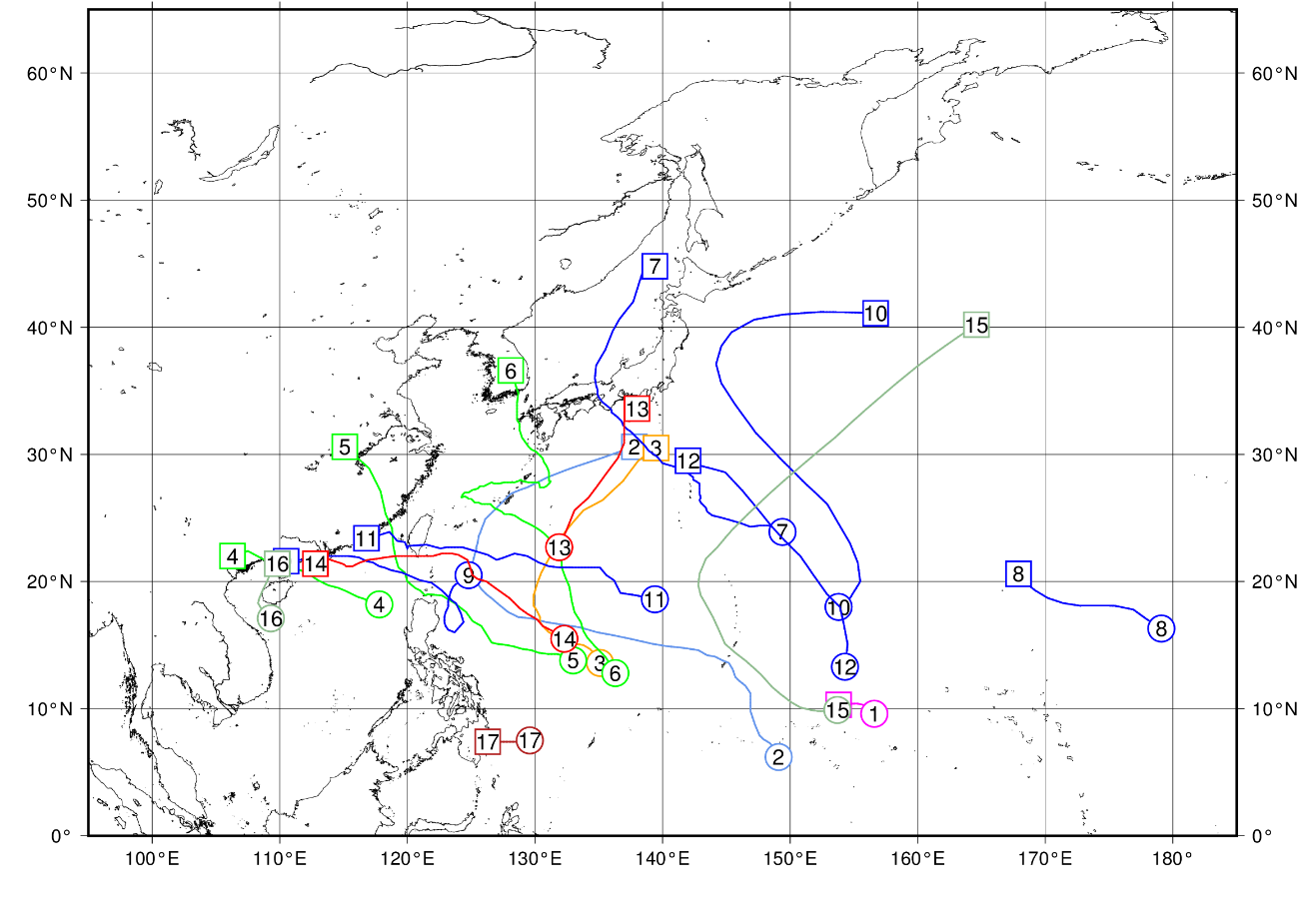


**Figure 1 Monthly formation number of named TCs in 2023**

Orange bar: formation number in 2023, green line: 30-year average from 1991 to 2020

**Figure 2 Genesis points of named TCs in 2023 (dots with the last two digits of TC identification numbers) and frequency distribution of genesis points for 1951-2022 (lines)**

Red and blue diamonds show the mean genesis points of named TCs in 2023 and the 30-year average period (1991 – 2020), respectively.



**Figure 3 Tracks of named TCs in 2023**

The numbers represent the genesis and dissipation points of named TCs (the last two digits of their identification numbers).**Narrative Accounts of the 17 Named Tropical Cyclones in 2023**

**TS SANVU (2301)**

SANVU formed as a tropical depression (TD) over the sea southwest of the Marshall Islands at 00 UTC on 19 April 2023 and moved north-northwestward. SANVU was upgraded to tropical storm (TS) intensity at 12 UTC the next day over the sea around the Marshall Islands and moved northwestward. Gradually turning west-northwestward, it reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 996 hPa over the same waters at 06 UTC on 21 April. After moving westward, SANVU weakened to TD intensity over the sea around the Chuuk Islands at 00 UTC the next day. It dissipated over the same waters at 12 UTC on 22 April.

**TY MAWAR (2302)**

MAWAR formed as a tropical depression (TD) over the sea around the Caroline Islands at 18 UTC on 19 May 2023 and moved westward. It was upgraded to tropical storm (TS) intensity over the same waters　at 12 UTC on 20 May and moved northwestward. It was upgraded to severe tropical storm (STS) intensity at 00 UTC and was upgraded to typhoon (TY) intensity at 18 UTC on 21 May over the same waters and moved northwestward. It reached its peak intensity with maximum sustained winds of 115 kt and a central pressure of 900 hPa near the Mariana Islands at 12 UTC on 25 May and moved westward. After turning northward, it was downgraded to STS intensity over the sea south of Okinawa at 18 UTC on 31 May and moved northward. It weakened to TS intensity over the same waters at 00 UTC on 2 June and moved east-northeastward. It transitioned into an extratropical cyclone over the sea south of Japan by 00 UTC on 3 June. It dissipated over the sea east of Japan at 18 UTC on 3 June.

**TY GUCHOL (2303)**

GUCHOL formed as a tropical depression (TD) over the sea east of Philippines at 00 UTC on 06 June 2023 and moved northward. It was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC the same day. After moving west-northwestward, it was upgraded to severe tropical storm (STS) intensity at 18 UTC on 07 June and further upgraded to typhoon (TY) intensity at 12 UTC the next day. Gradually turning northeastward slowly, it reached its peak intensity with maximum sustained winds of 80 kt and a central pressure of 960 hPa over the sea east of Philippines at 18 UTC on 09 June. Accelerating northeastward over the sea south of Japan, it was downgraded to STS intensity at 06 UTC on 11 June and transitioned into an extratropical cyclone by 12 UTC the next day. After continuously moving northeastward and eastward, it entered the sea south of Aleutians and crossed longitude 180 degrees east before 18 UTC on 16 June.

**STS TALIM (2304)**

TALIM formed as a tropical depression (TD) over the sea east of the Philippines at 06 UTC on 13 July 2023 and moved north-northwestward. It hit the Philippines with TD intensity around 12 UTC the same day before turning westward on 14 July. After entering the South China Sea, it was upgraded to tropical storm (TS) intensity over the same waters at 06 UTC on 15 July. It was further upgraded to severe tropical storm (STS) intensity over the same waters at 00 UTC on 16 July. It reached its peak intensity with maximum sustained winds of 60 kt and a central pressure of 970 hPa over the same waters at 00 UTC on 17 July. It hit the Leizhou Peninsula with STS intensity by 18 UTC the same day. It was downgraded to TS intensity in South China at 06 UTC on 18 July and then weakened to TD intensity in Viet Nam at 12 UTC the same day. TALIM dissipated in the same area at 00 UTC on 19 July.

**TY DOKSURI (2305)**

DOKSURI formed as a tropical depression (TD) over the sea east of the Philippines at 06 UTC on 20 July 2023 and moved northward and then westward. Moving westward, over the same waters, it was upgraded to tropical storm (TS) intensity at 00 UTC the next day and was further upgraded to typhoon (TY) intensity at 18 UTC on 23 July. After turning sharply northwestward, over the same waters, it developed rapidly and reached its peak intensity with maximum sustained winds of 100 kt and a central pressure of 925 hPa at 18 UTC on 24 July. After reaching its peak intensity, DOKSRI gradually turned westward and entered the Bashi channel. Gradually weakening, it turned northward and entered the Taiwan strait before it hit South China with TY intensity early on 28 July. Rapidly weakening, it moved north-northwestward and downgraded to TD intensity in Central China at 00 UTC the next day and then dissipated in North China at 18UTC on 30 July.

**TY KHANUN (2306)**

KHANUN formed as a tropical depression (TD) over the sea east of the Philippines at 18 UTC on 26 July 2023 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 28 July, to severe tropical storm (STS) intensity at 12 UTC the next day and to typhoon (TY) intensity at 00 UTC on 30 July while moving northwestward to northward. It reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 930 hPa over the sea south of Okinawa Island at 00 UTC on 01 August. While gradually turning westward and entering the East China Sea, it gradually weakened. It remained almost stationary over the same waters and then moved eastward. It developed again over the sea south of Kyushu Island at 06 UTC on 08 August while gradually turning northward. It hit Korea with TS intensity after 00 UTC on 10 August and transformed into an extratropical cyclone by 06 UTC the same day. After turning west-northwestward and entering the Yellow Sea on 11 August, it dissipated at 00UTC the next day.

**TY about LAN (2307)**

LAN formed as a tropical depression (TD) over the sea west of Minamitorishima Island at 00 UTC on 07 August 2023 and moved northeastward. It was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 08 August and moved west-northwestward. It was upgraded to severe tropical storm (STS) intensity over the sea around the Ogasawara Islands at 00 UTC on 09 August and moved west-northwestward. It was upgraded to typhoon (TY) intensity over the same waters at 00 UTC on 10 August and moved northwestward. It reached its peak intensity with maximum sustained winds of 90 kt and a central pressure of 940 hPa over the same waters at 18 UTC the same day and moved northwestward. It turned west-northwestward around 00 UTC on 12 August over the same waters. It was downgraded to STS intensity over the sea south of Japan at 12 UTC on 14 August and moved north-northwestward. It made landfall near ShionoMisaki, Wakayama Prefecture before 20 UTC on 14 August and made landfall again near Akashi city, Hyogo Prefecture around 04 UTC on 15 August respectively with STS intensity and moved northwestward. It weakened to TS intensity in Hyogo Prefecture about 5 hours later and moved northward. It turned north-northeastward and transitioned into an extratropical cyclone over the Sea of Japan by 06 UTC on 17 August and moved northeastward. It dissipated over the sea around the Kuril Islands at 18 UTC on 18 August.

**TY DORA (2308)**

DORA crossed longitude 180 degrees east over the sea south of Midways with typhoon (TY) intensity after 00 UTC on 12 August 2023 and entered the western North Pacific. After reaching its peak intensity with maximum sustained winds of 75 kt and a central pressure of 980 hPa at 06 UTC the same day, it moved west-northwestward and then moved westward weakening in intensity. It was downgraded to severe tropical storm (STS) intensity east of Wake Island at 12 UTC on 13 August and downgraded to tropical storm (TS) intensity at 00UTC the next day. Gradually turning northward, it weakened to tropical depression (TD) intensity around Wake Island at 00 UTC on 15 August. It moved northward and then turned sharply eastward over the sea far east of Japan on 18 August. Moving east-northeastward, it transitioned into an extratropical cyclone northwest of Midways by 12 UTC on 21 August. It entered the sea south of Aleutians and crossed longitude 180 degrees east before 06 UTC the next day.

**TY SAOLA (2309)**

SAOLA formed as a tropical depression (TD) over the sea east of the Philippines at 00 UTC on 22 August 2023 and moved westward. It was upgraded to tropical storm (TS) intensity over the sea south of Okinawa at 06 UTC on 24 August and moved southwestward. It developed rapidly and was upgraded to typhoon (TY) intensity over the sea east of the Philippines at 12 UTC on 25 August. It turned in a counterclockwise direction to circle from 26 to 29 August. It reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 920 hPa over the Bashi Channel at 00 UTC on 30 August. It downgraded to severe tropical storm (STS) intensity over the sea south of South China at 00 UTC on 2 September and then hit the South China six hours later. It downgraded to TS intensity in the same area at 12 UTC on 2 September and then weakened to TD intensity six hours later. SAOLA dissipated over the Gulf of Tonkin at 18 UTC on 03 September.

**STS DAMREY (2310)**

DAMREY formed as a tropical depression (TD) over the sea south of Minamitorishima Island at 18 UTC on 23 August 2023 and moved east-northeastward. It was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC the next day. It gradually turned northwestward and was further upgraded to severe tropical storm (STS) intensity and reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 985 hPa around Minamitorishima Island at 06 UTC on 26 August. Keeping its northwestward track, it was downgraded to TS intensity east of Japan at 18 UTC the next day. It gradually turned to eastward and temporally developed to STS intensity again before it transitioned into an extratropical cyclone far off east of Japan by 06 UTC on 29 August. Gradually turning northeastward and entering the sea south of Alleutians, it crossed longitude 180 degrees east before 12UTC the next day.

**TY HAIKUI (2311)**

HAIKUI formed as a tropical depression (TD) over the sea west of the Mariana Islands at 06 UTC on 27 August 2023 and moved westward. It was upgraded to tropical storm (TS) intensity over the sea east of the Philippines at 18 UTC the next day. It moved northwestward and was upgraded to severe tropical storm (STS) intensity over the sea south of Japan at 18 UTC on 30 August. Moving westward, it was further upgraded typhoon (TY) intensity over the sea south of Okinawa at 12 UTC on 1 September and reached its peak intensity with maximum sustained winds of 85 kt and a central pressure of 945 hPa over the same waters at 18 UTC the next day. It crossed Taiwan with TY intensity on 3 September and weakened in intensity. It hit the south China and weakened to TD intensity at 00 UTC on 5 September, and then dissipated at 06 UTC the next day.

**TS KIROGI (2312)**

KIROGI formed as a tropical depression (TD) around the Chuuk Islands at 18 UTC on 29 August 2023 and moved northward. It was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on 30 August and moved northward. It reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 994 hPa over the sea south of Minamitorishima at 06 UTC on 31 August and moved northward. It weakened to TD intensity over the sea around the Ogasawara Islands at 00 UTC on 3 September and moved west-northwestward. It turned east-northeastward around 12 UTC on 5 September and dissipated over the sea south of Shikoku　at 18 UTC on 6 September.

**TS YUN-YEUNG (2313)**

YUN-YEUNG formed as a tropical depression (TD) over the sea south of Okinawa at 06 UTC on 4 September 2023. It moved northeastward and was upgraded to tropical storm (TS) intensity over the sea south of Japan at 12 UTC the next day. Moving north-northeastward over the same waters, it reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 998 hPa at 06 UTC on 6 September. After continuing to move north-northeastward and then moving northward, it remained almost stationary south of the Kii Peninsula around 00 UTC on 8 September. Moving again north-northeastward, it weakened to TD intensity over the sea south of Shizuoka Prefecture at 12 UTC on 8 September and dissipated at 00 UTC the next day.

**TY KOINU (2314)**

KOINU formed as a tropical depression (TD) over the sea east of the Philippines at 12 UTC on 28 September 2023 and moved westward. It was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on 29 September before turning sharply northwestward. It was upgraded to typhoon (TY) intensity at 18 UTC on 1 October. It reached its first peak intensity with maximum sustained winds of 90 kt and a central pressure of 940 hPa over the sea south of Okinawa at 18 UTC on 2 October. After turning westward, it gradually weakened from the second half of 3 October. It crossed south of Taiwan with TY intensity around 00 UTC on 5 October and weakened until 18 hours later. After developing again, it reached its second peak intensity with maximum sustained winds of 85 kt and a central pressure of 955 hPa over the South China Sea at 18 UTC on 6 October. KOINU rapidly weakened to TD intensity over the sea south of South China at 06 UTC on 09 October and then dissipated 18 hours later.

**TY BOLAVEN (2315)**

BOLAVEN formed as a tropical depression (TD) over the sea west of Marshall Islands at 06 UTC on 6 October 2023 and moved northwestward slowly. Turning westward, it was upgraded to tropical storm (TS) intensity near the Chuuk Islands at 12 UTC the next day. It moved westward and was upgraded to severe tropical storm (STS) intensity over the same waters at 18 UTC on 8 October. It turned northwestward and was further upgraded to typhoon (TY) intensity near the Mariana Islands at 00 UTC on 10 October. After turning north-northwestward, it reached its peak intensity with maximum sustained winds of 115 kt and a central pressure of 905 hPa over the same waters at 12 UTC the next day. BOLAVEN turned northeastward and accelerated, transitioned into an extratropical cyclone far off east of Japan by 12 UTC on 14 October. It further moved northeastward and turned eastward and entered the sea south of Alleutians and crossed longitude 180 degrees east before 18 UTC the next day.

**TS SANBA (2316)**

SANBA formed as a tropical depression (TD) over the South China Sea at 06 UTC on 17 October 2023 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC the next day. After moving north-northeastward, it reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 1000 hPa over the Gulf of Tonkin at 12 UTC on 19 October. Turning eastward, it weakened to TD intensity over the same waters at 00 UTC on 20 October. After turning southward, it hit the Leizhou Peninsula and dissipated at 12 UTC the same day.

**TS JELAWAT (2317)**

JELAWAT formed as a tropical depression (TD) around the Caroline Islands at 12 UTC on 15 December 2023 and moved westward. It was upgraded to tropical storm (TS) intensity at 06 UTC on 17 December and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 1002 hPa over the sea east of Mindanao Island and moved westward. It weakened to TD intensity on the Mindanao Island at 00 UTC on 18 December. Moving westward, it entered the sea southwest of Mindanao Island at 06 UTC and dissipated at 12 UTC on 18 December.