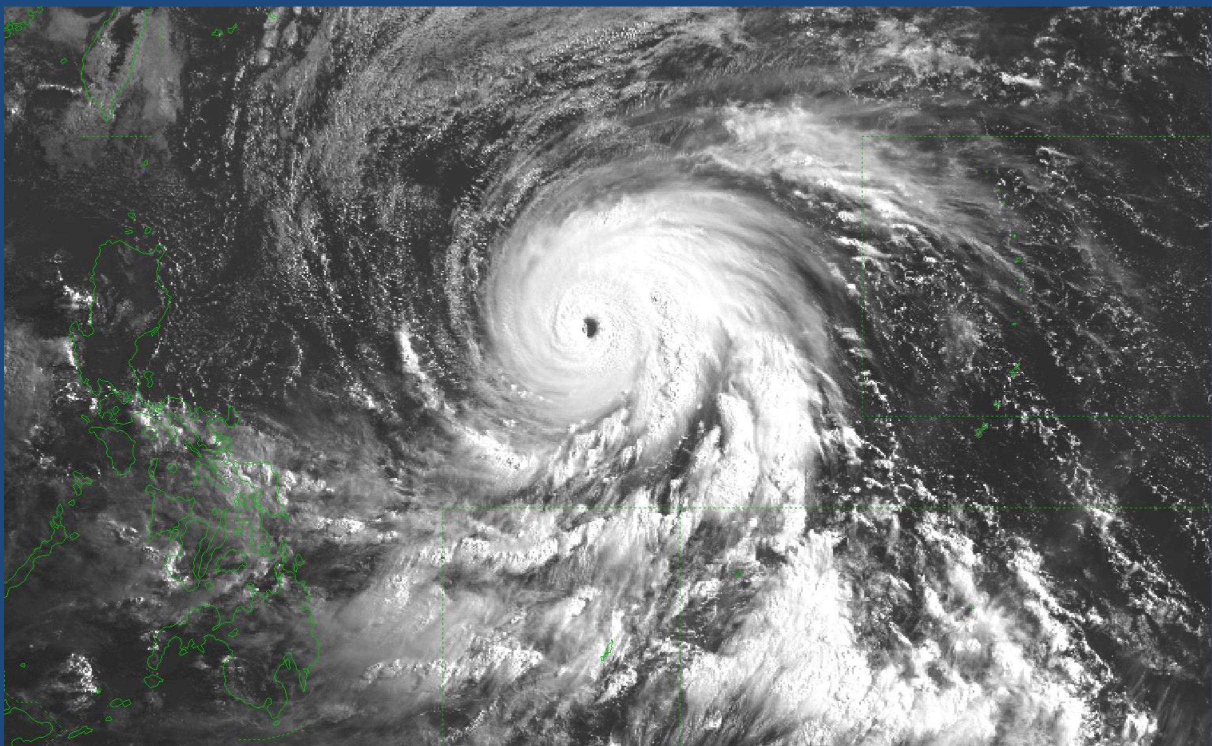
# Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2023



*TY MAWAR 22 UTC, 26 May 2023*

**Japan Meteorological Agency**

# Annual Report
# on the Activities of
# the RSMC Tokyo - Typhoon Center
# 2023

Japan Meteorological Agency

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# Introduction

The RSMC Tokyo - Typhoon Center (referred to here as the Center) is a Regional Specialized Meteorological Centre (RSMC) that carries out specialized activities in analysis, tracking and forecasting of western North Pacific tropical cyclones (TCs) within the framework of the World Weather Watch (WWW) Programme of the World Meteorological Organization (WMO). The Center was established at the headquarters of the Japan Meteorological Agency (JMA) in July 1989 following a designation by the WMO Executive Council at its 40th session (Geneva, June 1988).

The Center conducts the following operations on a routine basis:

(1) Preparation of information on the formation, movement and development of TCs and associated meteorological phenomena

(2) Preparation of information on synoptic-scale atmospheric situations that affect the behavior of TCs

(3) Provision of the above information to National Meteorological Services (NMSs), and in particular to United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)/WMO Typhoon Committee Members, in appropriate formats for operational processing

In addition to the routine services outlined above, the Center distributes a series of reports entitled *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center* as operational references for the NMSs concerned. The reports summarize the activities of the Center and review the TCs of the preceding year.

In this issue covering 2023, Chapter 1 outlines routine operations performed at the Center and its operational products, while Chapter 2 reports on its major activities in 2023. Chapter 3 describes atmospheric and oceanic conditions in the tropics and notes the highlights of TC activity in 2023. Chapter 4 presents verification statistics relating to operational forecasts (i.e., official forecasts), results from JMA's numerical weather prediction (NWP) models and other guidance models, Atmospheric Motion Vector (AMV) based Sea-surface Wind (ASWind) data, TC central pressure estimates based on satellite microwave observations and storm surge predictions. Best track data for 2023 TCs of tropical storm (TS) intensity or higher are shown in table and chart form in the appendices.

# Chapter 1
# Operations at the RSMC Tokyo - Typhoon Center in 2023

The Center's area of responsibility covers the western North Pacific and the South China Sea (0° – 60°N, 100° – 180°E) including marginal seas and adjacent land areas (Figure 1.1). The Center carries out analysis and forecasting in relation to TCs in the area and also provides the relevant NMSs with RSMC products via the Global Telecommunication System (GTS), the Aeronautical Fixed Telecommunication Network (AFTN), the Internet and other media.

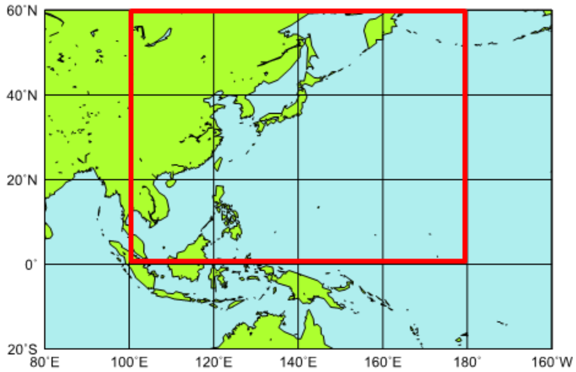



Figure 1.1
Area of responsibility of the RSMC Tokyo - Typhoon Center

## 1.1 Analysis

TC analysis is performed eight times a day at 00, 03, 06, 09, 12, 15, 18 and 21 UTC, and begins with determination of the TC's center position. Cloud imagery from Himawari-8/9 and microwave imagery from various polar orbiting satellites are the principal sources for this determination, especially for TCs migrating over data-sparse ocean areas. Information on the TC's direction and speed of movement is extracted primarily from six-hourly displacement vectors of the center position.

The maximum sustained wind speed in the vicinity of the TC's center is determined mainly from the Current Intensity (CI) number, which is derived from satellite imagery using the Dvorak method. The central pressure of the TC is then determined from the maximum sustained wind speed with the assumption of a certain pressure profile around the TC. The radii of circles representing winds with speeds exceeding 30 and 50 knots are determined mainly from surface observation, Advanced Scatterometer (ASCAT) observation and ASWind data derived from satellite images in the vicinity of the TC. The size of the central dense overcast area of the TC as observed in satellite imagery is also referenced to determine the radius of 50-knot wind speed circles.

## 1.2 Forecast

The Center issues TC track forecasts with probability circles, as well as intensity forecasts for tropical depressions (TDs) expected to reach tropical storm (TS) intensity within 24 hours and for TCs with TS intensity or higher up to 120 hours ahead. As a primary basis for TC track forecasts, JMA implements NWP using the Global Spectral Model (GSM) and the Global Ensemble Prediction System (GEPS). The GSM (TQ959, upgraded on 14 March 2023) has a horizontal resolution of approximately 13 km and 128 vertical layers, while GEPS (TQ479; upgraded on 14 March 2023) has 51 members with a horizontal resolution of approximately 27 km and the same number of vertical layers. GSM horizontal resolution was enhanced from 20 to 13 km in 2023. Further details and recent model improvements are detailed in Appendix 7. Since 2015 the Center has mainly employed a consensus method for TC track forecasts. This approach involves taking the mean of predicted TC positions from multiple deterministic models, including the GSM and other NWP centers' models, such as European Centre for Medium-Range Weather Forecasts (ECMWF), National Centers for Environmental Prediction (NCEP) and United Kingdom Met Office (UKMO) global models.

A probability circle shows the range into which the center of a TC is expected to move with 70% probability at each validation time. The radius for all forecast periods up to 120 hours is determined by the multiple ensemble method, which is solely according to the confidence level based on the cumulative ensemble spread calculated using multiple ensemble prediction systems (EPSs) consisting of ECMWF, NCEP and UKMO global EPSs in addition to GEPS.

In relation to TC intensity, the Center began providing TC intensity forecasts with extended lead times of up to 120 hours in March 2019, based on several tropical cyclone intensity forecast guidance products including Typhoon Intensity Forecasting scheme based on Statistical Hurricane Intensity Prediction Scheme (SHIPS), which is known as TIFS and Logistic Growth Equation Model (LGEM). These schemes were developed by JMA and Meteorological Research Institute (MRI) of JMA. The Center also refers to Hurricane Weather Research and Forecast model (HWRF) and Hurricane Analysis and Forecasting System (HAFS) in NCEP.

### 1.3 Provision of RSMC Products

The Center prepares and distributes the RSMC bulletins listed below via the GTS or the AFTN when:

- a TC of TS intensity or higher exists in the Center's area of responsibility
- a TD is expected to reach or exceed TS intensity in the area within 24 hours

RSMC products are issued while any TC of TS intensity or higher or any TD expected to reach or exceed TS intensity within 24 hours exists in the Center's area of responsibility. Appendix 6 denotes the code forms of the bulletins.

(1) RSMC Tropical Cyclone Advisory (WTPQ50-55 RJTD: via GTS)

The RSMC Tropical Cyclone Advisory is issued eight times a day after observations made at 00, 03 06, 09, 12, 15, 18 and 21 UTC, and reports the following elements in analysis and in 24-, 48-, 72-, 96- and 120-hour forecasts for TCs:

| | |
|---|---|
| Analysis | Center position |
| | Accuracy of center position determination |
| | Direction and speed of movement |
| | Central pressure |
| | Maximum sustained wind speed (10-minute average) |
| | Maximum gust wind speed |
| | Radii of wind areas over 50 and 30 knots |

| | |
|---|---|
| 24-, 48-, 72-, 96- and 120-hour Forecasts[1] | Center position and radius of probability circle<br>Direction and speed of movement<br>Central pressure<br>Maximum sustained wind speed (10-minute average)<br>Maximum gust wind speed |

(2) RSMC Guidance for Forecast by GSM (FXPQ20-25 RJTD: via GTS)
The RSMC Guidance for Forecast by GSM reports the results of predictions made by the GSM; which is run four times a day with initial analyses at 00, 06, 12 and 18 UTC. The guidance presents six-hourly GSM predictions for TCs up to 132 hours ahead and reports the following elements:

| | |
|---|---|
| NWP prediction (T = 006 to 132) | Center position<br>Central pressure*<br>Maximum sustained wind speed* |

** Predictions of these parameters are given as deviations from those at the initial time.*

(3) RSMC Guidance for Forecast by GEPS (FXPQ30-35 RJTD: via GTS)
The RSMC Guidance for Forecast by GEPS reports the results of predictions made by the GEPS; which is run four times a day with initial analyses at 00, 06, 12 and 18 UTC. The guidance presents the ensemble mean of GEPS six-hourly predictions up to 132 hours ahead and reports the following elements:

| | |
|---|---|
| NWP prediction (T = 006 to 132) | Center position<br>Central pressure*<br>Maximum sustained wind speed* |

** Predictions of these parameters are given as deviations from those at the initial time.*

(4) SAREP (IUCC10 RJTD: via GTS)
The SAREP in BUFR format reports the results of TC analysis including intensity information (i.e., the CI number) based on the Dvorak method. It is issued shortly after observations made for TCs with TS intensity or higher at 00, 03, 06, 09, 12, 15, 18 and 21 UTC (TDs expected to reach TS intensity or higher within 24 hours at 00, 06, 12 and 18), and reports the following elements:

| | |
|---|---|
| Himawari-8/9 imagery analysis | Center position<br>Accuracy of center position determination<br>Direction and speed of movement<br>Mean diameter of overcast cloud<br>Apparent past 24-hour change in intensity**<br>Dvorak Intensity (CI, T, DT, MET, PT number) **<br>Cloud pattern type of the DT number**<br>Trend of past 24-hour change**<br>Cloud pattern type of the PT number**<br>Type of the final T-number** |

*** Reported only at 00, 06, 12 and 18 UTC*

BUFR/CREX templates for translation into table-driven code forms are provided on the WMO website

[1] At 03, 09, 15 and 21 UTC, 24-, 45-, 69-, 93- and 117-hour forecasts for TCs are reported.

at https://community.wmo.int/activity-areas/wis/wis-manuals. The SAREP is provided in text format on the Numerical Typhoon Prediction (NTP) website (see 1.7).

(5) RSMC Prognostic Reasoning (WTPQ30-35 RJTD: via GTS)
The RSMC Prognostic Reasoning report provides brief reasoning for TC analysis and forecasts, and is issued at 00, 06, 12 and 18 UTC following the issuance of the RSMC Tropical Cyclone Advisory. The bulletin provides general comments on current positioning, intensity and related changes, synoptic situations such as those of the subtropical high and atmospheric/oceanographic fields, reasoning behind TC track and intensity forecasts (including details of methodology and guidance models), and relevant remarks in plain language.

(6) RSMC Tropical Cyclone Best Track (AXPQ20 RJTD: via GTS)
The RSMC Tropical Cyclone Best Track report provides post-analysis data on TCs of TS intensity or higher. It reports the center position, the central pressure and the maximum sustained wind speed. The best track for each TC is usually finalized three months after the termination of related issuance of the above RSMC bulletins.

(7) Tropical Cyclone Advisory for SIGMET (FKPQ30-35 RJTD: via AFTN, and IWXXM 3.0 format: via AMHS (see 1.4))
As a Tropical Cyclone Advisory Centre (TCAC) within the framework of the International Civil Aviation Organization (ICAO), the Center provides Tropical Cyclone Advisory (TCA) for SIGMET to Meteorological Watch Offices (MWOs) in order to support their preparations of SIGMET information on TCs. These advisories include the following elements in analysis and in 6-, 12-, 18- and 24-hour forecasts:

| | |
|---|---|
| Analysis | Center position |
| | Observed CB cloud |
| | Direction and speed of movement |
| | Changes in intensity |
| | Central pressure |
| | Maximum sustained wind speed (10-minute average) |
| Forecast | Center position |
| | Maximum sustained wind speed (10-minute average) |

## 1.4 Tropical Cyclone Advisory for SIGMET

The Center provides text-format and graphical TCAs in its role as the ICAO TCAC. These include the horizontal extent of cumulonimbus cloud and cloud top height associated with TCs potentially affecting aviation safety, in addition to text-format TCA information. Both text-format and graphical TCAs and related specifications are provided online for users via linkage from the NTP website (see 1.7), and graphical TCAs are also provided to World Area Forecast Centres (WAFCs).

In November 2020, TCAs in IWXXM 3.0 format were introduced and shared on the TCAC Tokyo website, followed by transmission via Air Traffic Services (ATS) Message Handling Services (AMHS) in March 2022. The IWXXM format is detailed in Guidelines for the Implementation of OPMET Data Exchange Using IWXXM, Third Edition (May 2019), ICAO.

## 1.5 WIS Global Information System Center Tokyo Server

As designated at the Sixteenth WMO Congress in June 2011, the Center introduced Data Collection or Production Centre (DCPC) service under the Global Information System Centre (GISC) Tokyo for the WMO Information System (WIS) in August 2011. It provides NWP products such as data on predicted fields in grid-point-value (GPV) form and observational values through WIS Data Discovery, Access and Retrieval (DAR) via a GISC Tokyo server (https://www.wis-jma.go.jp/). GSM products with resolution of 0.5 and 0.25 degrees (surface layer) and JMA SATAID (SATellite Animation and Interactive Diagnosis; https://www.wis-jma.go.jp/cms/sataid/) Service are also available from the server through WIS DAR. All products available via the server are listed in Appendix 8.

## 1.6 RSMC Tokyo - Typhoon Center Website

The RSMC Tokyo - Typhoon Center Website provides TC advisories on a real-time basis and a wide variety of products including TC analysis archives, technical reviews and annual reports on the Center's activities at https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.html. Since November 2012, the website provides experimental TC advisory information in Common Alert Protocol (CAP) format.

## 1.7 Numerical Typhoon Prediction Website

Since October 2004, the Center has operated the Numerical Typhoon Prediction (NTP) website to assist the NMSs of Typhoon Committee Members in improving their TC forecasting and warning services. The site provides TC track predictions and weather maps of deterministic global NWP models from nine centers (Bureau of Meteorology (BoM, Australia), China Meteorological Administration (CMA, China), Canadian Meteorological Centre (CMC, Canada), Deutscher Wetterdienst (DWD, Germany), ECMWF, Korea Meteorological Administration (KMA, Republic of Korea), NCEP (USA), UKMO (UK) and JMA), ensemble TC track predictions of global EPSs from four centers (ECMWF, NCEP, UKMO and JMA) and a wide variety of products including the results of the Center's TC analysis, upper-air analysis, ocean analysis, storm surge and ocean wave forecasting. All products available on the website are listed in Appendix 9.

## 1.8 TC Communication platform

The Center's TC communication platform (developed and maintained since July 2019) supports enhanced interaction between operational forecasters in the NMSs of Typhoon Committee Members and the Center, as well as sharing of advance-notice updates. Full-scale operation of the platform was started during the 2021 typhoon season and related discussions have helped to clarify TC status and forecasts. All services provided on the platform are listed in Appendix 9.

# Chapter 2
# Major Activities of the RSMC Tokyo - Typhoon Center in 2023

## 2.1 Provision of RSMC Products

The Center provides operational products for TC forecasting to NMSs via the GTS, the AFTN and other networks. Monthly and annual totals of products issued in 2023 are listed in Table 2.1.

Table 2.1 Monthly and annual totals of products issued by the RSMC Tokyo - Typhoon Center in 2023

| Product | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IUCC10 | 0 | 0 | 0 | 27 | 96 | 72 | 138 | 336 | 108 | 153 | 4 | 12 | 946 |
| WTPQ30-35 | 0 | 0 | 0 | 19 | 50 | 37 | 77 | 177 | 57 | 80 | 5 | 8 | 510 |
| WTPQ50-55 | 0 | 0 | 0 | 37 | 101 | 76 | 156 | 359 | 118 | 164 | 8 | 17 | 1036 |
| FXPQ20-25 | 0 | 0 | 0 | 18 | 50 | 37 | 77 | 177 | 57 | 80 | 4 | 8 | 508 |
| FXPQ30-35 | 0 | 0 | 0 | 18 | 50 | 37 | 77 | 177 | 57 | 80 | 4 | 8 | 508 |
| FKPQ30-35 | 0 | 0 | 0 | 18 | 51 | 37 | 77 | 177 | 57 | 80 | 4 | 8 | 509 |
| AXPQ20 | 9 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 7 | 0 | 22 |

Notes:

| | |
|---|---|
| IUCC10 RJTD | SAREP (BUFR format) |
| WTPQ30-35 RJTD | RSMC Prognostic Reasoning |
| WTPQ50-55 RJTD | RSMC Tropical Cyclone Advisory |
| FXPQ20-25 RJTD | RSMC Guidance for Forecast by GSM |
| FXPQ30-35 RJTD | RSMC Guidance for Forecast by GEPS |
| FKPQ30-35 RJTD | Tropical Cyclone Advisory for SIGMET |
| AXPQ20 RJTD | RSMC Tropical Cyclone Best Track |

## 2.2 Publications

In May and December 2023, the Center published the 25th and 26th issues of the RSMC Technical Review with the following areas of focus:

1. Upgrade of JMA's Storm Surge Prediction for the WMO Storm Surge Watch Scheme (SSWS) in 2022
2. JMA 30-year Dvorak Reanalysis for the Western North Pacific

In January 2024, the Center published the *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2022*. Both publications are available on the Center's website at https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.html.

### 2.3 Typhoon Committee Attachment Training

The Center has organized ESCAP/WMO Typhoon Committee Attachment Training courses every fiscal year since 2001 with the support of the WMO Tropical Cyclone Programme and the Typhoon Committee in order to advance the TC analysis and forecasting capacity of Committee Members.

In 2023, amid the COVID-19 pandemic, the 22nd course was held online (as in March 2021 and January 2022) from 11 to 13 January 2023 with 51 attendees from eight Typhoon Committee Members (China, Hong Kong China, Macao China, Malaysia, the Philippines, the Republic of Korea, Thailand and the United States of America), along with one invited lecturer. The course was enhanced with hands-on training materials for self-study and with interactive exercises on satellite analysis techniques/Dvorak analysis. The Center highlighted the purposes of the course as set out under Category 2 Unit of the Tropical Cyclone Forecast Competency in the Typhoon Committee Region specifications of the Typhoon Committee Operational Manual (TOM).

In addition, preparations were made for the 23rd event to be held from 15 to 26 January 2024. Amid the COVID-19 pandemic, the course had been held virtually for three years, but this one was held in person with attendees from seven Typhoon Committee Members (Hong Kong China, Lao PDR, Macao China, Malaysia, the Philippines, the Republic of Korea, and Vietnam) and two from the Panel on Tropical Cyclones (PTC) (Saudi Arabia and Sri Lanka). Presentations included content from researchers and Japanese experts from the Typhoon Committee’s Hydro and Disaster Risk Reduction group, and from weathercasting professionals, to give a broad perspective and contribute to the UN’s EW4All initiative.

The Center is committed to improving forecasting competence, and thereby the capacity of Meteorological Services in the Typhoon Committee region, via training to meet various regional needs, including basic application, state-of-the-art tropical cyclone forecasting and monitoring techniques/methodologies.

### 2.4 Other Activities in 2023

#### 2.4.1 Services Introduced in 2023

Update of probability-circle radii for tropical cyclone track forecasts

On 26 June 2023, the Center updated its 70% probability-circle radii based on recent improvements in forecast accuracy. Radii for two days ahead and beyond have been reduced, with those for five days ahead now being up to 40% smaller.

# Chapter 3
# Summary of the 2023 Typhoon Season

In 2023, 17 TCs of TS intensity or higher formed over the western North Pacific and the South China Sea. This total was below the climatological normal[2] frequency of 25.1. Among these 17 TCs, 10 reached Typhoon (TY) intensity, 2 reached severe tropical storm (STS) intensity and 5 reached TS intensity (Table 3.1).

Table 3.1 List of tropical cyclones reaching TS intensity or higher in 2023

| Tropical Cyclone | | | Duration (UTC) (TS or higher) | Minimum Central Pressure (UTC) | lat(N) | long(E) | (hPa) | Max Wind (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 |

## 3.1 Atmospheric and Oceanographic Conditions in the Tropics

In association with the La Niña event that began in boreal autumn 2021 (September – November 2021) and terminated in winter 2023 (December 2022 – February 2023), significantly positive SST anomalies were observed in the western part of the equatorial Pacific and negative SST anomalies were seen from central to eastern parts from autumn 2021 to winter 2023. Tropical convection was enhanced from the eastern Indian Ocean to Southeastern Asia, and was suppressed near the date line in the equatorial Pacific.

An El Niño event occurred in boreal spring 2023 (March – May), and developed through boreal autumn. In association, SSTs in the eastern equatorial Pacific increased, and significantly positive SST anomalies emerged in the western and eastern equatorial Pacific in spring. Influences from these anomalous temperatures on atmospheric circulation were seen in the tropics. Tropical convection in spring was enhanced over the latitude bands from 10 to 20˚N in the western and central tropical Pacific, and was suppressed from

[2] The base period for the climatological normal is 1991 – 2020. The normal was updated in early 2021 based on 30-year data.

the Indochina Peninsula to the eastern Indian Ocean and over the equatorial central South Pacific.

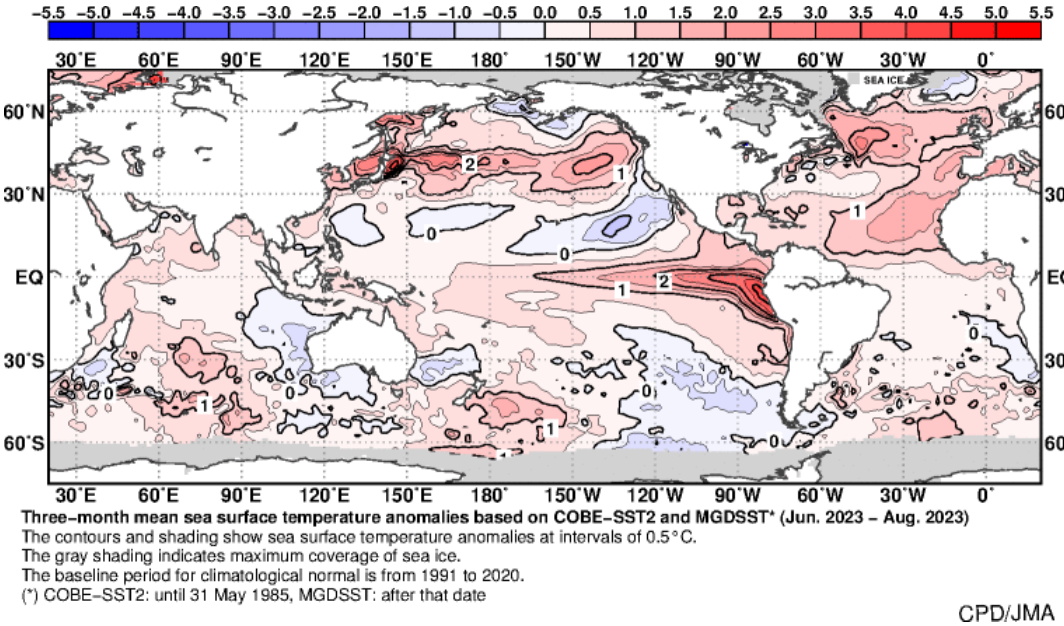
In summer (June – August), positive SST anomalies over a wide area of the equatorial Pacific were observed, with significant values from central to eastern parts. In the tropical Indian Ocean, significantly positive anomalies were also seen from the Bay of Bengal to the tropical western part and negative anomalies were seen in the tropical southeastern part, indicating the positive phase of an Indian Ocean Dipole (IOD) event (Figure 3.1 (a)). Tropical convection was enhanced from seas east of the Philippines to the western equatorial Pacific and over the equatorward-shifted intertropical convergence zone in the eastern Pacific, and was suppressed in the Indian Ocean (Figure 3.1 (b)). In the lower troposphere, anti-cyclonic circulation anomalies straddling the equator were seen over the Indian Ocean, and cyclonic circulation anomalies were seen to the south of Japan (Figure 3.1 (c)). The circulation anomalies over the tropical Pacific correspond to equatorward-shifted enhanced convection over the eastern tropical Pacific, suggesting an influence from the El Niño event.

In autumn the El Niño event persisted, and positive SST anomalies were observed over a wide area of the equatorial Pacific, accompanied by significant positive anomalies from central to eastern parts. In the tropical Indian Ocean, significantly positive SST anomalies were seen in the western part and significantly negative anomalies were seen in the southeastern part, corresponding to the positive phase of the IOD event that started in boreal summer. Tropical convection was enhanced in the equatorial Pacific and the western Indian Ocean and suppressed from the eastern Indian Ocean to Indonesia. In the lower troposphere, anti-cyclonic circulation anomalies straddling the equator were seen over the Indian Ocean. Anti-cyclonic circulation anomalies were also seen in the subtropics from the South China Sea to the western North Pacific. Those from the Indian Ocean to the Pacific in the tropics corresponded to tropical convection, suggesting influences from the persistent El Niño event and the positive phase of the IOD.

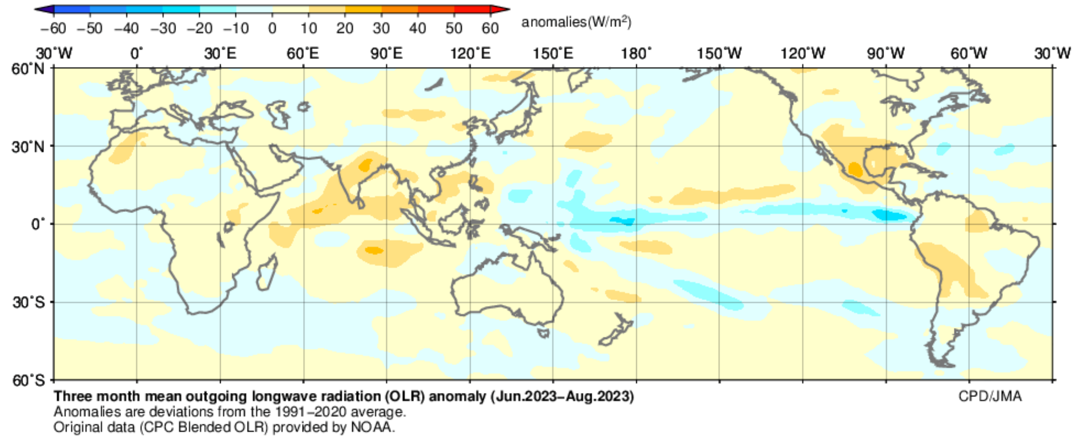
Atmospheric and oceanographic charts (including monthly mean streamlines at 850 and 200 hPa, OLRs[3] with related anomalies, and monthly mean SSTs with related anomalies for the western North Pacific and the South China Sea) are provided on the Tokyo Climate Center website at
https://www.data.jma.go.jp/tcc/tcc/products/clisys/figures/db_hist_mon_tcc.html and
https://www.data.jma.go.jp/tcc/tcc/products/elnino/ocean/index_tcc.html.

[3] OLR data were calculated using information provided by the Climate Prediction Center/NOAA at https://www.cpc.ncep.noaa.gov/products/global_precip/html/wpage.olr.html.

(a)




(b)




(c)

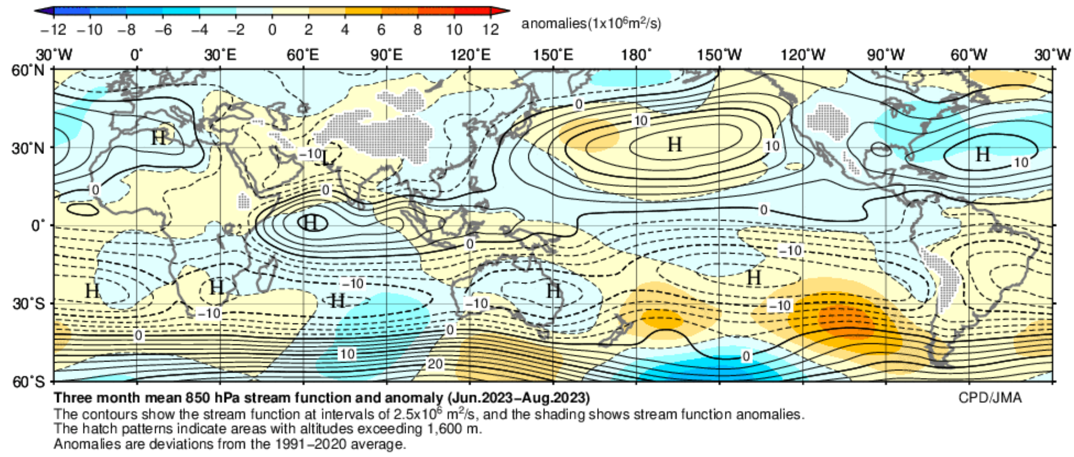



Figure 3.1 Three-month mean (a) sea surface temperature (SST) anomaly, (b) outgoing longwave radiation (OLR) anomaly, and (c) 850-hPa stream function (contours) and related anomaly (shading) in boreal summer (June – August 2023)

The base period for the normal is 1991 – 2020. (a) The contour interval is 0.5°C. Sea ice coverage areas are shaded in gray. (b) Negative (cold color) and positive (warm color) OLR anomalies show enhanced and suppressed convection, respectively, compared to the normal. Original data is provided by NOAA. (c) The contour interval is 2.5 x $10^6$ $m^2/s$. “H” and “L” denote high- and low-pressure systems, respectively.

### 3.2 Tropical Cyclones in 2023

A total of 17 named TCs formed over the western North Pacific and the South China Sea in 2023, which was below the climatological normal. Monthly and normal numbers of named TC formations are shown in Figure 3.2, and the tracks of the 17 TCs are shown in Figure 3.3. Figure 3.4 shows the genesis points of these TCs (dots) and related frequency distribution for past years (1951 – 2022).

The 2023 typhoon season started in April with Sanvu (2301), which formed over the sea southwest of the Marshall Islands. Only five typhoons formed from September onward, which was the lowest since records began. The lower number of formations during the peak period may have contributed to the reduced annual total. This situation may be related to the fact that the monsoon trough and the low-pressure area extending from the South China Sea to the Philippines in autumn were weaker than the climatological normal, and convective activity in this area was inactive.

The mean genesis point of named TCs was 15.1˚N and 137.9˚E, representing a south-eastward deviation from that of the 30-year average[4] (16.3˚N and 135.9˚E) (see Figure 3.4). The mean genesis point of named TCs formed in summer (June to August) was 17.0˚N and 138.2˚E, with south-eastward deviation from that of the 30-year summer average (18.5˚N and 134.2˚E), and that of named TCs formed in autumn (September to November) was 16.3˚N and 131.8˚E, with westward deviation from that of 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 2023.

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

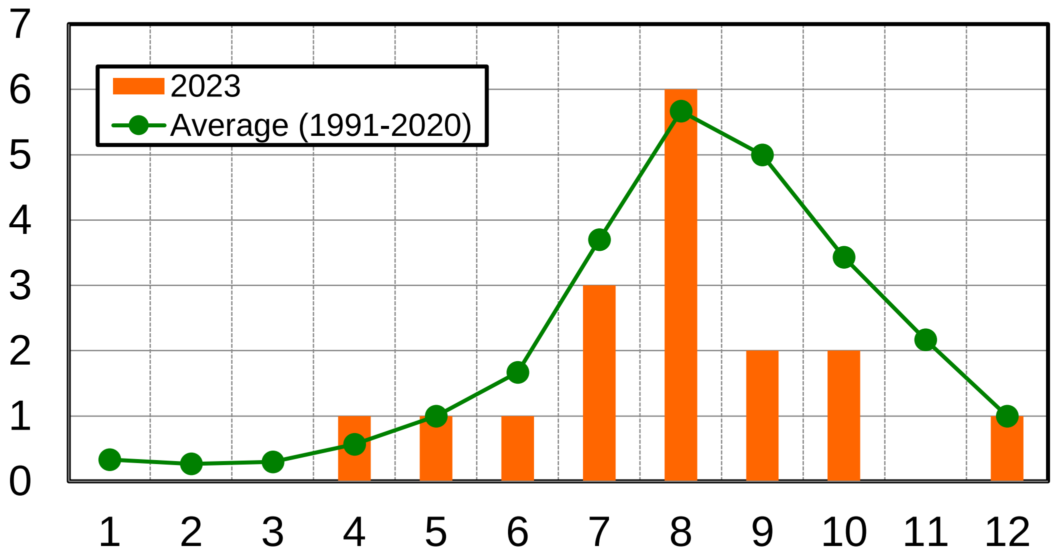



Figure 3.2 Monthly number of named TC formation for 2023 compared to the climatological normal

4 The 30-year averaging period is from 1991 to 2020.

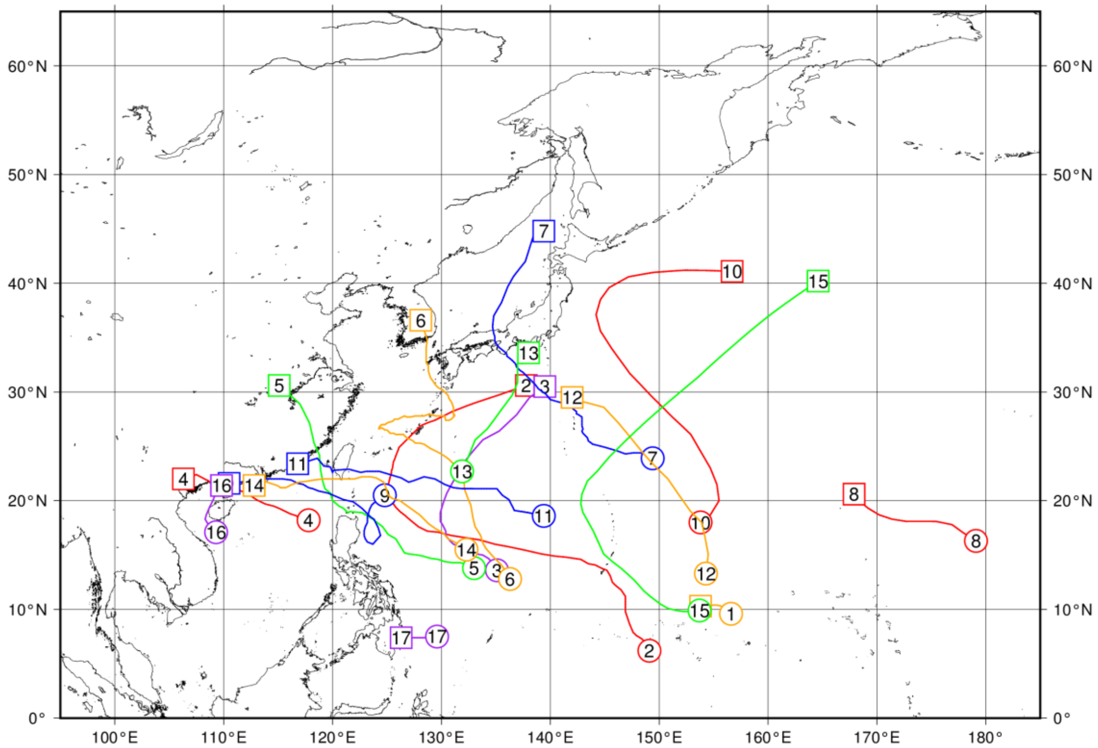



Figure 3.3 Tracks of the 17 named TCs that formed in 2023. TC tracks for those with an intensity of TS or higher are shown.

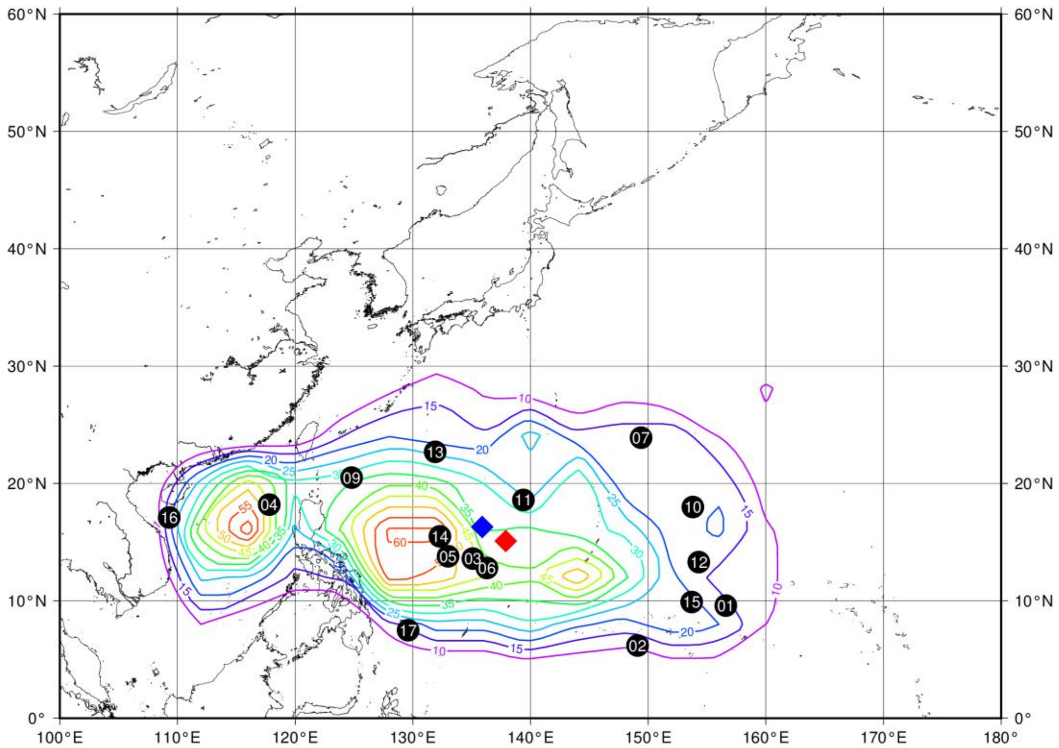



Figure 3.4 Genesis points of the 17 named TCs forming in 2023 (dots) and related frequency distribution for 1951 - 2022 (lines). Red and blue diamonds show the mean genesis points of TCs forming in 2023 and the 30-year average period (1991 – 2020), respectively.

# Chapter 4
# Verification of Forecasts and Other Products in 2023

## 4.1 Verification of Operational Forecasts

Operational forecasts for the 17 TCs of TS intensity or higher that formed in 2023 were verified using RSMC TC best track data[5]. The verified elements were forecasts of the center position, central pressure and maximum sustained wind speed (up to five days ahead). In addition to forecast errors, improvement ratios of forecast errors to climatological model were also evaluated to assess operational forecast skill. Forecasts issued at 00, 06, 12 and 18 UTC were included in verification for TCs classified in best track data as TS, STS or TY at both initial and forecast valid times. The position and intensity errors of such operational forecasts are shown in bold face in Appendix 3. (Those for TD before upgrading into TS intensity or higher are indicated in italic face in Appendix 3.)

### 4.1.1 Center Position

Figure 4.1 shows annual mean errors in TC track forecasts covering periods of 24 hours (since 1982), 48 hours (since 1989), 72 hours (since 1997), 96 hours and 120 hours (since 2009). It can be seen that operational TC track forecasts have steadily improved since 1982, although year-to-year fluctuations are seen due in part to differences in TC characteristics. The improvement observed since 2015 is partially attributed to the introduction of the consensus method using four global numerical models of ECMWF, JMA, NCEP and UKMO for operational forecasts in that year. The errors in 2023 were 61, 110, 165, 249 and 356 km for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively. 24-, 48- and 72-hour forecast errors in 2023 were the lowest on record.

The annual mean improvement ratios in relation to the climatology and persistence model (CLIPER)[6] for TC track prediction since 2011 are shown in Figure 4.2 to support evaluation of the operational forecast skill. The values are defined as

$$\frac{\text{Mean Position Error (CLIPER)} - \text{Mean Position Error (Operational)}}{\text{Mean Position Error (CLIPER)}}$$

and positive/negative values indicate that the operational forecasts were better/worse than the CLIPER predictions. Although there are year-to-year fluctuations, it can be seen that operational forecasts have steadily improved in the long run. The annual mean improvement ratios for 24-, 48-, 72-, 96- and 120-hour forecasts in 2023 were 59% (61% in 2022), 69% (69%), 72% (73%), 70% (77%) and 68% (74%), respectively.

The details of errors including improvement ratios to CLIPER for each named TC that formed in 2023 are summarized in Table 4.1. Forecasts for Haikui (2311) was characterized by large errors. Those in forecasts for Haikui (2311) are attributable to the fact that guidance models predict more northwest-northern tracks than reality. Meanwhile, forecasts for Lan (2307) and Koinu (2314) showed relatively small errors.

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[5] Maximum sustained wind of TD is not described in best track data or operational forecast. Therefore, maximum sustained wind of TD was treated as 30 kt for convenience in verification in 4.1.

[6] The Center operates the CLIPER model based on Aberson (1998), Neumann (1972) and Merrill (1980). The model outputs no information on current atmospheric status, but best track data such as TC center position/central pressure/movement and dates are referenced. Multiple regression coefficients for the model were generated from best track data between 1980 and 2010.

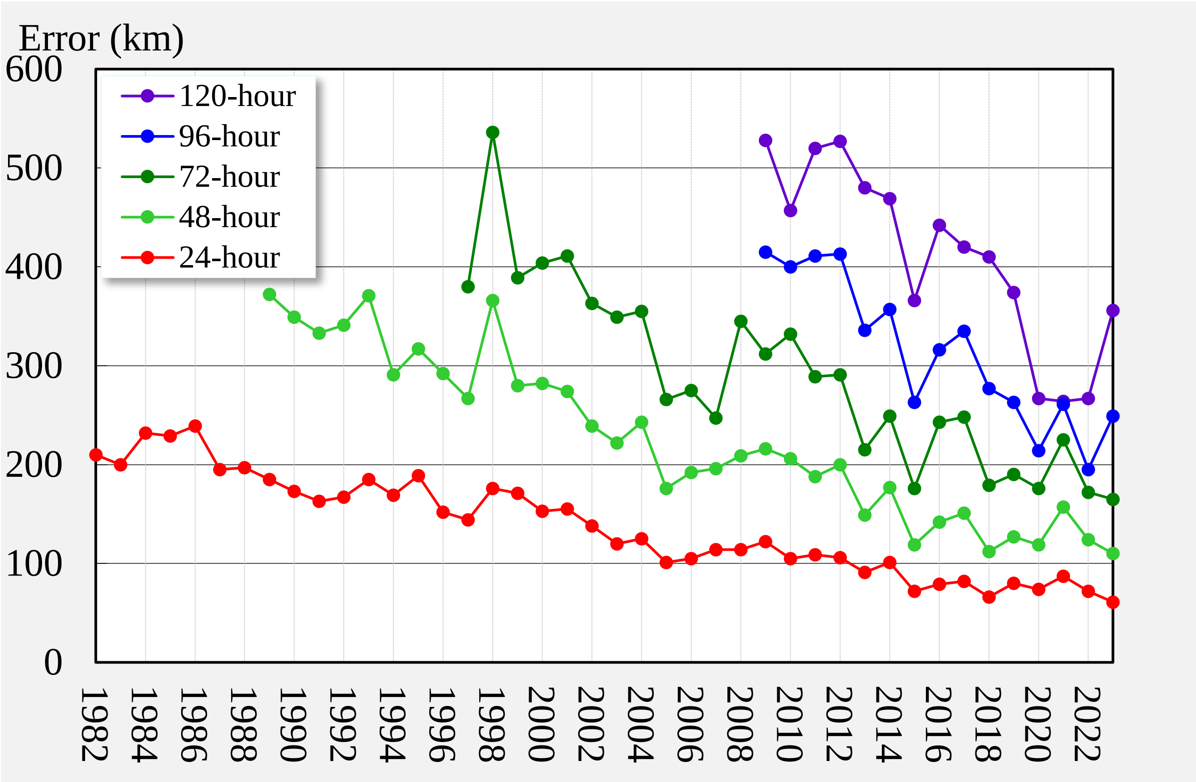


Figure 4.1 Annual mean position errors in 24-, 48-, 72-, 96- and 120-hour operational track forecasts

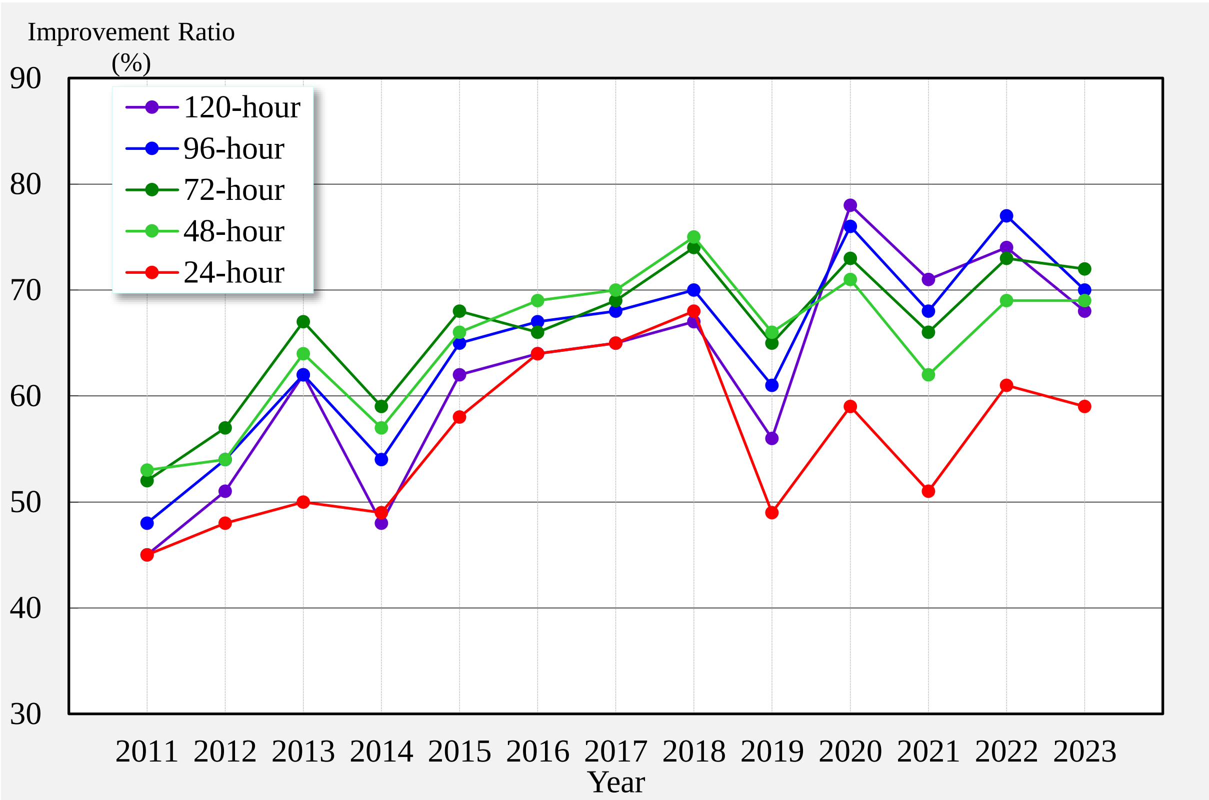


Figure 4.2 Annual mean improvement ratios in 24-, 48-, 72-, 96- and 120-hour operational track forecasts.

Table 4.1 Mean position errors of 24-, 48-, 72-, 96- and 120-hour operational forecasts for each named TC that formed in 2023. S.D., Impr. and Num. represent the standard deviation of operational forecast position errors, improvement ratio (see the equation in 4.1.1 for detail) and number of samples, respectively.

| Tropical Cyclone | 24-hour Forecast | | | | 48-hour Forecast | | | | 72-hour Forecast | | | | 96-hour Forecast | | | | 120-hour Forecast | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (km) | S.D. (km) | Num. | Impr. (%) | Mean (km) | S.D. (km) | Num. | Impr. (%) | Mean (km) | S.D. (km) | Num. | Impr. (%) | Mean (km) | S.D. (km) | Num. | Impr. (%) | Mean (km) | S.D. (km) | Num. | Impr. (%) |
| TS Sanvu (2301) | 67 | 21 | 2 | 27 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY Mawar (2302) | 43 | 29 | 50 | 66 | 98 | 43 | 46 | 71 | 158 | 91 | 42 | 75 | 210 | 156 | 38 | 80 | 240 | 237 | 34 | 83 |
| TY Guchol (2303) | 38 | 23 | 20 | 68 | 90 | 64 | 16 | 71 | 174 | 107 | 12 | 65 | 250 | 86 | 8 | 63 | 406 | 31 | 4 | 9 |
| STS Talim (2304) | 38 | 16 | 9 | 69 | 72 | 24 | 5 | 80 | 170 | 0 | 1 | 81 | - | - | 0 | - | - | - | 0 | - |
| TY Doksuri (2305) | 46 | 29 | 28 | 66 | 79 | 41 | 24 | 69 | 144 | 48 | 20 | 43 | 232 | 102 | 16 | 15 | 323 | 133 | 12 | 17 |
| TY Khanun (2306) | 53 | 42 | 49 | 61 | 101 | 85 | 45 | 73 | 161 | 133 | 41 | 75 | 271 | 158 | 37 | 68 | 419 | 193 | 33 | 59 |
| TY Lan (2307) | 33 | 28 | 33 | 71 | 44 | 26 | 29 | 85 | 68 | 33 | 25 | 85 | 121 | 49 | 21 | 78 | 192 | 74 | 17 | 69 |
| TY Dora (2308) | 76 | 43 | 7 | 57 | 128 | 35 | 3 | 44 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY Saola (2309) | 59 | 26 | 34 | 62 | 100 | 40 | 30 | 73 | 141 | 38 | 26 | 76 | 210 | 69 | 22 | 71 | 307 | 82 | 18 | 63 |
| STS Damrey (2310) | 52 | 27 | 14 | 85 | 70 | 62 | 10 | 91 | 109 | 30 | 6 | 90 | 320 | 137 | 2 | 75 | - | - | 0 | - |
| TY Haikui (2311) | 119 | 90 | 25 | 26 | 251 | 144 | 21 | 8 | 385 | 180 | 17 | 12 | 626 | 195 | 13 | 15 | 1046 | 176 | 9 | 10 |
| TS Kirogi (2312) | 139 | 30 | 10 | 46 | 216 | 48 | 6 | 67 | 314 | 45 | 2 | 72 | - | - | 0 | - | - | - | 0 | - |
| TS Yun-yeung (2313) | 128 | 42 | 8 | 52 | 256 | 81 | 4 | 56 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY Koinu (2314) | 64 | 34 | 34 | 47 | 107 | 65 | 30 | 68 | 134 | 78 | 26 | 79 | 178 | 78 | 21 | 84 | 215 | 115 | 17 | 86 |
| TY Bolaven (2315) | 73 | 59 | 24 | 43 | 148 | 138 | 20 | 61 | 218 | 194 | 16 | 73 | 331 | 247 | 12 | 76 | 597 | 199 | 8 | 72 |
| TS Sanba (2316) | 98 | 41 | 4 | 53 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS Jelawat (2317) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| Annual Mean (Total) | 61 | 49 | 351 | 59 | 110 | 91 | 289 | 69 | 165 | 128 | 234 | 72 | 249 | 179 | 190 | 70 | 356 | 264 | 152 | 68 |

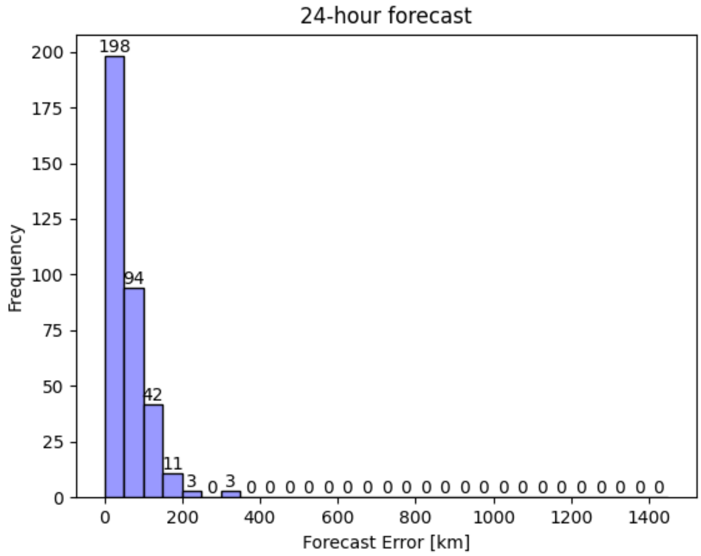


Figure 4.3 Histogram of 24-hour forecast position errors in 2023 (Histograms for 48-, 72-, 96- and 120-hour forecasts are available in the Appendix 5)

Figure 4.3 shows a histogram of 24-hour forecast position errors (histograms for 48-, 72-, 96- and 120-hour forecasts are available in Appendix 5). About 95% (91% in 2022) of 24-hour forecasts, 95% (94%) of 48-hour forecasts, 97% (95%) of 72-hour forecasts, 89% (96%) of 96-hour forecasts and 82% (96%) of 120-hour forecasts had errors of less than 150, 300, 450, 500 and 600 km, respectively.

Figure 4.4 shows frequency distributions of 48-hour forecast position errors in longitudinal/latitudinal direction and cross-track/along-track direction (Scatter diagrams of 24-, 72-, 96- and 120-hour forecasts are available in Appendix 5). While mean position biases are relatively small, a clear slow bias for Bolaven (2315) after recurvature is seen.

Table 4.2 presents the mean hitting ratios and radii of 70% probability circles[7] provided in operational forecasts for each named TC that formed in 2023. The term hitting ratio here is used to describe the ratio of the number of 70% probability circles within which the actual TC center fell to the total number of circles. The annual mean radius of circles provided in 24-hour position forecasts was 86 km (89 km in 2022), and their hitting ratio was 80% (73%). The corresponding values for 48-hour forecasts were 148 km (159 km in 2022) and 76% (72%), those for 72-hour forecasts were 217 km (258 km in 2022) and 75% (85%), those for 96-hour forecasts were 284 km (385 km in 2022) and 68% (95%), and those for 120-hour forecasts were 370 km (564 km in 2022) and 61% (94%).

[7] Probability circle: a circular range in which a TC is expected to be located with a probability of 70% at each forecast period

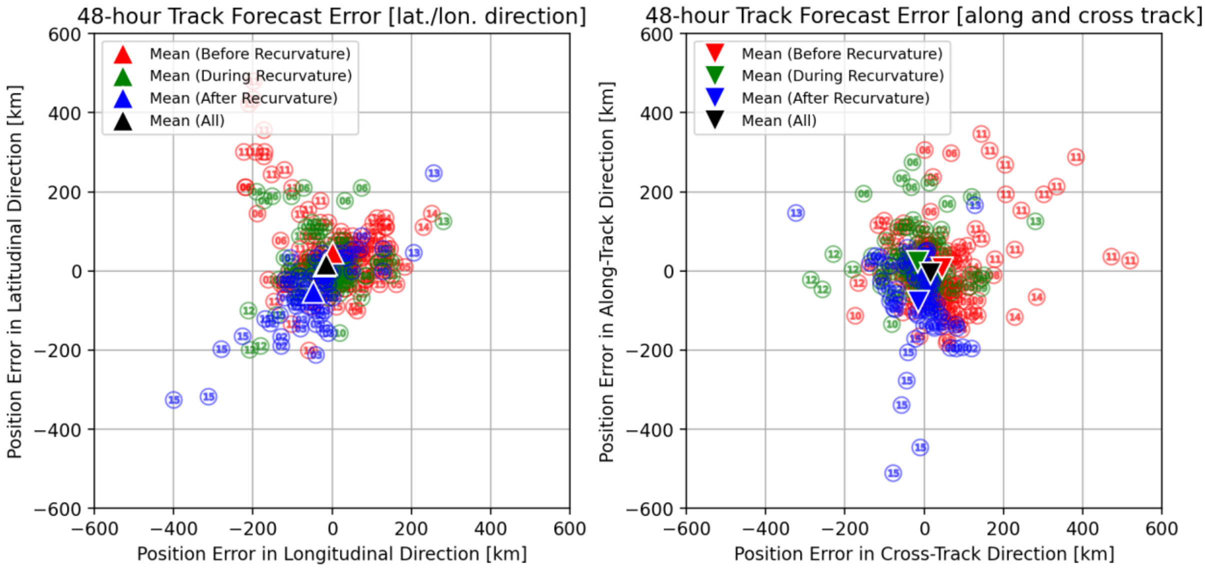


Figure 4.4 Scatter diagrams of 48-hour forecast position errors in longitudinal/latitudinal direction (left) and cross-/along-track direction (right) in 2023. (Scatter diagrams of 24-, 72-, 96- and 120-hour forecasts are available in Appendix 5.) Red, green and blue circles with TC numbers denote biases for each initial time in the stages before, during and after recurvature, respectively. Red, green and blue triangles indicate mean biases in the stages before, during and after recurvature, respectively. The definition of the stages is based on the direction of movement of each TC at individual prediction times (Figure 4.5). Black triangles indicate mean bias for all initial time.

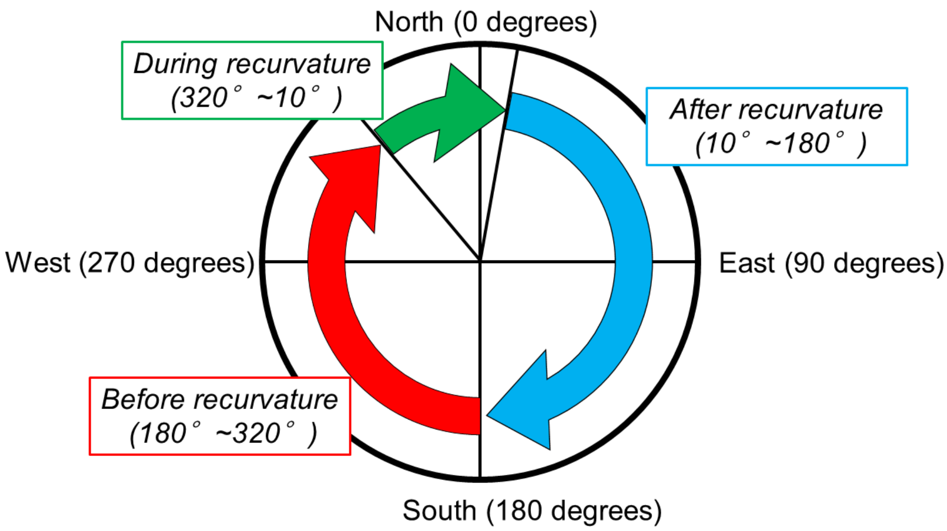


Figure 4.5 Definition of the stages before, during and after recurvature based on TC direction as calculated from positions at individual prediction times and those observed six hours prior.

Table 4.2 Mean hitting ratios (%) and radii (km) of 70% probability circles provided in 24-, 48-, 72-, 96- and 120-hour operational forecasts for each named TC that formed in 2023. Num. represents the number of samples.

| Tropical Cyclone | | | 24-hour Forecast | | | 48-hour Forecast | | | 72-hour Forecast | | | 96-hour Forecast | | | 120-hour Forecast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ratio (%) | Num. | Radius (km) | Ratio (%) | Num. | Radius (km) | Ratio (%) | Num. | Radius (km) | Ratio (%) | Num. | Radius (km) | Ratio (%) | Num. | Radius (km) |
| TS | Sanvu | (2301) | 100 | 2 | 106 | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Mawar | (2302) | 84 | 50 | 70 | 78 | 46 | 124 | 76 | 42 | 199 | 76 | 38 | 281 | 82 | 34 | 407 |
| TY | Guchol | (2303) | 95 | 20 | 68 | 63 | 16 | 118 | 58 | 12 | 194 | 50 | 8 | 280 | 50 | 4 | 426 |
| STS | Talim | (2304) | 89 | 9 | 80 | 100 | 5 | 148 | 100 | 1 | 222 | - | 0 | - | - | 0 | - |
| TY | Doksuri | (2305) | 93 | 28 | 87 | 92 | 24 | 142 | 90 | 20 | 204 | 63 | 16 | 258 | 50 | 12 | 315 |
| TY | Khanun | (2306) | 84 | 49 | 76 | 71 | 45 | 123 | 66 | 41 | 182 | 46 | 37 | 244 | 30 | 33 | 312 |
| TY | Lan | (2307) | 91 | 33 | 70 | 93 | 29 | 126 | 100 | 25 | 203 | 100 | 21 | 282 | 100 | 17 | 360 |
| TY | Dora | (2308) | 57 | 7 | 104 | 100 | 3 | 167 | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Saola | (2309) | 82 | 34 | 81 | 80 | 30 | 145 | 88 | 26 | 218 | 91 | 22 | 276 | 67 | 18 | 342 |
| STS | Damrey | (2310) | 100 | 14 | 109 | 100 | 10 | 210 | 100 | 6 | 296 | 50 | 2 | 370 | - | 0 | - |
| TY | Haikui | (2311) | 60 | 25 | 115 | 48 | 21 | 210 | 29 | 17 | 296 | 15 | 13 | 370 | 0 | 9 | 463 |
| TS | Kirogi | (2312) | 10 | 10 | 120 | 50 | 6 | 213 | 50 | 2 | 296 | - | 0 | - | - | 0 | - |
| TS | Yun-yeung | (2313) | 38 | 8 | 120 | 50 | 4 | 213 | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Koinu | (2314) | 79 | 34 | 93 | 73 | 30 | 160 | 81 | 26 | 231 | 86 | 21 | 295 | 88 | 17 | 383 |
| TY | Bolaven | (2315) | 75 | 24 | 95 | 70 | 20 | 177 | 63 | 16 | 259 | 58 | 12 | 343 | 25 | 8 | 455 |
| TS | Sanba | (2316) | 50 | 4 | 96 | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TS | Jelawat | (2317) | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Annual Mean (Total) | | | 80 | 351 | 86 | 76 | 289 | 148 | 75 | 234 | 217 | 68 | 190 | 284 | 61 | 152 | 370 |

### 4.1.2 Central Pressure and Maximum Wind Speed

Figure 4.6 shows annual means of root mean square errors (RMSEs) for TC central pressure and maximum wind speed forecasts covering periods of 24 hours, 48 hours (since 2001), 72 hours (since 2003) 96 hours and 120 hours (since 2019). The values for maximum wind speed forecasts for individual TCs are available in Appendix 5.

Operational TC intensity forecasts have improved recently after a long period with no notable enhancement, although year-to-year fluctuations exist. The annual RMSEs of central pressure for 24-, 48-, 72- 96- and 120-hour forecasts were 12.8 hPa (13.7 hPa in 2022), 16.9 hPa (19.4 hPa), 18.0 hPa (21.3 hPa), 20.6 hPa (19.4 hPa) and 22.2 hPa (15.5 hPa), respectively. The corresponding values for maximum wind speed were 5.1 m/s (6.3 m/s in 2022), 7.2 m/s (8.7 m/s), 7.9 m/s (8.7 m/s), 9.2 m/s (7.7 m/s) and 10.4 m/s (6.0 m/s), respectively.

Figure 4.7 shows annual mean improvement ratios for central pressure and maximum wind speed forecasts in relation to a guidance model based on climatology and persistence (Statistical Hurricane Intensity Forecast; SHIFOR[8]) to highlight operational forecast skill. The values are defined as

$$\frac{\mathrm{RMSE(SHIFOR)} - \mathrm{RMSE(Operational)}}{\mathrm{RMSE(SHIFOR)}}$$

with positive/negative values indicating better/worse operational forecasts than SHIFOR predictions. The values for maximum wind speed forecasts are available in Appendix 5. It can be seen that the operational TC intensity forecasts have improved recently, with minimal year-to-year fluctuations. The annual mean improvement ratios of central pressure for 24-, 48-, 72-, 96- and 120-hour forecasts were 13% (7% in 2022), 18% (7%), 12% (9%), -6% (12%) and -9% (25%), respectively. The corresponding values of maximum wind were 17% (-3% in 2022), 26% (6%), 30% (19%), 22% (35%) and 14% (50%), respectively.

The details of errors in operational central pressure forecasts, including improvement ratios to SHIFOR for each named TC that formed in 2023, are summarized in Table 4.3. The data for maximum wind speed forecasts are available in Appendix 5. Forecasts for Koinu (2314) were characterized by large errors attributed to the difficulty of estimation for rapid intensification and weaking.

Figure 4.8 shows a histogram of maximum wind speed errors for 24-hour forecasts (Histograms for 48-, 72-, 96- and 120-hour forecasts are also available in Appendix 5). Approximately 56% (58% in 2022) of 24-hour forecasts had errors of less than ±3.75 m/s, with figures of ±6.25 m/s for 63% (64%) of 48-hour forecasts, ±6.25 m/s for 59% (65%) of 72-hour forecasts, ±8.75 m/s for 66% (77%) of 96-hour forecasts and ±8.75 m/s for 60% (91%) of 120-hour forecasts.

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[8] The Center operates the SHIFOR model based on Jarvinen and Neumann (1979). The explanatory variables include TC analysis data (center position, central pressure and maximum sustained wind, and related temporal variation from best track data) and date. Multiple regression coefficients for the model were generated from best track data for named TCs forming between 1977 and 2010.

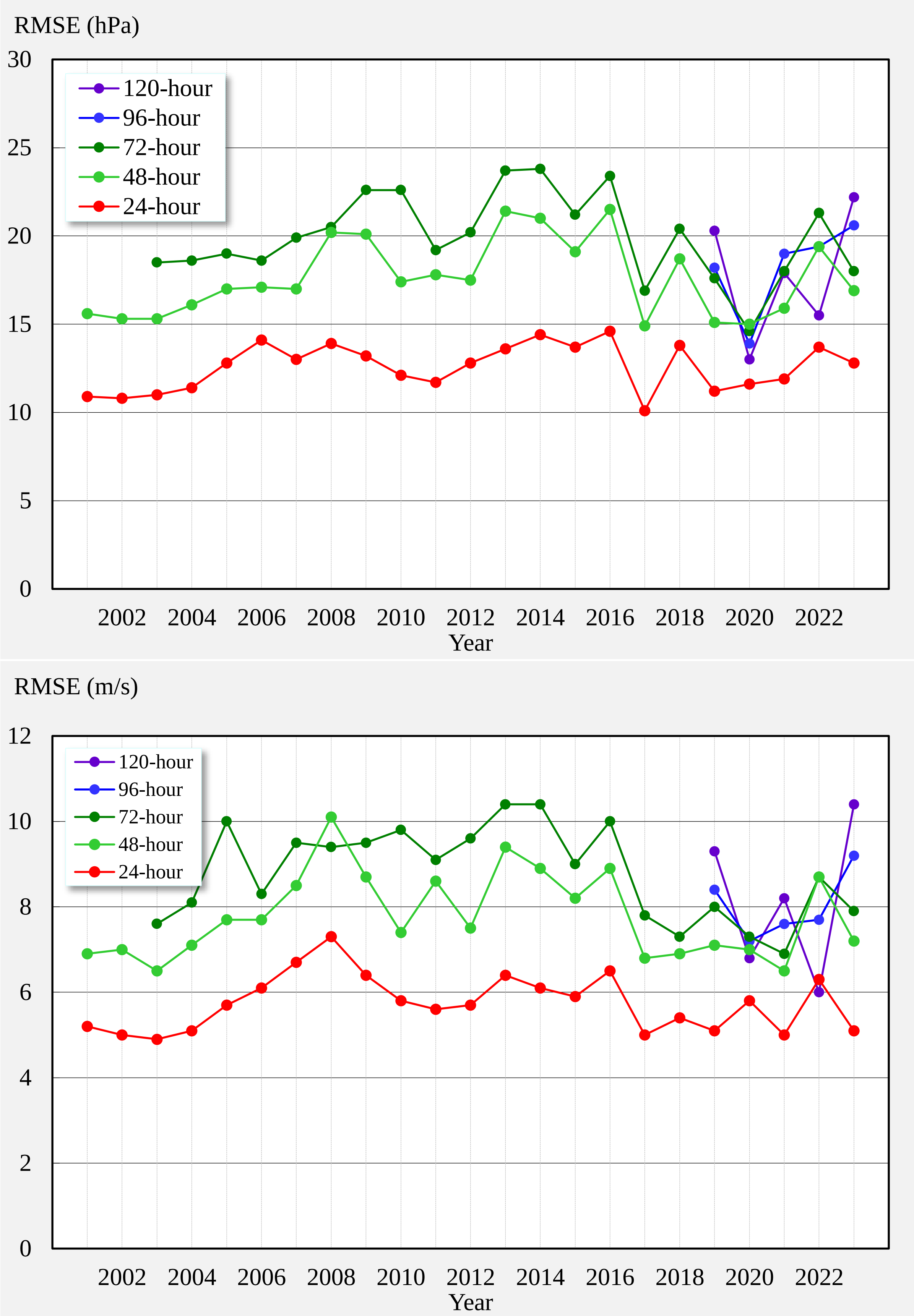
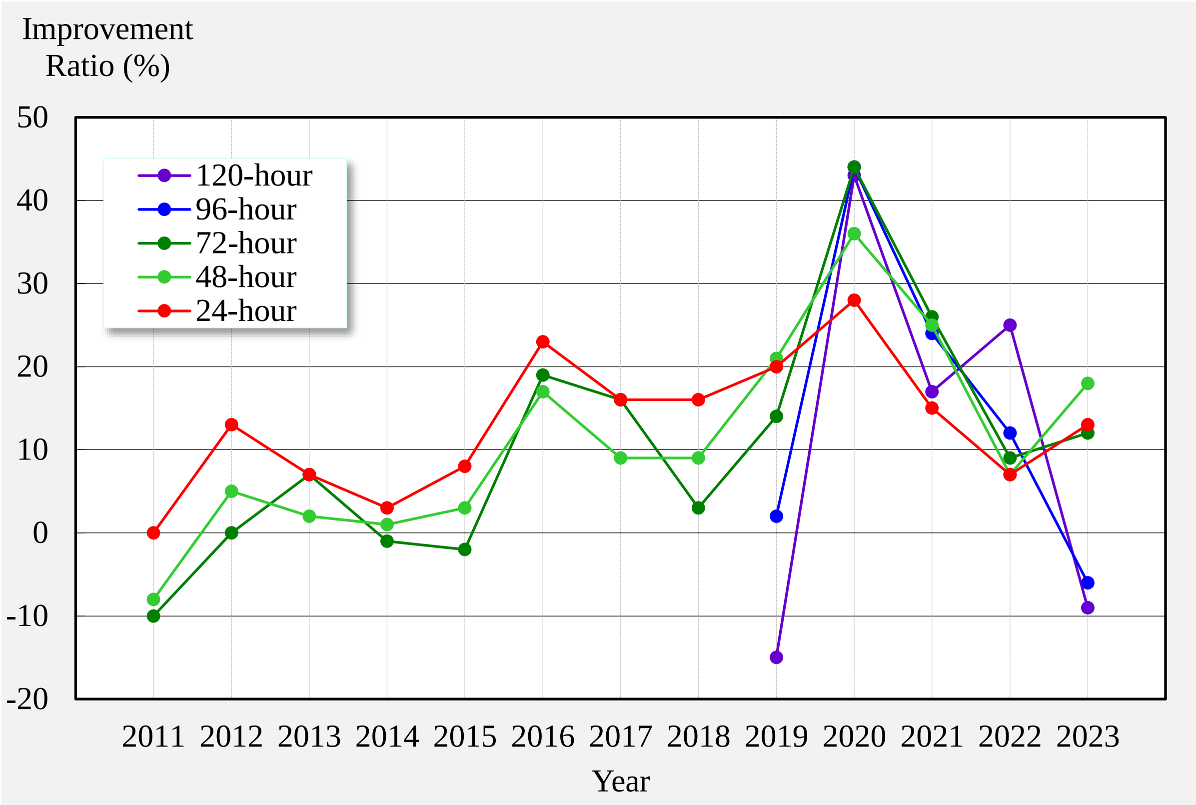



Figure 4.6 Annual RMSEs in 24-, 48, 72-, 96- and 120-hour operational central pressure (top) and maximum wind speed (bottom) forecasts



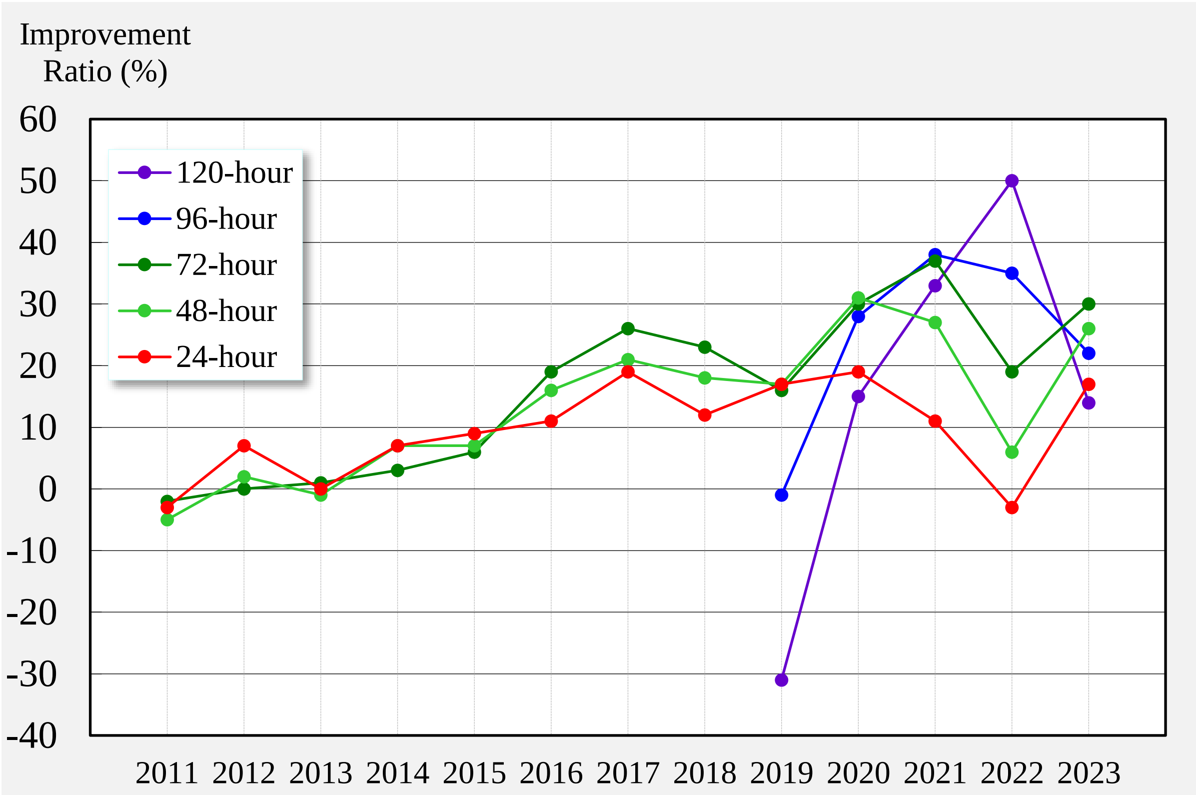




Figure 4.7 Annual mean improvement ratios in 24-, 48, 72-, 96- and 120-hour operational central pressure (top) and maximum wind speed (bottom) forecasts

Table 4.3 Mean errors of 24-, 48-, 72-, 96- and 120-hour operational central pressure forecasts for each named TC that formed in 2023. Impr. and Num. represent improvement ratio of RMSEs (see the equation in 4.1.2 for detail) and the number of samples, respectively.

| Tropical Cyclone | | | 24-hour Forecast | | | | 48-hour Forecast | | | | 72-hour Forecast | | | | 96-hour Forecast | | | | 120-hour Forecast | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Error (hPa) | RMSE (hPa) | Num. | Impr. (%) | Error (hPa) | RMSE (hPa) | Num. | Impr. (%) | Error (hPa) | RMSE (hPa) | Num. | Impr. (%) | Error (hPa) | RMSE (hPa) | Num. | Impr. (%) | Error (hPa) | RMSE (hPa) | Num. | Impr. (%) |
| TS | Sanvu | (2301) | 2.0 | 2.8 | 2 | 87 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Mawar | (2302) | 3.6 | 17.8 | 50 | -2 | 2.8 | 22.4 | 46 | 1 | -2.7 | 21.2 | 42 | -6 | -5.1 | 21.3 | 38 | -10 | -3.4 | 21.6 | 34 | 5 |
| TY | Guchol | (2303) | 6.0 | 9.0 | 20 | -8 | 2.8 | 7.2 | 16 | 42 | -6.3 | 8.5 | 12 | 37 | -15.6 | 18.8 | 8 | -25 | -21.3 | 21.9 | 4 | -4 |
| STS | Talim | (2304) | 1.1 | 2.4 | 9 | 75 | -2.0 | 3.2 | 5 | 70 | -25.0 | 25.0 | 1 | -52 | - | - | 0 | - | - | - | 0 | - |
| TY | Doksuri | (2305) | -2.2 | 10.3 | 28 | 41 | -0.9 | 12.0 | 24 | 41 | 0.3 | 13.2 | 20 | 40 | 4.4 | 14.9 | 16 | 32 | 0.8 | 13.1 | 12 | 20 |
| TY | Khanun | (2306) | 0.4 | 9.5 | 49 | -6 | -1.2 | 14.4 | 45 | -10 | -4.1 | 17.3 | 41 | -6 | -2.6 | 20.5 | 37 | -27 | 0.3 | 24.2 | 33 | -62 |
| TY | Lan | (2307) | 0.4 | 11.7 | 33 | -17 | -0.5 | 13.4 | 29 | 8 | -4.0 | 11.8 | 25 | 12 | -9.8 | 13.1 | 21 | -55 | -10.1 | 14.1 | 17 | -90 |
| TY | Dora | (2308) | -4.3 | 5.4 | 7 | 72 | -7.3 | 8.4 | 3 | 78 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Saola | (2309) | 5.1 | 17.9 | 34 | -1 | 4.0 | 21.3 | 30 | 18 | -2.2 | 19.9 | 26 | 24 | 5.4 | 22.8 | 22 | 24 | 17.7 | 26.7 | 18 | 27 |
| STS | Damrey | (2310) | -0.6 | 6.4 | 14 | 14 | 2.4 | 6.2 | 10 | 61 | 5.7 | 6.5 | 6 | 77 | 9.5 | 10.1 | 2 | 68 | - | - | 0 | - |
| TY | Haikui | (2311) | 3.2 | 10.9 | 25 | 21 | 3.6 | 13.7 | 21 | 19 | 4.8 | 14.8 | 17 | -5 | 15.8 | 19.4 | 13 | -46 | 15.8 | 18.8 | 9 | -21 |
| TS | Kirogi | (2312) | -3.2 | 3.9 | 10 | 73 | -5.3 | 6.0 | 6 | 84 | -4.0 | 4.0 | 2 | 92 | - | - | 0 | - | - | - | 0 | - |
| TS | Yun-yeung | (2313) | -2.5 | 3.2 | 8 | 38 | -4.5 | 4.6 | 4 | 69 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Koinu | (2314) | 7.1 | 13.1 | 34 | 28 | 16.8 | 21.5 | 30 | -9 | 19.4 | 24.9 | 26 | -44 | 19.2 | 27.1 | 21 | -90 | 15.8 | 28.7 | 17 | -135 |
| TY | Bolaven | (2315) | -3.3 | 17.1 | 24 | 12 | -0.5 | 20.3 | 20 | 33 | 5.9 | 19.5 | 16 | 34 | 7.1 | 22.6 | 12 | 15 | -0.6 | 15.7 | 8 | 18 |
| TS | Sanba | (2316) | -2.0 | 2.4 | 4 | 73 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Jelawat | (2317) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| Annual Mean (Total) | | | 1.7 | 12.8 | 351 | 13 | 2.5 | 16.9 | 289 | 18 | 0.7 | 18.0 | 234 | 12 | 1.5 | 20.6 | 190 | -6 | 2.4 | 22.2 | 152 | -9 |

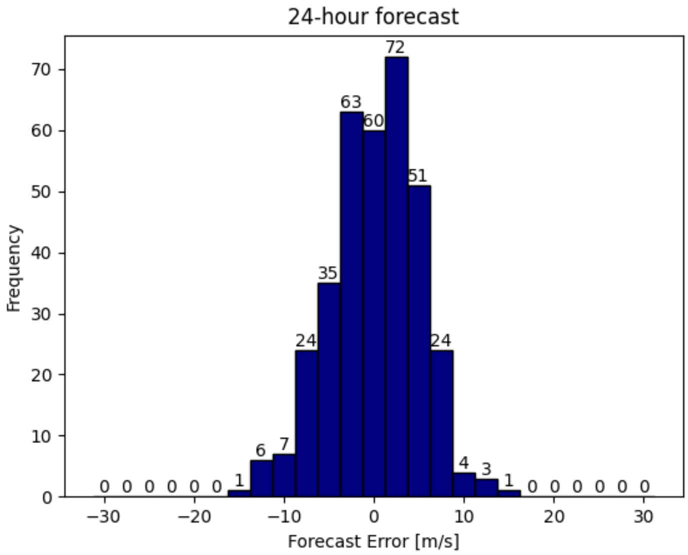



Figure 4.8 Histogram of 24-hour forecast maximum wind speed errors in 2023 (Histograms for 48-, 72-, 96- and 120-hour forecasts are also available at Appendix 5).

[Reference]


Aberson, S. D., 1998. Five-Day Tropical Cyclone Track Forecasts in the North Atlantic Basin, *Weather and Forecasting*, **13**, 1005-1015.

Jarvinen, B. R. and C. J. Neumann, 1979: Statistical forecasts of tropical cyclone intensity, *NOAA Tech. Memo. NWS NHC-10*, 22 pp.

Neumann, C. J., 1972: An alternate to the Hurran (hurricane analog) tropical cyclone forecasting system. *NOAA Tech. Memo. NWS SR 62*, 23 pp.

Merrill, R. T., 1980: A statistical tropical cyclone motion forecasting system for the Gulf of Mexico. *NOAA Tech. Memo. NWS NHC 14*, 21 pp.

## 4.2 Verification of Timing of First-issued Operational Forecasts

The Center issues TC track forecasts with probability circles and intensity forecasts when a TC of TS intensity or higher is present or expected within 24 hours in its area of responsibility. Accordingly, initial forecasts for individual TCs are also used as 24-hour genesis forecasts in addition to track and intensity forecasts.

Table 4.4 shows differences between initial times of first forecast and upgrade times in best track data/real-time provisional analysis data for individual named TCs. Differences are almost the ideal for 24 hours.

Table 4.4 Lead times of operational forecasting for upgrade to TS intensity or higher. "First forecast", "Upgrade (Best/Prov.)" and "Lead time (Best/Prov.)" are the initial time of the first forecast for individual named TCs, the time when the TC was upgraded to TS intensity or higher in best track data/provisional analysis, and the time difference between the two, respectively.

| Tropical Cyclone | | | First Forecast | Upgrade (Best) | Upgrade (Prov.) | Lead Time (Best) | Lead Time (Prov.) |
|---|---|---|---|---|---|---|---|
| TS | Sanvu | (2301) | 06UTC 19 Apr | 12UTC 20 Apr | 06UTC 20 Apr | 30 h | 24 h |
| TY | Mawar | (2302) | 12UTC 19 May | 12UTC 20 May | 06UTC 20 May | 24 h | 18 h |
| TY | Guchol | (2303) | 18UTC 05 Jun | 12UTC 06 Jun | 12UTC 06 Jun | 18 h | 18 h |
| STS | Talim | (2304) | 00UTC 14 Jul | 06UTC 15 Jul | 06UTC 15 Jul | 30 h | 30 h |
| TY | Doksuri | (2305) | 18UTC 19 Jul | 00UTC 21 Jul | 00UTC 21 Jul | 30 h | 30 h |
| TY | Khanun | (2306) | 12UTC 26 Jul | 00UTC 28 Jul | 18UTC 27 Jul | 36 h | 30 h |
| TY | Lan | (2307) | 00UTC 07 Aug | 00UTC 08 Aug | 00UTC 08 Aug | 24 h | 24 h |
| TY | Dora | (2308) | 00UTC 12 Aug | --- | --- | --- h | --- h |
| TY | Saola | (2309) | 18UTC 23 Aug | 06UTC 24 Aug | 06UTC 24 Aug | 12 h | 12 h |
| STS | Damrey | (2310) | 00UTC 24 Aug | 18UTC 24 Aug | 18UTC 24 Aug | 18 h | 18 h |
| TY | Haikui | (2311) | 00UTC 27 Aug | 18UTC 28 Aug | 00UTC 28 Aug | 42 h | 24 h |
| TS | Kirogi | (2312) | 12UTC 29 Aug | 12UTC 30 Aug | 12UTC 30 Aug | 24 h | 24 h |
| TS | Yun-yeung | (2313) | 00UTC 04 Sep | 12UTC 05 Sep | 12UTC 05 Sep | 36 h | 36 h |
| TY | Koinu | (2314) | 06UTC 29 Sep | 18UTC 29 Sep | 18UTC 29 Sep | 12 h | 12 h |
| TY | Bolaven | (2315) | 12UTC 06 Oct | 12UTC 07 Oct | 06UTC 07 Oct | 24 h | 18 h |
| TS | Sanba | (2316) | 00UTC 17 Oct | 00UTC 18 Oct | 06UTC 18 Oct | 24 h | 30 h |
| TS | Jelawat | (2317) | 00UTC 16 Dec | 06UTC 17 Dec | 00UTC 17 Dec | 30 h | 24 h |

## 4.3 Verification of Numerical Models (GSM, GEPS)

GSM and GEPS provide primary information for use by JMA forecasters in making operational TC track and intensity forecasts. The details of GSM and GEPS and information on recent related improvements are given in Appendix 7. GSM and GEPS predictions were verified with RSMC TC best track data and predictions using the persistency (PER) method. All TC forecast verifications were conducted for both systems.

### 4.3.1 GSM Prediction

#### 1) Center Position

GSM annual mean position errors observed since 1997 are presented in Figure 4.9. In 2023, the annual mean errors for 30-, 54-, 78-, 102- and 126-hour[9] predictions were 85 km (96 km in 2022), 144km (156 km), 225km (232 km), 337km (266 km) and 466km (340 km), respectively. The mean position errors of 18-, 30-, 42-, 54-, 66-, 78-, 90-, 102-, 114- and 126-hour predictions for each named TC are given in Table 4.5.

Table 4.6 shows relative GSM performance compared with results obtained using the PER method[10]. In this comparison, TCs were classified into the three life stages of before, during and after recurvature. The definition of the stages is based on the direction of movement of each TC at individual prediction times (Figure 4.5). The table indicates that GSM results outperformed those of the PER method throughout the forecast period beyond 18 hours from the initial time, and that the ratios of error reduction for the GSM compared to the PER method were about 52% (59% in 2022), 64% (70%), 70% (76%), 69% (77%), 65% (81%) and 62% (81%) for 18-, 30-, 54-, 78-, 102- and 126-hour predictions, respectively.

About 87% (83% in 2022) of 30-hour predictions (histograms showing the position errors of 30-, 54-, 78-, 102- and 126-hour predictions are shown in Appendix 5) had errors of less than 150 km, while 92% (91%) of 54-hour predictions had errors of less than 300 km, and 92% (89%) of 78-hour predictions had errors of less than 450 km.

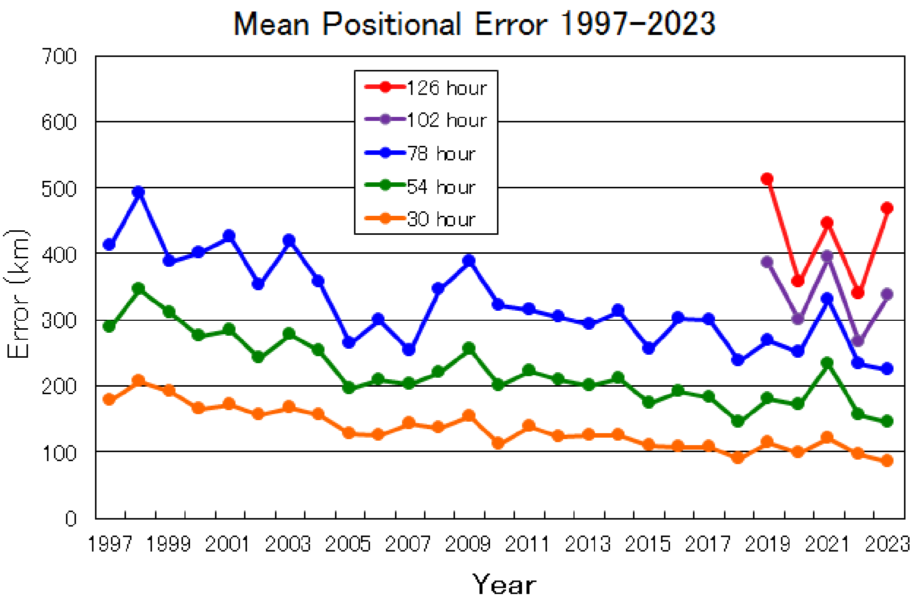



Figure 4.9 GSM annual mean position errors since 1997

[9] 30-, 54-, 78-, 102- and 126-hour GSM predictions are used as primary information by forecasters creating 24-, 48-, 72-, 96- and 120-hour operational forecasts, respectively.

[10] The PER method is based on the assumption that a TC holds the same movement throughout the forecast period, and linear extrapolation for the latest 12-hour track of the TC is applied to create TC track forecasts. Position errors with the PER method are used to evaluate the relative performance of operational forecasts and model predictions.

Table 4.5 GSM mean position errors (km) for each named TC that formed in 2023. The number of samples is given in parentheses.

| Tropical Cyclone | | | T=18 | | T=30 | | T=42 | | T=54 | | T=66 | | T=78 | | T=90 | | T=102 | | T=114 | | T=126 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TS | 2301 | SANVU | 162.5 | (8) | 133.6 | (6) | 184.3 | (4) | 200.8 | (2) | 306.6 | (1) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) |
| TY | 2302 | MAWAR | 43.3 | (54) | 58.3 | (52) | 79.5 | (50) | 107.7 | (48) | 131.4 | (46) | 144.5 | (44) | 167.2 | (42) | 196.8 | (40) | 223.5 | (38) | 237.7 | (36) |
| TY | 2303 | GUCHOL | 48.2 | (24) | 53.2 | (22) | 77.8 | (20) | 130.6 | (18) | 199.5 | (16) | 271.2 | (14) | 346.0 | (12) | 433.4 | (10) | 537.4 | (8) | 681.8 | (6) |
| STS | 2304 | TALIM | 59.2 | (14) | 61.8 | (12) | 82.8 | (10) | 134.5 | (8) | 218.0 | (6) | 319.5 | (4) | 407.1 | (2) | 521.7 | (1) | - | (-) | - | (-) |
| TY | 2305 | DOKSURI | 45.8 | (32) | 65.6 | (30) | 86.1 | (28) | 113.3 | (26) | 142.5 | (24) | 190.3 | (22) | 248.7 | (20) | 311.5 | (18) | 352.4 | (16) | 375.3 | (14) |
| TY | 2306 | KHANUN | 68.5 | (57) | 91.5 | (55) | 119.9 | (53) | 162.1 | (51) | 193.0 | (49) | 230.1 | (47) | 281.3 | (45) | 337.7 | (43) | 398.9 | (41) | 482.4 | (39) |
| TY | 2307 | LAN | 50.9 | (38) | 58.2 | (36) | 66.9 | (34) | 71.3 | (32) | 81.5 | (30) | 108.0 | (28) | 130.2 | (26) | 155.7 | (24) | 196.5 | (22) | 253.2 | (20) |
| TY | 2308 | DORA | 84.2 | (10) | 107.0 | (8) | 139.3 | (6) | 178.4 | (4) | 162.9 | (2) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) |
| TY | 2309 | SAOLA | 53.4 | (37) | 86.4 | (35) | 124.2 | (33) | 167.3 | (31) | 213.0 | (29) | 273.0 | (27) | 333.5 | (25) | 387.8 | (23) | 461.3 | (21) | 526.5 | (19) |
| STS | 2310 | DAMREY | 95.8 | (18) | 115.3 | (16) | 106.5 | (14) | 130.1 | (12) | 187.7 | (10) | 290.9 | (8) | 597.1 | (5) | 1430.8 | (1) | - | (-) | - | (-) |
| TY | 2311 | HAIKUI | 89.8 | (32) | 139.7 | (30) | 196.1 | (28) | 252.5 | (26) | 326.3 | (24) | 415.4 | (22) | 547.2 | (20) | 752.7 | (18) | 955.5 | (16) | 1270.0 | (14) |
| TS | 2312 | KIROGI | 82.1 | (15) | 127.4 | (13) | 156.0 | (11) | 189.0 | (9) | 256.0 | (7) | 294.1 | (5) | 290.9 | (3) | 192.5 | (1) | - | (-) | - | (-) |
| TS | 2313 | YUN-YEUNG | 112.0 | (14) | 137.6 | (12) | 157.8 | (9) | 180.9 | (7) | 161.1 | (5) | 270.9 | (3) | 623.2 | (2) | - | (-) | - | (-) | - | (-) |
| TY | 2314 | KOINU | 54.9 | (38) | 84.4 | (36) | 109.3 | (34) | 144.2 | (32) | 173.0 | (30) | 199.2 | (28) | 253.3 | (25) | 290.6 | (22) | 319.3 | (17) | 331.3 | (15) |
| TY | 2315 | BOLAVEN | 55.7 | (29) | 75.3 | (27) | 100.5 | (25) | 138.5 | (23) | 191.4 | (21) | 250.4 | (19) | 313.6 | (17) | 386.1 | (15) | 466.1 | (13) | 598.7 | (11) |
| TS | 2316 | SANBA | 57.4 | (10) | 101.4 | (8) | 151.9 | (6) | 188.8 | (4) | 228.9 | (2) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) |
| TS | 2317 | JELAWAT | 140.3 | (5) | 102.8 | (3) | 158.9 | (1) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) |
| All | Annual | Mean | 64.7 | (435) | 85.4 | (401) | 110.6 | (366) | 144.3 | (333) | 181.0 | (302) | 224.8 | (271) | 283.0 | (244) | 337.3 | (216) | 393.6 | (192) | 466.2 | (174) |

Table 4.6 Mean position errors (km) of GSM and PER method predictions for the 17 named TCs that formed in 2023 in the stages before, during and after recurvature. The number of samples is given in parentheses. IMPROV is the ratio of error reductions in GSM results to those observed using the PER method.

| TIME | MODEL | Before | | During | | After | | All | |
|---|---|---|---|---|---|---|---|---|---|
| T=18 | GSM | 61.2 | (238) | 66.8 | (115) | 71.5 | (82) | 64.7 | (435) |
| | PER | 114.0 | (238) | 136.8 | (115) | 191.8 | (82) | 134.7 | (435) |
| | IMPROV | 46.3 | % | 51.2 | % | 62.7 | % | 52.0 | % |
| T=30 | GSM | 82.8 | (217) | 89.7 | (107) | 86.8 | (77) | 85.4 | (401) |
| | PER | 198.2 | (217) | 236.7 | (107) | 346.7 | (77) | 237.0 | (401) |
| | IMPROV | 58.2 | % | 62.1 | % | 75.0 | % | 64.0 | % |
| T=42 | GSM | 112.1 | (195) | 110.6 | (99) | 106.7 | (72) | 110.6 | (366) |
| | PER | 300.2 | (195) | 349.4 | (99) | 518.4 | (72) | 356.5 | (366) |
| | IMPROV | 62.7 | % | 68.4 | % | 79.4 | % | 69.0 | % |
| T=54 | GSM | 143.9 | (171) | 145.5 | (94) | 143.5 | (68) | 144.3 | (333) |
| | PER | 392.1 | (171) | 514.8 | (94) | 654.4 | (68) | 480.3 | (333) |
| | IMPROV | 63.3 | % | 71.7 | % | 78.1 | % | 70.0 | % |
| T=66 | GSM | 184.2 | (152) | 169.7 | (85) | 188.0 | (65) | 181.0 | (302) |
| | PER | 495.0 | (152) | 660.8 | (85) | 816.8 | (65) | 610.9 | (302) |
| | IMPROV | 62.8 | % | 74.3 | % | 77.0 | % | 70.4 | % |
| T=78 | GSM | 233.3 | (134) | 202.7 | (76) | 233.8 | (61) | 224.8 | (271) |
| | PER | 569.9 | (134) | 724.3 | (76) | 1083. | (61) | 728.8 | (271) |
| | IMPROV | 59.1 | % | 72.0 | % | 78.4 | % | 69.2 | % |
| T=90 | GSM | 293.1 | (121) | 240.5 | (63) | 307.2 | (60) | 283.0 | (244) |
| | PER | 674.6 | (121) | 776.4 | (63) | 1324. | (60) | 860.8 | (244) |
| | IMPROV | 56.6 | % | 69.0 | % | 76.8 | % | 67.1 | % |
| T=102 | GSM | 359.8 | (111) | 288.4 | (52) | 338.4 | (53) | 337.3 | (216) |
| | PER | 799.9 | (111) | 795.3 | (52) | 1440. | (53) | 955.9 | (216) |
| | IMPROV | 55.0 | % | 63.7 | % | 76.5 | % | 64.7 | % |
| T=114 | GSM | 426.5 | (101) | 342.8 | (42) | 369.2 | (49) | 393.6 | (192) |
| | PER | 936.4 | (101) | 888.1 | (42) | 1552. | (49) | 1083. | (192) |
| | IMPROV | 54.4 | % | 61.4 | % | 76.2 | % | 63.7 | % |
| T=126 | GSM | 495.5 | (92) | 410.6 | (35) | 450.2 | (47) | 466.2 | (174) |
| | PER | 1065. | (92) | 1016. | (35) | 1635. | (47) | 1209. | (174) |
| | IMPROV | 53.5 | % | 59.6 | % | 72.5 | % | 61.5 | % |

## 2) Central Pressure and Maximum Wind Speed

The mean errors of 30-, 54-, 78-, 102- and 126-hour GSM central pressure predictions in 2023 were +0.4 hPa (+6.7 hPa in 2022), -0.5 hPa (+8.8 hPa), -1.8 hPa (+9.5 hPa), -1.6 hPa (+7.3 hPa) and -2.6 hPa (+5.3 hPa), respectively. Their root mean square errors (RMSEs) were 15.3 hPa (15.7 hPa in 2022) for 30-hour predictions, 18.7 hPa (19.9 hPa) for 54-hour predictions, 23.8 hPa (22.1 hPa) for 78-hour predictions, 27.4 hPa (24.2 hPa) for 102-hour predictions and 27.5 hPa (20.4 hPa) for 126-hour predictions. The biases in 30-, 54-, 78-, 102- and 126-hour maximum wind speed predictions were -0.4 m/s (-6.0 m/s in 2022) with an RMSE of 8.1 m/s (9.8 m/s), -0.4 m/s (-7.1 m/s) with a RMSE of 10.0 m/s (12.2 m/s), -0.4 m/s (-7.2 m/s) with a RMSE of 12.2 m/s (12.7 m/s), -1.5 m/s (-5.9 m/s) with a RMSE of 13.3 m/s (13.2 m/s) and -1.9 m/s (-5.9 m/s) with a RMSE of 13.0 m/s (11.5 m/s), respectively.

Figure 4.10 shows histograms of central pressure errors and maximum wind speed errors in 30-hour GSM predictions. The GSM exhibited a small positive bias in central pressure prediction, and tended to underestimate the wind speed of TCs until 2022. However, these biases were smaller in 2023, probably in association to the GSM upgrade of March 2023, including horizontal resolution enhancement. The upgrade is detailed in Appendix 7.

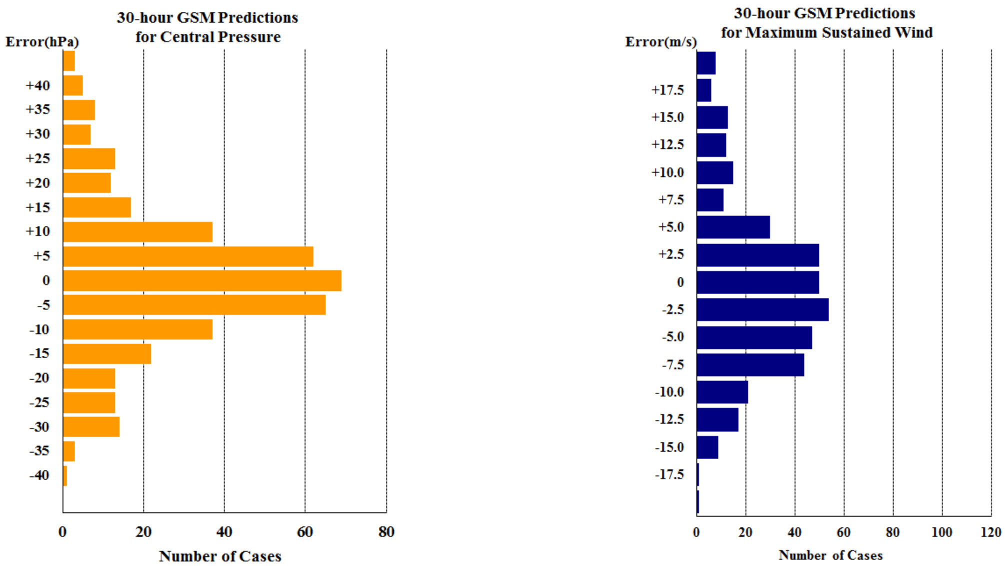



Figure 4.10 Error distribution of GSM 30-hour intensity predictions in 2023. The figure on the left shows error distribution for central pressure, while the one on the right shows that for maximum wind speed (the error distributions of 54-, 78-, 102- and 126-hour predictions are shown at the Appendix 5).

### 4.3.2 GEPS Prediction

**1) Ensemble Mean Center Position**

GEPS took over the role of the Typhoon Ensemble Prediction System (TEPS), and has been providing ensemble forecasts for TCs since January 2017. GEPS and TEPS annual mean position errors observed since 2008 are presented in Figure 4.11. In 2023, the mean position errors of GEPS ensemble mean forecasts for 30-, 54-, 78-, 102- and 126-hour predictions for each named TC are given in Table 4.7. The annual means of ensemble mean position errors for 30-, 54-, 78-, 102- and 126-hour predictions were 92 km (85 km with the GSM), 152 km (144 km), 230 km (225 km), 343 km (337 km) and 471 km (466 km), respectively.

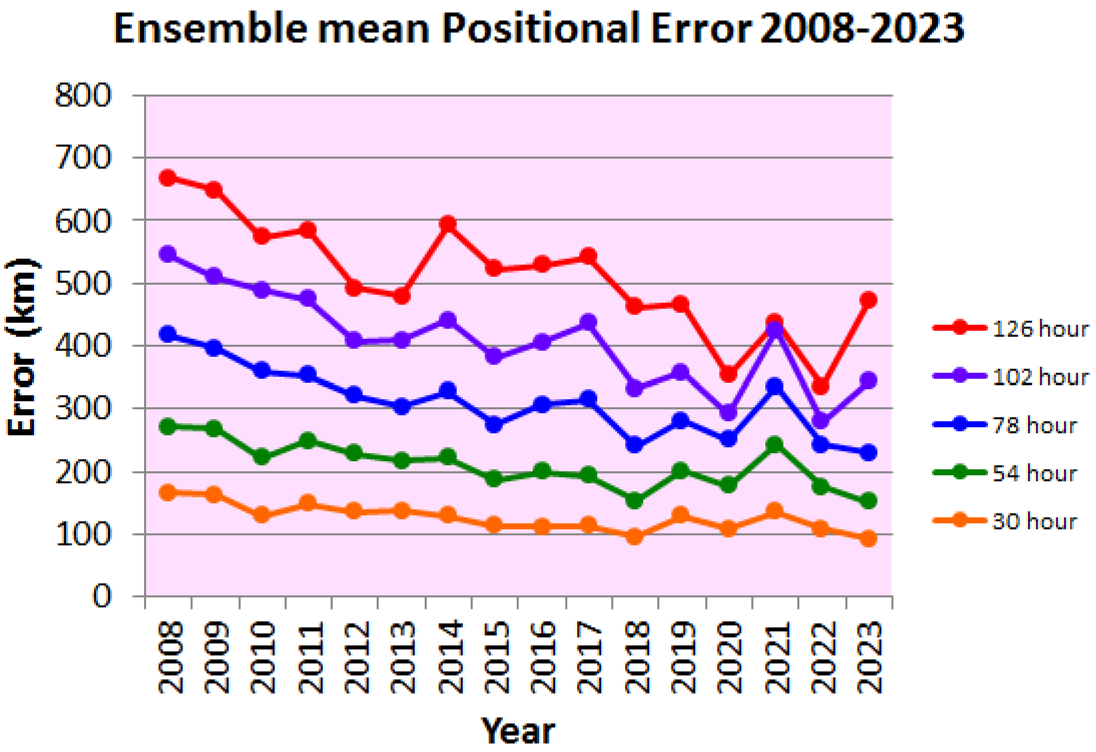



Figure 4.11 GEPS and TEPS annual mean position errors since 2008

Table 4.7 Mean position errors (km) of GEPS ensemble mean forecasts for each named TC that formed in 2023. The number of samples is given in parentheses.

| **Tropical Cyclone** | | | **T=18** | | **T=30** | | **T=42** | | **T=54** | | **T=66** | | **T=78** | | **T=90** | | **T=102** | | **T=114** | | **T=126** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TS | 2301 | SANVU | 138.6 | (6) | 198.4 | (4) | 265.0 | (2) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) |
| TY | 2302 | MAWAR | 40.2 | (55) | 55.3 | (53) | 74.4 | (51) | 100.1 | (49) | 123.3 | (47) | 142.8 | (45) | 164.2 | (43) | 187.5 | (41) | 201.4 | (39) | 224.7 | (37) |
| TY | 2303 | GUCHOL | 56.7 | (24) | 68.7 | (22) | 95.5 | (20) | 154.2 | (18) | 225.7 | (16) | 293.1 | (14) | 360.4 | (12) | 438.9 | (10) | 527.0 | (8) | 634.7 | (6) |
| STS | 2304 | TALIM | 64.7 | (15) | 85.3 | (13) | 118.8 | (11) | 181.2 | (9) | 264.2 | (7) | 365.7 | (5) | 422.6 | (3) | 499.2 | (1) | - | (-) | - | (-) |
| TY | 2305 | DOKSURI | 46.0 | (32) | 66.9 | (30) | 88.7 | (28) | 106.5 | (26) | 124.7 | (24) | 149.2 | (22) | 191.1 | (20) | 231.4 | (18) | 262.5 | (16) | 277.1 | (14) |
| TY | 2306 | KHANUN | 68.0 | (57) | 92.3 | (55) | 122.1 | (53) | 160.2 | (51) | 193.2 | (49) | 239.4 | (47) | 298.6 | (45) | 367.2 | (43) | 447.0 | (41) | 527.0 | (39) |
| TY | 2307 | LAN | 53.5 | (38) | 64.0 | (36) | 80.2 | (34) | 87.7 | (32) | 101.3 | (30) | 128.1 | (28) | 159.2 | (26) | 188.6 | (24) | 207.7 | (22) | 217.5 | (20) |
| TY | 2308 | DORA | 68.7 | (10) | 65.7 | (8) | 56.9 | (6) | 67.5 | (4) | 141.1 | (2) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) |
| TY | 2309 | SAOLA | 60.3 | (35) | 90.2 | (33) | 125.9 | (31) | 166.4 | (29) | 209.6 | (27) | 259.2 | (25) | 311.3 | (23) | 376.4 | (21) | 453.2 | (19) | 541.0 | (17) |
| STS | 2310 | DAMREY | 103.2 | (18) | 129.3 | (16) | 125.0 | (14) | 128.5 | (12) | 184.8 | (10) | 239.5 | (8) | 457.6 | (5) | 1121.2 | (1) | - | (-) | - | (-) |
| TY | 2311 | HAIKUI | 94.4 | (32) | 138.6 | (30) | 195.0 | (28) | 258.2 | (26) | 334.7 | (24) | 423.3 | (22) | 531.3 | (20) | 713.2 | (18) | 940.7 | (16) | 1166.7 | (14) |
| TS | 2312 | KIROGI | 121.4 | (15) | 203.1 | (13) | 275.5 | (11) | 337.3 | (9) | 393.1 | (7) | 423.4 | (5) | 484.8 | (3) | 426.5 | (1) | - | (-) | - | (-) |
| TS | 2313 | YUN-YEUNG | 86.2 | (14) | 111.2 | (12) | 136.0 | (10) | 150.8 | (8) | 125.3 | (6) | 176.6 | (4) | 195.0 | (2) | - | (-) | - | (-) | - | (-) |
| TY | 2314 | KOINU | 60.2 | (37) | 89.0 | (35) | 112.9 | (34) | 137.1 | (32) | 164.8 | (30) | 191.2 | (28) | 246.5 | (25) | 302.7 | (23) | 379.3 | (18) | 449.4 | (17) |
| TY | 2315 | BOLAVEN | 59.5 | (29) | 85.1 | (27) | 126.5 | (25) | 191.3 | (23) | 260.1 | (21) | 329.8 | (19) | 412.6 | (17) | 513.4 | (15) | 618.2 | (13) | 755.2 | (11) |
| TS | 2316 | SANBA | 91.1 | (10) | 168.7 | (8) | 268.0 | (5) | 287.7 | (2) | 312.0 | (1) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) |
| TS | 2317 | JELAWAT | 135.1 | (5) | 158.7 | (3) | 195.7 | (1) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) | - | (-) |
| All | Annual | Mean | 67.1 | (432) | 92.2 | (398) | 119.8 | (364) | 151.5 | (330) | 188.7 | (301) | 230.2 | (272) | 283.4 | (244) | 342.6 | (216) | 404.6 | (192) | 470.7 | (175) |

**2) Spread-Skill Relationship**

Although position errors of GEPS ensemble mean forecasts were larger than those of the GSM, GEPS provides useful information on the reliability of TC track forecasts with its ensemble spread. Figure 4.12 shows the relationship between 6-hourly cumulative ensemble spreads in TC position forecasts and ensemble mean forecast position errors in 126-hour prediction. In an ideal EPS with a large number of samples, significant positional errors are observed when the ensemble spread is large. However, no clear correlation is seen from the figure. One of the reasons why it is considered non-ideal is that the number of samples is not enough.

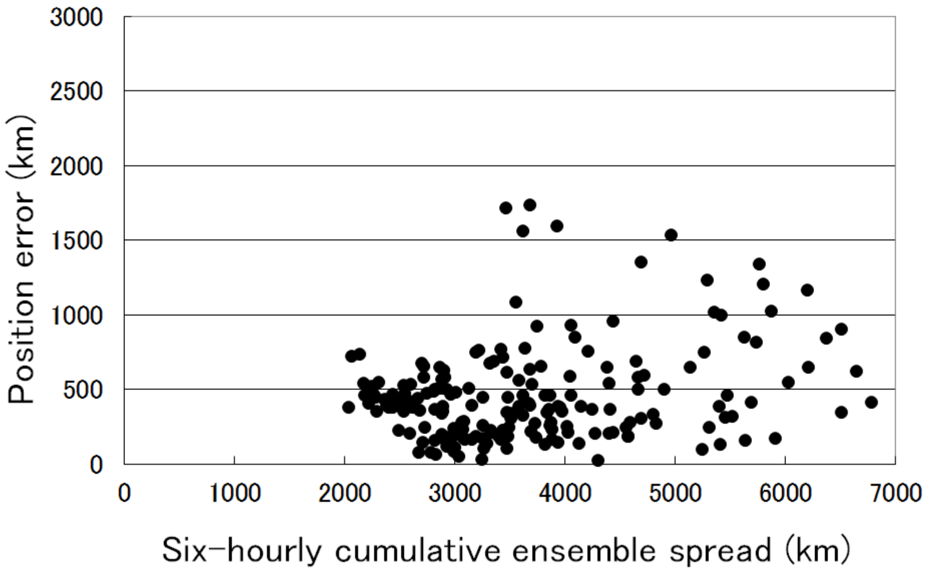



Figure 4.12 Relationship between six-hourly cumulative ensemble spread in TC position forecasts (km) and ensemble mean forecast position errors (km) in 126-hour predictions in 2023.

### 4.4 Verification for Other Guidance Models

#### 4.4.1 Verification by WGNE

The Center utilizes other guidance models in addition to JMA's NWP models for operational TC track and intensity forecasting, including global deterministic NWP models from seven other centers (BOM, CMC, DWD, ECMWF, KMA, NCEP and UKMO). These models (as well as the Meteo France (FRN) model, the Naval Research Laboratory (NRL) model and National Centre for Medium Range Weather Forecasting (NCMRWF) model) are verified under the framework of WGNE (the Working Group on Numerical Experimentation), which is a collaborative working group for development of Earth system models (design, implementation, error diagnosis and model revision) across the full range of temporal and spatial scales. JMA works on inter-comparison of these models under the framework. Figures 4.13 and 4.14 show the results of the verification for center positions and 72-hour intensity forecasts by WGNE.

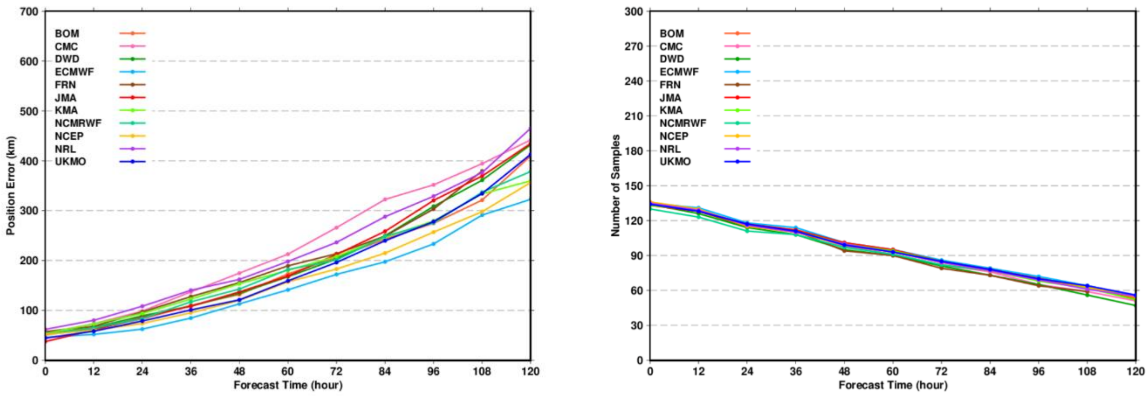



Figure 4.13 (Left) Positional errors for 2023 named TCs. The tropical depression (TD) stage and the extra-tropical cyclone (L) stage of targeted TCs is also included in this verification. (Right) Sample numbers.

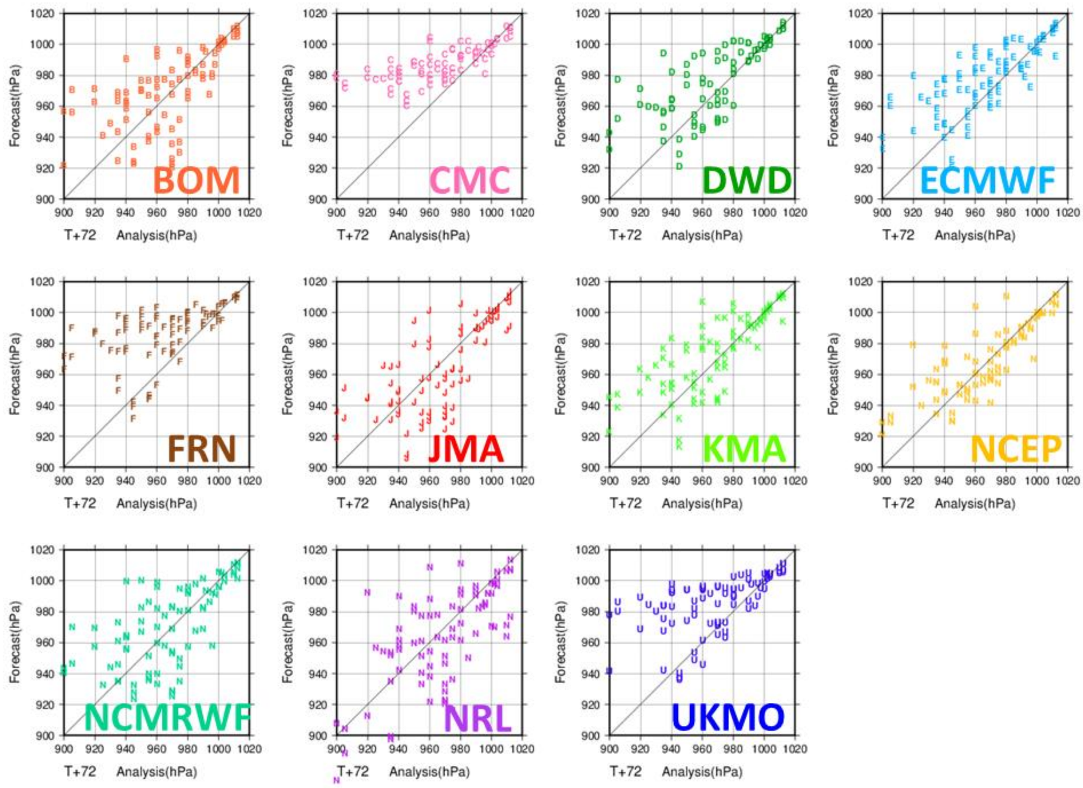



Figure 4.14 Scatter diagrams of 72-hour TC center pressure forecasts from 11 deterministic models for 2023. The tropical depression (TD) stage and the extra-tropical cyclone (L) stage of targeted TCs is also included in this verification.

### 4.4.2 Verification of Intensity Guidance Models

Table 4.8 shows mean central pressure and maximum wind speed errors in TIFS and LGEM intensity guidance and related consensus. This section describes verification of the latest guidance data available for each initial time of real-time operation conducted for RSMC operational forecasting.

Table 4.8 Mean error and RMSE of central pressure (top) and maximum wind speed (bottom) forecasts from intensity guidance models produced by the Center in 2023. Num. represents number of samples.

| Prediction | | 24-hour Forecast | | | 48-hour Forecast | | | 72-hour Forecast | | | 96-hour Forecast | | | 120-hour Forecast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Error (hPa) | RMSE (hPa) | Num. | Error (hPa) | RMSE (hPa) | Num. | Error (hPa) | RMSE (hPa) | Num. | Error (hPa) | RMSE (hPa) | Num. | Error (hPa) | RMSE (hPa) | Num. |
| Intensity guidance model | TIFS | -2.1 | 14.0 | 351 | -2.3 | 16.4 | 289 | -1.7 | 17.3 | 234 | -0.2 | 19.3 | 188 | 2.9 | 21.5 | 149 |
| | LGEM | -0.1 | 13.9 | 351 | -0.8 | 16.6 | 289 | -1.8 | 16.6 | 234 | -0.4 | 18.2 | 188 | - | - | 0 |
| Consensus method | TIFS&LGEM | -1.1 | 13.5 | 351 | -1.5 | 16.1 | 289 | -1.7 | 16.6 | 234 | -0.3 | 18.3 | 188 | - | - | 0 |

| Prediction | | 24-hour Forecast | | | 48-hour Forecast | | | 72-hour Forecast | | | 96-hour Forecast | | | 120-hour Forecast | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Error (m/s) | RMSE (m/s) | Num. | Error (m/s) | RMSE (m/s) | Num. | Error (m/s) | RMSE (m/s) | Num. | Error (m/s) | RMSE (m/s) | Num. | Error (m/s) | RMSE (m/s) | Num. |
| Intensity guidance model | TIFS | 0.6 | 5.9 | 351 | 0.3 | 7.1 | 289 | -0.5 | 7.8 | 234 | -1.8 | 8.7 | 188 | -3.2 | 10.2 | 149 |
| | LGEM | 0.6 | 5.8 | 351 | 1.1 | 7.3 | 289 | 0.9 | 8.1 | 234 | -0.6 | 9.1 | 188 | - | - | 0 |
| Consensus method | TIFS&LGEM | 0.6 | 5.7 | 351 | 0.7 | 7.1 | 289 | 0.2 | 7.9 | 234 | -1.2 | 8.8 | 188 | - | - | 0 |

## 4.5 Verification of AMV-based Sea-surface Winds (ASWinds)

JMA produces Atmospheric Motion Vectors (AMVs) using successive satellite imagery from the Himawari-8/9 geostationary satellite. These are derived from the Full-disk observation conducted every 10 minutes and Region 3 tropical cyclone observation conducted over an area of 1,000 square kilometers every 2.5 – 5 minutes. Since July 2017, JMA has used the AMV-based Sea-surface Winds (ASWinds) product based on low-level AMVs (assigned below 700 hPa level) to estimate sea-surface winds in the vicinity of TCs. The ASWinds are derived at intervals of 10 – 30 minutes with frequent and wide-ranging wind distribution information. Figure 4.15 shows the distributions of ASWind derived using the Full-disk and Region 3 observations by Himawari-9 for TY Haikui (2311). The wide-area coverage and high temporal resolution of ASWinds data are also expected to support real-time determination of 30-kt wind radii for TC areas where low-level clouds appear in Himawari-8/9 imagery together with surface wind observations from satellite microwave scatterometers such as the ASCAT units on board MetOp polar-orbiting satellites (referred to here as “ASCAT winds”).

JMA verified the quality of ASWinds data from Visible (B03: 0.64 µm), Short-wave Infrared (B07: 3.9 µm), and Infrared (B13: 10.4 µm) with respect to ASCAT wind data in the vicinity of 17 TCs occurring in 2023 (Table 4.9). Wind speed biases in ASWinds data from Full-disk and Region 3 observation were small at -0.6 to -0.4 m/s, and 0.0 to -0.5 m/s, respectively. Vector differences in ASWinds from Region 3 observation were slightly larger than those from Full-disk observation, which suggested that the use of high-frequency Region-3 observation data supports tracking to determine the movement of low-level cloud associated with mesoscale phenomena.

The mean distribution of ASWinds data from Full-disk and Region-3 observation (Figure 4.16) for 2023 suggests that the representation of Region-3 ASWinds is higher than that of Full-disk ASWinds, particularly near TC centers. This is attributed to the higher temporal frequency of Region-3 imagery.

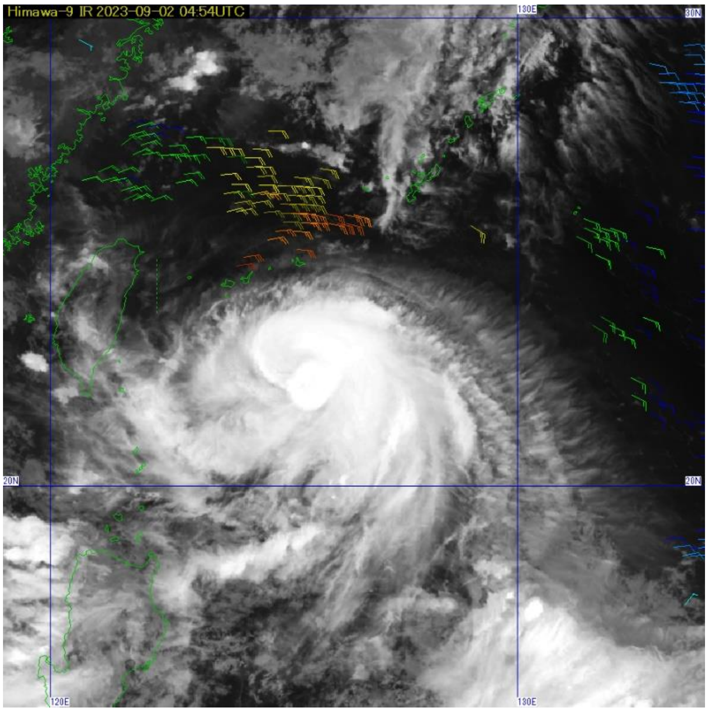



Figure 4.15 ASWinds derived from a series of Himawari-9 Full-disk and Region 3 Infrared (B13) and Short-wave Infrared (B07) images for TY Haikui (2311) at 0454 UTC on 2 September 2023.

Table 4.9 Vector Differences and biases of ASWinds (0.85 < QI) with reference to ASCAT winds within a square of 20 degrees centered at the TC center for 17 TCs in 2023.

(a) ASWind (Full-disk)

| | Number of collocations | Vector Difference [m/s] | Bias [m/s] |
|---|---|---|---|
| B03 (VIS) | 275867 | 1.8 | -0.4 |
| B07 (SWIR) | 244460 | 2.0 | -0.6 |
| B13 (IR) | 222385 | 2.0 | -0.6 |

(b) ASWind (Region 3)

| | Number of collocations | Vector Difference [m/s] | Bias [m/s] |
|---|---|---|---|
| B03 (VIS) | 486919 | 3.1 | 0.5 |
| B07 (SWIR) | 529488 | 3.3 | 0.2 |
| B13 (IR) | 384599 | 3.1 | 0.0 |

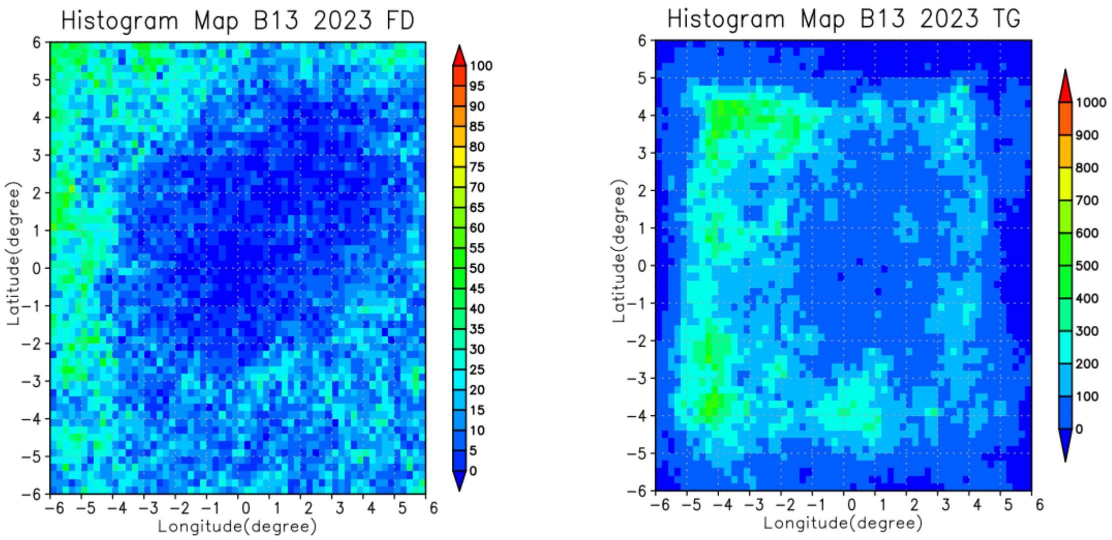



Figure 4.16 Spatial distributions of Full-disk (left) and Region 3 (right) ASWind data derived from Infrared (B13) images within a square of 12 degrees centered at TC center for 17 TCs in 2023.

### 4.6 Verification of TC Central Pressure Estimates Based on Satellite Microwave Observations

JMA uses TC central pressure (Minimum Sea Level Pressure, or MSLP) estimates based on TC warm core intensity (i.e., the maximum temperature anomaly near the TC center) from microwave sounders on board polar-orbiting satellites as reference for JMA operational TC analysis. The Advanced Microwave Sounding Unit-A (AMSU-A) of the NOAA and MetOp series of polar-orbiting satellites has been used for MSLP estimation since 2013. JMA also began to use data from the Advanced Technology Microwave Sounder (ATMS) on board the Suomi-NPP and JPSS-1 (NOAA-20) satellites in 2015. The higher spatial resolution of ATMS observation (32 km at the sub-satellite point) as compared to AMSU-A (48 km) enables more accurate determination of warm core intensity. Figure 4.17 shows the MSLP estimates based on AMSU-A and ATMS observations (referred to here as AMSU/ATMS estimates) together with MSLP estimates based on the Dvorak technique (Dvorak estimates) and a product based on consensus between AMSU/ATMS estimates and Dvorak estimates (CONSENSUS) for TY Doksuri (2305).

Table 4.10 shows the results of AMSU and ATMS estimate verification with respect to JMA best track data for 2015 - 2023 together with Dvorak TC intensity estimates and CONSENSUS. The biases and root mean square errors (RMSEs) of AMSU estimates were -5.5 to 2.7 hPa and 10.0 to 14.0 hPa, respectively (Table 4.10a). It should be noted that the RMSE of CONSENSUS between AMSU estimates and Dvorak estimates is consistently smaller than that for AMSU and Dvorak estimates over a period of nine years, which is attributed to the benefits of independent information from the satellite microwave observation. The RMSE for ATMS estimates was smaller than that for AMSU (Table 4.10b), which indicates that the higher resolution of ATMS observation as compared to AMSU leads to more accurate determination of TC warm core intensity. As with the AMSU estimate result, the RMSEs of CONSENSUS between ATMS and Dvorak estimates were smaller than those of ATMS and Dvorak estimates. The superiority of CONSENSUS to individual estimates is seen in bias comparison.

Use of AMSU/ATMS estimates via CONSENSUS is expected to support JMA's operational TC intensity analysis, particularly when in-situ observation data are scarce and operational TC intensity analysis depends largely on the Dvorak estimates.

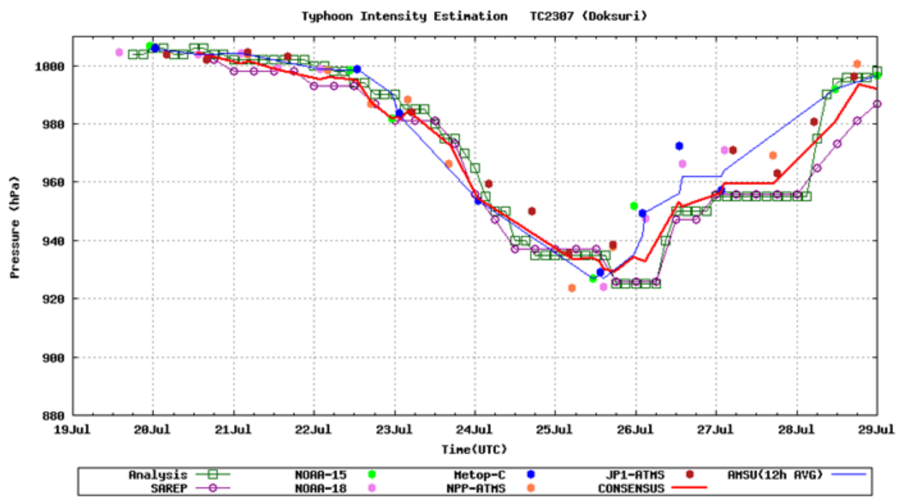



Figure 4.17 Time-series representation of Dvorak MSLP estimates, microwave-based MSLP estimates (AMSU and ATMS), CONSENSUS between Dvorak and AMSU/ATMS estimates and JMA analysis for TY Doksuri (2305) on the Numerical Typhoon Prediction (NTP) website

Table 4.10 (a) Bias and RMSE of Dvorak MSLP estimates, AMSU MSLP estimates and CONSENSUS between Dvorak and AMSU estimates with respect to the best track data for the previous nine years (2015 - 2023); (b) as per (a) but for ATMS estimates

(a) BIAS and RMSE of central pressure estimates to best track for AMSU

| Year | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| BIAS (hPa) | AMSU | 1.3 | 2.7 | -2.9 | -3.1 | -2.5 | -5.5 | -2.9 | -1.9 | -0.6 |
| | Dvorak | 0.1 | -2.1 | -2.0 | -0.4 | -2.9 | -2.8 | -2.1 | -1.8 | -0.3 |
| | Consensus | **0.3** | **-0.8** | **-2.6** | **-1.5** | **-3.2** | **-4.0** | **-2.8** | **-2.2** | **-0.8** |
| RMSE (hPa) | AMSU | 12.8 | 13.8 | 10.0 | 12.4 | 11.7 | 14.0 | 13.1 | 11.3 | 12.6 |
| | Dvorak | 7.5 | 9.6 | 7.2 | 7.0 | 9.2 | 8.4 | 7.9 | 6.5 | 8.6 |
| | Consensus | **6.8** | **8.2** | **6.7** | **6.7** | **7.6** | **7.9** | **6.6** | **6.3** | **6.2** |
| Number of Data | | 819 | 595 | 569 | 680 | 645 | 478 | 703 | 473 | 398 |

(b) BIAS and RMSE of central pressure estimates to best track for ATMS

| Year | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| BIAS (hPa) | ATMS | 3.0 | 4.1 | 1.8 | 0.9 | 1.9 | 0.9 | 1.7 | 1.1 | 2.9 |
| | Dvorak | -0.5 | -1.4 | -2.0 | -0.9 | -3.7 | -3.6 | -2.1 | -2.7 | -1.4 |
| | Consensus | **0.8** | **0.3** | **-0.7** | **-0.3** | **-1.9** | **-1.8** | **-0.9** | **-1.2** | **-0.1** |
| RMSE (hPa) | ATMS | 11.9 | 13.0 | 8.7 | 11.4 | 9.9 | 9.0 | 10.9 | 8.1 | 11.8 |
| | Dvorak | 7.8 | 8.5 | 7.9 | 7.9 | 9.7 | 9.6 | 8.5 | 8.0 | 8.3 |
| | Consensus | **6.1** | **7.1** | **6.3** | **7.0** | **7.1** | **6.0** | **6.0** | **5.7** | **5.4** |
| Number of Data | | 229 | 190 | 193 | 224 | 244 | 148 | 159 | 116 | 136 |

## 4.7 Verification of Storm Surge Prediction

Storm surge predictions have been provided since 2011 via the Numerical Typhoon Prediction (NTP) website to Typhoon Committee Members within the framework of the Storm Surge Watch Scheme (SSWS). The Asia-area storm surge ensemble prediction system has been operational and probabilistic forecast products have been provided since August 2022, with a forecast period extended to 132 hours. For details of the system and the new SSWS forecast products, refer to Hasegawa et al. (2023) on the NTP website. Verification of deterministic storm surge predictions was conducted on data from eight stations (Table 4.11) for which sea level observation information is provided on the University of Hawaii Sea Level Center (UHSLC) database website (http://uhslc.soest.hawaii.edu/data/?fd) and the Global Sea Level Observing System (GLOSS) website (http://www.ioc-sealevelmonitoring.org/index.php) for all named TCs that formed in 2023. Hourly hindcast data (from T = -5 to T = 0) and forecast data (from T = 1 to T = 132) were compared with observation data. Ensemble predictions were also verified with information including data from the Quarry Bay tide station (Hong Kong) for TY Saola (2309).

Table 4.11 Stations used for verification

| | Station | Abbreviation | Member | Data Source |
|---|---|---|---|---|
| 1 | Quarry Bay | QB | Hong Kong | UHSLC |
| 2 | Shek Pik | SP | Hong Kong | GLOSS |
| 3 | Langkawi | LK | Malaysia | UHSLC |
| 4 | Legaspi Port | LG | Philippines | UHSLC |
| 5 | Manila South Harbor | ML | Philippines | UHSLC |
| 6 | Subic Bay | SB | Philippines | UHSLC |
| 7 | Busan | BS | Republic of Korea | GLOSS |
| 8 | Apra Harbor | AP | U.S.A. | UHSLC |

Table 4.12 Storm surges exceeding 0.5 m observed at the eight stations for each named TC that formed in 2023

| Station | Named TC | Storm surge [m] |
|---|---|---|
| BS | Khanun (2306) | 0.59 |
| QB | Saola (2309) | 0.75 |
| SP | Koinu (2314) | 0.56 |

### 4.7.1 Deterministic Prediction

Storm surges exceeding 1.0 m were not observed in any of eight stations in 2023 (Table 4.12). Figure 4.18 shows scatter diagrams of modeled storm surges (hindcast and forecast) against observation data. Verification results for 2023 (Figure 4.18) indicate that deterministic predictions tend to underestimate storm surges, which can be attributed to errors in official tracks, mainly for TY Saola.

The verification results shown in Figure 4.18 may be insufficient to evaluate model accuracy for TCs, given that there were sparse observation data for verification and remarkable storm surges were not observed at most stations. Accordingly, additional verification was conducted using data from stations in Japan, where sufficient observation data are available, and TCs frequently approach or make landfall in Japan. Although the characteristics of model forecasts may vary by region, the system is considered to have comparable accuracy at storm surge watch scheme stations.

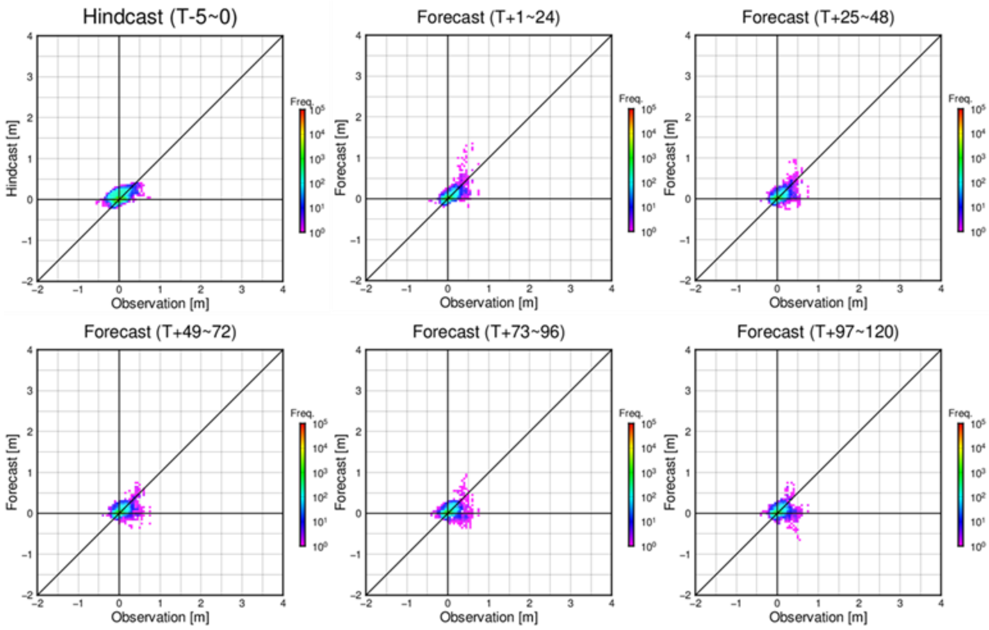



Figure 4.18 Scatter diagrams of modeled storm surges against observation data from eight stations for all the named TCs that formed in 2023 (top left: hindcast; others: forecast)

Figure 4.19 shows scatter diagrams of modeled storm surges (forecast) against observation data from around 200 stations (operated by JMA, the Ports and Harbours Bureau, the Japan Coast Guard, and the Geospatial Information Authority of Japan) in Japan. The verification period is from January to December 2023, and cases of TCs are extracted. Nine named TCs approached the country, including TY Lan (2307) making landfall. The diagrams indicate that forecasts for Japan compare well with observed storm surges, although some predictions exhibit significant errors (e.g., due to TY Khanun (2306)). Naturally, prediction errors increase with lead time.

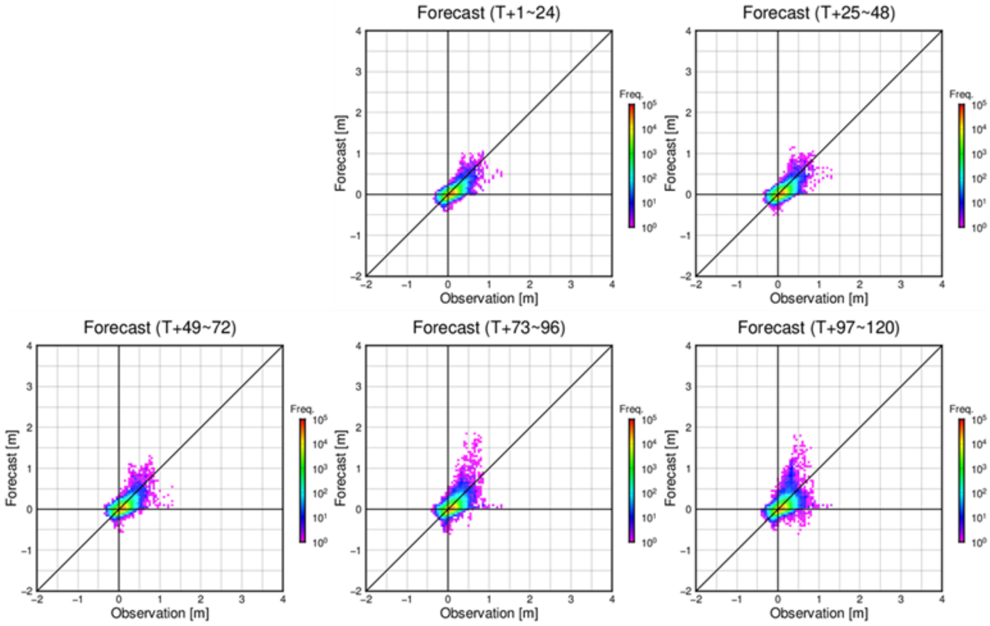



Figure 4.19 Scatter diagrams of modeled storm surges (forecast) against observation data from around 200 stations (operated by JMA, the Ports and Harbours Bureau, the Japan Coast Guard, and the Geospatial Information Authority of Japan) in Japan for TCs in 2023. All plots are three-hourly maximum values.

### 4.7.2 Ensemble Prediction

Threat scores from ensemble prediction in Japan for TCs in 2023 (Figure 4.20; statistical period: as per deterministic forecast verification) generally peak in the probability range from 20 to 40%. The values are lower than expected even though the threshold is set low, and the effects of specific typhoons are significant. The results are probably affected by the low number of remarkable storm surges in 2023. The figures show that the system maintains scores of approximately 0.1 up to five days ahead.

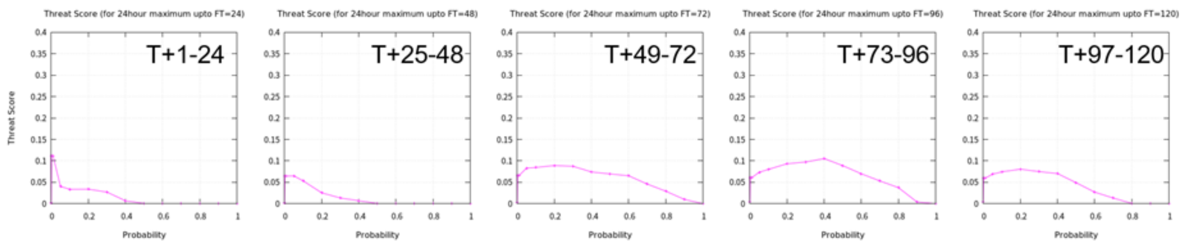



Figure 4.20 Threat scores of the ensemble prediction system for each probability against storm surges exceeding 0.5 m at around 200 stations in Japan in 2023.

### 4.7.3 Case Study

TY Saola (2309) passed through the Bashi Channel and moved westward over the South China Sea in August 2023, developing to a maximum wind speed of 55 m/s and a minimum pressure of 920 hPa. Figure 4.21 shows the analysis track and all predicted tracks (official forecast and 51 tracks calculated using GEPS) for the 72-hour period before the storm surge peak in Quarry Bay. The typhoon moved just south of Hong Kong, although many ensemble members with the initial time (00 UTC on 30 August 2023) had predicted eastern courses in this area. Accordingly, peak storm surges for these members were estimated to be lower and later than observed. Tracks of ensemble members were not uniformly predicted, highlighting uncertainties in TC track forecasting. Meanwhile, prediction for the peak storm surge in the official forecast was higher (maximum storm surge for Quarry Bay: 0.93 m (Figure 4.24); maximum storm tide: 3.14 m above mean sea level) than observation in Quarry Bay (maximum storm surge: 0.75 m; maximum storm tide: 3.04 m).

The ensemble system predicted a probability of storm surges exceeding 1.0 m along the eastern coast of Hong Kong (Figure 4.22), while no such surges were predicted for Quarry Bay (Figure 4.23). Accurate prediction of storm surges caused by TY Saola was challenging due to the uncertainty of TC track prediction (Figure 4.24).

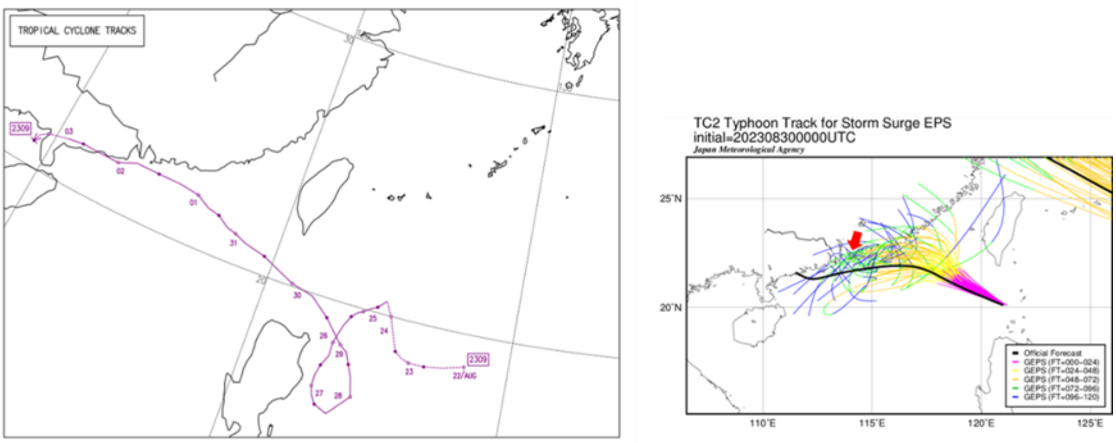



Figure 4.21 Analysis track (left) and predicted tracks (right) for TY Saola. In the figure on the right, colored lines show the 51 tracks from GEPS members, and the bold black line shows the official forecast. The red arrow shows the location of Quarry Bay.

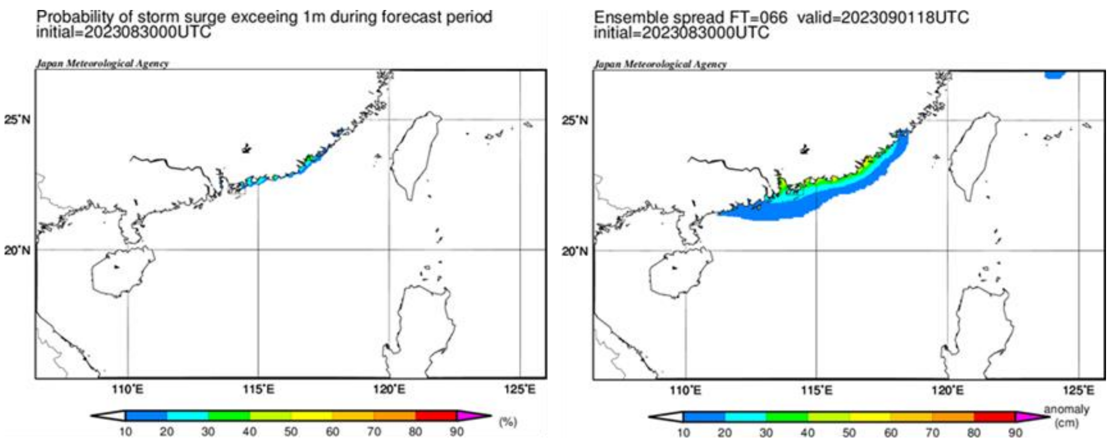



Figure 4.22 Probabilities of storm surges exceeding 1.0 m (left) and ensemble spread (right).

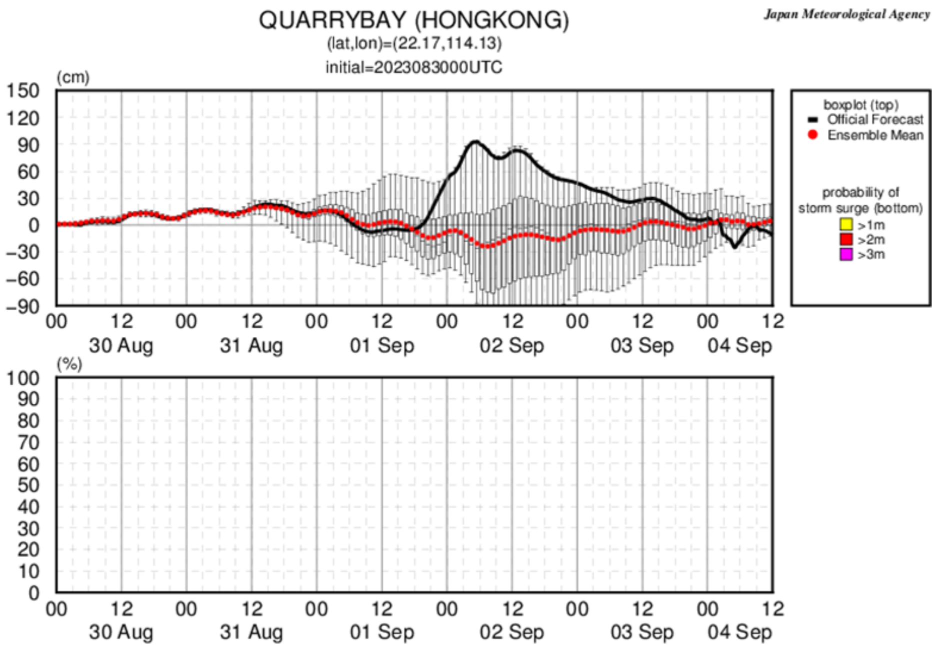



Figure 4.23 Time-series representation of storm surge boxplots (top), storm surge probability bars (bottom) for Quarry Bay.

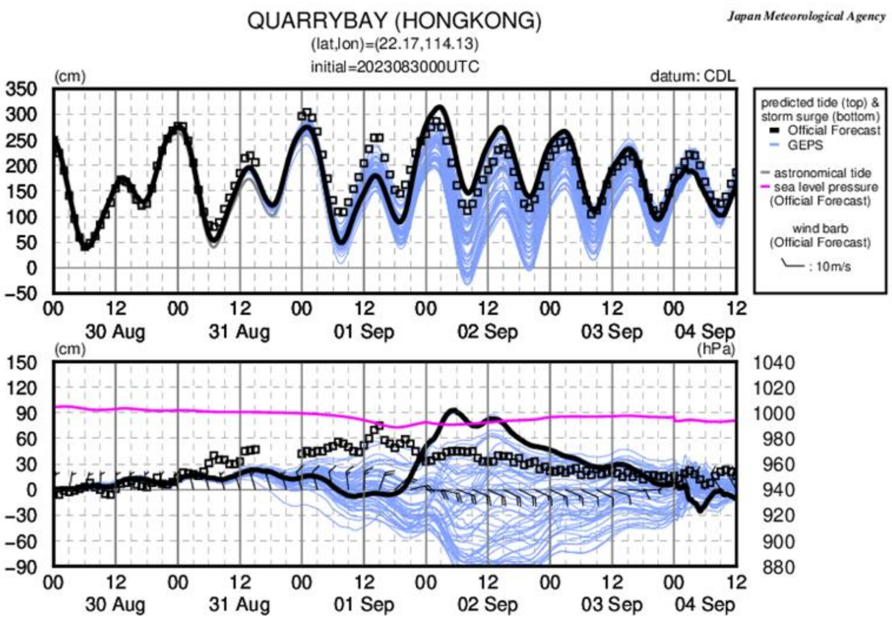



Figure 4.24 Time-series representation of storm tide and astronomical tide (top), storm surge, sea level pressure and surface wind (bottom) for Quarry Bay. Squares show hourly observation values.

[Reference]


Hasegawa. H., N. Kohno, and H. Hayashibara, 2012: JMA's Storm Surge Prediction for the WMO Storm Surge Watch Scheme (SSWS). *RSMC Tokyo-Typhoon Center Technical Review*, **14**, 13-24.

Hasegawa. H., N. Kohno, M. Higaki, and M. Itoh, 2017: Upgrade of JMA's Storm Surge Prediction for WMO Storm Surge Watch Scheme (SSWS). *RSMC Tokyo-Typhoon Center Technical Review*, **19**, 26-34.

Hasegawa. H., J. Sugano, T. Fukuura and M. Higaki, 2023: Upgrade of JMA's Storm Surge Prediction for WMO Storm Surge Watch Scheme (SSWS) in 2022. *RSMC Tokyo-Typhoon Center Technical Review*, **25**, 1-14.

# Appendices

# Appendix 1
# RSMC Tropical Cyclone Best Track Data in 2023

**TS SANVU (2301)**

| Date/Time | | Center Position | | Central pressure | Max Wind | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| | (UTC) | Lat (N) | Lon (E) | (hPa) | (kt) | | |
| Apr. | 19/00 | 3.5 | 159.6 | 1008 | − | 0.5 | TD |
| | 19/06 | 4.3 | 159.1 | 1004 | − | 0.5 | TD |
| | 19/12 | 5.3 | 158.7 | 1008 | − | 1.0 | TD |
| | 19/18 | 6.9 | 158.0 | 1004 | − | 1.5 | TD |
| | 20/00 | 8.1 | 157.8 | 1006 | − | 1.5 | TD |
| | 20/06 | 9.1 | 157.1 | 1002 | − | 1.5 | TD |
| | 20/12 | 9.6 | 156.6 | 1000 | 35 | 2.0 | TS |
| | 20/18 | 9.9 | 156.3 | 998 | 40 | 2.5 | TS |
| | 21/00 | 10.1 | 156.0 | 998 | 40 | 2.5 | TS |
| | 21/06 | 10.3 | 155.7 | 996 | 45 | 3.0 | TS |
| | 21/12 | 10.4 | 155.3 | 1000 | 40 | 3.0 | TS |
| | 21/18 | 10.4 | 154.5 | 1002 | 35 | 3.0 | TS |
| | 22/00 | 10.3 | 153.8 | 1006 | − | 2.5 | TD |
| | 22/06 | 10.3 | 153.1 | 1004 | − | − | TD |
| | 22/12 | | | | | | Dissip. |

**TY MAWAR (2302)**

| Date/Time | | Center Position | | Central pressure | Max Wind | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| | (UTC) | Lat (N) | Lon (E) | (hPa) | (kt) | | |
| May | 19/18 | 6.1 | 149.6 | 1004 | − | 0.5 | TD |
| | 20/00 | 6.1 | 149.4 | 1004 | − | 1.0 | TD |
| | 20/06 | 6.1 | 149.2 | 1004 | − | 1.5 | TD |
| | 20/12 | 6.2 | 149.1 | 1000 | 35 | 2.0 | TS |
| | 20/18 | 6.6 | 149.0 | 994 | 45 | 2.5 | TS |
| | 21/00 | 7.0 | 148.7 | 992 | 50 | 3.0 | STS |
| | 21/06 | 7.3 | 148.4 | 992 | 50 | 3.0 | STS |
| | 21/12 | 7.6 | 147.9 | 990 | 55 | 3.5 | STS |
| | 21/18 | 7.9 | 147.6 | 980 | 65 | 4.0 | TY |
| | 22/00 | 8.6 | 147.3 | 980 | 65 | 4.0 | TY |
| | 22/06 | 9.2 | 147.1 | 975 | 70 | 4.5 | TY |
| | 22/12 | 9.8 | 146.9 | 970 | 75 | 5.0 | TY |
| | 22/18 | 10.5 | 146.9 | 940 | 95 | 6.0 | TY |
| | 23/00 | 11.2 | 146.9 | 940 | 95 | 6.0 | TY |
| | 23/06 | 11.8 | 146.5 | 920 | 105 | 7.0 | TY |
| | 23/12 | 12.2 | 146.0 | 920 | 105 | 7.0 | TY |
| | 23/18 | 12.5 | 145.7 | 920 | 105 | 7.0 | TY |
| | 24/00 | 13.1 | 145.5 | 935 | 95 | 6.0 | TY |
| | 24/06 | 13.6 | 145.2 | 935 | 95 | 6.0 | TY |
| | 24/12 | 13.8 | 144.7 | 935 | 95 | 6.0 | TY |
| | 24/18 | 14.1 | 144.1 | 935 | 95 | 6.0 | TY |
| | 25/00 | 14.2 | 143.5 | 925 | 100 | 6.5 | TY |
| | 25/06 | 14.6 | 142.8 | 905 | 110 | 7.0 | TY |
| | 25/12 | 14.8 | 141.5 | 900 | 115 | 7.5 | TY |
| | 25/18 | 14.9 | 140.4 | 900 | 115 | 7.5 | TY |
| | 26/00 | 15.1 | 139.2 | 900 | 115 | 7.5 | TY |
| | 26/06 | 15.4 | 137.9 | 900 | 115 | 7.5 | TY |
| | 26/12 | 15.7 | 136.5 | 900 | 115 | 7.5 | TY |
| | 26/18 | 16.0 | 134.9 | 900 | 115 | 7.5 | TY |
| | 27/00 | 16.4 | 133.5 | 910 | 105 | 7.0 | TY |
| | 27/06 | 16.6 | 132.2 | 925 | 95 | 6.0 | TY |
| | 27/12 | 16.8 | 130.9 | 945 | 85 | 5.5 | TY |
| | 27/18 | 17.1 | 129.7 | 945 | 85 | 5.5 | TY |
| | 28/00 | 17.2 | 128.7 | 945 | 85 | 5.5 | TY |
| | 28/06 | 17.6 | 127.9 | 945 | 85 | 5.5 | TY |
| | 28/12 | 18.0 | 127.4 | 945 | 85 | 5.5 | TY |
| | 28/18 | 18.6 | 126.7 | 945 | 85 | 5.5 | TY |
| | 29/00 | 19.0 | 126.2 | 945 | 85 | 5.5 | TY |
| | 29/06 | 19.4 | 125.8 | 945 | 85 | 5.5 | TY |
| | 29/12 | 19.7 | 125.6 | 945 | 85 | 5.5 | TY |
| | 29/18 | 20.1 | 125.4 | 945 | 85 | 5.5 | TY |
| | 30/00 | 20.3 | 125.1 | 950 | 80 | 5.0 | TY |
| | 30/06 | 20.6 | 125.0 | 950 | 80 | 5.0 | TY |
| | 30/12 | 20.8 | 125.0 | 955 | 70 | 4.5 | TY |
| | 30/18 | 21.2 | 125.0 | 955 | 70 | 4.5 | TY |
| | 31/00 | 21.4 | 125.1 | 955 | 70 | 4.5 | TY |
| | 31/06 | 22.2 | 125.3 | 960 | 65 | 4.0 | TY |
| | 31/09 | 22.5 | 125.4 | 960 | 65 | − | TY |
| | 31/12 | 22.7 | 125.4 | 960 | 65 | 4.0 | TY |
| | 31/15 | 23.0 | 125.5 | 960 | 65 | − | TY |
| | 31/18 | 23.6 | 125.6 | 965 | 60 | 3.5 | STS |
| | 31/21 | 23.8 | 125.7 | 965 | 60 | − | STS |
| Jun. | 01/00 | 24.1 | 125.8 | 970 | 50 | 3.0 | STS |
| | 01/03 | 24.6 | 126.0 | 970 | 50 | − | STS |
| | 01/06 | 24.9 | 126.1 | 970 | 50 | 3.0 | STS |
| | 01/09 | 25.4 | 126.6 | 970 | 50 | − | STS |
| | 01/12 | 25.9 | 127.1 | 970 | 50 | 3.0 | STS |
| | 01/15 | 26.4 | 127.6 | 970 | 50 | − | STS |
| | 01/18 | 26.9 | 128.1 | 970 | 50 | 3.0 | STS |
| | 01/21 | 27.2 | 128.8 | 970 | 50 | − | STS |
| | 02/00 | 27.4 | 129.4 | 975 | 45 | 2.5 | TS |
| | 02/06 | 28.2 | 131.0 | 975 | 45 | 2.5 | TS |
| | 02/12 | 28.9 | 132.8 | 980 | 45 | 2.5 | TS |
| | 02/18 | 29.7 | 135.2 | 980 | 45 | 2.5 | TS |
| | 03/00 | 30.6 | 137.8 | 984 | − | 2.0 | L |
| | 03/06 | 32.4 | 140.8 | 990 | − | 1.5 | L |
| | 03/12 | 33.7 | 144.7 | 996 | − | − | L |
| | 03/18 | | | | | | Dissip. |

**TY GUCHOL (2303)**

| Date/Time | | Center Position | | Central pressure | Max Wind | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| | (UTC) | Lat (N) | Lon (E) | (hPa) | (kt) | | |
| Jun. | 06/00 | 12.8 | 135.0 | 1004 | − | 0.0 | TD |
| | 06/06 | 13.1 | 135.1 | 1002 | − | 0.5 | TD |
| | 06/12 | 13.6 | 135.1 | 1000 | 35 | 1.0 | TS |
| | 06/18 | 14.1 | 134.9 | 1000 | 35 | 1.5 | TS |
| | 07/00 | 14.7 | 134.3 | 998 | 40 | 2.0 | TS |
| | 07/06 | 15.0 | 133.8 | 996 | 40 | 2.5 | TS |
| | 07/12 | 15.1 | 133.2 | 992 | 45 | 2.5 | TS |
| | 07/18 | 15.5 | 132.4 | 990 | 50 | 3.0 | STS |
| | 08/00 | 15.8 | 131.6 | 985 | 55 | 3.5 | STS |
| | 08/06 | 16.0 | 131.1 | 980 | 60 | 4.0 | STS |
| | 08/12 | 16.3 | 130.8 | 970 | 70 | 4.5 | TY |
| | 08/18 | 16.8 | 130.4 | 965 | 75 | 5.0 | TY |
| | 09/00 | 17.2 | 130.4 | 965 | 75 | 5.0 | TY |
| | 09/06 | 17.8 | 130.1 | 965 | 75 | 5.0 | TY |
| | 09/12 | 18.1 | 129.9 | 965 | 75 | 5.0 | TY |
| | 09/18 | 18.5 | 129.9 | 960 | 80 | 5.0 | TY |
| | 10/00 | 18.9 | 129.9 | 960 | 80 | 5.0 | TY |
| | 10/06 | 19.9 | 130.2 | 960 | 80 | 5.0 | TY |
| | 10/12 | 20.7 | 130.5 | 960 | 75 | 4.5 | TY |
| | 10/18 | 21.8 | 131.1 | 965 | 70 | 4.5 | TY |
| | 11/00 | 23.0 | 131.7 | 970 | 65 | 4.0 | TY |
| | 11/06 | 24.2 | 132.6 | 975 | 60 | 4.0 | STS |
| | 11/12 | 25.6 | 133.8 | 980 | 55 | 4.0 | STS |
| | 11/18 | 26.4 | 135.3 | 980 | 55 | 3.5 | STS |
| | 12/00 | 27.9 | 136.9 | 980 | 55 | 3.5 | STS |
| | 12/06 | 29.5 | 138.1 | 985 | 50 | 3.5 | STS |
| | 12/12 | 30.5 | 139.5 | 990 | − | 2.5 | L |
| | 12/18 | 32.0 | 142.0 | 990 | − | 2.0 | L |
| | 13/00 | 33.6 | 144.0 | 992 | − | − | L |
| | 13/06 | 34.5 | 146.4 | 992 | − | − | L |
| | 13/12 | 35.8 | 148.8 | 996 | − | − | L |
| | 13/18 | 38.1 | 152.0 | 996 | − | − | L |
| | 14/00 | 38.5 | 155.0 | 996 | − | − | L |
| | 14/06 | 39.1 | 158.5 | 996 | − | − | L |
| | 14/12 | 39.3 | 162.0 | 996 | − | − | L |
| | 14/18 | 39.0 | 166.5 | 998 | − | − | L |
| | 15/00 | 38.7 | 169.5 | 998 | − | − | L |
| | 15/06 | 38.9 | 171.0 | 996 | − | − | L |
| | 15/12 | 38.9 | 172.8 | 994 | − | − | L |
| | 15/18 | 39.3 | 174.5 | 990 | − | − | L |
| | 16/00 | 39.2 | 176.5 | 986 | − | − | L |
| | 16/06 | 39.6 | 178.1 | 984 | − | − | L |
| | 16/12 | 39.6 | 179.6 | 984 | − | − | L |
| | 16/18 | 39.7 | 180.9 | 986 | − | − | Out |

## STS TALIM (2304)

| Date/Time | | Center Position | | Central pressure | Max Wind | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| | (UTC) | Lat (N) | Lon (E) | (hPa) | (kt) | | |
| Jul. | 13/06 | 15.7 | 122.3 | 1002 | − | 1.0 | TD |
| | 13/12 | 16.4 | 122.3 | 1002 | − | 1.0 | TD |
| | 13/18 | 16.9 | 122.1 | 1000 | − | 1.0 | TD |
| | 14/00 | 18.1 | 121.5 | 1000 | − | 1.0 | TD |
| | 14/06 | 17.9 | 120.3 | 1000 | − | 1.5 | TD |
| | 14/12 | 17.4 | 119.3 | 998 | − | 1.5 | TD |
| | 14/18 | 17.8 | 118.6 | 996 | − | 1.5 | TD |
| | 15/00 | 18.2 | 118.1 | 996 | − | 1.5 | TD |
| | 15/06 | 18.2 | 117.8 | 992 | 35 | 2.0 | TS |
| | 15/12 | 18.3 | 117.0 | 990 | 40 | 2.5 | TS |
| | 15/18 | 18.6 | 116.7 | 985 | 45 | 3.0 | TS |
| | 16/00 | 18.8 | 116.1 | 980 | 50 | 3.5 | STS |
| | 16/06 | 19.2 | 115.3 | 980 | 50 | 3.5 | STS |
| | 16/12 | 19.5 | 114.6 | 980 | 50 | 3.5 | STS |
| | 16/18 | 19.7 | 113.8 | 975 | 55 | 3.5 | STS |
| | 17/00 | 20.1 | 113.0 | 970 | 60 | 4.0 | STS |
| | 17/06 | 20.7 | 112.1 | 970 | 60 | 3.5 | STS |
| | 17/12 | 21.2 | 110.8 | 970 | 60 | 3.5 | STS |
| | 17/18 | 21.4 | 109.7 | 975 | 55 | 3.5 | STS |
| | 18/00 | 21.7 | 108.8 | 980 | 50 | 3.0 | STS |
| | 18/06 | 22.4 | 107.5 | 985 | 45 | 2.5 | TS |
| | 18/12 | 22.0 | 106.3 | 996 | − | 2.0 | TD |
| | 18/18 | 22.1 | 105.8 | 1000 | − | − | TD |
| | 19/00 | | | | | | Dissip. |

## TY DOKSURI (2305)

| Date/Time | | Center Position | | Central pressure | Max Wind | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| | (UTC) | Lat (N) | Lon (E) | (hPa) | (kt) | | |
| Jul. | 20/06 | 12.6 | 133.7 | 1004 | − | 0.5 | TD |
| | 20/12 | 13.2 | 133.7 | 1006 | − | 1.0 | TD |
| | 20/18 | 13.7 | 133.5 | 1004 | − | 1.5 | TD |
| | 21/00 | 13.8 | 133.0 | 1002 | 35 | 2.0 | TS |
| | 21/06 | 13.9 | 132.8 | 1002 | 35 | 2.0 | TS |
| | 21/12 | 14.0 | 132.5 | 1002 | 35 | 2.0 | TS |
| | 21/18 | 14.2 | 132.2 | 1002 | 35 | 2.0 | TS |
| | 22/00 | 14.3 | 131.7 | 998 | 40 | 2.5 | TS |
| | 22/06 | 14.3 | 131.0 | 998 | 40 | 2.5 | TS |
| | 22/12 | 14.4 | 130.3 | 994 | 45 | 2.5 | TS |
| | 22/18 | 14.6 | 129.7 | 990 | 50 | 3.0 | STS |
| | 23/00 | 14.7 | 129.0 | 985 | 55 | 3.5 | STS |
| | 23/06 | 14.9 | 128.3 | 980 | 60 | 3.5 | STS |
| | 23/12 | 15.0 | 127.8 | 980 | 60 | 3.5 | STS |
| | 23/18 | 15.1 | 127.0 | 970 | 70 | 4.5 | TY |
| | 24/00 | 15.2 | 126.6 | 965 | 75 | 5.0 | TY |
| | 24/06 | 15.7 | 126.3 | 950 | 85 | 5.5 | TY |
| | 24/12 | 16.5 | 125.8 | 940 | 90 | 6.0 | TY |
| | 24/18 | 16.9 | 125.1 | 925 | 100 | 6.5 | TY |
| | 25/00 | 17.6 | 124.6 | 925 | 100 | 6.5 | TY |
| | 25/06 | 18.3 | 123.7 | 925 | 100 | 6.5 | TY |
| | 25/12 | 18.9 | 122.7 | 925 | 100 | 6.5 | TY |
| | 25/18 | 19.0 | 121.6 | 925 | 100 | 6.5 | TY |
| | 26/00 | 18.9 | 121.4 | 940 | 90 | 5.5 | TY |
| | 26/06 | 19.3 | 121.0 | 950 | 85 | 5.5 | TY |
| | 26/12 | 19.5 | 120.6 | 955 | 80 | 5.0 | TY |
| | 26/18 | 20.0 | 120.0 | 955 | 80 | 5.0 | TY |
| | 27/00 | 20.7 | 119.8 | 955 | 75 | 4.5 | TY |
| | 27/06 | 21.1 | 119.3 | 955 | 75 | 4.5 | TY |
| | 27/12 | 21.8 | 119.1 | 955 | 80 | 5.0 | TY |
| | 27/18 | 22.8 | 118.9 | 955 | 80 | 5.0 | TY |
| | 28/00 | 24.2 | 118.8 | 965 | 70 | 5.0 | TY |
| | 28/06 | 25.3 | 118.3 | 985 | 50 | 4.5 | STS |
| | 28/12 | 27.1 | 117.9 | 994 | 40 | 4.0 | TS |
| | 28/18 | 28.9 | 117.0 | 996 | 35 | 3.5 | TS |
| | 29/00 | 30.6 | 115.1 | 998 | − | 3.0 | TD |
| | 29/06 | 31.9 | 114.7 | 998 | − | − | TD |
| | 29/12 | 33.0 | 114.5 | 998 | − | − | TD |
| | 29/18 | 33.8 | 114.4 | 998 | − | − | TD |
| | 30/00 | 35.4 | 114.0 | 1000 | − | − | TD |
| | 30/06 | 36.1 | 113.7 | 1000 | − | − | TD |
| | 30/12 | 36.7 | 113.5 | 1000 | − | − | TD |
| | 30/18 | | | | | | Dissip. |

## TY KHANUN (2306)

| Date/Time | | Center Position | | Central pressure | Max Wind | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| | (UTC) | Lat (N) | Lon (E) | (hPa) | (kt) | | |
| Jul. | 26/18 | 10.5 | 138.1 | 1006 | − | 0.0 | TD |
| | 27/00 | 10.9 | 137.7 | 1006 | − | 0.0 | TD |
| | 27/06 | 11.2 | 137.2 | 1004 | − | 0.5 | TD |
| | 27/12 | 11.6 | 136.9 | 1004 | − | 1.0 | TD |
| | 27/18 | 12.2 | 136.6 | 1002 | − | 1.5 | TD |
| | 28/00 | 12.8 | 136.3 | 1000 | 35 | 2.0 | TS |
| | 28/06 | 13.5 | 135.9 | 998 | 35 | 2.0 | TS |
| | 28/12 | 14.1 | 135.5 | 998 | 35 | 2.0 | TS |
| | 28/18 | 14.9 | 134.7 | 996 | 40 | 2.0 | TS |
| | 29/00 | 15.6 | 134.1 | 996 | 40 | 2.0 | TS |
| | 29/06 | 16.1 | 133.8 | 992 | 45 | 2.5 | TS |
| | 29/12 | 16.8 | 133.6 | 985 | 50 | 3.0 | STS |
| | 29/18 | 17.6 | 133.1 | 980 | 55 | 3.5 | STS |
| | 30/00 | 18.4 | 132.9 | 970 | 65 | 4.0 | TY |
| | 30/06 | 19.6 | 132.7 | 965 | 70 | 4.5 | TY |
| | 30/12 | 20.3 | 132.4 | 960 | 75 | 5.0 | TY |
| | 30/18 | 21.1 | 132.1 | 950 | 80 | 5.0 | TY |
| | 30/21 | 21.5 | 132.1 | 950 | 80 | − | TY |
| | 31/00 | 22.0 | 132.0 | 945 | 85 | 5.5 | TY |
| | 31/03 | 22.4 | 131.8 | 945 | 85 | − | TY |
| | 31/06 | 22.8 | 131.6 | 945 | 85 | 5.5 | TY |
| | 31/09 | 23.1 | 131.3 | 945 | 85 | − | TY |
| | 31/12 | 23.4 | 131.1 | 935 | 90 | 6.0 | TY |
| | 31/15 | 23.8 | 130.7 | 935 | 90 | − | TY |
| | 31/18 | 24.1 | 130.3 | 935 | 90 | 6.0 | TY |
| | 31/21 | 24.4 | 129.8 | 935 | 90 | − | TY |
| Aug. | 01/00 | 24.6 | 129.4 | 930 | 95 | 6.0 | TY |
| | 01/03 | 24.8 | 129.0 | 930 | 95 | − | TY |
| | 01/06 | 25.0 | 128.7 | 930 | 95 | 6.0 | TY |
| | 01/09 | 25.2 | 128.4 | 930 | 95 | − | TY |
| | 01/12 | 25.3 | 128.0 | 930 | 95 | 6.0 | TY |
| | 01/15 | 25.3 | 127.6 | 930 | 95 | − | TY |
| | 01/18 | 25.5 | 127.4 | 935 | 90 | 5.5 | TY |
| | 01/21 | 25.7 | 127.0 | 935 | 90 | − | TY |
| | 02/00 | 25.7 | 126.9 | 935 | 90 | 5.5 | TY |
| | 02/03 | 26.1 | 126.5 | 935 | 90 | − | TY |
| | 02/06 | 26.1 | 126.1 | 935 | 90 | 5.5 | TY |
| | 02/09 | 26.1 | 125.8 | 935 | 90 | − | TY |
| | 02/12 | 26.2 | 125.6 | 935 | 90 | 5.5 | TY |
| | 02/15 | 26.2 | 125.3 | 935 | 90 | − | TY |
| | 02/18 | 26.5 | 125.0 | 935 | 90 | 5.5 | TY |
| | 02/21 | 26.5 | 124.8 | 935 | 90 | − | TY |
| | 03/00 | 26.6 | 124.7 | 940 | 85 | 5.5 | TY |
| | 03/03 | 26.7 | 124.5 | 940 | 85 | − | TY |
| | 03/06 | 26.6 | 124.2 | 945 | 80 | 5.0 | TY |
| | 03/09 | 26.6 | 124.2 | 945 | 80 | − | TY |
| | 03/12 | 26.6 | 124.2 | 960 | 70 | 4.5 | TY |
| | 03/15 | 26.7 | 124.3 | 960 | 70 | − | TY |
| | 03/18 | 26.8 | 124.3 | 965 | 65 | 4.0 | TY |
| | 03/21 | 26.9 | 124.4 | 965 | 65 | − | TY |
| | 04/00 | 27.0 | 124.5 | 970 | 60 | 3.5 | STS |
| | 04/03 | 27.0 | 124.8 | 970 | 60 | − | STS |
| | 04/06 | 27.2 | 125.1 | 970 | 60 | 3.5 | STS |
| | 04/09 | 27.3 | 125.5 | 970 | 60 | − | STS |
| | 04/12 | 27.5 | 125.7 | 970 | 60 | 3.0 | STS |
| | 04/15 | 27.5 | 126.0 | 970 | 60 | − | STS |
| | 04/18 | 27.7 | 126.4 | 970 | 55 | 3.0 | STS |
| | 04/21 | 27.8 | 126.6 | 970 | 55 | − | STS |
| | 05/00 | 27.7 | 126.8 | 970 | 55 | 3.0 | STS |
| | 05/03 | 27.7 | 127.2 | 970 | 55 | − | STS |
| | 05/06 | 27.8 | 127.6 | 970 | 50 | 3.0 | STS |
| | 05/09 | 27.8 | 128.1 | 970 | 50 | − | STS |
| | 05/12 | 27.8 | 128.4 | 970 | 50 | 3.0 | STS |
| | 05/15 | 27.9 | 128.7 | 970 | 50 | − | STS |
| | 05/18 | 28.0 | 128.9 | 970 | 50 | 3.0 | STS |
| | 05/21 | 27.9 | 129.0 | 970 | 50 | − | STS |
| | 06/00 | 27.8 | 129.5 | 970 | 50 | 3.0 | STS |
| | 06/03 | 27.8 | 129.7 | 970 | 50 | − | STS |
| | 06/06 | 27.8 | 129.9 | 970 | 50 | 3.0 | STS |
| | 06/09 | 27.8 | 130.3 | 970 | 50 | − | STS |
| | 06/12 | 27.4 | 130.4 | 970 | 50 | 3.0 | STS |
| | 06/15 | 27.4 | 130.7 | 970 | 50 | − | STS |
| | 06/18 | 27.5 | 130.9 | 970 | 50 | 3.0 | STS |
| | 06/21 | 27.6 | 131.0 | 970 | 50 | − | STS |
| | 07/00 | 27.8 | 131.2 | 970 | 50 | 3.0 | STS |
| | 07/03 | 27.9 | 131.2 | 970 | 50 | − | STS |
| | 07/06 | 27.9 | 131.1 | 970 | 50 | 3.0 | STS |
| | 07/09 | 28.0 | 131.1 | 970 | 50 | − | STS |
| | 07/12 | 28.2 | 131.1 | 975 | 45 | 3.0 | TS |
| | 07/15 | 28.3 | 131.1 | 975 | 45 | − | TS |
| | 07/18 | 28.4 | 131.1 | 975 | 45 | 3.0 | TS |
| | 07/21 | 28.6 | 131.1 | 975 | 45 | − | TS |
| | 08/00 | 28.9 | 131.0 | 975 | 45 | 3.0 | TS |
| | 08/03 | 29.1 | 130.9 | 975 | 45 | − | TS |
| | 08/06 | 29.4 | 130.7 | 970 | 50 | 3.5 | STS |
| | 08/09 | 29.7 | 130.6 | 970 | 50 | − | STS |
| | 08/12 | 29.9 | 130.4 | 970 | 50 | 3.5 | STS |
| | 08/15 | 30.2 | 130.1 | 970 | 50 | − | STS |
| | 08/18 | 30.4 | 129.7 | 970 | 50 | 3.5 | STS |
| | 08/21 | 30.6 | 129.5 | 970 | 50 | − | STS |
| | 09/00 | 30.9 | 129.3 | 970 | 50 | 3.5 | STS |
| | 09/03 | 31.3 | 129.0 | 970 | 50 | − | STS |
| | 09/06 | 31.6 | 128.9 | 970 | 50 | 3.5 | STS |
| | 09/09 | 31.9 | 128.8 | 970 | 50 | − | STS |
| | 09/12 | 32.4 | 128.8 | 975 | 50 | 3.0 | STS |
| | 09/15 | 32.7 | 128.6 | 975 | 50 | − | STS |
| | 09/18 | 33.4 | 128.6 | 975 | 50 | 2.5 | STS |
| | 09/21 | 34.1 | 128.6 | 975 | 50 | − | STS |
| | 10/00 | 34.8 | 128.7 | 980 | 45 | 2.0 | TS |
| | 10/06 | 36.6 | 128.1 | 986 | − | 2.0 | L |
| | 10/12 | 38.0 | 128.3 | 992 | − | 1.5 | L |
| | 10/18 | 38.4 | 126.5 | 994 | − | 1.5 | L |
| | 11/00 | 38.7 | 125.9 | 996 | − | − | L |
| | 11/06 | 39.2 | 124.9 | 996 | − | − | L |
| | 11/12 | 38.8 | 124.0 | 998 | − | − | L |
| | 11/18 | 37.6 | 124.9 | 1002 | − | − | L |
| | 12/00 | | | | | | Dissip. |

## TY LAN (2307)

| Date/Time | | Center Position | | Central pressure | Max Wind | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| | (UTC) | Lat (N) | Lon (E) | (hPa) | (kt) | | |
| Aug. | 07/00 | 22.5 | 149.0 | 1004 | − | 1.0 | TD |
| | 07/06 | 22.8 | 149.4 | 1002 | − | 1.5 | TD |
| | 07/12 | 23.1 | 149.8 | 1004 | − | 2.0 | TD |
| | 07/18 | 23.6 | 149.9 | 1002 | − | 2.0 | TD |
| | 08/00 | 23.9 | 149.4 | 1000 | 35 | 2.5 | TS |
| | 08/06 | 24.2 | 148.8 | 996 | 40 | 2.5 | TS |
| | 08/12 | 24.4 | 148.3 | 992 | 45 | 3.0 | TS |
| | 08/18 | 24.4 | 147.6 | 992 | 45 | 3.0 | TS |
| | 09/00 | 24.3 | 146.9 | 990 | 50 | 3.0 | STS |
| | 09/06 | 24.6 | 146.1 | 985 | 50 | 3.0 | STS |
| | 09/12 | 24.8 | 145.4 | 980 | 55 | 3.5 | STS |
| | 09/18 | 25.0 | 144.7 | 975 | 60 | 4.0 | STS |
| | 10/00 | 25.2 | 143.9 | 970 | 65 | 5.0 | TY |
| | 10/06 | 25.5 | 143.5 | 960 | 75 | 5.0 | TY |
| | 10/09 | 25.8 | 143.4 | 955 | 80 | − | TY |
| | 10/12 | 26.0 | 143.2 | 950 | 85 | 5.5 | TY |
| | 10/15 | 26.2 | 143.0 | 950 | 85 | − | TY |
| | 10/18 | 26.4 | 142.9 | 940 | 90 | 6.0 | TY |
| | 10/21 | 26.6 | 143.0 | 940 | 90 | − | TY |
| | 11/00 | 26.9 | 142.9 | 940 | 90 | 6.0 | TY |
| | 11/03 | 27.1 | 142.9 | 940 | 90 | − | TY |
| | 11/06 | 27.4 | 142.9 | 940 | 90 | 6.0 | TY |
| | 11/09 | 27.7 | 142.9 | 940 | 90 | − | TY |
| | 11/12 | 27.9 | 142.6 | 940 | 90 | 6.0 | TY |
| | 11/15 | 28.0 | 142.4 | 940 | 90 | − | TY |
| | 11/18 | 28.2 | 142.4 | 950 | 85 | 5.5 | TY |
| | 12/00 | 28.6 | 141.9 | 950 | 85 | 5.5 | TY |
| | 12/06 | 28.9 | 141.4 | 950 | 85 | 5.5 | TY |
| | 12/12 | 29.1 | 140.7 | 955 | 80 | 5.0 | TY |
| | 12/18 | 29.3 | 140.0 | 965 | 75 | 4.5 | TY |
| | 13/00 | 29.8 | 139.6 | 965 | 75 | 4.5 | TY |
| | 13/06 | 30.3 | 138.9 | 965 | 75 | 4.5 | TY |
| | 13/12 | 30.7 | 138.6 | 965 | 75 | 4.5 | TY |
| | 13/18 | 31.2 | 138.1 | 970 | 70 | 4.5 | TY |
| | 14/00 | 31.8 | 137.5 | 970 | 70 | 4.5 | TY |
| | 14/03 | 32.0 | 137.2 | 970 | 70 | − | TY |
| | 14/06 | 32.3 | 136.9 | 970 | 65 | 4.0 | TY |
| | 14/09 | 32.6 | 136.8 | 970 | 65 | − | TY |
| | 14/12 | 32.8 | 136.6 | 975 | 60 | 3.5 | STS |
| | 14/15 | 33.0 | 136.4 | 975 | 60 | − | STS |
| | 14/18 | 33.3 | 136.0 | 975 | 60 | 3.0 | STS |
| | 14/19 | 33.5 | 136.0 | 975 | 60 | − | STS |
| | 14/21 | 33.7 | 135.8 | 975 | 60 | − | STS |
| | 15/00 | 34.1 | 135.3 | 980 | 55 | 3.0 | STS |
| | 15/03 | 34.5 | 135.0 | 985 | 50 | − | STS |
| | 15/04 | 34.7 | 134.9 | 985 | 50 | − | STS |
| | 15/06 | 35.1 | 134.9 | 985 | 50 | 2.5 | STS |
| | 15/09 | 35.4 | 134.8 | 990 | 45 | − | TS |
| | 15/12 | 36.0 | 134.7 | 990 | 45 | 2.5 | TS |
| | 15/18 | 37.0 | 134.8 | 990 | 40 | 2.0 | TS |
| | 16/00 | 38.2 | 135.5 | 990 | 40 | 2.0 | TS |
| | 16/06 | 39.7 | 136.1 | 990 | 40 | 2.0 | TS |
| | 16/12 | 40.6 | 136.6 | 990 | 40 | 2.0 | TS |
| | 16/18 | 42.0 | 137.7 | 990 | 40 | 2.0 | TS |
| | 17/00 | 44.2 | 138.4 | 990 | 40 | 1.5 | TS |
| | 17/06 | 44.8 | 139.4 | 990 | − | 1.5 | L |
| | 17/12 | 45.8 | 141.1 | 992 | − | − | L |
| | 17/18 | 46.9 | 144.2 | 992 | − | − | L |
| | 18/00 | 47.8 | 147.5 | 994 | − | − | L |
| | 18/06 | 48.5 | 150.6 | 998 | − | − | L |
| | 18/12 | 49.2 | 154.3 | 1000 | − | − | L |
| | 18/18 | | | | | | Dissip. |

## TY DORA (2308)

| Date/Time | (UTC) | Lat (N) | Lon (E) | Central pressure (hPa) | Max Wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| Aug. | 12/00 | 15.6 | 180.1 | 975 | 80 | 5.0 | Out |
| | 12/06 | 16.3 | 179.1 | 980 | 75 | 5.0 | TY |
| | 12/12 | 17.0 | 178.0 | 980 | 75 | 5.0 | TY |
| | 12/18 | 17.8 | 176.9 | 980 | 75 | 5.0 | TY |
| | 13/00 | 18.1 | 175.4 | 985 | 70 | 4.5 | TY |
| | 13/06 | 18.1 | 174.1 | 990 | 65 | 4.0 | TY |
| | 13/12 | 18.1 | 172.7 | 994 | 55 | 3.5 | STS |
| | 13/18 | 18.3 | 171.4 | 998 | 50 | 3.0 | STS |
| | 14/00 | 18.7 | 170.2 | 1000 | 45 | 2.5 | TS |
| | 14/06 | 19.3 | 169.2 | 1000 | 45 | 2.5 | TS |
| | 14/12 | 19.8 | 168.6 | 1000 | 45 | 2.5 | TS |
| | 14/18 | 20.2 | 168.2 | 1004 | 35 | 2.5 | TS |
| | 15/00 | 20.6 | 167.9 | 1006 | − | 2.5 | TD |
| | 15/06 | 21.5 | 167.8 | 1006 | − | 2.5 | TD |
| | 15/12 | 22.6 | 168.2 | 1010 | − | 2.5 | TD |
| | 15/18 | 23.5 | 168.2 | 1010 | − | − | TD |
| | 16/00 | 24.1 | 168.3 | 1010 | − | − | TD |
| | 16/06 | 25.4 | 168.7 | 1010 | − | − | TD |
| | 16/12 | 26.9 | 168.7 | 1010 | − | − | TD |
| | 16/18 | 27.9 | 168.5 | 1010 | − | − | TD |
| | 17/00 | 29.0 | 168.2 | 1012 | − | − | TD |
| | 17/06 | 29.8 | 167.7 | 1010 | − | − | TD |
| | 17/12 | 30.5 | 167.2 | 1012 | − | − | TD |
| | 17/18 | 31.2 | 166.6 | 1010 | − | − | TD |
| | 18/00 | 31.6 | 166.2 | 1012 | − | − | TD |
| | 18/06 | 31.9 | 165.9 | 1012 | − | − | TD |
| | 18/12 | 32.1 | 166.2 | 1012 | − | − | TD |
| | 18/18 | 32.5 | 166.9 | 1012 | − | − | TD |
| | 19/00 | 32.9 | 167.4 | 1012 | − | − | TD |
| | 19/06 | 33.2 | 168.0 | 1012 | − | − | TD |
| | 19/12 | 33.2 | 168.7 | 1012 | − | − | TD |
| | 19/18 | 33.1 | 169.4 | 1012 | − | − | TD |
| | 20/00 | 32.9 | 170.4 | 1012 | − | − | TD |
| | 20/06 | 32.5 | 171.6 | 1010 | − | − | TD |
| | 20/12 | 32.4 | 172.7 | 1010 | − | − | TD |
| | 20/18 | 32.6 | 173.9 | 1008 | − | − | TD |
| | 21/00 | 33.0 | 174.9 | 1008 | − | − | TD |
| | 21/06 | 33.5 | 175.7 | 1008 | − | − | TD |
| | 21/12 | 34.3 | 177.1 | 1010 | − | − | L |
| | 21/18 | 35.2 | 178.3 | 1010 | − | − | L |
| | 22/00 | 36.2 | 179.6 | 1008 | − | − | L |
| | 22/06 | 37.0 | 181.2 | 1008 | − | − | Out |

## TY SAOLA (2309)

| Date/Time | (UTC) | Lat (N) | Lon (E) | Central pressure (hPa) | Max Wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| Aug. | 22/00 | 18.8 | 128.3 | 1006 | − | 0.0 | TD |
| | 22/06 | 18.6 | 127.5 | 1004 | − | 0.5 | TD |
| | 22/12 | 18.5 | 126.8 | 1004 | − | 1.0 | TD |
| | 22/18 | 18.5 | 126.5 | 1004 | − | 1.0 | TD |
| | 23/00 | 18.5 | 126.2 | 1006 | − | 1.5 | TD |
| | 23/06 | 18.6 | 125.9 | 1004 | − | 1.5 | TD |
| | 23/12 | 18.8 | 125.6 | 1006 | − | 1.5 | TD |
| | 23/18 | 19.5 | 125.3 | 1004 | − | 1.5 | TD |
| | 24/00 | 20.0 | 125.1 | 1006 | − | 1.5 | TD |
| | 24/06 | 20.5 | 124.8 | 1002 | 35 | 2.0 | TS |
| | 24/12 | 20.2 | 124.5 | 1002 | 35 | 2.5 | TS |
| | 24/18 | 20.1 | 124.3 | 1000 | 40 | 2.5 | TS |
| | 25/00 | 19.9 | 124.0 | 998 | 45 | 2.5 | TS |
| | 25/06 | 19.8 | 123.8 | 994 | 50 | 3.0 | STS |
| | 25/12 | 19.6 | 123.6 | 980 | 65 | 4.0 | TY |
| | 25/18 | 19.2 | 123.4 | 975 | 70 | 4.5 | TY |
| | 26/00 | 18.5 | 123.2 | 970 | 75 | 5.0 | TY |
| | 26/06 | 18.0 | 123.2 | 955 | 85 | 5.5 | TY |
| | 26/12 | 17.6 | 123.0 | 950 | 90 | 6.0 | TY |
| | 26/18 | 17.2 | 122.9 | 940 | 95 | 6.0 | TY |
| | 27/00 | 16.8 | 122.9 | 940 | 95 | 6.0 | TY |
| | 27/06 | 16.5 | 123.0 | 940 | 95 | 6.0 | TY |
| | 27/12 | 16.2 | 123.2 | 940 | 95 | 6.0 | TY |
| | 27/18 | 16.0 | 123.7 | 955 | 85 | 5.0 | TY |
| | 28/00 | 16.8 | 124.4 | 960 | 80 | 5.0 | TY |
| | 28/06 | 17.5 | 124.2 | 955 | 85 | 5.5 | TY |
| | 28/12 | 17.9 | 124.0 | 955 | 85 | 5.5 | TY |
| | 28/18 | 18.3 | 123.8 | 955 | 85 | 5.5 | TY |
| | 29/00 | 18.5 | 123.5 | 955 | 85 | 5.5 | TY |
| | 29/06 | 18.9 | 123.1 | 950 | 90 | 6.0 | TY |
| | 29/12 | 19.3 | 122.7 | 940 | 95 | 6.5 | TY |
| | 29/18 | 19.9 | 121.9 | 935 | 100 | 6.5 | TY |
| | 30/00 | 20.1 | 121.0 | 920 | 105 | 7.0 | TY |
| | 30/06 | 20.4 | 120.3 | 920 | 105 | 7.0 | TY |
| | 30/12 | 20.7 | 119.6 | 920 | 105 | 7.0 | TY |
| | 30/18 | 20.9 | 118.7 | 920 | 105 | 7.0 | TY |
| | 31/00 | 21.1 | 118.2 | 920 | 105 | 7.0 | TY |
| | 31/06 | 21.2 | 117.8 | 920 | 105 | 7.0 | TY |
| | 31/12 | 21.5 | 117.3 | 935 | 100 | 6.5 | TY |
| | 31/18 | 21.6 | 116.8 | 940 | 95 | 6.5 | TY |
| Sep. | 01/00 | 21.9 | 116.2 | 940 | 95 | 6.5 | TY |
| | 01/06 | 22.0 | 115.4 | 940 | 95 | 6.5 | TY |
| | 01/12 | 22.0 | 114.4 | 950 | 85 | 5.5 | TY |
| | 01/18 | 22.0 | 113.4 | 970 | 70 | 5.0 | TY |
| | 02/00 | 21.7 | 112.7 | 980 | 60 | 4.5 | STS |
| | 02/06 | 21.7 | 111.9 | 990 | 50 | 4.5 | STS |
| | 02/12 | 21.7 | 111.1 | 996 | 35 | 4.0 | TS |
| | 02/18 | 21.6 | 110.5 | 998 | − | 3.5 | TD |
| | 03/00 | 21.4 | 109.7 | 1000 | − | − | TD |
| | 03/06 | 21.2 | 109.4 | 1000 | − | − | TD |
| | 03/12 | 20.9 | 109.3 | 1000 | − | − | TD |
| | 03/18 | | | | | | Dissip. |

## STS DAMREY (2310)

| Date/Time | (UTC) | Lat (N) | Lon (E) | Central pressure (hPa) | Max Wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| Aug. | 23/18 | 16.9 | 151.6 | 1002 | − | − | TD |
| | 24/00 | 17.1 | 152.0 | 1002 | − | 0.0 | TD |
| | 24/06 | 17.3 | 152.4 | 1000 | − | 0.5 | TD |
| | 24/12 | 17.6 | 153.1 | 1002 | − | 1.0 | TD |
| | 24/18 | 18.0 | 153.8 | 998 | 35 | 1.5 | TS |
| | 25/00 | 18.7 | 154.7 | 998 | 35 | 2.0 | TS |
| | 25/06 | 20.0 | 155.5 | 994 | 40 | 2.0 | TS |
| | 25/12 | 21.5 | 155.3 | 994 | 40 | 2.0 | TS |
| | 25/18 | 23.0 | 154.7 | 994 | 40 | 2.0 | TS |
| | 26/00 | 24.2 | 154.0 | 990 | 45 | 2.5 | TS |
| | 26/06 | 26.1 | 152.9 | 985 | 50 | 3.0 | STS |
| | 26/12 | 27.8 | 151.1 | 985 | 50 | 3.0 | STS |
| | 26/18 | 29.6 | 149.3 | 985 | 50 | 3.0 | STS |
| | 27/00 | 31.7 | 147.3 | 985 | 50 | 3.0 | STS |
| | 27/06 | 33.9 | 145.7 | 985 | 50 | 3.0 | STS |
| | 27/12 | 35.6 | 144.6 | 985 | 50 | 3.0 | STS |
| | 27/18 | 37.1 | 144.2 | 990 | 45 | 3.0 | TS |
| | 28/00 | 38.5 | 144.6 | 990 | 45 | 3.0 | TS |
| | 28/06 | 39.6 | 145.4 | 990 | 45 | 3.0 | TS |
| | 28/12 | 40.6 | 147.2 | 985 | 50 | 3.0 | STS |
| | 28/18 | 41.0 | 149.5 | 985 | 50 | 2.5 | STS |
| | 29/00 | 41.2 | 152.3 | 990 | 45 | 2.0 | TS |
| | 29/06 | 41.1 | 156.7 | 992 | − | 1.5 | L |
| | 29/12 | 41.3 | 161.2 | 992 | − | − | L |
| | 29/18 | 41.4 | 165.7 | 992 | − | − | L |
| | 30/00 | 42.4 | 172.7 | 988 | − | − | L |
| | 30/06 | 44.5 | 178.8 | 980 | − | − | L |
| | 30/12 | 46.2 | 182.1 | 974 | − | − | Out |

## TY HAIKUI (2311)

| Date/Time | (UTC) | Lat (N) | Lon (E) | Central pressure (hPa) | Max Wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| Aug. | 27/06 | 18.3 | 144.3 | 998 | − | 0.5 | TD |
| | 27/12 | 18.4 | 144.0 | 1000 | − | 1.0 | TD |
| | 27/18 | 18.3 | 143.4 | 998 | − | 1.5 | TD |
| | 28/00 | 18.6 | 142.4 | 998 | − | 2.0 | TD |
| | 28/06 | 18.7 | 141.3 | 998 | − | 2.0 | TD |
| | 28/12 | 18.7 | 140.4 | 998 | − | 2.0 | TD |
| | 28/18 | 18.6 | 139.4 | 996 | 35 | 2.0 | TS |
| | 29/00 | 18.9 | 138.0 | 994 | 40 | 2.5 | TS |
| | 29/06 | 19.0 | 137.4 | 990 | 45 | 3.0 | TS |
| | 29/12 | 19.1 | 136.7 | 990 | 45 | 3.0 | TS |
| | 29/18 | 19.5 | 136.5 | 990 | 45 | 3.0 | TS |
| | 30/00 | 20.1 | 136.2 | 990 | 45 | 3.0 | TS |
| | 30/06 | 20.5 | 135.6 | 990 | 45 | 3.0 | TS |
| | 30/12 | 21.1 | 135.1 | 990 | 45 | 3.0 | TS |
| | 30/18 | 21.1 | 133.7 | 985 | 50 | 3.0 | STS |
| | 31/00 | 21.1 | 133.0 | 980 | 55 | 3.5 | STS |
| | 31/06 | 21.1 | 132.0 | 980 | 55 | 3.5 | STS |
| | 31/12 | 21.2 | 131.1 | 980 | 55 | 3.5 | STS |
| | 31/18 | 21.5 | 130.3 | 980 | 55 | 3.5 | STS |
| Sep. | 01/00 | 22.0 | 129.4 | 975 | 60 | 3.5 | STS |
| | 01/06 | 22.2 | 128.4 | 975 | 60 | 3.5 | STS |
| | 01/12 | 21.9 | 127.6 | 970 | 65 | 4.0 | TY |
| | 01/18 | 21.7 | 127.0 | 970 | 65 | 4.0 | TY |
| | 02/00 | 22.1 | 126.3 | 965 | 70 | 4.5 | TY |
| | 02/06 | 22.4 | 125.3 | 960 | 75 | 5.0 | TY |
| | 02/12 | 22.7 | 124.3 | 960 | 75 | 5.0 | TY |
| | 02/18 | 22.7 | 123.1 | 945 | 85 | 5.5 | TY |
| | 03/00 | 22.6 | 122.6 | 950 | 80 | 5.5 | TY |
| | 03/06 | 22.9 | 121.5 | 965 | 65 | 5.5 | TY |
| | 03/12 | 22.8 | 120.1 | 975 | 55 | 5.0 | STS |
| | 03/18 | 22.6 | 120.0 | 980 | 50 | 4.5 | STS |
| | 04/00 | 23.1 | 119.8 | 985 | 45 | 4.0 | TS |
| | 04/06 | 23.2 | 119.2 | 985 | 45 | 3.5 | TS |
| | 04/12 | 23.9 | 118.6 | 992 | 40 | 3.0 | TS |
| | 04/18 | 23.5 | 117.3 | 996 | 35 | 2.5 | TS |
| | 05/00 | 23.4 | 116.8 | 1000 | − | 2.0 | TD |
| | 05/06 | 23.5 | 116.5 | 1000 | − | − | TD |
| | 05/12 | 23.5 | 116.1 | 1002 | − | − | TD |
| | 05/18 | 23.3 | 115.5 | 1004 | − | − | TD |
| | 06/00 | 23.2 | 115.1 | 1006 | − | − | TD |
| | 06/06 | | | | | | Dissip. |

## TS KIROGI (2312)

| Date/Time (UTC) | | Center Position Lat (N) | Center Position Lon (E) | Central pressure (hPa) | Max Wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| Aug. | 29/18 | 11.3 | 154.7 | 1004 | − | 0.5 | TD |
| | 30/00 | 12.2 | 154.5 | 1004 | − | 1.0 | TD |
| | 30/06 | 12.8 | 154.4 | 1002 | − | 1.5 | TD |
| | 30/12 | 13.3 | 154.3 | 1000 | 35 | 2.0 | TS |
| | 30/18 | 14.0 | 154.4 | 998 | 40 | 2.0 | TS |
| | 31/00 | 15.1 | 154.5 | 998 | 40 | 2.5 | TS |
| | 31/06 | 16.7 | 154.2 | 994 | 45 | 2.5 | TS |
| | 31/12 | 18.0 | 153.9 | 994 | 45 | 2.5 | TS |
| | 31/18 | 19.0 | 152.9 | 994 | 45 | 2.5 | TS |
| Sep. | 01/00 | 20.4 | 151.9 | 994 | 45 | 2.5 | TS |
| | 01/06 | 22.0 | 150.8 | 998 | 40 | 2.5 | TS |
| | 01/12 | 23.4 | 149.4 | 998 | 40 | 2.5 | TS |
| | 01/18 | 24.4 | 148.5 | 998 | 40 | 2.5 | TS |
| | 02/00 | 25.4 | 147.7 | 1000 | 35 | 2.0 | TS |
| | 02/06 | 27.1 | 146.3 | 1000 | 35 | 2.0 | TS |
| | 02/12 | 28.6 | 144.9 | 1000 | 35 | 2.0 | TS |
| | 02/18 | 29.1 | 143.0 | 1000 | 35 | 2.0 | TS |
| | 03/00 | 29.5 | 142.0 | 1002 | − | 2.0 | TD |
| | 03/06 | 30.2 | 140.7 | 1002 | − | 2.0 | TD |
| | 03/12 | 30.5 | 139.7 | 1002 | − | 2.0 | TD |
| | 03/18 | 31.2 | 138.2 | 1002 | − | 2.0 | TD |
| | 04/00 | 31.8 | 137.1 | 1002 | − | 1.5 | TD |
| | 04/06 | 31.8 | 135.7 | 1002 | − | 1.5 | TD |
| | 04/12 | 31.6 | 134.5 | 1004 | − | − | TD |
| | 04/18 | 31.5 | 133.3 | 1004 | − | − | TD |
| | 05/00 | 31.1 | 131.8 | 1004 | − | − | TD |
| | 05/06 | 31.0 | 132.0 | 1004 | − | − | TD |
| | 05/12 | 31.2 | 132.4 | 1004 | − | − | TD |
| | 05/18 | 31.8 | 132.7 | 1004 | − | − | TD |
| | 06/00 | 32.1 | 133.3 | 1004 | − | − | TD |
| | 06/06 | 32.1 | 134.0 | 1002 | − | − | TD |
| | 06/12 | 32.1 | 134.6 | 1004 | − | − | TD |
| | 06/18 | | | | | | Dissip. |

## TS YUN-YEUNG (2313)

| Date/Time (UTC) | | Center Position Lat (N) | Center Position Lon (E) | Central pressure (hPa) | Max Wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| Sep. | 04/06 | 20.0 | 129.4 | 1002 | − | 0.5 | TD |
| | 04/12 | 20.5 | 130.3 | 1002 | − | 1.0 | TD |
| | 04/18 | 20.9 | 130.7 | 1002 | − | 1.5 | TD |
| | 05/00 | 21.3 | 131.0 | 1004 | − | 1.5 | TD |
| | 05/06 | 21.9 | 131.5 | 1002 | − | 2.0 | TD |
| | 05/12 | 22.7 | 131.9 | 1000 | 35 | 2.0 | TS |
| | 05/18 | 24.1 | 132.5 | 1000 | 35 | 2.0 | TS |
| | 06/00 | 25.6 | 133.1 | 1000 | 35 | 2.0 | TS |
| | 06/06 | 26.6 | 134.2 | 998 | 40 | 2.5 | TS |
| | 06/12 | 27.4 | 134.8 | 998 | 40 | 2.5 | TS |
| | 06/18 | 28.5 | 135.6 | 998 | 40 | 2.5 | TS |
| | 07/00 | 29.7 | 136.5 | 998 | 40 | 2.5 | TS |
| | 07/06 | 30.9 | 137.0 | 998 | 40 | 2.5 | TS |
| | 07/12 | 31.7 | 137.0 | 998 | 40 | 2.5 | TS |
| | 07/18 | 32.6 | 137.0 | 998 | 40 | 2.5 | TS |
| | 08/00 | 32.7 | 137.1 | 998 | 40 | 2.5 | TS |
| | 08/06 | 32.6 | 137.4 | 1000 | 35 | 2.0 | TS |
| | 08/12 | 33.6 | 138.0 | 1004 | − | 1.5 | TD |
| | 08/18 | 34.2 | 138.2 | 1006 | − | 1.0 | TD |
| | 09/00 | | | | | | Dissip. |

## TY KOINU (2314)

| Date/Time (UTC) | | Center Position Lat (N) | Center Position Lon (E) | Central pressure (hPa) | Max Wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| Sep. | 28/12 | 15.8 | 139.0 | 1004 | − | 0.0 | TD |
| | 28/18 | 15.6 | 137.5 | 1004 | − | 0.5 | TD |
| | 29/00 | 15.3 | 135.8 | 1004 | − | 0.5 | TD |
| | 29/06 | 15.2 | 135.1 | 1002 | − | 1.0 | TD |
| | 29/12 | 15.6 | 134.2 | 1004 | − | 1.5 | TD |
| | 29/18 | 15.5 | 132.3 | 1000 | 35 | 1.5 | TS |
| | 30/00 | 15.3 | 131.8 | 1000 | 35 | 2.0 | TS |
| | 30/06 | 16.1 | 131.4 | 998 | 35 | 2.0 | TS |
| | 30/12 | 16.5 | 130.6 | 996 | 40 | 2.0 | TS |
| | 30/18 | 17.0 | 130.2 | 992 | 45 | 2.5 | TS |
| Oct. | 01/00 | 17.4 | 129.5 | 990 | 50 | 3.0 | STS |
| | 01/06 | 17.9 | 128.8 | 990 | 50 | 3.0 | STS |
| | 01/12 | 18.3 | 128.4 | 985 | 55 | 3.5 | STS |
| | 01/18 | 18.7 | 128.0 | 975 | 65 | 4.0 | TY |
| | 02/00 | 19.2 | 127.3 | 965 | 75 | 5.0 | TY |
| | 02/06 | 19.7 | 126.6 | 955 | 80 | 5.5 | TY |
| | 02/12 | 20.0 | 126.2 | 950 | 85 | 6.0 | TY |
| | 02/18 | 20.2 | 125.5 | 940 | 90 | 6.0 | TY |
| | 03/00 | 20.5 | 125.1 | 940 | 90 | 6.0 | TY |
| | 03/06 | 21.2 | 124.9 | 940 | 90 | 6.0 | TY |
| | 03/12 | 21.7 | 124.7 | 940 | 90 | 6.0 | TY |
| | 03/18 | 22.1 | 124.0 | 950 | 85 | 6.0 | TY |
| | 04/00 | 22.2 | 123.5 | 950 | 85 | 6.0 | TY |
| | 04/06 | 22.2 | 122.7 | 940 | 90 | 6.0 | TY |
| | 04/12 | 22.0 | 122.0 | 940 | 90 | 6.0 | TY |
| | 04/18 | 22.0 | 121.2 | 940 | 90 | 6.0 | TY |
| | 05/00 | 22.0 | 120.8 | 960 | 80 | 6.0 | TY |
| | 05/06 | 22.0 | 120.0 | 975 | 70 | 5.5 | TY |
| | 05/12 | 22.0 | 119.1 | 975 | 70 | 5.5 | TY |
| | 05/18 | 21.9 | 118.3 | 980 | 65 | 5.0 | TY |
| | 06/00 | 21.8 | 117.7 | 970 | 75 | 5.0 | TY |
| | 06/06 | 21.7 | 116.9 | 960 | 80 | 5.5 | TY |
| | 06/12 | 21.5 | 116.3 | 960 | 80 | 5.5 | TY |
| | 06/18 | 21.2 | 115.7 | 955 | 85 | 5.5 | TY |
| | 07/00 | 21.2 | 115.4 | 955 | 85 | 5.5 | TY |
| | 07/06 | 21.2 | 115.2 | 955 | 85 | 5.5 | TY |
| | 07/12 | 21.3 | 115.1 | 960 | 80 | 5.0 | TY |
| | 07/18 | 21.4 | 114.9 | 970 | 75 | 5.0 | TY |
| | 08/00 | 21.5 | 114.6 | 975 | 70 | 4.5 | TY |
| | 08/06 | 21.6 | 114.3 | 975 | 70 | 4.5 | TY |
| | 08/12 | 21.7 | 114.0 | 980 | 65 | 4.5 | TY |
| | 08/18 | 21.8 | 113.7 | 992 | 55 | 4.0 | STS |
| | 09/00 | 21.7 | 113.3 | 998 | 45 | 3.5 | TS |
| | 09/06 | 21.4 | 112.8 | 1010 | − | 3.0 | TD |
| | 09/12 | 21.2 | 112.6 | 1012 | − | − | TD |
| | 09/18 | 20.9 | 112.4 | 1012 | − | − | TD |
| | 10/00 | | | | | | Dissip. |

## TY BOLAVEN (2315)

| Date/Time (UTC) | | Center Position Lat (N) | Center Position Lon (E) | Central pressure (hPa) | Max Wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| Oct. | 06/06 | 9.4 | 155.3 | 1006 | − | − | TD |
| | 06/12 | 9.7 | 155.0 | 1006 | − | 0.0 | TD |
| | 06/18 | 9.8 | 154.8 | 1004 | − | 0.5 | TD |
| | 07/00 | 9.9 | 154.5 | 1004 | − | 1.0 | TD |
| | 07/06 | 9.9 | 154.1 | 1002 | − | 1.5 | TD |
| | 07/12 | 9.9 | 153.7 | 1000 | 35 | 2.0 | TS |
| | 07/18 | 9.9 | 153.3 | 1000 | 35 | 2.0 | TS |
| | 08/00 | 9.8 | 152.8 | 1000 | 35 | 2.5 | TS |
| | 08/06 | 9.8 | 152.3 | 998 | 40 | 2.5 | TS |
| | 08/12 | 9.9 | 151.6 | 996 | 45 | 3.0 | TS |
| | 08/18 | 10.1 | 150.8 | 992 | 50 | 3.0 | STS |
| | 09/00 | 10.5 | 150.1 | 990 | 55 | 3.5 | STS |
| | 09/06 | 11.1 | 149.3 | 990 | 55 | 3.5 | STS |
| | 09/12 | 11.7 | 148.6 | 990 | 55 | 3.5 | STS |
| | 09/18 | 12.7 | 147.7 | 985 | 60 | 4.0 | STS |
| | 10/00 | 13.7 | 146.6 | 980 | 65 | 4.5 | TY |
| | 10/06 | 14.4 | 145.7 | 975 | 70 | 5.0 | TY |
| | 10/12 | 15.1 | 144.9 | 970 | 75 | 5.5 | TY |
| | 10/18 | 16.0 | 144.5 | 955 | 85 | 6.0 | TY |
| | 11/00 | 17.1 | 144.0 | 935 | 100 | 7.0 | TY |
| | 11/06 | 18.2 | 143.4 | 910 | 110 | 7.5 | TY |
| | 11/12 | 18.9 | 143.0 | 905 | 115 | 7.5 | TY |
| | 11/18 | 19.7 | 142.8 | 905 | 115 | 7.5 | TY |
| | 12/00 | 20.6 | 142.9 | 905 | 115 | 7.5 | TY |
| | 12/06 | 21.8 | 143.4 | 905 | 115 | 7.5 | TY |
| | 12/12 | 22.7 | 144.3 | 905 | 115 | 7.5 | TY |
| | 12/18 | 24.0 | 145.4 | 920 | 105 | 7.0 | TY |
| | 13/00 | 25.5 | 146.9 | 925 | 100 | 6.0 | TY |
| | 13/06 | 27.2 | 148.7 | 935 | 95 | 5.5 | TY |
| | 13/12 | 29.2 | 151.0 | 935 | 90 | 5.5 | TY |
| | 13/18 | 31.3 | 153.5 | 945 | 85 | 5.0 | TY |
| | 14/00 | 34.1 | 156.6 | 950 | 80 | 4.5 | TY |
| | 14/06 | 37.1 | 160.2 | 950 | 75 | 4.0 | TY |
| | 14/12 | 40.2 | 164.6 | 950 | − | 3.5 | L |
| | 14/18 | 42.9 | 168.0 | 950 | − | − | L |
| | 15/00 | 44.3 | 170.8 | 952 | − | − | L |
| | 15/06 | 44.7 | 174.9 | 954 | − | − | L |
| | 15/12 | 45.1 | 179.2 | 956 | − | − | L |
| | 15/18 | 45.3 | 183.4 | 956 | − | − | Out |

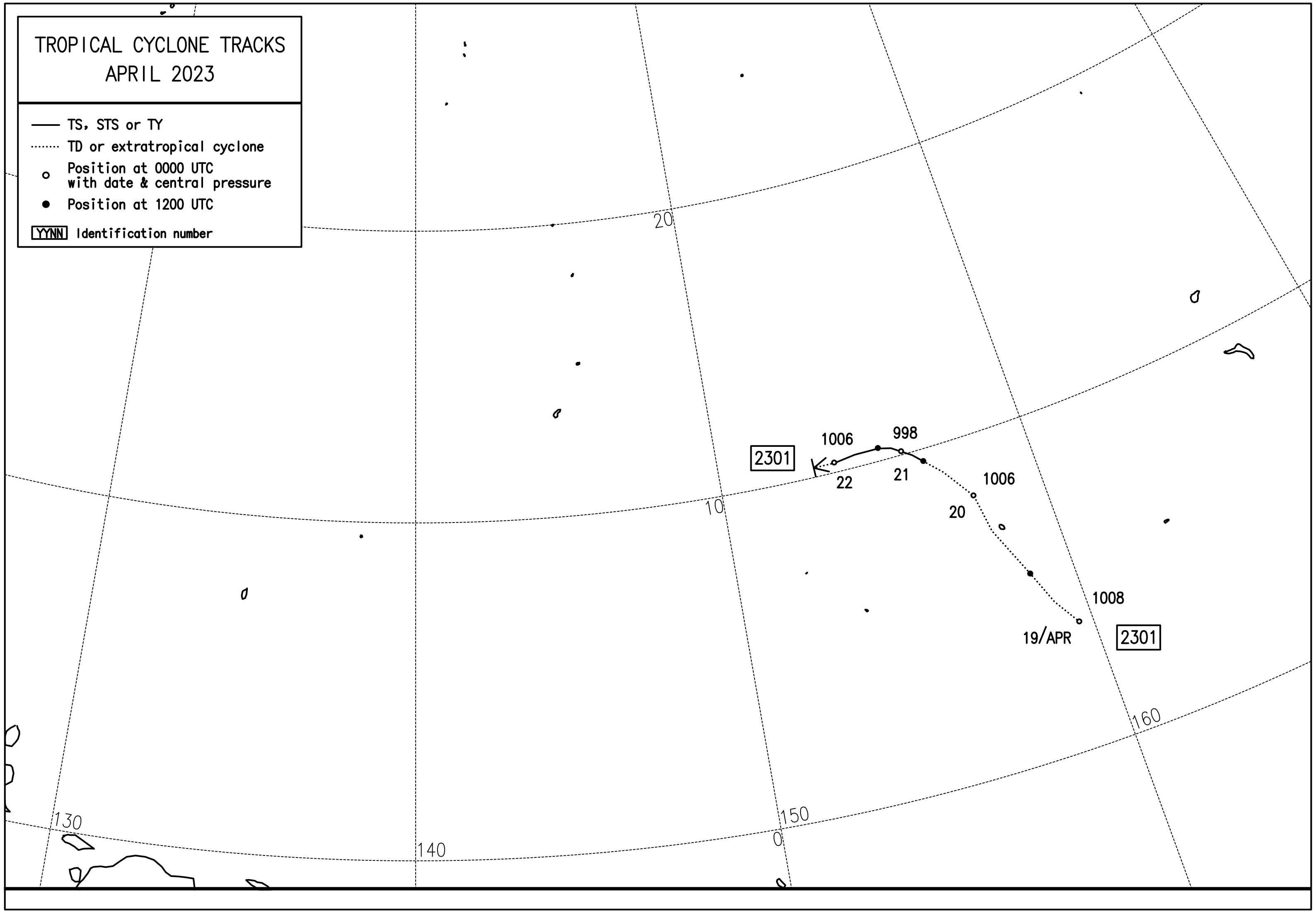
## TS SANBA (2316)

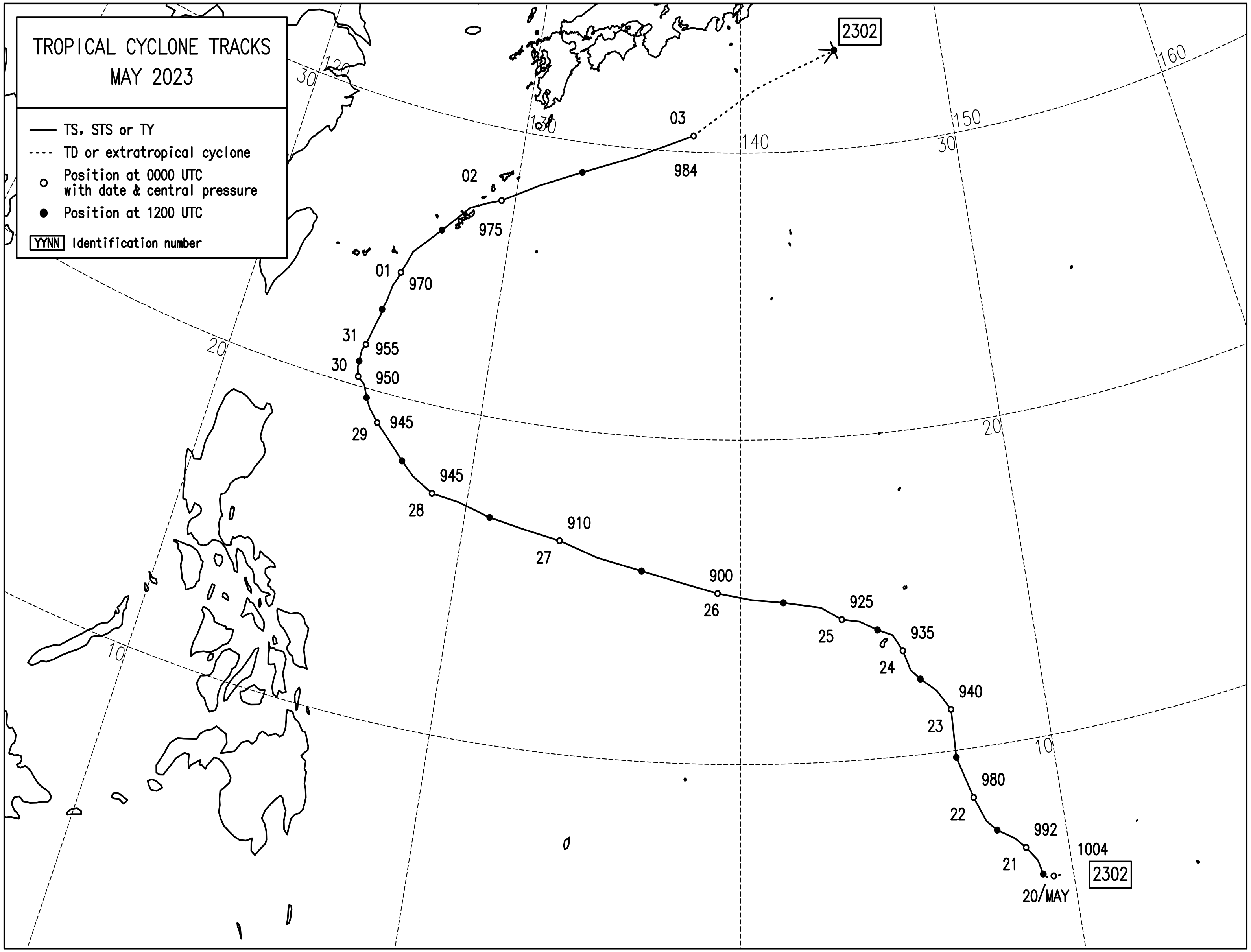
| Date/Time (UTC) | | Center Position Lat (N) | Center Position Lon (E) | Central pressure (hPa) | Max Wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| Oct. | 17/06 | 15.9 | 110.2 | 1006 | − | 0.0 | TD |
| | 17/12 | 16.1 | 110.0 | 1006 | − | 0.5 | TD |
| | 17/18 | 16.5 | 109.7 | 1006 | − | 1.0 | TD |
| | 18/00 | 17.1 | 109.3 | 1002 | 35 | 1.5 | TS |
| | 18/06 | 17.6 | 108.7 | 1002 | 35 | 1.5 | TS |
| | 18/12 | 18.3 | 108.3 | 1002 | 35 | 2.0 | TS |
| | 18/18 | 18.7 | 108.4 | 1002 | 35 | 2.0 | TS |
| | 19/00 | 19.4 | 108.7 | 1002 | 35 | 2.0 | TS |
| | 19/06 | 20.0 | 109.0 | 1002 | 35 | 2.0 | TS |
| | 19/12 | 21.0 | 109.4 | 1000 | 40 | 2.5 | TS |
| | 19/18 | 21.4 | 109.5 | 1002 | 35 | 2.5 | TS |
| | 20/00 | 21.4 | 109.8 | 1008 | − | 2.0 | TD |
| | 20/06 | 20.9 | 109.7 | 1008 | − | 1.5 | TD |
| | 20/12 | | | | | | Dissip. |

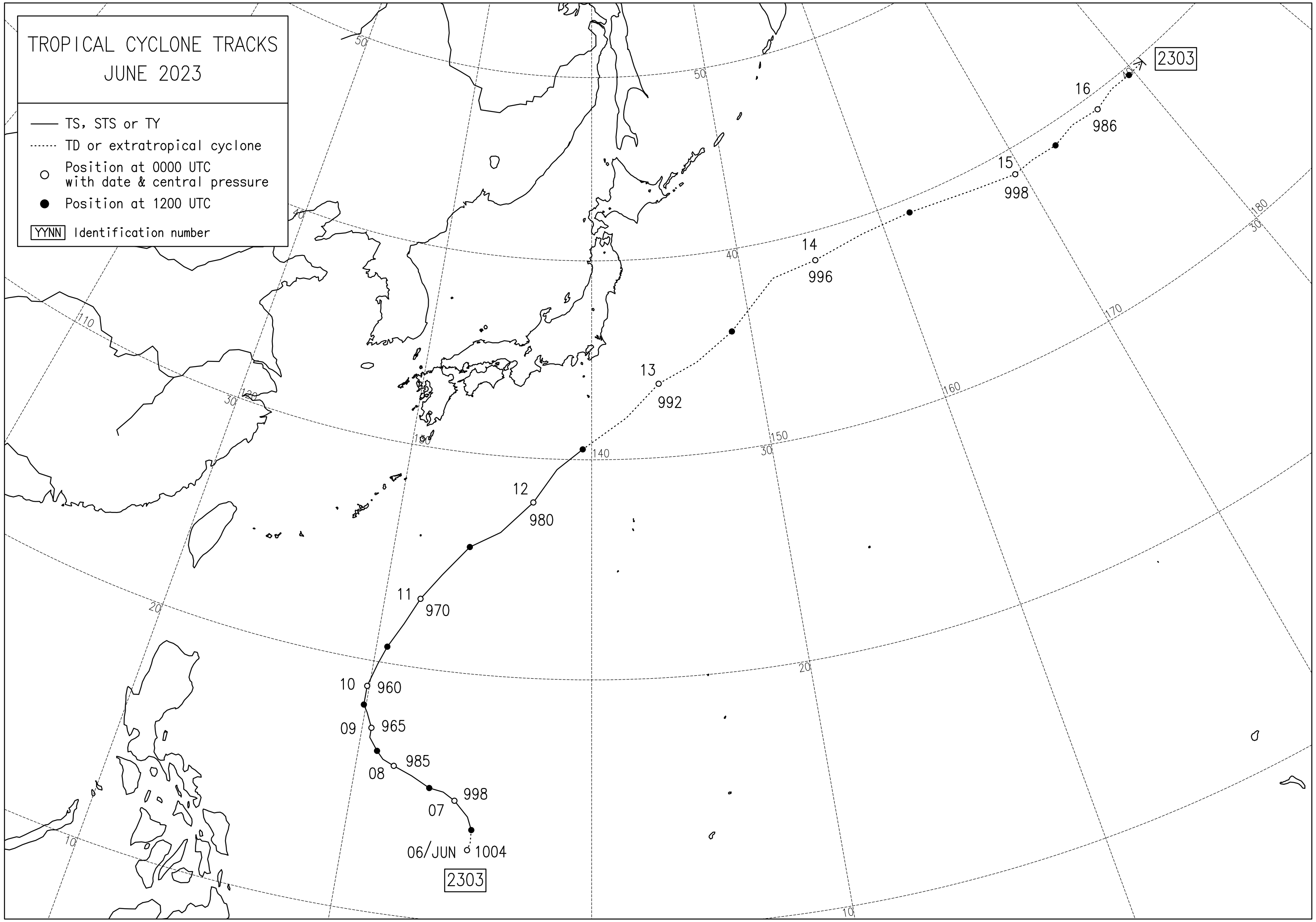
## TS JELAWAT (2317)

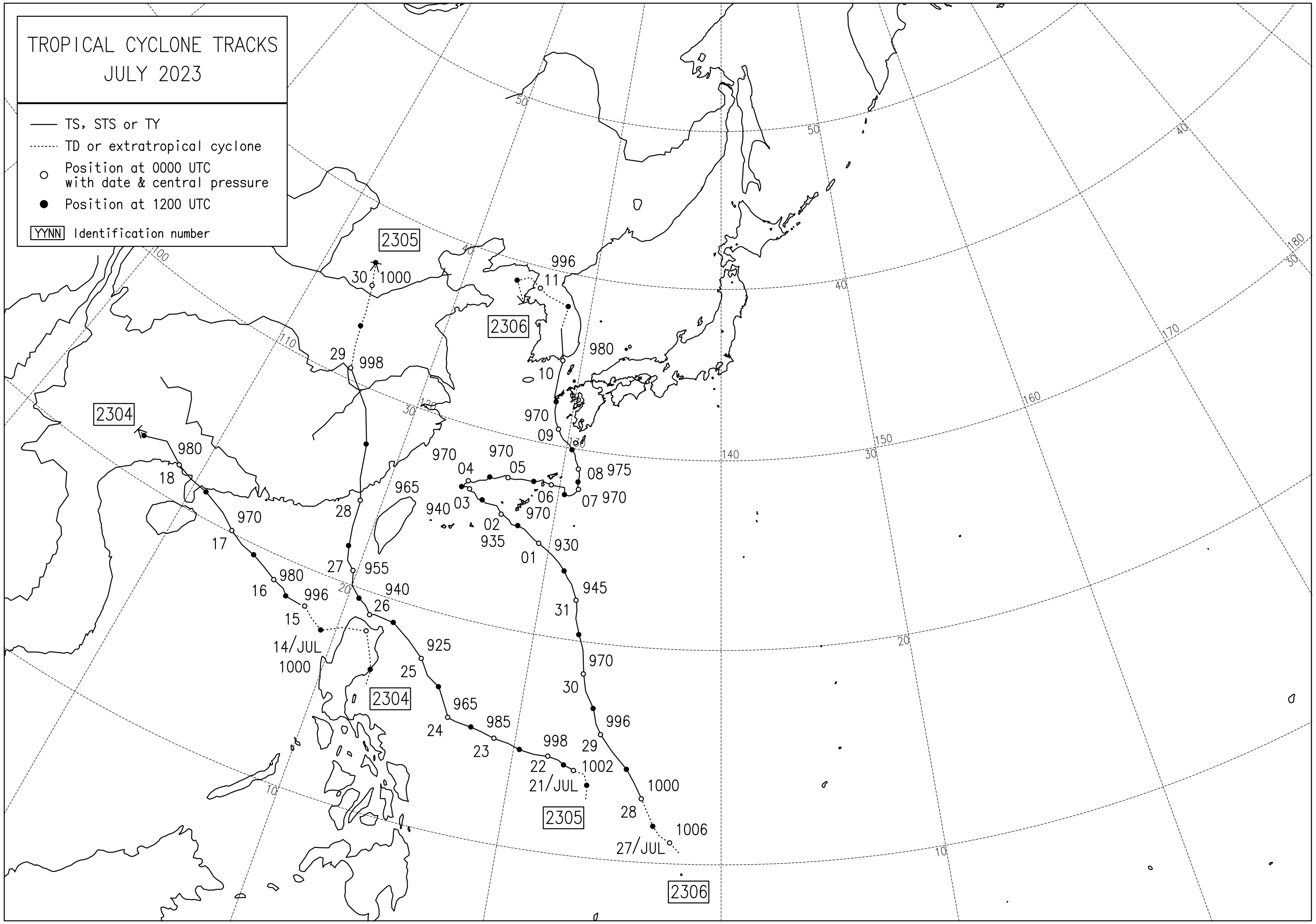
| Date/Time (UTC) | | Center Position Lat (N) | Center Position Lon (E) | Central pressure (hPa) | Max Wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|---|
| Dec. | 15/12 | 6.7 | 138.2 | 1006 | − | 0.0 | TD |
| | 15/18 | 6.9 | 136.0 | 1004 | − | 0.0 | TD |
| | 16/00 | 6.9 | 134.8 | 1006 | − | 0.5 | TD |
| | 16/06 | 6.9 | 133.3 | 1004 | − | 0.5 | TD |
| | 16/12 | 7.0 | 131.9 | 1006 | − | 0.5 | TD |
| | 16/18 | 6.9 | 131.1 | 1004 | − | 1.0 | TD |
| | 17/00 | 6.9 | 130.3 | 1006 | − | 1.5 | TD |
| | 17/06 | 7.5 | 129.6 | 1002 | 35 | 2.0 | TS |
| | 17/12 | 7.4 | 128.5 | 1002 | 35 | 2.0 | TS |
| | 17/18 | 7.4 | 127.4 | 1002 | 35 | 2.0 | TS |
| | 18/00 | 7.4 | 126.3 | 1008 | − | 2.0 | TD |
| | 18/06 | 7.3 | 123.9 | 1006 | − | − | TD |
| | 18/12 | | | | | | Dissip. |

# Appendix 2
# Monthly Tracks of Tropical Cyclones in 2023

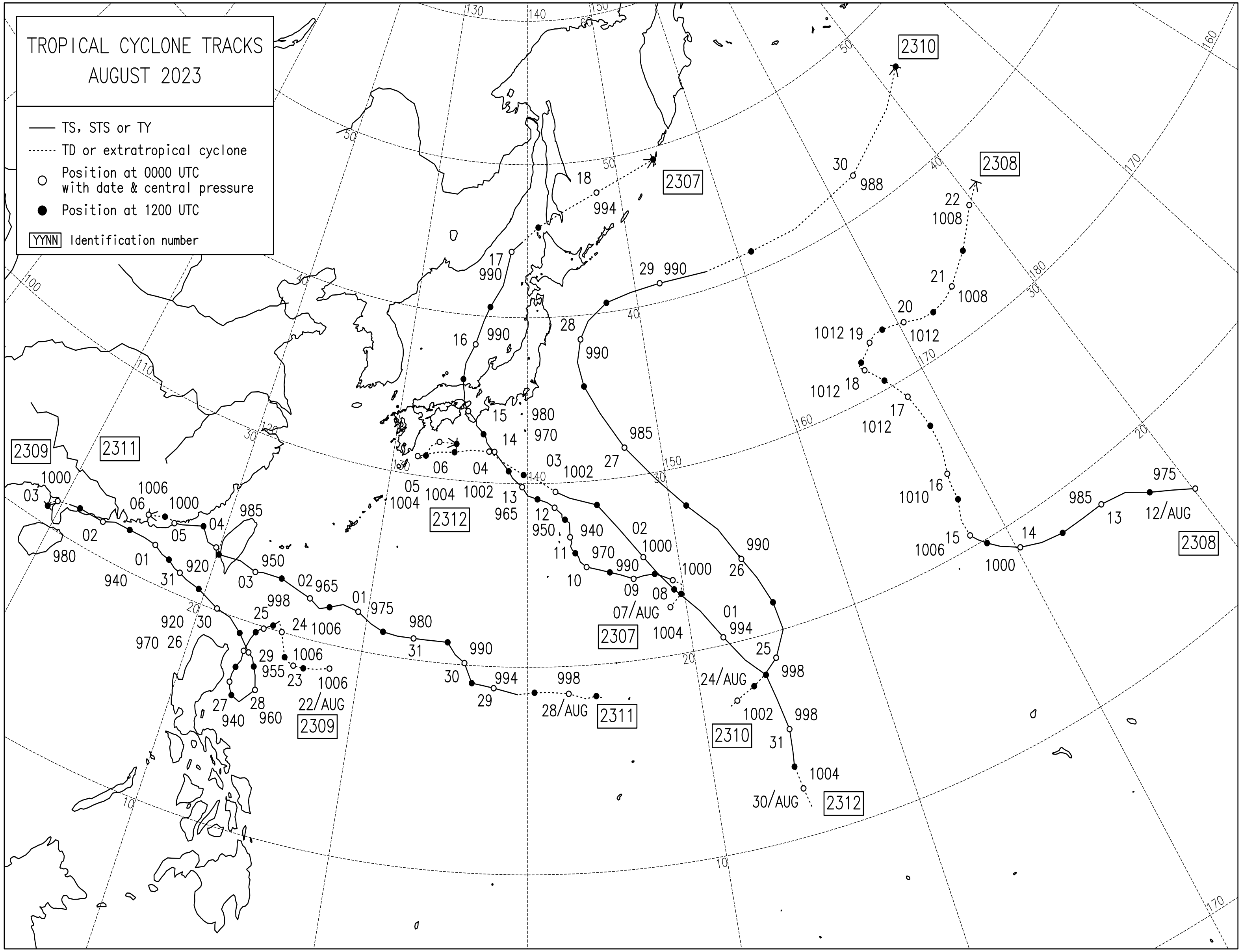

TROPICAL CYCLONE TRACKS
APRIL 2023
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2301
1006
998
22
21
1006
20
1008
19/APR
2301
20
10
0
130
140
150
160

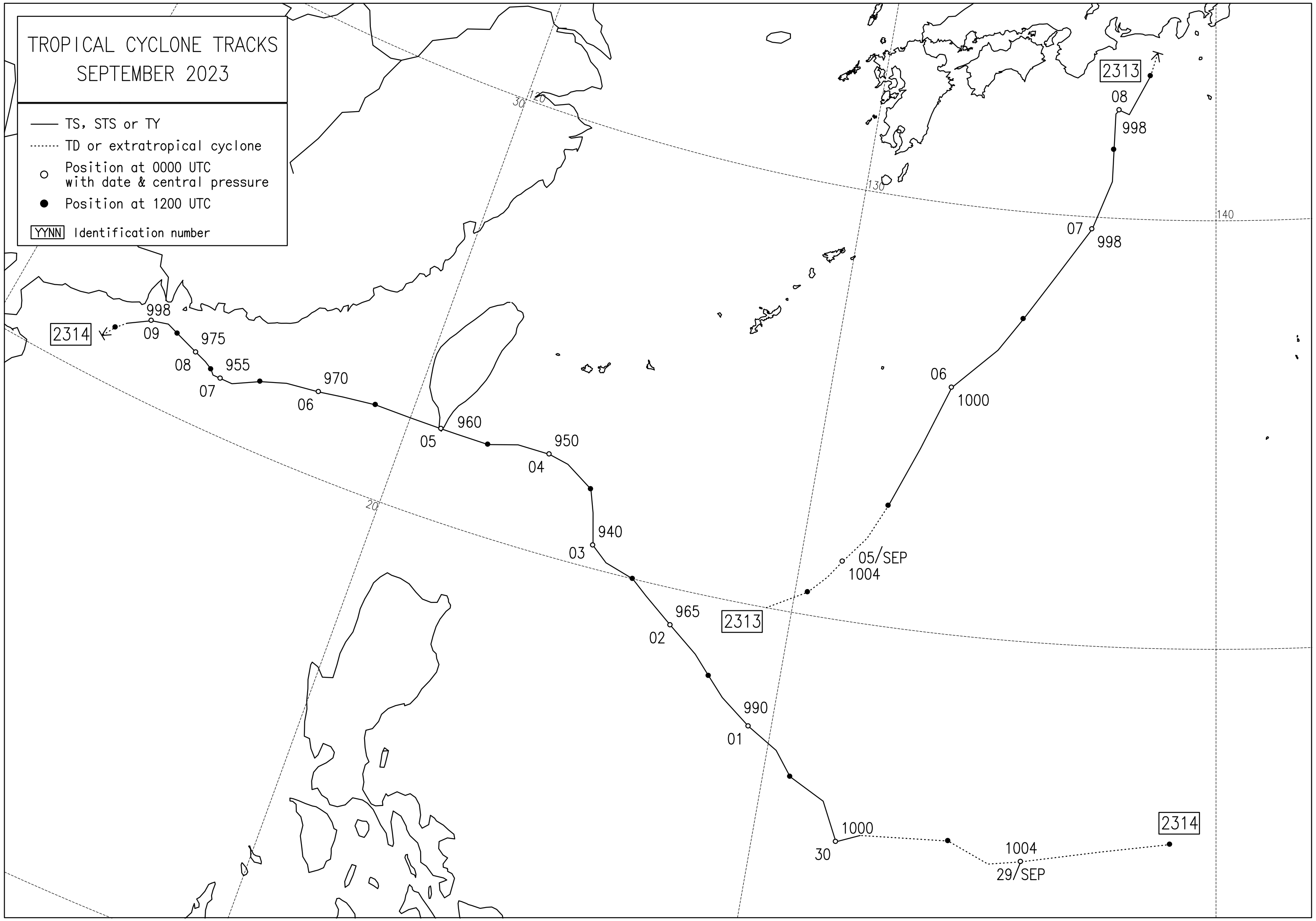

TROPICAL CYCLONE TRACKS
MAY 2023
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
2302
20/MAY
1004
21
992
22
980
23
940
24
935
25
925
26
900
27
910
28
945
29
945
30
950
31
955
01
970
02
975
03
984
2302
120
130
140
150
160
30
20
10


TROPICAL CYCLONE TRACKS
JUNE 2023
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2303
06/JUN 1004
07 998
08 985
09 965
10 960
11 970
12 980
13 992
14 996
15 998
986
16
2303

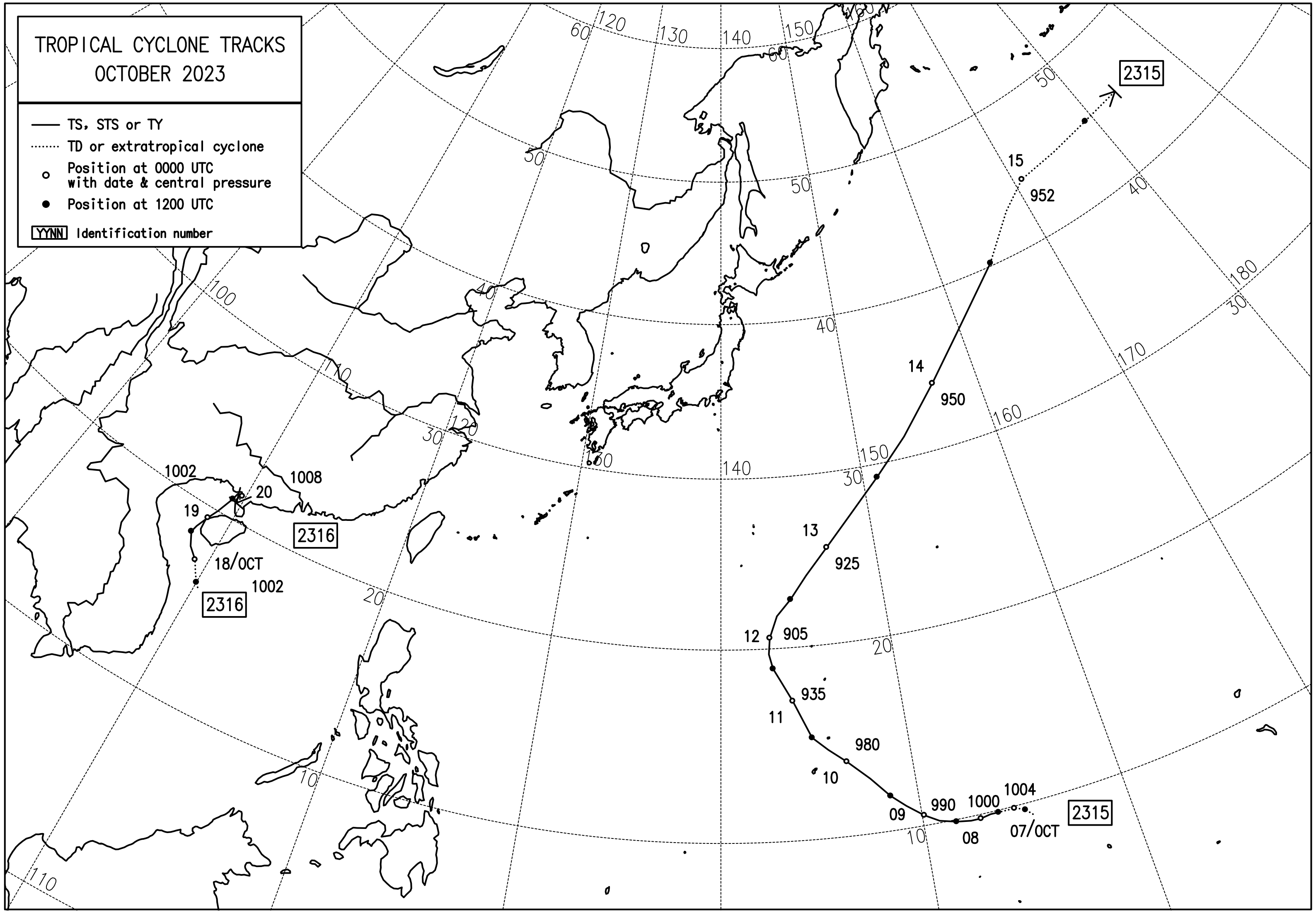


TROPICAL CYCLONE TRACKS
JULY 2023
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2304
2305
2306
14/JUL
1000
15
996
16
980
17
970
18
980
21/JUL
1002
22
998
23
985
24
965
25
925
26
940
27
955
28
965
29
998
30
1000
27/JUL
1006
28
1000
29
996
30
970
31
945
01
930
02
935
03
940
04
970
05
970
06
970
07
970
08
975
09
970
10
980
11
996

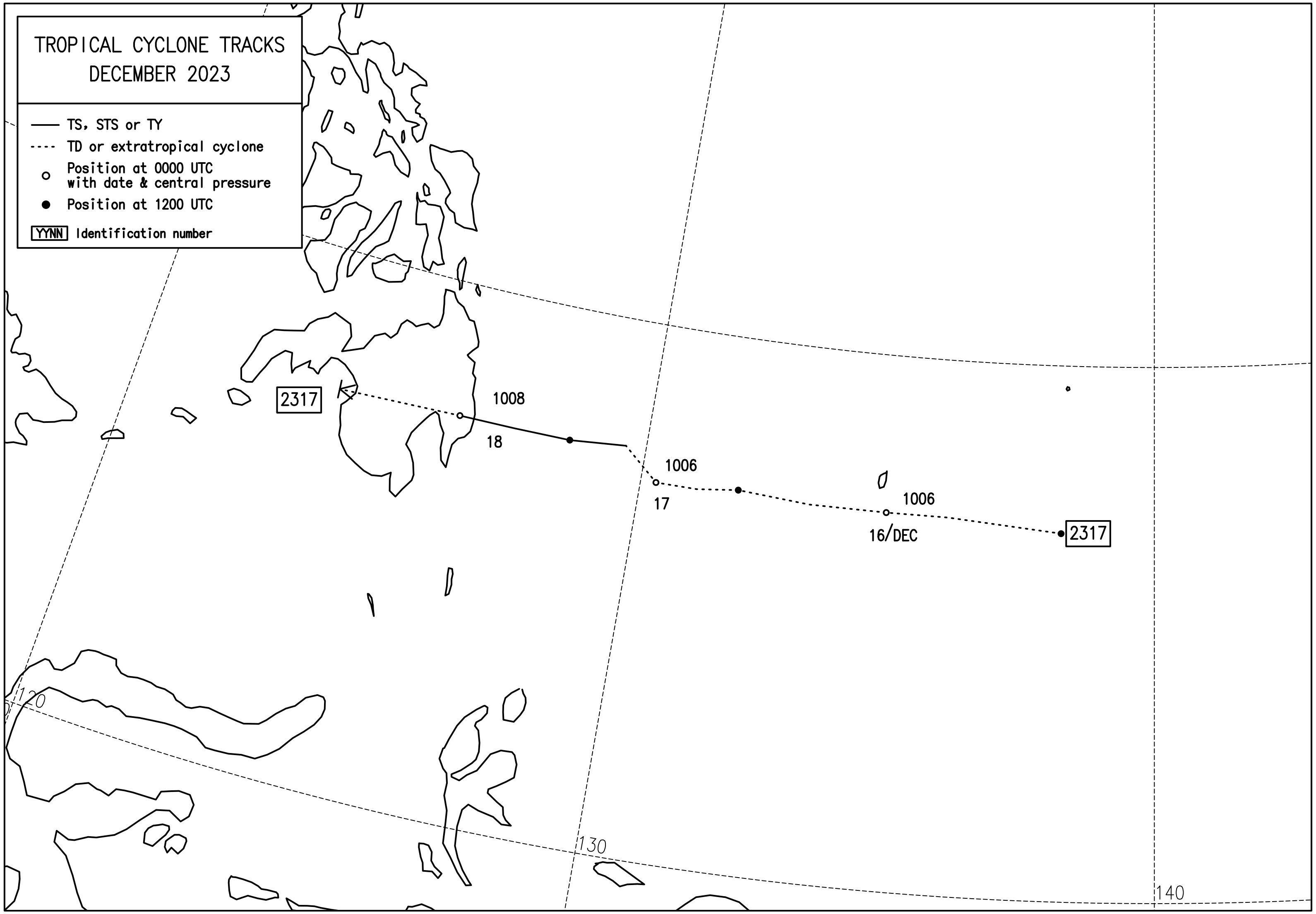

TROPICAL CYCLONE TRACKS
AUGUST 2023
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
2307
2308
2309
2310
2311
2312
07/AUG
12/AUG
22/AUG
24/AUG
28/AUG
30/AUG



TROPICAL CYCLONE TRACKS
SEPTEMBER 2023
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2313
08
998
07
998
06
1000
05/SEP
1004
2313
2314
998
09
975
08
955
07
970
06
960
05
950
04
940
03
965
02
990
01
1000
30
1004
29/SEP
2314
30
20
120
130
140



TROPICAL CYCLONE TRACKS
OCTOBER 2023
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
2315
15
952
14
950
13
925
12
905
935
11
980
10
09
990
1000
1004
08
07/OCT
2315
2316
1002
1008
20
19
18/OCT
1002
2316


TROPICAL CYCLONE TRACKS
DECEMBER 2023
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2317
1008
18
1006
17
1006
16/DEC
2317
120
130
140

# Appendix 3
# Errors of Track and Intensity Forecasts for Each Tropical Cyclone in 2023

| Date/Time | (UTC) | Grade Best | Prov. | Center Position (km) T=0‡ | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt)† T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **Sanvu(2301)** | | | | | | | | | | | |
| Apr. | 19/06 | TD | TD | *99* | *67* | *184* | *104* | | | *0* | *2* | *-2* | | | *5* | *0* | *5* | | |
| | 19/12 | TD | TD | *80* | *22* | *109* | | | | *2* | *-2* | | | | *0* | *5* | | | |
| | 19/18 | TD | TD | *229* | *71* | *74* | | | | *2* | *0* | | | | *0* | *0* | | | |
| | 20/00 | TD | TD | *105* | *56* | *74* | | | | *2* | *-4* | | | | *0* | *5* | | | |
| | 20/06 | TD | TS | *16* | *165* | *167* | | | | *6* | *-2* | | | | *-10* | *5* | | | |
| | 20/12 | TS | TS | **0** | **88** | | | | | **4** | | | | | **-5** | | | | |
| | 20/18 | TS | TS | **22** | **46** | | | | | **0** | | | | | **0** | | | | |
| | 21/00 | TS | TS | **16** | | | | | | | | | | | | | | | |
| | 21/06 | TS | TS | **31** | | | | | | | | | | | | | | | |
| | 21/12 | TS | TS | **74** | | | | | | | | | | | | | | | |
| | 21/18 | TS | TS | **157** | | | | | | | | | | | | | | | |
| | 22/00 | TD | TS | | | | | | | | | | | | | | | | |
| | 22/06 | TD | TS | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **50** | **67** | **--** | **--** | **--** | **--** | **2** | **--** | **--** | **--** | **--** | **-3** | **--** | **--** | **--** | **--** |
| **Valid: TS/STS/TY** | | | **sample** | **6** | **2** | **0** | **0** | **0** | **0** | **2** | **0** | **0** | **0** | **0** | **2** | **0** | **0** | **0** | **0** |
| *Initial: TD(before upg.)* | | | *mean* | *106* | *76* | *122* | *104* | *--* | *--* | *2* | *-1* | *-2* | *--* | *--* | *-1* | *3* | *5* | *--* | *--* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *5* | *5* | *5* | *1* | *0* | *0* | *5* | *5* | *1* | *0* | *0* | *5* | *5* | *1* | *0* | *0* |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | | Grade | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt)† | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | Best | Prov. | T=0‡ | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| | | | | | | | **Mawar(2302)** | | | | | | | | | | | | |
| May. | 19/18 | TD | TD | *70* | *46* | *135* | *180* | *193* | *204* | *6* | *14* | *50* | *55* | *30* | *-10* | *-20* | *-40* | *-40* | *-20* |
| | 20/00 | TD | TD | *71* | *33* | *117* | *182* | *214* | *257* | *6* | *10* | *35* | *20* | *25* | *-10* | *-10* | *-25* | *-15* | *-15* |
| | 20/06 | TD | TS | *65* | *44* | *113* | *139* | *194* | *370* | *2* | *10* | *55* | *20* | *35* | *-5* | *-10* | *-35* | *-15* | *-20* |
| | 20/12 | TS | TS | 60 | 90 | 105 | 140 | 196 | 242 | 2 | 15 | 50 | 15 | 40 | -5 | -15 | -30 | -10 | -25 |
| | 20/18 | TS | TS | 16 | 133 | 119 | 179 | 217 | 262 | 10 | 45 | 50 | 15 | 40 | -10 | -35 | -30 | -10 | -25 |
| | 21/00 | STS | STS | 25 | 113 | 129 | 168 | 255 | 248 | 10 | 40 | 30 | 15 | 35 | -10 | -30 | -20 | -10 | -20 |
| | 21/06 | STS | STS | 40 | 102 | 113 | 156 | 244 | 231 | 5 | 50 | 15 | 30 | 25 | -5 | -30 | -10 | -15 | -15 |
| | 21/12 | STS | STS | 11 | 84 | 102 | 119 | 162 | 164 | 10 | 50 | 15 | 35 | 25 | -10 | -30 | -10 | -20 | -15 |
| | 21/18 | TY | TY | 16 | 57 | 70 | 92 | 112 | 39 | 30 | 35 | 0 | 25 | 25 | -20 | -20 | 0 | -15 | -15 |
| | 22/00 | TY | TY | 16 | 11 | 49 | 162 | 144 | 79 | 30 | 20 | 10 | 25 | 15 | -20 | -10 | -5 | -15 | -5 |
| | 22/06 | TY | TY | 25 | 24 | 76 | 178 | 126 | 74 | 40 | 15 | 30 | 25 | 0 | -25 | -5 | -15 | -15 | 5 |
| | 22/12 | TY | TY | 22 | 11 | 121 | 171 | 160 | 54 | 35 | 5 | 25 | 15 | -30 | -20 | 0 | -15 | -10 | 20 |
| | 22/18 | TY | TY | 11 | 39 | 127 | 144 | 96 | 11 | 30 | 0 | 15 | 5 | -40 | -15 | 5 | -10 | -5 | 25 |
| | 23/00 | TY | TY | 0 | 43 | 123 | 131 | 70 | 91 | 5 | 10 | 15 | -5 | -40 | 0 | 0 | -10 | 5 | 25 |
| | 23/06 | TY | TY | 0 | 66 | 163 | 118 | 75 | 123 | -25 | 20 | 5 | -25 | -30 | 15 | -10 | -5 | 20 | 20 |
| | 23/12 | TY | TY | 11 | 87 | 133 | 107 | 68 | 161 | -25 | 25 | 5 | -45 | -30 | 15 | -15 | -5 | 30 | 20 |
| | 23/18 | TY | TY | 0 | 79 | 107 | 86 | 77 | 146 | -15 | 25 | 5 | -45 | -30 | 10 | -15 | -5 | 30 | 20 |
| | 24/00 | TY | TY | 16 | 68 | 76 | 43 | 101 | 115 | 15 | 25 | 5 | -40 | -30 | -5 | -15 | 0 | 25 | 20 |
| | 24/06 | TY | TY | 11 | 65 | 58 | 31 | 90 | 89 | 35 | 25 | -20 | -40 | -25 | -15 | -15 | 15 | 25 | 15 |
| | 24/12 | TY | TY | 11 | 48 | 78 | 44 | 100 | 104 | 40 | 15 | -40 | -35 | -20 | -20 | -10 | 25 | 20 | 10 |
| | 24/18 | TY | TY | 0 | 48 | 58 | 63 | 128 | 203 | 25 | 15 | -40 | -35 | -10 | -15 | -10 | 25 | 20 | 5 |
| | 25/00 | TY | TY | 11 | 48 | 53 | 92 | 157 | 230 | 15 | -5 | -40 | -25 | -5 | -10 | 5 | 25 | 15 | 5 |
| | 25/06 | TY | TY | 15 | 58 | 68 | 116 | 173 | 168 | 10 | -15 | -30 | -20 | 0 | -5 | 15 | 20 | 10 | 0 |
| | 25/12 | TY | TY | 11 | 44 | 68 | 141 | 188 | 182 | 10 | -35 | -20 | -10 | -5 | -5 | 25 | 15 | 5 | 10 |
| | 25/18 | TY | TY | 11 | 31 | 39 | 110 | 170 | 139 | 10 | -35 | -20 | -10 | -5 | -5 | 25 | 15 | 5 | 10 |
| | 26/00 | TY | TY | 0 | 15 | 35 | 69 | 94 | 43 | -5 | -40 | -20 | -5 | 5 | 10 | 30 | 15 | 5 | 5 |
| | 26/06 | TY | TY | 15 | 24 | 61 | 101 | 127 | 106 | -20 | -40 | -20 | -10 | -10 | 20 | 30 | 15 | 5 | 10 |
| | 26/12 | TY | TY | 0 | 11 | 72 | 97 | 125 | 130 | -40 | -30 | -20 | -15 | -5 | 25 | 20 | 10 | 10 | 5 |
| | 26/18 | TY | TY | 11 | 11 | 42 | 115 | 116 | 147 | -30 | -25 | -20 | -5 | -5 | 20 | 15 | 5 | 5 | 5 |
| | 27/00 | TY | TY | 0 | 25 | 53 | 94 | 76 | 129 | -20 | -20 | -25 | -5 | -10 | 15 | 10 | 10 | 5 | 15 |
| | 27/06 | TY | TY | 0 | 24 | 73 | 100 | 108 | 226 | -20 | -20 | -25 | -10 | -10 | 15 | 10 | 10 | 10 | 15 |
| | 27/12 | TY | TY | 0 | 44 | 85 | 119 | 167 | 382 | -10 | -10 | -15 | -5 | 0 | 10 | 5 | 10 | 5 | 10 |
| | 27/18 | TY | TY | 0 | 54 | 138 | 174 | 302 | 612 | -10 | 0 | -5 | -5 | 5 | 10 | 0 | 5 | 5 | 5 |
| | 28/00 | TY | TY | 11 | 54 | 104 | 136 | 279 | 630 | 0 | 0 | 0 | -10 | 0 | 0 | 0 | 5 | 15 | 10 |
| | 28/06 | TY | TY | 11 | 43 | 115 | 212 | 338 | 755 | 10 | 10 | 5 | 0 | 5 | -5 | -5 | 5 | 10 | 5 |
| | 28/12 | TY | TY | 11 | 54 | 92 | 212 | 411 | 878 | 10 | 5 | 5 | 0 | 0 | -5 | 5 | 5 | 10 | 5 |
| | 28/18 | TY | TY | 0 | 43 | 107 | 234 | 434 | 965 | 5 | -5 | -5 | 5 | 5 | -5 | 5 | 5 | 5 | 0 |
| | 29/00 | TY | TY | 0 | 43 | 84 | 206 | 460 | | 0 | -5 | -10 | 5 | | 0 | 5 | 15 | 5 | |
| | 29/06 | TY | TY | 0 | 24 | 99 | 157 | 459 | | 0 | -10 | -10 | 5 | | 0 | 10 | 15 | 5 | |
| | 29/12 | TY | TY | 0 | 38 | 121 | 224 | 625 | | -5 | -10 | -10 | -5 | | 10 | 10 | 15 | 5 | |
| | 29/18 | TY | TY | 0 | 11 | 108 | 269 | 733 | | 0 | -5 | 0 | -5 | | 5 | 10 | 10 | 5 | |
| | 30/00 | TY | TY | 15 | 46 | 59 | 297 | | | 5 | -5 | 0 | | | 5 | 15 | 10 | | |
| | 30/06 | TY | TY | 0 | 0 | 35 | 392 | | | 0 | -5 | 0 | | | 10 | 15 | 10 | | |
| | 30/12 | TY | TY | 0 | 11 | 93 | 422 | | | 5 | -5 | -5 | | | 5 | 15 | 5 | | |
| | 30/18 | TY | TY | 15 | 39 | 107 | 414 | | | 0 | 0 | 0 | | | 10 | 10 | 5 | | |
| | 31/00 | TY | TY | 0 | 15 | 126 | | | | -5 | 0 | | | | 15 | 10 | | | |
| | 31/06 | TY | TY | 0 | 0 | 210 | | | | -5 | 0 | | | | 15 | 10 | | | |
| | 31/12 | TY | TY | 0 | 32 | 228 | | | | 0 | 0 | | | | 10 | 5 | | | |
| | 31/18 | STS | STS | 22 | 30 | 205 | | | | 5 | 5 | | | | 5 | 0 | | | |
| Jun. | 01/00 | STS | STS | 0 | 24 | | | | | 0 | | | | | 5 | | | | |
| | 01/06 | STS | STS | 11 | 46 | | | | | 0 | | | | | 5 | | | | |
| | 01/12 | STS | STS | 15 | 33 | | | | | 5 | | | | | 0 | | | | |
| | 01/18 | STS | STS | 11 | 22 | | | | | 5 | | | | | 0 | | | | |
| | 02/00 | TS | TS | 51 | | | | | | | | | | | | | | | |
| | 02/06 | TS | TS | 20 | | | | | | | | | | | | | | | |
| | 02/12 | TS | TS | 46 | | | | | | | | | | | | | | | |
| | 02/18 | TS | TS | 53 | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | 12 | 43 | 98 | 158 | 210 | 240 | 4 | 3 | -3 | -5 | -3 | 1 | 1 | 4 | 5 | 5 |
| **Valid: TS/STS/TY** | | | **sample** | 54 | 50 | 46 | 42 | 38 | 34 | 50 | 46 | 42 | 38 | 34 | 50 | 46 | 42 | 38 | 34 |
| *Initial: TD(before upg.)* | | | *mean* | *69* | *41* | *122* | *167* | *200* | *277* | *5* | *11* | *47* | *32* | *30* | *-8* | *-13* | *-33* | *-23* | *-18* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | | Grade | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt)† | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | Best | Prov. | T=0‡ | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| | | | | | | Guchol(2303) | | | | | | | | | | | | | |
| Jun. | 06/00 | TD | TD | 54 | 92 | 35 | 58 | 70 | 359 | 4 | 7 | 15 | 15 | 5 | -5 | -10 | -20 | -20 | -5 |
| | 06/06 | TD | TD | 47 | 54 | 46 | 40 | 89 | 290 | 6 | 12 | 15 | 15 | 0 | -5 | -15 | -20 | -20 | 0 |
| | 06/12 | TS | TS | 95 | 40 | 25 | 46 | 123 | 362 | 2 | 15 | 5 | 5 | -15 | 0 | -15 | -10 | -5 | 15 |
| | 06/18 | TS | TS | 15 | 24 | 15 | 56 | 182 | 410 | 2 | 15 | 5 | -5 | -20 | 0 | -15 | -10 | 5 | 20 |
| | 07/00 | TS | TS | 33 | 53 | 11 | 39 | 192 | 400 | 0 | 0 | -10 | -20 | -30 | 0 | -5 | 0 | 15 | 25 |
| | 07/06 | TS | TS | 22 | 48 | 39 | 78 | 213 | 450 | 5 | 0 | -10 | -25 | -20 | -5 | -5 | 0 | 20 | 20 |
| | 07/12 | TS | TS | 11 | 31 | 40 | 112 | 263 | | 15 | 0 | -10 | -30 | | -15 | -5 | 5 | 25 | |
| | 07/18 | STS | TS | 24 | 21 | 33 | 137 | 289 | | 15 | 5 | -15 | -20 | | -15 | -10 | 10 | 20 | |
| | 08/00 | STS | STS | 25 | 15 | 21 | 156 | 335 | | 20 | 10 | -5 | -15 | | -15 | -5 | 10 | 15 | |
| | 08/06 | STS | STS | 11 | 25 | 67 | 241 | 406 | | 10 | 10 | -5 | -15 | | -5 | -5 | 10 | 15 | |
| | 08/12 | TY | TY | 0 | 31 | 102 | 306 | | | 5 | 5 | -10 | | | -5 | 0 | 15 | | |
| | 08/18 | TY | TY | 15 | 15 | 140 | 282 | | | 5 | 5 | -10 | | | -5 | 0 | 10 | | |
| | 09/00 | TY | TY | 11 | 24 | 146 | 331 | | | 5 | 0 | -5 | | | -5 | 5 | 10 | | |
| | 09/06 | TY | TY | 11 | 22 | 156 | 298 | | | 15 | 0 | -5 | | | -10 | 5 | 10 | | |
| | 09/12 | TY | TY | 0 | 44 | 215 | | | | 15 | -5 | | | | -5 | 10 | | | |
| | 09/18 | TY | TY | 0 | 64 | 165 | | | | 10 | -5 | | | | 0 | 10 | | | |
| | 10/00 | TY | TY | 0 | 57 | 146 | | | | 0 | -5 | | | | 5 | 10 | | | |
| | 10/06 | TY | TY | 0 | 57 | 115 | | | | 0 | -5 | | | | 5 | 10 | | | |
| | 10/12 | TY | TY | 11 | 111 | | | | | -5 | | | | | 10 | | | | |
| | 10/18 | TY | TY | 0 | 24 | | | | | 0 | | | | | 5 | | | | |
| | 11/00 | TY | TY | 0 | 41 | | | | | 0 | | | | | 0 | | | | |
| | 11/06 | STS | STS | 0 | 10 | | | | | 0 | | | | | 0 | | | | |
| | 11/12 | STS | STS | 108 | | | | | | | | | | | | | | | |
| | 11/18 | STS | STS | 39 | | | | | | | | | | | | | | | |
| | 12/00 | STS | STS | 23 | | | | | | | | | | | | | | | |
| | 12/06 | STS | TS | 15 | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **20** | **38** | **90** | **174** | **250** | **406** | **6** | **3** | **-6** | **-16** | **-21** | **-3** | **-1** | **5** | **14** | **20** |
| **Valid: TS/STS/TY** | | | **sample** | **24** | **20** | **16** | **12** | **8** | **4** | **20** | **16** | **12** | **8** | **4** | **20** | **16** | **12** | **8** | **4** |
| *Initial: TD(before upg.)* | | | *mean* | *50* | *73* | *40* | *49* | *79* | *324* | *5* | *10* | *15* | *15* | *3* | *-5* | *-13* | *-20* | *-20* | *-3* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | (UTC) | Grade Best | Prov. | Center Position (km) T=0‡ | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt)† T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **Talim(2304)** | | | | | | | | | | | |
| Jul. | 14/00 | TD | TD | *85* | *44* | *115* | *33* | *200* | | *-2* | *5* | *0* | *0* | | *5* | *-5* | *0* | *0* | |
| | 14/06 | TD | TD | *57* | *85* | *138* | *133* | *259* | | *-2* | *0* | *-5* | *5* | | *5* | *0* | *10* | *-5* | |
| | 14/12 | TD | TD | *46* | *129* | *110* | *145* | *227* | | *0* | *-5* | *-5* | *-16* | | *0* | *5* | *10* | *20* | |
| | 14/18 | TD | TD | *0* | *70* | *33* | *114* | *141* | | *5* | *-5* | *-15* | *-10* | | *-5* | *5* | *20* | *10* | |
| | 15/00 | TD | TD | *0* | *61* | *52* | *138* | | | *10* | *0* | *-20* | | | *-10* | *0* | *25* | | |
| | 15/06 | TS | TS | **0** | **39** | **54** | **170** | | | **5** | **0** | **-25** | | | **-5** | **0** | **30** | | |
| | 15/12 | TS | TS | **0** | **39** | **77** | | | | **0** | **-5** | | | | **0** | **10** | | | |
| | 15/18 | TS | TS | **0** | **25** | **54** | | | | **0** | **-5** | | | | **0** | **10** | | | |
| | 16/00 | STS | STS | **0** | **21** | **56** | | | | **0** | **0** | | | | **5** | **0** | | | |
| | 16/06 | STS | STS | **11** | **47** | **118** | | | | **0** | **0** | | | | **5** | **0** | | | |
| | 16/12 | STS | STS | **0** | **49** | | | | | **0** | | | | | **5** | | | | |
| | 16/18 | STS | STS | **0** | **35** | | | | | **0** | | | | | **0** | | | | |
| | 17/00 | STS | STS | **0** | **15** | | | | | **0** | | | | | **0** | | | | |
| | 17/06 | STS | STS | **22** | **69** | | | | | **5** | | | | | **-5** | | | | |
| | 17/12 | STS | STS | **0** | | | | | | | | | | | | | | | |
| | 17/18 | STS | STS | **21** | | | | | | | | | | | | | | | |
| | 18/00 | STS | STS | **0** | | | | | | | | | | | | | | | |
| | 18/06 | TS | TS | **0** | | | | | | | | | | | | | | | |
| | 18/12 | TD | TD | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **4** | **38** | **72** | **170** | **--** | **--** | **1** | **-2** | **-25** | **--** | **--** | **1** | **4** | **30** | **--** | **--** |
| **Valid: TS/STS/TY** | | | **sample** | **13** | **9** | **5** | **1** | **0** | **0** | **9** | **5** | **1** | **0** | **0** | **9** | **5** | **1** | **0** | **0** |
| *Initial: TD(before upg.)* | | | *mean* | *38* | *78* | *90* | *113* | *207* | *--* | *2* | *-1* | *-9* | *-5* | *--* | *-1* | *1* | *13* | *6* | *--* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *5* | *5* | *5* | *5* | *4* | *0* | *5* | *5* | *5* | *4* | *0* | *5* | *5* | *5* | *4* | *0* |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | | Grade | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt)[†] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | Best | Prov. | T=0[‡] | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| | | | | | | | **Doksuri(2305)** | | | | | | | | | | | | |
| Jul. | 20/06 | TD | TD | *44* | *103* | *175* | *39* | *85* | *200* | *0* | *2* | *14* | *35* | *50* | *0* | *0* | *-15* | *-30* | *-35* |
| | 20/12 | TD | TD | *79* | *97* | *116* | *35* | *75* | *340* | *-2* | *-4* | *-10* | *10* | *20* | *0* | *0* | *5* | *-10* | *-15* |
| | 20/18 | TD | TD | *0* | *134* | *75* | *48* | *74* | *278* | *-2* | *0* | *0* | *25* | *20* | *0* | *-5* | *-5* | *-20* | *-15* |
| | 21/00 | TS | TS | **22** | **141** | **33** | **75** | **107** | **333** | **0** | **0** | **0** | **25** | **5** | **0** | **-5** | **-5** | **-20** | **-5** |
| | 21/06 | TS | TS | **11** | **116** | **34** | **65** | **139** | **289** | **0** | **0** | **5** | **15** | **-5** | **0** | **-5** | **-5** | **-10** | **0** |
| | 21/12 | TS | TS | **11** | **15** | **44** | **88** | **167** | **356** | **4** | **0** | **15** | **15** | **-10** | **-5** | **-5** | **-10** | **-10** | **5** |
| | 21/18 | TS | TS | **0** | **58** | **165** | **199** | **363** | **480** | **8** | **10** | **30** | **10** | **-20** | **-10** | **-15** | **-20** | **-5** | **10** |
| | 22/00 | TS | TS | **0** | **44** | **183** | **229** | **412** | **572** | **9** | **10** | **25** | **-5** | **-10** | **-10** | **-15** | **-15** | **5** | **10** |
| | 22/06 | TS | TS | **34** | **44** | **120** | **201** | **344** | **448** | **10** | **20** | **15** | **-25** | **-5** | **-10** | **-20** | **-10** | **15** | **5** |
| | 22/12 | TS | TS | **0** | **63** | **86** | **171** | **356** | **334** | **5** | **15** | **0** | **-20** | **10** | **-5** | **-10** | **0** | **15** | **-5** |
| | 22/18 | STS | STS | **11** | **76** | **82** | **204** | **304** | **347** | **0** | **10** | **0** | **-10** | **25** | **0** | **-5** | **0** | **5** | **-25** |
| | 23/00 | STS | STS | **15** | **48** | **39** | **122** | **263** | **261** | **0** | **10** | **-15** | **5** | **25** | **0** | **-5** | **10** | **0** | **-25** |
| | 23/06 | STS | STS | **0** | **22** | **48** | **137** | **306** | **234** | **5** | **0** | **-15** | **15** | **0** | **-5** | **0** | **10** | **-15** | **-5** |
| | 23/12 | STS | STS | **0** | **25** | **42** | **123** | **226** | **145** | **10** | **0** | **-20** | **20** | **-4** | **-5** | **0** | **15** | **-25** | **0** |
| | 23/18 | TY | TY | **22** | **31** | **43** | **116** | **178** | **74** | **15** | **0** | **-15** | **20** | **-2** | **-10** | **0** | **10** | **-25** | **0** |
| | 24/00 | TY | TY | **0** | **25** | **49** | **70** | **120** | | **10** | **-15** | **-15** | **10** | | **-5** | **10** | **15** | **-15** | |
| | 24/06 | TY | TY | **0** | **21** | **39** | **126** | **103** | | **0** | **-15** | **0** | **5** | | **0** | **10** | **5** | **-10** | |
| | 24/12 | TY | TY | **0** | **31** | **81** | **159** | **105** | | **0** | **-20** | **0** | **-4** | | **0** | **15** | **0** | **-5** | |
| | 24/18 | TY | TY | **0** | **21** | **78** | **166** | **216** | | **0** | **-20** | **5** | **-6** | | **0** | **15** | **-5** | **0** | |
| | 25/00 | TY | TY | **0** | **35** | **47** | **156** | | | **-15** | **-20** | **5** | | | **10** | **20** | **-5** | | |
| | 25/06 | TY | TY | **0** | **15** | **64** | **161** | | | **-25** | **-20** | **-10** | | | **15** | **20** | **5** | | |
| | 25/12 | TY | TY | **0** | **57** | **98** | **204** | | | **-20** | **-5** | **0** | | | **15** | **5** | **-10** | | |
| | 25/18 | TY | TY | **0** | **57** | **133** | **110** | | | **-20** | **10** | **-4** | | | **15** | **-5** | **-5** | | |
| | 26/00 | TY | TY | **11** | **25** | **102** | | | | **-15** | **15** | | | | **15** | **-10** | | | |
| | 26/06 | TY | TY | **0** | **33** | **125** | | | | **-5** | **0** | | | | **10** | **0** | | | |
| | 26/12 | TY | TY | **0** | **30** | **105** | | | | **-5** | **-2** | | | | **5** | **-10** | | | |
| | 26/18 | TY | TY | **0** | **42** | **67** | | | | **-5** | **-4** | | | | **5** | **-5** | | | |
| | 27/00 | TY | TY | **0** | **88** | | | | | **-15** | | | | | **15** | | | | |
| | 27/06 | TY | TY | **0** | **60** | | | | | **-5** | | | | | **0** | | | | |
| | 27/12 | TY | TY | **0** | **41** | | | | | **-4** | | | | | **0** | | | | |
| | 27/18 | TY | TY | **0** | **29** | | | | | **-4** | | | | | **-5** | | | | |
| | 28/00 | TY | TY | **0** | | | | | | | | | | | | | | | |
| | 28/06 | STS | TY | **32** | | | | | | | | | | | | | | | |
| | 28/12 | TS | TS | **22** | | | | | | | | | | | | | | | |
| | 28/18 | TS | TS | **0** | | | | | | | | | | | | | | | |
| | 29/00 | TD | TD | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **6** | **46** | **79** | **144** | **232** | **323** | **-2** | **-1** | **0** | **4** | **1** | **1** | **-1** | **-1** | **-6** | **-3** |
| **Valid: TS/STS/TY** | | | **sample** | **32** | **28** | **24** | **20** | **16** | **12** | **28** | **24** | **20** | **16** | **12** | **28** | **24** | **20** | **16** | **12** |
| *Initial: TD(before upg.)* | | | *mean* | *41* | *111* | *122* | *41* | *78* | *273* | *-1* | *-1* | *1* | *23* | *30* | *0* | *-2* | *-5* | *-20* | *-22* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* | *3* |

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

| Date/Time | | Grade | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt)† | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | Best | Prov. | T=0‡ | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **Khanun(2306)** | | | | | | | | | | | | | | | | | | | |
| Jul. | 26/18 | TD | TD | *213* | *156* | *193* | *269* | *268* | *454* | *0* | *2* | *12* | *35* | *40* | *5* | *0* | *-10* | *-25* | *-25* |
| | 27/00 | TD | TD | *255* | *147* | *222* | *245* | *269* | *376* | *0* | *0* | *20* | *35* | *45* | *0* | *0* | *-15* | *-25* | *-30* |
| | 27/06 | TD | TD | *252* | *123* | *264* | *275* | *395* | *466* | *2* | *2* | *20* | *20* | *25* | *0* | *-5* | *-15* | *-10* | *-15* |
| | 27/12 | TD | TD | *212* | *127* | *246* | *296* | *442* | *530* | *2* | *9* | *20* | *30* | *25* | *0* | *-10* | *-15* | *-15* | *-15* |
| | 27/18 | TD | TS | *174* | *155* | *262* | *328* | *522* | *715* | *2* | *10* | *30* | *30* | *20* | *0* | *-10* | *-20* | *-15* | *-10* |
| | 28/00 | TS | TS | **79** | **130** | **224** | **332** | **513** | **776** | **2** | **20** | **35** | **35** | **40** | **0** | **-20** | **-25** | **-20** | **-25** |
| | 28/06 | TS | TS | **39** | **102** | **181** | **380** | **536** | **727** | **-2** | **5** | **5** | **20** | **25** | **0** | **-5** | **-5** | **-15** | **-25** |
| | 28/12 | TS | TS | **11** | **74** | **223** | **419** | **545** | **727** | **5** | **10** | **15** | **20** | **40** | **-5** | **-10** | **-10** | **-15** | **-35** |
| | 28/18 | TS | TS | **22** | **81** | **215** | **359** | **540** | **612** | **5** | **15** | **15** | **15** | **45** | **-5** | **-10** | **-10** | **-10** | **-40** |
| | 29/00 | TS | TS | **70** | **112** | **249** | **396** | **562** | **653** | **15** | **20** | **20** | **30** | **50** | **-15** | **-15** | **-15** | **-20** | **-45** |
| | 29/06 | TS | TS | **56** | **78** | **243** | **389** | **463** | **615** | **15** | **20** | **20** | **30** | **45** | **-15** | **-15** | **-15** | **-20** | **-40** |
| | 29/12 | STS | TS | **0** | **135** | **278** | **402** | **480** | **646** | **15** | **30** | **20** | **35** | **30** | **-15** | **-20** | **-15** | **-25** | **-30** |
| | 29/18 | STS | STS | **0** | **150** | **306** | **405** | **529** | **723** | **20** | **25** | **15** | **35** | **25** | **-15** | **-15** | **-10** | **-30** | **-25** |
| | 30/00 | TY | STS | **0** | **178** | **306** | **380** | **482** | **713** | **20** | **20** | **25** | **30** | **20** | **-15** | **-15** | **-15** | **-25** | **-20** |
| | 30/06 | TY | STS | **0** | **151** | **239** | **262** | **354** | **585** | **15** | **20** | **25** | **25** | **20** | **-10** | **-15** | **-15** | **-20** | **-20** |
| | 30/12 | TY | TY | **0** | **117** | **152** | **134** | **207** | **411** | **25** | **20** | **15** | **5** | **5** | **-15** | **-15** | **-10** | **0** | **-5** |
| | 30/18 | TY | TY | **0** | **75** | **35** | **37** | **146** | **258** | **15** | **15** | **15** | **0** | **-5** | **-10** | **-10** | **-10** | **5** | **15** |
| | 31/00 | TY | TY | **0** | **23** | **37** | **63** | **30** | **89** | **15** | **15** | **10** | **-5** | **-5** | **-10** | **-10** | **-5** | **10** | **15** |
| | 31/06 | TY | TY | **10** | **39** | **44** | **45** | **40** | **193** | **5** | **10** | **5** | **-20** | **-20** | **-5** | **-5** | **0** | **20** | **30** |
| | 31/12 | TY | TY | **0** | **54** | **30** | **24** | **148** | **326** | **5** | **10** | **-10** | **-20** | **-20** | **-5** | **-5** | **10** | **20** | **30** |
| | 31/18 | TY | TY | **0** | **11** | **15** | **70** | **236** | **396** | **-10** | **0** | **-20** | **-25** | **-20** | **5** | **0** | **20** | **30** | **30** |
| Aug. | 01/00 | TY | TY | **0** | **15** | **30** | **160** | **305** | **494** | **-10** | **-5** | **-25** | **-25** | **-20** | **5** | **5** | **25** | **30** | **30** |
| | 01/06 | TY | TY | **0** | **24** | **32** | **168** | **256** | **377** | **-5** | **0** | **-20** | **-20** | **-15** | **5** | **5** | **20** | **25** | **20** |
| | 01/12 | TY | TY | **0** | **46** | **90** | **231** | **374** | **488** | **-5** | **-15** | **-20** | **-20** | **-20** | **5** | **15** | **20** | **25** | **25** |
| | 01/18 | TY | TY | **0** | **46** | **114** | **186** | **285** | **351** | **-5** | **-20** | **-20** | **-20** | **-20** | **5** | **20** | **25** | **25** | **25** |
| | 02/00 | TY | TY | **0** | **40** | **121** | **187** | **317** | **329** | **-5** | **-25** | **-20** | **-20** | **-20** | **5** | **25** | **25** | **25** | **25** |
| | 02/06 | TY | TY | **0** | **15** | **77** | **72** | **111** | **158** | **-10** | **-20** | **-20** | **-20** | **-20** | **10** | **20** | **25** | **25** | **25** |
| | 02/12 | TY | TY | **0** | **41** | **136** | **110** | **150** | **182** | **-15** | **-20** | **-20** | **-20** | **-25** | **15** | **15** | **20** | **20** | **25** |
| | 02/18 | TY | TY | **11** | **41** | **89** | **49** | **135** | **239** | **-15** | **-20** | **-20** | **-20** | **-25** | **15** | **15** | **20** | **20** | **25** |
| | 03/00 | TY | TY | **10** | **23** | **30** | **22** | **150** | **328** | **-10** | **-10** | **-20** | **-20** | **-25** | **15** | **10** | **20** | **20** | **25** |
| | 03/06 | TY | TY | **0** | **45** | **37** | **15** | **133** | **251** | **-15** | **-15** | **-20** | **-20** | **-20** | **15** | **15** | **20** | **20** | **20** |
| | 03/12 | TY | TY | **0** | **45** | **50** | **67** | **125** | **209** | **-10** | **-10** | **-20** | **-25** | **-20** | **10** | **15** | **20** | **25** | **20** |
| | 03/18 | TY | TY | **30** | **52** | **30** | **73** | **198** | **334** | **-5** | **-10** | **-15** | **-20** | **-15** | **10** | **20** | **20** | **25** | **20** |
| | 04/00 | STS | TY | **40** | **10** | **10** | **92** | **162** | **272** | **-5** | **-10** | **-15** | **-20** | **-15** | **10** | **20** | **20** | **25** | **20** |
| | 04/06 | STS | TY | **0** | **11** | **49** | **178** | **211** | **279** | **-5** | **-10** | **-15** | **-15** | **0** | **15** | **20** | **20** | **20** | **10** |
| | 04/12 | STS | TY | **0** | **11** | **89** | **186** | **199** | **313** | **-5** | **-15** | **-20** | **-10** | **0** | **15** | **20** | **25** | **15** | **5** |
| | 04/18 | STS | STS | **0** | **11** | **74** | **150** | **203** | **376** | **0** | **-10** | **-15** | **0** | **0** | **10** | **15** | **20** | **10** | **5** |
| | 05/00 | STS | STS | **0** | **10** | **52** | **116** | **184** | **413** | **0** | **-10** | **-15** | **0** | **-5** | **10** | **15** | **20** | **10** | **10** |
| | 05/06 | STS | STS | **0** | **20** | **77** | **87** | **227** | | **0** | **-10** | **-10** | **0** | | **10** | **15** | **15** | **10** | |
| | 05/12 | STS | STS | **0** | **44** | **83** | **73** | **229** | | **0** | **-15** | **-10** | **-5** | | **10** | **20** | **15** | **10** | |
| | 05/18 | STS | STS | **0** | **56** | **70** | **77** | **189** | | **5** | **-5** | **0** | **0** | | **5** | **15** | **10** | **5** | |
| | 06/00 | STS | STS | **20** | **22** | **35** | **57** | **82** | | **5** | **-5** | **0** | **-5** | | **5** | **15** | **10** | **10** | |
| | 06/06 | STS | STS | **15** | **15** | **40** | **22** | | | **0** | **-5** | **-5** | | | **5** | **10** | **10** | | |
| | 06/12 | STS | STS | **37** | **15** | **37** | **15** | | | **-5** | **-5** | **-10** | | | **10** | **10** | **10** | | |
| | 06/18 | STS | STS | **11** | **49** | **31** | **35** | | | **-5** | **-5** | **-10** | | | **10** | **10** | **10** | | |
| | 07/00 | STS | STS | **11** | **31** | **29** | **67** | | | **-5** | **-5** | **-15** | | | **10** | **10** | **15** | | |
| | 07/06 | STS | STS | **35** | **40** | **28** | | | | **0** | **-5** | | | | **5** | **10** | | | |
| | 07/12 | TS | STS | **24** | **53** | **57** | | | | **0** | **-10** | | | | **5** | **10** | | | |
| | 07/18 | TS | STS | **24** | **36** | **65** | | | | **0** | **-10** | | | | **5** | **10** | | | |
| | 08/00 | TS | STS | **0** | **65** | **110** | | | | **0** | **-5** | | | | **5** | **5** | | | |
| | 08/06 | STS | STS | **0** | **36** | | | | | **0** | | | | | **5** | | | | |
| | 08/12 | STS | STS | **10** | **48** | | | | | **-5** | | | | | **5** | | | | |
| | 08/18 | STS | STS | **0** | **14** | | | | | **-5** | | | | | **5** | | | | |
| | 09/00 | STS | STS | **0** | **51** | | | | | **-5** | | | | | **10** | | | | |
| | 09/06 | STS | STS | **0** | | | | | | | | | | | | | | | |
| | 09/12 | STS | STS | **0** | | | | | | | | | | | | | | | |
| | 09/18 | STS | STS | **11** | | | | | | | | | | | | | | | |
| | 10/00 | TS | TS | **0** | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **11** | **53** | **101** | **161** | **271** | **419** | **0** | **-1** | **-4** | **-3** | **0** | **3** | **5** | **8** | **8** | **4** |
| **Valid: TS/STS/TY** | | | **sample** | **53** | **49** | **45** | **41** | **37** | **33** | **49** | **45** | **41** | **37** | **33** | **49** | **45** | **41** | **37** | **33** |
| *Initial: TD(before upg.)* | | | *mean* | *221* | *142* | *237* | *283* | *379* | *508* | *1* | *5* | *20* | *30* | *31* | *1* | *-5* | *-15* | *-18* | *-19* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *5* | *5* | *5* | *5* | *5* | *5* | *5* | *5* | *5* | *5* | *5* | *5* | *5* | *5* | *5* | *5* |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | | Grade | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt)[†] | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | Best | Prov. | T=0[‡] | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| | | | | | | | | | **Lan(2307)** | | | | | | | | | | |
| Aug. | 07/00 | TD | TD | *190* | *176* | *127* | *69* | *104* | *125* | *-2* | *4* | *15* | *40* | *20* | *0* | *-10* | *-20* | *-40* | *-25* |
| | 07/06 | TD | TD | *181* | *102* | *45* | *128* | *134* | *253* | *2* | *5* | *15* | *20* | *10* | *-5* | *-5* | *-20* | *-25* | *-20* |
| | 07/12 | TD | TD | *174* | *67* | *52* | *126* | *94* | *118* | *6* | *10* | *25* | *20* | *0* | *-10* | *-10* | *-30* | *-25* | *-10* |
| | 07/18 | TD | TD | *82* | *24* | *32* | *60* | *15* | *66* | *4* | *10* | *30* | *5* | *-10* | *-5* | *-10* | *-30* | *-15* | *-5* |
| | 08/00 | TS | TS | **73** | **39** | **32** | **20** | **30** | **102** | **2** | **10** | **20** | **5** | **-10** | **-5** | **-10** | **-25** | **-15** | **-5** |
| | 08/06 | TS | TS | **24** | **11** | **40** | **54** | **121** | **171** | **5** | **15** | **20** | **0** | **-15** | **-5** | **-20** | **-25** | **-10** | **0** |
| | 08/12 | TS | TS | **30** | **10** | **32** | **41** | **145** | **149** | **5** | **20** | **15** | **-5** | **-15** | **-5** | **-25** | **-20** | **-5** | **0** |
| | 08/18 | TS | TS | **0** | **11** | **41** | **66** | **170** | **198** | **10** | **30** | **5** | **-15** | **-20** | **-10** | **-30** | **-15** | **0** | **5** |
| | 09/00 | STS | TS | **15** | **15** | **46** | **103** | **190** | **210** | **10** | **25** | **0** | **-15** | **-20** | **-10** | **-25** | **-10** | **0** | **5** |
| | 09/06 | STS | STS | **15** | **15** | **15** | **89** | **145** | **239** | **15** | **25** | **0** | **-15** | **-20** | **-15** | **-20** | **-10** | **0** | **10** |
| | 09/12 | STS | STS | **10** | **23** | **32** | **123** | **202** | **286** | **25** | **10** | **-5** | **-10** | **5** | **-25** | **-10** | **-5** | **-5** | **-10** |
| | 09/18 | STS | STS | **0** | **22** | **23** | **118** | **142** | **284** | **30** | **0** | **-15** | **-15** | **5** | **-25** | **-5** | **0** | **0** | **-10** |
| | 10/00 | TY | STS | **11** | **24** | **22** | **56** | **66** | **253** | **25** | **0** | **-15** | **-15** | **-20** | **-20** | **-5** | **0** | **0** | **10** |
| | 10/06 | TY | TY | **0** | **20** | **24** | **91** | **150** | **277** | **20** | **0** | **-15** | **-15** | **-25** | **-15** | **-5** | **0** | **5** | **15** |
| | 10/12 | TY | TY | **11** | **31** | **37** | **48** | **112** | **265** | **5** | **-10** | **-20** | **-25** | **-15** | **-5** | **5** | **5** | **15** | **10** |
| | 10/18 | TY | TY | **11** | **31** | **10** | **15** | **117** | **240** | **-10** | **-20** | **-20** | **-25** | **-15** | **5** | **10** | **10** | **15** | **15** |
| | 11/00 | TY | TY | **15** | **20** | **37** | **48** | **214** | **193** | **-15** | **-30** | **-25** | **-20** | **-10** | **10** | **15** | **15** | **20** | **10** |
| | 11/06 | TY | TY | **0** | **39** | **51** | **69** | **107** | **67** | **-15** | **-15** | **-5** | **-10** | **0** | **10** | **10** | **10** | **10** | **5** |
| | 11/12 | TY | TY | **0** | **39** | **80** | **83** | **98** | **52** | **-15** | **-15** | **-10** | **-15** | **0** | **10** | **10** | **15** | **15** | **5** |
| | 11/18 | TY | TY | **15** | **31** | **44** | **24** | **118** | **183** | **-15** | **-5** | **-5** | **-10** | **0** | **10** | **5** | **5** | **15** | **0** |
| | 12/00 | TY | TY | **0** | **15** | **15** | **65** | **85** | **101** | **-10** | **0** | **-5** | **0** | **4** | **5** | **0** | **5** | **5** | **-5** |
| | 12/06 | TY | TY | **0** | **11** | **19** | **80** | **41** | | **-5** | **-5** | **-5** | **-5** | | **0** | **5** | **5** | **5** | |
| | 12/12 | TY | TY | **0** | **24** | **29** | **121** | **108** | | **0** | **-5** | **-10** | **0** | | **-5** | **5** | **5** | **0** | |
| | 12/18 | TY | TY | **0** | **45** | **43** | **107** | **47** | | **0** | **0** | **-5** | **0** | | **-5** | **0** | **5** | **0** | |
| | 13/00 | TY | TY | **11** | **9** | **100** | **62** | **142** | | **-5** | **-5** | **0** | **4** | | **0** | **5** | **0** | **-5** | |
| | 13/06 | TY | TY | **10** | **15** | **44** | **69** | | | **0** | **-5** | **0** | | | **0** | **0** | **0** | | |
| | 13/12 | TY | TY | **19** | **38** | **48** | **8** | | | **-5** | **-10** | **0** | | | **5** | **5** | **0** | | |
| | 13/18 | TY | TY | **0** | **11** | **58** | **40** | | | **-5** | **-5** | **0** | | | **5** | **5** | **0** | | |
| | 14/00 | TY | TY | **11** | **30** | **52** | **101** | | | **-5** | **-5** | **0** | | | **5** | **5** | **0** | | |
| | 14/06 | TY | TY | **0** | **22** | **28** | | | | **-5** | **-5** | | | | **5** | **5** | | | |
| | 14/12 | STS | TY | **15** | **24** | **54** | | | | **-10** | **-5** | | | | **10** | **5** | | | |
| | 14/18 | STS | STS | **0** | **43** | **112** | | | | **-5** | **0** | | | | **10** | **0** | | | |
| | 15/00 | STS | STS | **14** | **44** | **106** | | | | **-5** | **-5** | | | | **5** | **0** | | | |
| | 15/06 | STS | STS | **14** | **80** | | | | | **-5** | | | | | **5** | | | | |
| | 15/12 | TS | TS | **9** | **121** | | | | | **-5** | | | | | **5** | | | | |
| | 15/18 | TS | TS | **9** | **128** | | | | | **0** | | | | | **0** | | | | |
| | 16/00 | TS | TS | **11** | **58** | | | | | **0** | | | | | **0** | | | | |
| | 16/06 | TS | TS | **0** | | | | | | | | | | | | | | | |
| | 16/12 | TS | TS | **56** | | | | | | | | | | | | | | | |
| | 16/18 | TS | TS | **59** | | | | | | | | | | | | | | | |
| | 17/00 | TS | TS | **22** | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **13** | **33** | **44** | **68** | **121** | **192** | **0** | **-1** | **-4** | **-10** | **-10** | **-1** | **-2** | **-1** | **3** | **4** |
| **Valid: TS/STS/TY** | | | **sample** | **37** | **33** | **29** | **25** | **21** | **17** | **33** | **29** | **25** | **21** | **17** | **33** | **29** | **25** | **21** | **17** |
| *Initial: TD(before upg.)* | | | *mean* | *157* | *93* | *64* | *96* | *87* | *140* | *3* | *7* | *21* | *21* | *5* | *-5* | *-9* | *-25* | *-26* | *-15* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *4* | *4* | *4* | *4* | *4* | *4* | *4* | *4* | *4* | *4* | *4* | *4* | *4* | *4* | *4* | *4* |

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

| Date/Time | (UTC) | Grade Best | Grade Prov. | Center Position (km) T=0‡ | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt)† T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **Dora(2308)** | | | | | | | | | | | |
| Aug. | 12/00 | TY | TY | **15** | **40** | **87** | | | | **15** | **4** | | | | **-25** | **-5** | | | |
| | 12/06 | TY | TY | **21** | **35** | **92** | | | | **2** | **-2** | | | | **-5** | **5** | | | |
| | 12/12 | TY | TY | **0** | **94** | **118** | | | | **-4** | **-8** | | | | **10** | **15** | | | |
| | 12/18 | TY | TY | **15** | **138** | **175** | | | | **-8** | **-12** | | | | **10** | **20** | | | |
| | 13/00 | TY | TY | **54** | **124** | | | | | **-8** | | | | | **10** | | | | |
| | 13/06 | TY | STS | **53** | **81** | | | | | **-4** | | | | | **5** | | | | |
| | 13/12 | STS | STS | **21** | **42** | | | | | **-2** | | | | | **0** | | | | |
| | 13/18 | STS | STS | **0** | **15** | | | | | **-6** | | | | | **10** | | | | |
| | 14/00 | TS | TS | **0** | | | | | | | | | | | | | | | |
| | 14/06 | TS | TS | **0** | | | | | | | | | | | | | | | |
| | 14/12 | TS | TS | **15** | | | | | | | | | | | | | | | |
| | 14/18 | TS | TS | **33** | | | | | | | | | | | | | | | |
| | 15/00 | TD | TS | | | | | | | | | | | | | | | | |
| | 15/06 | TD | TD | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **19** | **71** | **118** | **--** | **--** | **--** | **-2** | **-5** | **--** | **--** | **--** | **2** | **9** | **--** | **--** | **--** |
| **Valid: TS/STS/TY** | | | **sample** | **12** | **8** | **4** | **0** | **0** | **0** | **8** | **4** | **0** | **0** | **0** | **8** | **4** | **0** | **0** | **0** |
| *Initial: TD(before upg.)* | | | *mean* | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Valid: TD/TS/STS/TY* | | | *sample* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | (UTC) | Grade Best | Grade Prov. | Center Position (km) T=0[‡] | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt)[†] T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | **Saola(2309)** | | | | | | | | | | |
| Aug. | 23/18 | TD | TD | *67* | *92* | *159* | *266* | *352* | *278* | *-2* | *21* | *52* | *30* | *20* | *-5* | *-30* | *-50* | *-30* | *-20* |
| | 24/00 | TD | TD | *54* | *124* | *139* | *169* | *176* | *276* | *2* | *24* | *45* | *15* | *15* | *-10* | *-30* | *-35* | *-10* | *-10* |
| | 24/06 | TS | TS | **46** | **79** | **59** | **97** | **49** | **214** | **0** | **30** | **35** | **5** | **5** | **-5** | **-25** | **-25** | **-5** | **-5** |
| | 24/12 | TS | TS | **43** | **49** | **48** | **108** | **54** | **169** | **12** | **20** | **10** | **-15** | **0** | **-10** | **-10** | **0** | **10** | **0** |
| | 24/18 | TS | TS | **33** | **39** | **107** | **165** | **105** | **139** | **15** | **25** | **-15** | **-15** | **5** | **-10** | **-10** | **10** | **10** | **-5** |
| | 25/00 | TS | STS | **22** | **42** | **139** | **129** | **168** | **208** | **15** | **25** | **-20** | **-15** | **20** | **-10** | **-10** | **15** | **10** | **-10** |
| | 25/06 | STS | STS | **25** | **31** | **128** | **149** | **206** | **304** | **20** | **20** | **-15** | **-15** | **15** | **-10** | **-5** | **10** | **10** | **-5** |
| | 25/12 | TY | TY | **0** | **34** | **140** | **129** | **176** | **333** | **10** | **0** | **-20** | **-5** | **15** | **-10** | **0** | **15** | **5** | **-5** |
| | 25/18 | TY | TY | **22** | **39** | **116** | **117** | **177** | **333** | **20** | **-15** | **-20** | **0** | **15** | **-15** | **10** | **15** | **0** | **-5** |
| | 26/00 | TY | TY | **11** | **48** | **46** | **139** | **220** | **335** | **15** | **-20** | **-35** | **0** | **15** | **-10** | **15** | **20** | **0** | **-5** |
| | 26/06 | TY | TY | **0** | **88** | **119** | **178** | **253** | **283** | **10** | **-20** | **-30** | **0** | **15** | **-5** | **15** | **15** | **0** | **-5** |
| | 26/12 | TY | TY | **0** | **112** | **150** | **169** | **255** | **298** | **0** | **-20** | **-20** | **15** | **25** | **0** | **15** | **10** | **-5** | **-20** |
| | 26/18 | TY | TY | **0** | **116** | **144** | **192** | **292** | **408** | **-20** | **-35** | **-15** | **30** | **45** | **15** | **20** | **5** | **-15** | **-35** |
| | 27/00 | TY | TY | **0** | **39** | **152** | **194** | **316** | **386** | **-40** | **-35** | **0** | **55** | **54** | **25** | **20** | **0** | **-35** | **-50** |
| | 27/06 | TY | TY | **0** | **64** | **139** | **175** | **235** | **274** | **-35** | **-30** | **0** | **55** | **58** | **20** | **15** | **0** | **-35** | **-55** |
| | 27/12 | TY | TY | **0** | **96** | **122** | **162** | **167** | **257** | **-35** | **-20** | **0** | **25** | **42** | **20** | **10** | **0** | **-20** | **-35** |
| | 27/18 | TY | TY | **0** | **98** | **130** | **221** | **252** | **403** | **-20** | **-15** | **20** | **20** | **15** | **15** | **5** | **-10** | **-15** | **-10** |
| | 28/00 | TY | TY | **11** | **111** | **156** | **206** | **247** | **417** | **-5** | **20** | **30** | **20** | **0** | **5** | **-10** | **-15** | **-15** | **5** |
| | 28/06 | TY | TY | **0** | **77** | **117** | **113** | **186** | **372** | **0** | **20** | **30** | **20** | **-10** | **0** | **-10** | **-15** | **-15** | **15** |
| | 28/12 | TY | TY | **15** | **54** | **136** | **124** | **258** | **386** | **10** | **20** | **20** | **10** | **-16** | **-5** | **-10** | **-15** | **-5** | **30** |
| | 28/18 | TY | TY | **0** | **52** | **139** | **86** | **227** | | **5** | **30** | **15** | **-10** | | **-5** | **-15** | **-10** | **10** | |
| | 29/00 | TY | TY | **0** | **74** | **94** | **93** | **248** | | **30** | **35** | **15** | **-20** | | **-15** | **-20** | **-10** | **20** | |
| | 29/06 | TY | TY | **0** | **42** | **46** | **62** | **239** | | **30** | **35** | **20** | **-20** | | **-15** | **-20** | **-15** | **25** | |
| | 29/12 | TY | TY | **0** | **43** | **21** | **138** | **291** | | **20** | **15** | **5** | **-21** | | **-10** | **-10** | **0** | **35** | |
| | 29/18 | TY | TY | **0** | **62** | **53** | **138** | | | **15** | **10** | **-15** | | | **-5** | **-5** | **10** | | |
| | 30/00 | TY | TY | **0** | **33** | **41** | **104** | | | **20** | **10** | **-20** | | | **-10** | **-10** | **15** | | |
| | 30/06 | TY | TY | **0** | **57** | **69** | **136** | | | **20** | **10** | **-15** | | | **-10** | **-10** | **10** | | |
| | 30/12 | TY | TY | **10** | **25** | **45** | **136** | | | **5** | **5** | **-16** | | | **-5** | **-5** | **20** | | |
| | 30/18 | TY | TY | **0** | **54** | **83** | | | | **10** | **10** | | | | **-5** | **-10** | | | |
| | 31/00 | TY | TY | **11** | **39** | **93** | | | | **10** | **0** | | | | **-5** | **0** | | | |
| | 31/06 | TY | TY | **0** | **39** | **76** | | | | **15** | **-5** | | | | **-10** | **5** | | | |
| | 31/12 | TY | TY | **10** | **43** | **86** | | | | **20** | **-4** | | | | **-10** | **10** | | | |
| | 31/18 | TY | TY | **0** | **53** | | | | | **0** | | | | | **0** | | | | |
| Sep. | 01/00 | TY | TY | **0** | **38** | | | | | **5** | | | | | **-5** | | | | |
| | 01/06 | TY | TY | **0** | **33** | | | | | **0** | | | | | **0** | | | | |
| | 01/12 | TY | TY | **0** | **94** | | | | | **-4** | | | | | **10** | | | | |
| | 01/18 | TY | TY | **0** | | | | | | | | | | | | | | | |
| | 02/00 | STS | STS | **25** | | | | | | | | | | | | | | | |
| | 02/06 | STS | STS | **0** | | | | | | | | | | | | | | | |
| | 02/12 | TS | TS | **11** | | | | | | | | | | | | | | | |
| | 02/18 | TD | TD | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **8** | **59** | **100** | **141** | **210** | **307** | **5** | **4** | **-2** | **5** | **18** | **-3** | **-2** | **2** | **-1** | **-11** |
| **Valid: TS/STS/TY** | | | **sample** | **38** | **34** | **30** | **26** | **22** | **18** | **34** | **30** | **26** | **22** | **18** | **34** | **30** | **26** | **22** | **18** |
| *Initial: TD(before upg.)* | | | *mean* | *61* | *108* | *149* | *217* | *264* | *277* | *0* | *23* | *49* | *23* | *18* | *-8* | *-30* | *-43* | *-20* | *-15* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* |

[†] Max. wind for TDs are treated as 30 kt in this validation

[‡] Position error of provisional analysis

| Date/Time | (UTC) | Grade Best | Prov. | Center Position (km) T=0[‡] | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt)[†] T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Damrey(2310)** | | | | | | | | | | | | |
| Aug. | 24/00 | TD | TD | *259* | *455* | *331* | *591* | *370* | *758* | *0* | *6* | *13* | *10* | *12* | *0* | *-5* | *-10* | *-10* | *-10* |
| | 24/06 | TD | TD | *295* | *257* | *275* | *125* | *413* | | *4* | *11* | *13* | *10* | | *-5* | *-10* | *-10* | *-10* | |
| | 24/12 | TD | TD | *310* | *150* | *219* | *223* | *177* | | *4* | *11* | *13* | *15* | | *-5* | *-10* | *-10* | *-15* | |
| | 24/18 | TS | TS | **204** | **65** | **209** | **69** | **183** | | **4** | **11** | **6** | **13** | | **-5** | **-10** | **-5** | **-15** | |
| | 25/00 | TS | TS | **31** | **94** | **157** | **73** | **457** | | **8** | **13** | **6** | **6** | | **-10** | **-15** | **-5** | **-5** | |
| | 25/06 | TS | TS | **0** | **90** | **24** | **136** | | | **5** | **5** | **0** | | | **-5** | **-5** | **0** | | |
| | 25/12 | TS | TS | **0** | **59** | **69** | **150** | | | **5** | **5** | **9** | | | **-5** | **-5** | **-10** | | |
| | 25/18 | TS | TS | **54** | **29** | **80** | **120** | | | **5** | **0** | **9** | | | **-5** | **0** | **-10** | | |
| | 26/00 | TS | TS | **30** | **96** | **33** | **108** | | | **5** | **0** | **4** | | | **-5** | **0** | **-5** | | |
| | 26/06 | STS | TS | **0** | **29** | **51** | | | | **0** | **-5** | | | | **-5** | **5** | | | |
| | 26/12 | STS | TS | **49** | **14** | **28** | | | | **-5** | **0** | | | | **0** | **0** | | | |
| | 26/18 | STS | TS | **29** | **35** | **45** | | | | **-15** | **0** | | | | **10** | **0** | | | |
| | 27/00 | STS | TS | **19** | **49** | **0** | | | | **-10** | **-5** | | | | **10** | **5** | | | |
| | 27/06 | STS | TS | **22** | **48** | | | | | **-5** | | | | | **5** | | | | |
| | 27/12 | STS | TS | **0** | **54** | | | | | **0** | | | | | **0** | | | | |
| | 27/18 | TS | TS | **0** | **11** | | | | | **0** | | | | | **0** | | | | |
| | 28/00 | TS | TS | **37** | **55** | | | | | **-5** | | | | | **5** | | | | |
| | 28/06 | TS | TS | **0** | | | | | | | | | | | | | | | |
| | 28/12 | STS | TS | **48** | | | | | | | | | | | | | | | |
| | 28/18 | STS | STS | **0** | | | | | | | | | | | | | | | |
| | 29/00 | TS | TS | **0** | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **29** | **52** | **70** | **109** | **320** | **--** | **-1** | **2** | **6** | **10** | **--** | **-1** | **-3** | **-6** | **-10** | **--** |
| **Valid: TS/STS/TY** | | | **sample** | **18** | **14** | **10** | **6** | **2** | **0** | **14** | **10** | **6** | **2** | **0** | **14** | **10** | **6** | **2** | **0** |
| *Initial: TD(before upg.)* | | | *mean* | *288* | *287* | *275* | *313* | *320* | *758* | *3* | *9* | *13* | *12* | *12* | *-3* | *-8* | *-10* | *-12* | *-10* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *3* | *3* | *3* | *3* | *3* | *1* | *3* | *3* | *3* | *3* | *1* | *3* | *3* | *3* | *3* | *1* |

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

| Date/Time | | Grade | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt)† | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | Best | Prov. | T=0‡ | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| | | | | | | | **Haikui(2311)** | | | | | | | | | | | | |
| Aug. | 27/06 | TD | TD | *59* | *244* | *278* | *79* | *109* | *358* | *-2* | *0* | *-5* | *0* | *0* | *5* | *0* | *5* | *0* | *0* |
| | 27/12 | TD | TD | *0* | *255* | *302* | *119* | *204* | *537* | *-2* | *0* | *-5* | *0* | *5* | *5* | *0* | *5* | *0* | *-5* |
| | 27/18 | TD | TD | *21* | *285* | *192* | *84* | *318* | *518* | *0* | *0* | *0* | *0* | *10* | *0* | *0* | *0* | *0* | *-10* |
| | 28/00 | TD | TS | *67* | *328* | *74* | *262* | *445* | *721* | *0* | *0* | *5* | *5* | *15* | *0* | *0* | *-5* | *-5* | *-15* |
| | 28/06 | TD | TS | *116* | *213* | *67* | *265* | *402* | *706* | *6* | *4* | *10* | *5* | *10* | *-10* | *-5* | *-10* | *-5* | *-10* |
| | 28/12 | TD | TS | *0* | *169* | *94* | *279* | *446* | *632* | *8* | *4* | *5* | *0* | *20* | *-10* | *-5* | *-5* | *0* | *-20* |
| | 28/18 | TS | TS | **0** | **123** | **166** | **377** | **544** | **648** | **6** | **0** | **-5** | **0** | **35** | **-5** | **0** | **5** | **0** | **-30** |
| | 29/00 | TS | TS | **0** | **192** | **358** | **561** | **741** | **1034** | **2** | **5** | **0** | **5** | **30** | **0** | **-5** | **0** | **-5** | **-25** |
| | 29/06 | TS | STS | **0** | **114** | **289** | **422** | **803** | **1229** | **-10** | **-10** | **-5** | **15** | **20** | **15** | **10** | **5** | **-15** | **-15** |
| | 29/12 | TS | STS | **84** | **146** | **396** | **493** | **617** | **945** | **-20** | **-25** | **-15** | **15** | **15** | **30** | **25** | **15** | **-10** | **-5** |
| | 29/18 | TS | STS | **81** | **133** | **338** | **439** | **534** | **1011** | **-15** | **-25** | **-15** | **30** | **10** | **25** | **25** | **15** | **-20** | **0** |
| | 30/00 | TS | STS | **0** | **206** | **375** | **518** | **640** | **1060** | **0** | **0** | **10** | **42** | **11** | **10** | **10** | **0** | **-30** | **-5** |
| | 30/06 | TS | STS | **10** | **320** | **479** | **678** | **914** | **1296** | **5** | **5** | **20** | **29** | **13** | **5** | **5** | **-10** | **-20** | **-10** |
| | 30/12 | TS | STS | **0** | **338** | **473** | **586** | **823** | **1036** | **5** | **10** | **20** | **17** | **6** | **5** | **0** | **-10** | **-10** | **-5** |
| | 30/18 | STS | STS | **0** | **314** | **520** | **600** | **880** | **1152** | **5** | **10** | **35** | **16** | **2** | **5** | **0** | **-25** | **-10** | **0** |
| | 31/00 | STS | STS | **0** | **133** | **347** | **439** | **588** | | **5** | **10** | **25** | **13** | | **5** | **0** | **-15** | **-10** | |
| | 31/06 | STS | STS | **0** | **98** | **283** | **359** | **452** | | **0** | **10** | **10** | **13** | | **10** | **0** | **0** | **-10** | |
| | 31/12 | STS | STS | **10** | **105** | **167** | **298** | **252** | | **5** | **10** | **0** | **6** | | **5** | **0** | **10** | **-5** | |
| | 31/18 | STS | STS | **15** | **129** | **181** | **285** | **346** | | **5** | **30** | **10** | **4** | | **5** | **-15** | **0** | **-5** | |
| Sep. | 01/00 | STS | TY | **0** | **112** | **235** | **224** | | | **10** | **30** | **9** | | | **0** | **-20** | **-5** | | |
| | 01/06 | STS | TY | **0** | **57** | **126** | **112** | | | **15** | **15** | **0** | | | **-5** | **-5** | **5** | | |
| | 01/12 | TY | TY | **11** | **15** | **84** | **30** | | | **15** | **5** | **-7** | | | **-5** | **5** | **10** | | |
| | 01/18 | TY | TY | **0** | **11** | **103** | **124** | | | **30** | **0** | **-11** | | | **-15** | **0** | **10** | | |
| | 02/00 | TY | TY | **0** | **35** | **121** | | | | **20** | **0** | | | | **-5** | **0** | | | |
| | 02/06 | TY | TY | **15** | **24** | **99** | | | | **10** | **0** | | | | **5** | **5** | | | |
| | 02/12 | TY | TY | **10** | **80** | **81** | | | | **0** | **-2** | | | | **5** | **5** | | | |
| | 02/18 | TY | TY | **21** | **76** | **45** | | | | **0** | **-2** | | | | **5** | **5** | | | |
| | 03/00 | TY | TY | **0** | **42** | | | | | **0** | | | | | **5** | | | | |
| | 03/06 | TY | TY | **0** | **45** | | | | | **0** | | | | | **5** | | | | |
| | 03/12 | STS | TY | **21** | **49** | | | | | **-2** | | | | | **5** | | | | |
| | 03/18 | STS | TY | **24** | **84** | | | | | **-11** | | | | | **10** | | | | |
| | 04/00 | TS | STS | **15** | | | | | | | | | | | | | | | |
| | 04/06 | TS | TS | **0** | | | | | | | | | | | | | | | |
| | 04/12 | TS | TS | **0** | | | | | | | | | | | | | | | |
| | 04/18 | TS | TS | **0** | | | | | | | | | | | | | | | |
| | 05/00 | TD | TD | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **11** | **119** | **251** | **385** | **626** | **1046** | **3** | **4** | **5** | **16** | **16** | **5** | **2** | **1** | **-12** | **-11** |
| **Valid: TS/STS/TY** | | | **sample** | **29** | **25** | **21** | **17** | **13** | **9** | **25** | **21** | **17** | **13** | **9** | **25** | **21** | **17** | **13** | **9** |
| *Initial: TD(before upg.)* | | | *mean* | *44* | *249* | *168* | *181* | *321* | *579* | *2* | *1* | *2* | *2* | *10* | *-2* | *-2* | *-2* | *-2* | *-10* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* | *6* |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | (UTC) | Grade Best | Prov. | Center Position (km) T=0‡ | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt)† T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Kirogi(2312)** | | | | | | | | | | | | |
| Aug. | 29/18 | TD | TD | 65 | 68 | 137 | 148 | 203 | 394 | 2 | 0 | -2 | -2 | -4 | -5 | 0 | 0 | 0 | 5 |
| | 30/00 | TD | TD | 0 | 78 | 107 | 190 | 207 | 597 | 2 | 0 | -4 | -4 | 0 | -5 | 0 | 5 | 5 | 0 |
| | 30/06 | TD | TD | 11 | 109 | 205 | 314 | 437 | | 4 | -6 | -4 | -2 | | -5 | 10 | 5 | 0 | |
| | 30/12 | TS | TS | 0 | 158 | 168 | 359 | | | 0 | -8 | -4 | | | 0 | 15 | 5 | | |
| | 30/18 | TS | TS | 0 | 134 | 181 | 269 | | | -2 | -8 | -4 | | | 5 | 15 | 5 | | |
| | 31/00 | TS | TS | 25 | 133 | 234 | | | | -4 | -8 | | | | 10 | 10 | | | |
| | 31/06 | TS | STS | 11 | 142 | 261 | | | | -8 | -4 | | | | 15 | 5 | | | |
| | 31/12 | TS | STS | 25 | 166 | 288 | | | | -6 | -2 | | | | 10 | 0 | | | |
| | 31/18 | TS | STS | 62 | 120 | 166 | | | | -4 | -2 | | | | 5 | 0 | | | |
| Sep. | 01/00 | TS | STS | 10 | 131 | | | | | -2 | | | | | 5 | | | | |
| | 01/06 | TS | STS | 0 | 155 | | | | | -2 | | | | | 0 | | | | |
| | 01/12 | TS | TS | 60 | 185 | | | | | -2 | | | | | 0 | | | | |
| | 01/18 | TS | TS | 63 | 67 | | | | | -2 | | | | | 0 | | | | |
| | 02/00 | TS | TS | 0 | | | | | | | | | | | | | | | |
| | 02/06 | TS | TS | 15 | | | | | | | | | | | | | | | |
| | 02/12 | TS | TS | 10 | | | | | | | | | | | | | | | |
| | 02/18 | TS | TS | 33 | | | | | | | | | | | | | | | |
| | 03/00 | TD | TS | | | | | | | | | | | | | | | | |
| | 03/06 | TD | TD | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | 22 | 139 | 216 | 314 | -- | -- | -3 | -5 | -4 | -- | -- | 5 | 8 | 5 | -- | -- |
| **Valid: TS/STS/TY** | | | **sample** | 14 | 10 | 6 | 2 | 0 | 0 | 10 | 6 | 2 | 0 | 0 | 10 | 6 | 2 | 0 | 0 |
| *Initial: TD(before upg.)* | | | *mean* | 26 | 85 | 149 | 217 | 282 | 495 | 3 | -2 | -3 | -3 | -2 | -5 | 3 | 3 | 2 | 3 |
| *Valid: TD/TS/STS/TY* | | | *sample* | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | (UTC) | Grade Best | Prov. | Center Position (km) T=0‡ | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt)† T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Yun-yeung(2313)** | | | | | | | | | | | | |
| Sep. | 04/06 | TD | TD | 86 | 204 | 334 | 637 | 861 | | -2 | -6 | -8 | -10 | | 5 | 5 | 10 | 10 | |
| | 04/12 | TD | TD | 79 | 207 | 213 | 551 | 849 | | 0 | -6 | -8 | -14 | | 0 | 5 | 10 | 15 | |
| | 04/18 | TD | TD | 79 | 185 | 295 | 574 | 672 | | 0 | -6 | -8 | -16 | | 0 | 5 | 10 | 15 | |
| | 05/00 | TD | TD | 39 | 181 | 399 | 686 | | | 0 | -6 | -8 | | | 0 | 5 | 10 | | |
| | 05/06 | TD | TD | 21 | 141 | 278 | 421 | | | 2 | -6 | -10 | | | -5 | 5 | 15 | | |
| | 05/12 | TS | TS | 78 | 166 | 307 | | | | 0 | -4 | | | | 0 | 5 | | | |
| | 05/18 | TS | TS | 129 | 83 | 150 | | | | 0 | -4 | | | | 0 | 5 | | | |
| | 06/00 | TS | TS | 10 | 124 | 210 | | | | 0 | -4 | | | | 0 | 5 | | | |
| | 06/06 | TS | TS | 15 | 145 | 356 | | | | -4 | -6 | | | | 5 | 10 | | | |
| | 06/12 | TS | TS | 33 | 130 | | | | | -4 | | | | | 5 | | | | |
| | 06/18 | TS | TS | 20 | 76 | | | | | -4 | | | | | 5 | | | | |
| | 07/00 | TS | TS | 10 | 93 | | | | | -4 | | | | | 5 | | | | |
| | 07/06 | TS | TS | 11 | 208 | | | | | -4 | | | | | 5 | | | | |
| | 07/12 | TS | TS | 53 | | | | | | | | | | | | | | | |
| | 07/18 | TS | TS | 28 | | | | | | | | | | | | | | | |
| | 08/00 | TS | TS | 44 | | | | | | | | | | | | | | | |
| | 08/06 | TS | TS | 56 | | | | | | | | | | | | | | | |
| | 08/12 | TD | TD | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | 41 | 128 | 256 | -- | -- | -- | -3 | -5 | -- | -- | -- | 3 | 6 | -- | -- | -- |
| **Valid: TS/STS/TY** | | | **sample** | 12 | 8 | 4 | 0 | 0 | 0 | 8 | 4 | 0 | 0 | 0 | 8 | 4 | 0 | 0 | 0 |
| *Initial: TD(before upg.)* | | | *mean* | 61 | 184 | 304 | 574 | 794 | -- | 0 | -6 | -8 | -13 | -- | 0 | 5 | 11 | 13 | -- |
| *Valid: TD/TS/STS/TY* | | | *sample* | 5 | 5 | 5 | 5 | 3 | 0 | 5 | 5 | 5 | 3 | 0 | 5 | 5 | 5 | 3 | 0 |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | | Grade | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt)† | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | Best | Prov. | T=0‡ | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| | | | | | | | **Koinu(2314)** | | | | | | | | | | | | |
| Sep. | 29/06 | TD | TD | *0* | *92* | *211* | *310* | *300* | *114* | *0* | *6* | *39* | *50* | *40* | *0* | *-15* | *-40* | *-45* | *-35* |
| | 29/12 | TD | TD | *0* | *109* | *272* | *310* | *179* | *174* | *2* | *9* | *40* | *45* | *40* | *-5* | *-15* | *-40* | *-40* | *-35* |
| | 29/18 | TS | TS | 25 | 140 | 290 | 308 | 186 | 196 | 4 | 15 | 45 | 30 | 35 | -5 | -20 | -40 | -30 | -30 |
| | 30/00 | TS | TS | 76 | 149 | 256 | 245 | 126 | 76 | 0 | 15 | 25 | 0 | -10 | -5 | -20 | -20 | -5 | 0 |
| | 30/06 | TS | TS | 22 | 131 | 158 | 63 | 57 | 31 | 0 | 25 | 20 | 10 | -25 | -5 | -25 | -15 | -5 | 15 |
| | 30/12 | TS | TS | 0 | 86 | 105 | 57 | 30 | 15 | 0 | 25 | 20 | 10 | -20 | -5 | -25 | -15 | -5 | 10 |
| | 30/18 | TS | TS | 0 | 55 | 83 | 88 | 56 | 83 | 5 | 30 | 0 | 10 | -25 | -10 | -25 | -5 | -5 | 15 |
| Oct. | 01/00 | STS | STS | 0 | 74 | 80 | 61 | 41 | 135 | 10 | 25 | 0 | -10 | -15 | -15 | -20 | 0 | 5 | 5 |
| | 01/06 | STS | STS | 0 | 97 | 84 | 85 | 173 | 346 | 15 | 10 | 10 | -20 | 10 | -15 | -5 | -5 | 10 | -10 |
| | 01/12 | STS | STS | 0 | 80 | 53 | 94 | 215 | 378 | 10 | 10 | 10 | -5 | 25 | -10 | -5 | -5 | 0 | -25 |
| | 01/18 | TY | TY | 0 | 52 | 22 | 84 | 187 | 357 | 10 | 0 | 15 | -10 | 30 | -10 | 0 | -10 | 0 | -35 |
| | 02/00 | TY | TY | 0 | 43 | 21 | 78 | 197 | 349 | 0 | 0 | 5 | 15 | 39 | 0 | 0 | -10 | -25 | -45 |
| | 02/06 | TY | TY | 0 | 11 | 11 | 81 | 144 | 305 | 0 | 10 | -5 | 30 | 39 | 0 | -5 | -5 | -35 | -45 |
| | 02/12 | TY | TY | 0 | 30 | 56 | 54 | 115 | 153 | 0 | 15 | -5 | 30 | 40 | 0 | -10 | -5 | -35 | -45 |
| | 02/18 | TY | TY | 0 | 45 | 78 | 137 | 234 | 188 | 0 | 20 | -5 | 43 | 36 | 0 | -15 | -5 | -45 | -45 |
| | 03/00 | TY | TY | 0 | 47 | 108 | 122 | 225 | 199 | 5 | 10 | 10 | 45 | 33 | -5 | -15 | -20 | -50 | -40 |
| | 03/06 | TY | TY | 0 | 15 | 123 | 157 | 296 | 302 | 15 | -5 | 20 | 45 | 33 | -10 | -5 | -25 | -50 | -40 |
| | 03/12 | TY | TY | 0 | 25 | 69 | 184 | 249 | 257 | 15 | 5 | 32 | 40 | 28 | -10 | -10 | -30 | -45 | -35 |
| | 03/18 | TY | TY | 0 | 43 | 106 | 244 | 249 | 286 | 15 | 5 | 39 | 30 | 16 | -10 | -10 | -40 | -40 | -25 |
| | 04/00 | TY | TY | 0 | 38 | 136 | 258 | 258 | | 10 | 20 | 43 | 33 | | -10 | -25 | -45 | -40 | |
| | 04/06 | TY | TY | 0 | 38 | 174 | 265 | 269 | | 0 | 30 | 43 | 33 | | -5 | -30 | -45 | -40 | |
| | 04/12 | TY | TY | 11 | 66 | 151 | 204 | 216 | | 0 | 30 | 38 | 28 | | -5 | -30 | -40 | -35 | |
| | 04/18 | TY | TY | 0 | 83 | 189 | 189 | 215 | | -5 | 37 | 30 | 16 | | 0 | -40 | -40 | -25 | |
| | 05/00 | TY | TY | 0 | 91 | 175 | 170 | | | 15 | 39 | 31 | | | -15 | -40 | -40 | | |
| | 05/06 | TY | TY | 0 | 99 | 160 | 100 | | | 25 | 39 | 33 | | | -20 | -40 | -40 | | |
| | 05/12 | TY | TY | 0 | 80 | 103 | 61 | | | 25 | 34 | 26 | | | -20 | -35 | -35 | | |
| | 05/18 | TY | TY | 0 | 98 | 84 | 43 | | | 35 | 28 | 14 | | | -30 | -35 | -25 | | |
| | 06/00 | TY | TY | 0 | 91 | 70 | 43 | | | 30 | 23 | 10 | | | -25 | -25 | -15 | | |
| | 06/06 | TY | TY | 0 | 46 | 15 | | | | 20 | 15 | | | | -15 | -10 | | | |
| | 06/12 | TY | TY | 0 | 24 | 68 | | | | 15 | 10 | | | | -10 | -5 | | | |
| | 06/18 | TY | TY | 0 | 22 | 88 | | | | 0 | -2 | | | | 0 | 5 | | | |
| | 07/00 | TY | TY | 0 | 56 | 103 | | | | -5 | -13 | | | | 5 | 20 | | | |
| | 07/06 | TY | TY | 0 | 57 | | | | | -5 | | | | | 5 | | | | |
| | 07/12 | TY | TY | 11 | 56 | | | | | -10 | | | | | 10 | | | | |
| | 07/18 | TY | TY | 11 | 39 | | | | | -7 | | | | | 10 | | | | |
| | 08/00 | TY | TY | 15 | 53 | | | | | -6 | | | | | 10 | | | | |
| | 08/06 | TY | TY | 0 | | | | | | | | | | | | | | | |
| | 08/12 | TY | TY | 0 | | | | | | | | | | | | | | | |
| | 08/18 | STS | STS | 0 | | | | | | | | | | | | | | | |
| | 09/00 | TS | TS | 10 | | | | | | | | | | | | | | | |
| | 09/06 | TD | TS | | | | | | | | | | | | | | | | |
| | 09/12 | TD | TD | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | 5 | 64 | 107 | 134 | 178 | 215 | 7 | 17 | 19 | 19 | 16 | -7 | -17 | -22 | -24 | -22 |
| **Valid: TS/STS/TY** | | | **sample** | 38 | 34 | 30 | 26 | 21 | 17 | 34 | 30 | 26 | 21 | 17 | 34 | 30 | 26 | 21 | 17 |
| *Initial: TD(before upg.)* | | | *mean* | *0* | *100* | *242* | *310* | *239* | *144* | *1* | *8* | *40* | *48* | *40* | *-3* | *-15* | *-40* | *-43* | *-35* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* | *2* |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | | Grade | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt)† | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | Best | Prov. | T=0‡ | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| | | | | | | | **Bolaven(2315)** | | | | | | | | | | | | |
| Oct. | 06/12 | TD | TD | 11 | 101 | 230 | 240 | 341 | 220 | 2 | 2 | 0 | 10 | 65 | 0 | -5 | -5 | -15 | -45 |
| | 06/18 | TD | TD | 35 | 67 | 109 | 144 | 187 | 148 | 2 | 6 | 0 | 15 | 50 | 0 | -10 | -5 | -15 | -35 |
| | 07/00 | TD | TD | 16 | 25 | 11 | 167 | 201 | 300 | 0 | 2 | -5 | 20 | 35 | 5 | -5 | 0 | -20 | -25 |
| | 07/06 | TD | TS | 49 | 25 | 35 | 181 | 192 | 330 | -4 | -15 | -20 | 30 | 30 | 5 | 10 | 10 | -20 | -20 |
| | 07/12 | TS | TS | 0 | 55 | 88 | 186 | 140 | 269 | -6 | -25 | -20 | 35 | 30 | 10 | 20 | 10 | -25 | -20 |
| | 07/18 | TS | TS | 0 | 40 | 90 | 128 | 111 | 397 | -2 | -20 | -5 | 35 | 15 | 5 | 15 | 0 | -25 | -10 |
| | 08/00 | TS | TS | 11 | 49 | 104 | 67 | 143 | 548 | 0 | -15 | 15 | 35 | 10 | 0 | 10 | -15 | -25 | -5 |
| | 08/06 | TS | TS | 44 | 64 | 123 | 59 | 123 | 544 | -5 | -20 | 30 | 30 | -10 | 5 | 10 | -20 | -20 | 5 |
| | 08/12 | TS | TS | 35 | 64 | 89 | 70 | 176 | 689 | -5 | -10 | 35 | 20 | -10 | 5 | 5 | -20 | -15 | 10 |
| | 08/18 | STS | STS | 25 | 43 | 58 | 33 | 132 | 613 | -10 | 0 | 35 | 5 | -10 | 10 | 0 | -20 | -5 | 10 |
| | 09/00 | STS | STS | 11 | 73 | 31 | 24 | 204 | 749 | -15 | 5 | 20 | -5 | -15 | 10 | -10 | -15 | 0 | 10 |
| | 09/06 | STS | STS | 11 | 48 | 11 | 70 | 349 | 963 | -10 | 30 | 20 | -15 | -15 | 5 | -20 | -15 | 5 | 15 |
| | 09/12 | STS | STS | 11 | 24 | 44 | 98 | 495 | | -5 | 35 | 20 | -15 | | 0 | -25 | -15 | 10 | |
| | 09/18 | STS | STS | 25 | 54 | 53 | 128 | 535 | | 0 | 30 | 5 | -20 | | -5 | -20 | -5 | 10 | |
| | 10/00 | TY | TY | 0 | 68 | 43 | 232 | 690 | | 15 | 30 | 0 | -15 | | -15 | -20 | 0 | 10 | |
| | 10/06 | TY | TY | 11 | 15 | 74 | 305 | 871 | | 40 | 20 | -10 | -5 | | -25 | -15 | 5 | 10 | |
| | 10/12 | TY | TY | 0 | 15 | 84 | 427 | | | 35 | 20 | -10 | | | -25 | -15 | 10 | | |
| | 10/18 | TY | TY | 0 | 11 | 113 | 444 | | | 20 | 5 | -20 | | | -15 | -5 | 10 | | |
| | 11/00 | TY | TY | 11 | 11 | 172 | 581 | | | 10 | -5 | -15 | | | -10 | 0 | 10 | | |
| | 11/06 | TY | TY | 11 | 33 | 209 | 634 | | | 0 | -15 | -5 | | | -5 | 5 | 10 | | |
| | 11/12 | TY | TY | 0 | 38 | 280 | | | | -5 | -15 | | | | 0 | 10 | | | |
| | 11/18 | TY | TY | 0 | 55 | 343 | | | | -15 | -20 | | | | 5 | 10 | | | |
| | 12/00 | TY | TY | 0 | 129 | 516 | | | | -20 | -25 | | | | 10 | 15 | | | |
| | 12/06 | TY | TY | 0 | 118 | 445 | | | | -20 | -15 | | | | 10 | 15 | | | |
| | 12/12 | TY | TY | 15 | 147 | | | | | -25 | | | | | 15 | | | | |
| | 12/18 | TY | TY | 10 | 188 | | | | | -25 | | | | | 15 | | | | |
| | 13/00 | TY | TY | 11 | 230 | | | | | -25 | | | | | 15 | | | | |
| | 13/06 | TY | TY | 10 | 177 | | | | | -5 | | | | | 10 | | | | |
| | 13/12 | TY | TY | 31 | | | | | | | | | | | | | | | |
| | 13/18 | TY | TY | 44 | | | | | | | | | | | | | | | |
| | 14/00 | TY | TY | 35 | | | | | | | | | | | | | | | |
| | 14/06 | TY | TY | 24 | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | 14 | 73 | 148 | 218 | 331 | 597 | -3 | -1 | 6 | 7 | -1 | 1 | -1 | -4 | -6 | 2 |
| **Valid: TS/STS/TY** | | | **sample** | 28 | 24 | 20 | 16 | 12 | 8 | 24 | 20 | 16 | 12 | 8 | 24 | 20 | 16 | 12 | 8 |
| *Initial: TD(before upg.)* | | | *mean* | 28 | 54 | 96 | 183 | 230 | 249 | 0 | -1 | -6 | 19 | 45 | 3 | -3 | 0 | -18 | -31 |
| *Valid: TD/TS/STS/TY* | | | *sample* | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | | Grade | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt)† | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | Best | Prov. | T=0‡ | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| | | | | | | | | | **Sanba(2316)** | | | | | | | | | | |
| Oct. | 17/06 | TD | TD | *0* | *25* | *152* | *269* | | | *-2* | *-4* | *-6* | | | *0* | *5* | *5* | | |
| | 17/12 | TD | TD | *11* | *46* | *222* | | | | *-2* | *-2* | | | | *0* | *0* | | | |
| | 17/18 | TD | TD | *0* | *34* | *198* | | | | *-2* | *-2* | | | | *0* | *5* | | | |
| | 18/00 | TS | TD | **11** | **43** | | | | | **0** | | | | | **0** | | | | |
| | 18/06 | TS | TS | **25** | **74** | | | | | **-2** | | | | | **5** | | | | |
| | 18/12 | TS | TS | **22** | **144** | | | | | **-2** | | | | | **5** | | | | |
| | 18/18 | TS | TS | **79** | **130** | | | | | **-4** | | | | | **10** | | | | |
| | 19/00 | TS | TS | **39** | | | | | | | | | | | | | | | |
| | 19/06 | TS | TS | **64** | | | | | | | | | | | | | | | |
| | 19/12 | TS | TS | **11** | | | | | | | | | | | | | | | |
| | 19/18 | TS | TS | **0** | | | | | | | | | | | | | | | |
| | 20/00 | TD | TS | | | | | | | | | | | | | | | | |
| | 20/06 | TD | TS | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **31** | **98** | **--** | **--** | **--** | **--** | **-2** | **--** | **--** | **--** | **--** | **5** | **--** | **--** | **--** | **--** |
| **Valid: TS/STS/TY** | | | **sample** | **8** | **4** | **0** | **0** | **0** | **0** | **4** | **0** | **0** | **0** | **0** | **4** | **0** | **0** | **0** | **0** |
| *Initial: TD(before upg.)* | | | *mean* | *4* | *35* | *190* | *269* | *--* | *--* | *-2* | *-3* | *-6* | *--* | *--* | *0* | *3* | *5* | *--* | *--* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *3* | *3* | *3* | *1* | *0* | *0* | *3* | *3* | *1* | *0* | *0* | *3* | *3* | *1* | *0* | *0* |

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

| Date/Time | | Grade | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt)† | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | Best | Prov. | T=0‡ | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| | | | | | | | | | **Jelawat(2317)** | | | | | | | | | | |
| Dec. | 16/00 | TD | TD | *35* | *129* | *180* | | | | *-4* | *-6* | | | | *5* | *5* | | | |
| | 16/06 | TD | TD | *11* | *145* | *228* | | | | *-2* | *-4* | | | | *0* | *5* | | | |
| | 16/12 | TD | TD | *63* | *80* | | | | | *2* | | | | | *0* | | | | |
| | 16/18 | TD | TD | *102* | *135* | | | | | *0* | | | | | *0* | | | | |
| | 17/00 | TD | TS | *149* | *214* | | | | | *-6* | | | | | *5* | | | | |
| | 17/06 | TS | TS | **66** | | | | | | | | | | | | | | | |
| | 17/12 | TS | TS | **55** | | | | | | | | | | | | | | | |
| | 17/18 | TS | TS | **47** | | | | | | | | | | | | | | | |
| | 18/00 | TD | TD | | | | | | | | | | | | | | | | |
| **Initial: TS/STS/TY** | | | **mean** | **56** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** | **--** |
| **Valid: TS/STS/TY** | | | **sample** | **3** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| *Initial: TD(before upg.)* | | | *mean* | *72* | *141* | *204* | *--* | *--* | *--* | *-2* | *-5* | *--* | *--* | *--* | *2* | *5* | *--* | *--* | *--* |
| *Valid: TD/TS/STS/TY* | | | *sample* | *5* | *5* | *2* | *0* | *0* | *0* | *5* | *2* | *0* | *0* | *0* | *5* | *2* | *0* | *0* | *0* |

†Max. wind for TDs are treated as 30 kt in this validation

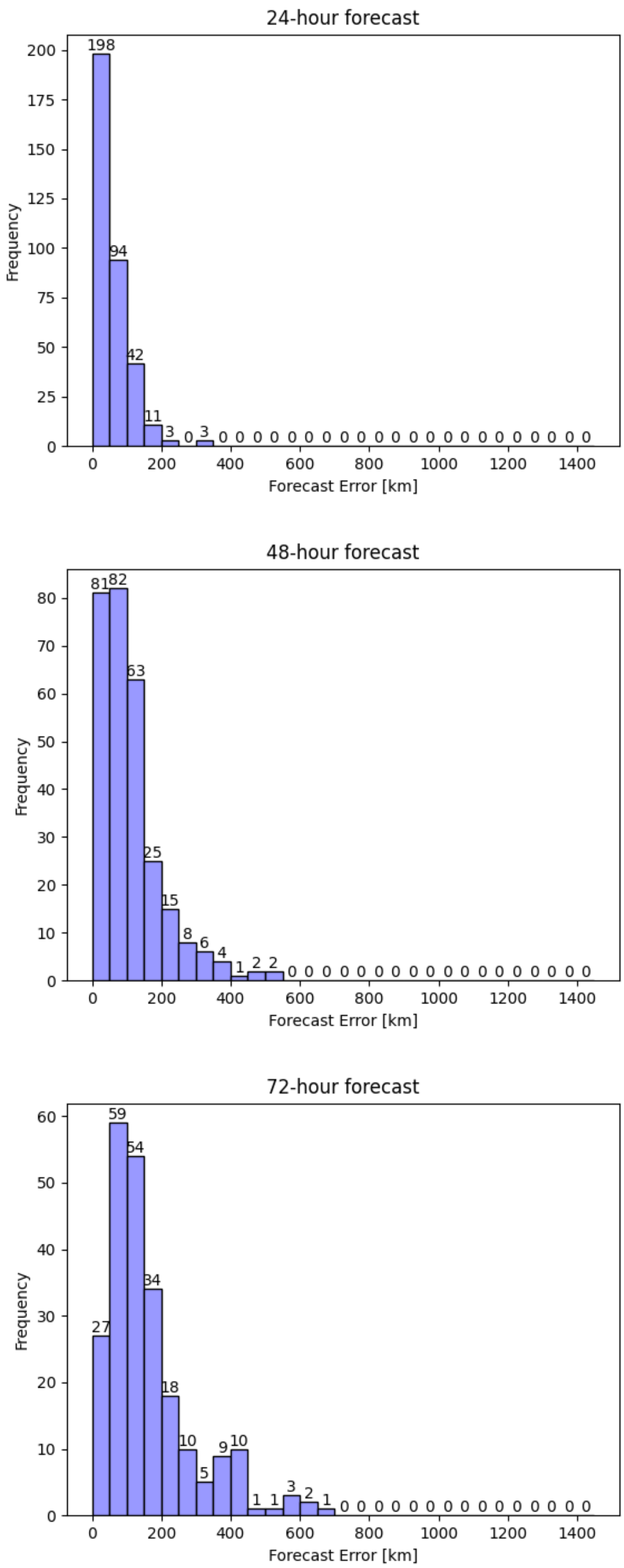
‡Position error of provisional analysis

# Appendix 4
# Monthly and Annual Frequencies of Tropical Cyclones

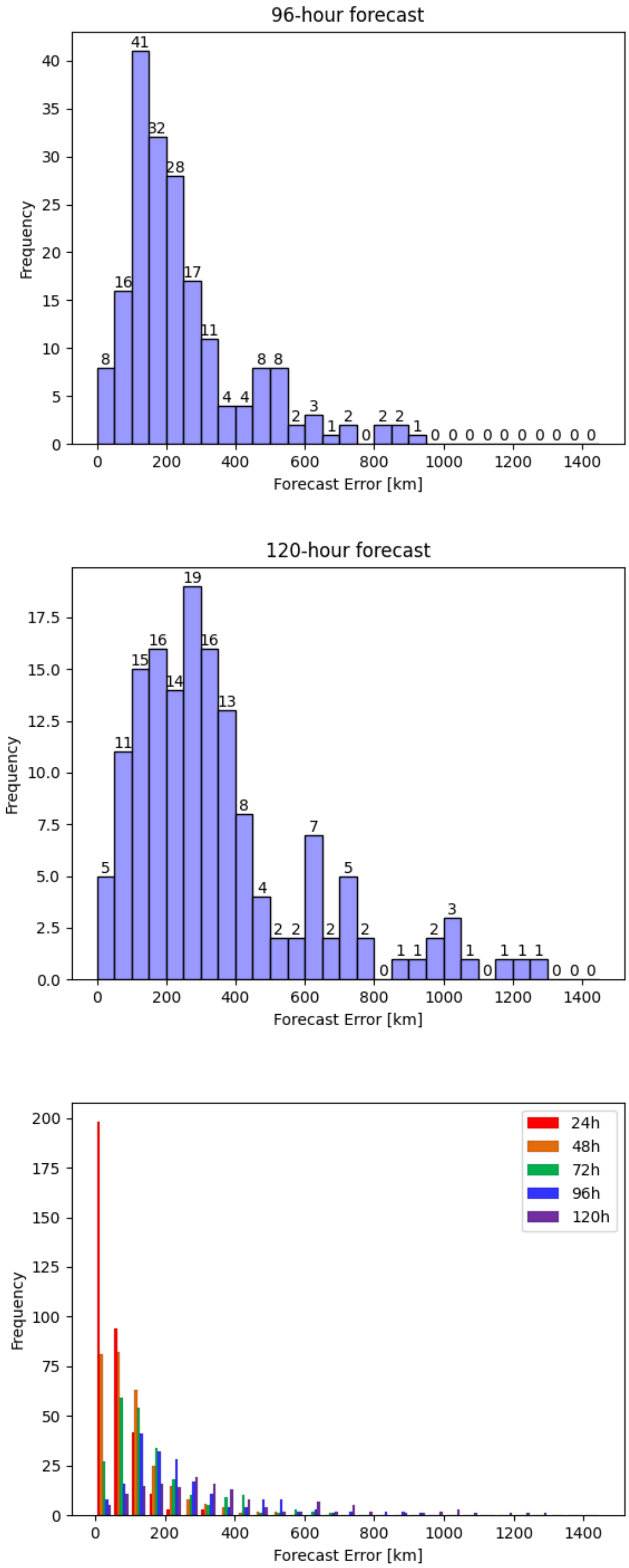
Monthly and annual frequencies of tropical cyclones that attained TS intensity or higher in the western North Pacific and the South China Sea for 1951 - 2023

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1951 | | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 2 | 4 | 1 | 2 | 21 |
| 1952 | | | | | | 3 | 3 | 5 | 3 | 6 | 3 | 4 | 27 |
| 1953 | | 1 | | | 1 | 2 | 1 | 6 | 3 | 5 | 3 | 1 | 23 |
| 1954 | | | 1 | | 1 | | 1 | 5 | 5 | 4 | 3 | 1 | 21 |
| 1955 | 1 | 1 | 1 | 1 | | 2 | 7 | 6 | 4 | 3 | 1 | 1 | 28 |
| 1956 | | | 1 | 2 | | 1 | 2 | 5 | 6 | 1 | 4 | 1 | 23 |
| 1957 | 2 | | | 1 | 1 | 1 | 1 | 4 | 5 | 4 | 3 | | 22 |
| 1958 | 1 | | | 1 | 1 | 4 | 7 | 5 | 5 | 3 | 2 | 2 | 31 |
| 1959 | | 1 | 1 | 1 | | | 2 | 5 | 5 | 4 | 2 | 2 | 23 |
| 1960 | | | | 1 | 1 | 3 | 3 | 10 | 3 | 4 | 1 | 1 | 27 |
| 1961 | 1 | | 1 | | 2 | 3 | 4 | 6 | 6 | 4 | 1 | 1 | 29 |
| 1962 | | 1 | | 1 | 2 | | 5 | 8 | 4 | 5 | 3 | 1 | 30 |
| 1963 | | | | 1 | | 4 | 4 | 3 | 5 | 4 | | 3 | 24 |
| 1964 | | | | | 2 | 2 | 7 | 5 | 6 | 5 | 6 | 1 | 34 |
| 1965 | 2 | 1 | 1 | 1 | 2 | 3 | 5 | 6 | 7 | 2 | 2 | | 32 |
| 1966 | | | | 1 | 2 | 1 | 4 | 10 | 9 | 5 | 2 | 1 | 35 |
| 1967 | | 1 | 2 | 1 | 1 | 1 | 7 | 9 | 9 | 4 | 3 | 1 | 39 |
| 1968 | | | | 1 | 1 | 1 | 3 | 8 | 3 | 5 | 5 | | 27 |
| 1969 | 1 | | 1 | 1 | | | 3 | 4 | 3 | 3 | 2 | 1 | 19 |
| 1970 | | 1 | | | | 2 | 3 | 6 | 5 | 5 | 4 | | 26 |
| 1971 | 1 | | 1 | 3 | 4 | 2 | 8 | 5 | 6 | 4 | 2 | | 36 |
| 1972 | 1 | | | | 1 | 3 | 7 | 5 | 4 | 5 | 3 | 2 | 31 |
| 1973 | | | | | | | 7 | 5 | 2 | 4 | 3 | | 21 |
| 1974 | 1 | | 1 | 1 | 1 | 4 | 4 | 5 | 5 | 4 | 4 | 2 | 32 |
| 1975 | 1 | | | | | | 2 | 4 | 5 | 5 | 3 | 1 | 21 |
| 1976 | 1 | 1 | | 2 | 2 | 2 | 4 | 4 | 5 | 1 | 1 | 2 | 25 |
| 1977 | | | 1 | | | 1 | 3 | 3 | 5 | 5 | 1 | 2 | 21 |
| 1978 | 1 | | | 1 | | 3 | 4 | 8 | 5 | 4 | 4 | | 30 |
| 1979 | 1 | | 1 | 1 | 2 | | 4 | 2 | 6 | 3 | 2 | 2 | 24 |
| 1980 | | | | 1 | 4 | 1 | 4 | 2 | 6 | 4 | 1 | 1 | 24 |
| 1981 | | | 1 | 2 | | 3 | 4 | 8 | 4 | 2 | 3 | 2 | 29 |
| 1982 | | | 3 | | 1 | 3 | 3 | 5 | 5 | 3 | 1 | 1 | 25 |
| 1983 | | | | | | 1 | 3 | 5 | 2 | 5 | 5 | 2 | 23 |
| 1984 | | | | | | 2 | 5 | 5 | 4 | 7 | 3 | 1 | 27 |
| 1985 | 2 | | | | 1 | 3 | 1 | 8 | 5 | 4 | 1 | 2 | 27 |
| 1986 | | 1 | | 1 | 2 | 2 | 4 | 4 | 3 | 5 | 4 | 3 | 29 |
| 1987 | 1 | | | 1 | | 2 | 4 | 4 | 6 | 2 | 2 | 1 | 23 |
| 1988 | 1 | | | | 1 | 3 | 2 | 8 | 8 | 5 | 2 | 1 | 31 |
| 1989 | 1 | | | 1 | 2 | 2 | 7 | 5 | 6 | 4 | 3 | 1 | 32 |
| 1990 | 1 | | | 1 | 1 | 3 | 4 | 6 | 4 | 4 | 4 | 1 | 29 |
| 1991 | | | 2 | 1 | 1 | 1 | 4 | 5 | 6 | 3 | 6 | | 29 |
| 1992 | 1 | 1 | | | | 2 | 4 | 8 | 5 | 7 | 3 | | 31 |
| 1993 | | | 1 | | | 1 | 4 | 7 | 6 | 4 | 2 | 3 | 28 |
| 1994 | | | | 1 | 1 | 2 | 7 | 9 | 8 | 6 | | 2 | 36 |
| 1995 | | | | 1 | | 1 | 2 | 6 | 5 | 6 | 1 | 1 | 23 |
| 1996 | | 1 | | 1 | 2 | | 6 | 5 | 6 | 2 | 2 | 1 | 26 |
| 1997 | | | | 2 | 3 | 3 | 4 | 6 | 4 | 3 | 2 | 1 | 28 |
| 1998 | | | | | | | 1 | 3 | 5 | 2 | 3 | 2 | 16 |
| 1999 | | | | 2 | | 1 | 4 | 6 | 6 | 2 | 1 | | 22 |
| 2000 | | | | | 2 | | 5 | 6 | 5 | 2 | 2 | 1 | 23 |
| 2001 | | | | | 1 | 2 | 5 | 6 | 5 | 3 | 1 | 3 | 26 |
| 2002 | 1 | 1 | | | 1 | 3 | 5 | 6 | 4 | 2 | 2 | 1 | 26 |
| 2003 | 1 | | | 1 | 2 | 2 | 2 | 5 | 3 | 3 | 2 | | 21 |
| 2004 | | | | 1 | 2 | 5 | 2 | 8 | 3 | 3 | 3 | 2 | 29 |
| 2005 | 1 | | 1 | 1 | 1 | | 5 | 5 | 5 | 2 | 2 | | 23 |
| 2006 | | | | | 1 | 2 | 2 | 7 | 3 | 4 | 2 | 2 | 23 |
| 2007 | | | | 1 | 1 | | 3 | 4 | 5 | 6 | 4 | | 24 |
| 2008 | | | | 1 | 4 | 1 | 2 | 4 | 4 | 2 | 3 | 1 | 22 |
| 2009 | | | | | 2 | 2 | 2 | 5 | 7 | 3 | 1 | | 22 |
| 2010 | | | 1 | | | | 2 | 5 | 4 | 2 | | | 14 |
| 2011 | | | | | 2 | 3 | 4 | 3 | 7 | 1 | | 1 | 21 |
| 2012 | | | 1 | | 1 | 4 | 4 | 5 | 3 | 5 | 1 | 1 | 25 |
| 2013 | 1 | 1 | | | | 4 | 3 | 6 | 8 | 6 | 2 | | 31 |
| 2014 | 2 | 1 | | 2 | | 2 | 5 | 1 | 5 | 2 | 1 | 2 | 23 |
| 2015 | 1 | 1 | 2 | 1 | 2 | 2 | 3 | 4 | 5 | 4 | 1 | 1 | 27 |
| 2016 | | | | | | | 4 | 7 | 7 | 4 | 3 | 1 | 26 |
| 2017 | | | | 1 | | 1 | 8 | 6 | 3 | 3 | 3 | 2 | 27 |
| 2018 | 1 | 1 | 1 | | | 4 | 5 | 9 | 4 | 1 | 3 | | 29 |
| 2019 | 1 | 1 | | | | 1 | 4 | 5 | 6 | 4 | 6 | 1 | 29 |
| 2020 | | | | | 1 | 1 | | 8 | 3 | 6 | 3 | 1 | 23 |
| 2021 | | 1 | | 1 | 1 | 2 | 3 | 4 | 4 | 4 | 1 | 1 | 22 |
| 2022 | | | | 2 | | 2 | 2 | 5 | 7 | 5 | 1 | 1 | 25 |
| 2023 | | | | 1 | 1 | 1 | 3 | 6 | 2 | 2 | | 1 | 17 |
| Normal 1991-2020 | 0.3 | 0.3 | 0.3 | 0.6 | 1.0 | 1.7 | 3.7 | 5.7 | 5.0 | 3.4 | 2.2 | 1.0 | 25.1 |

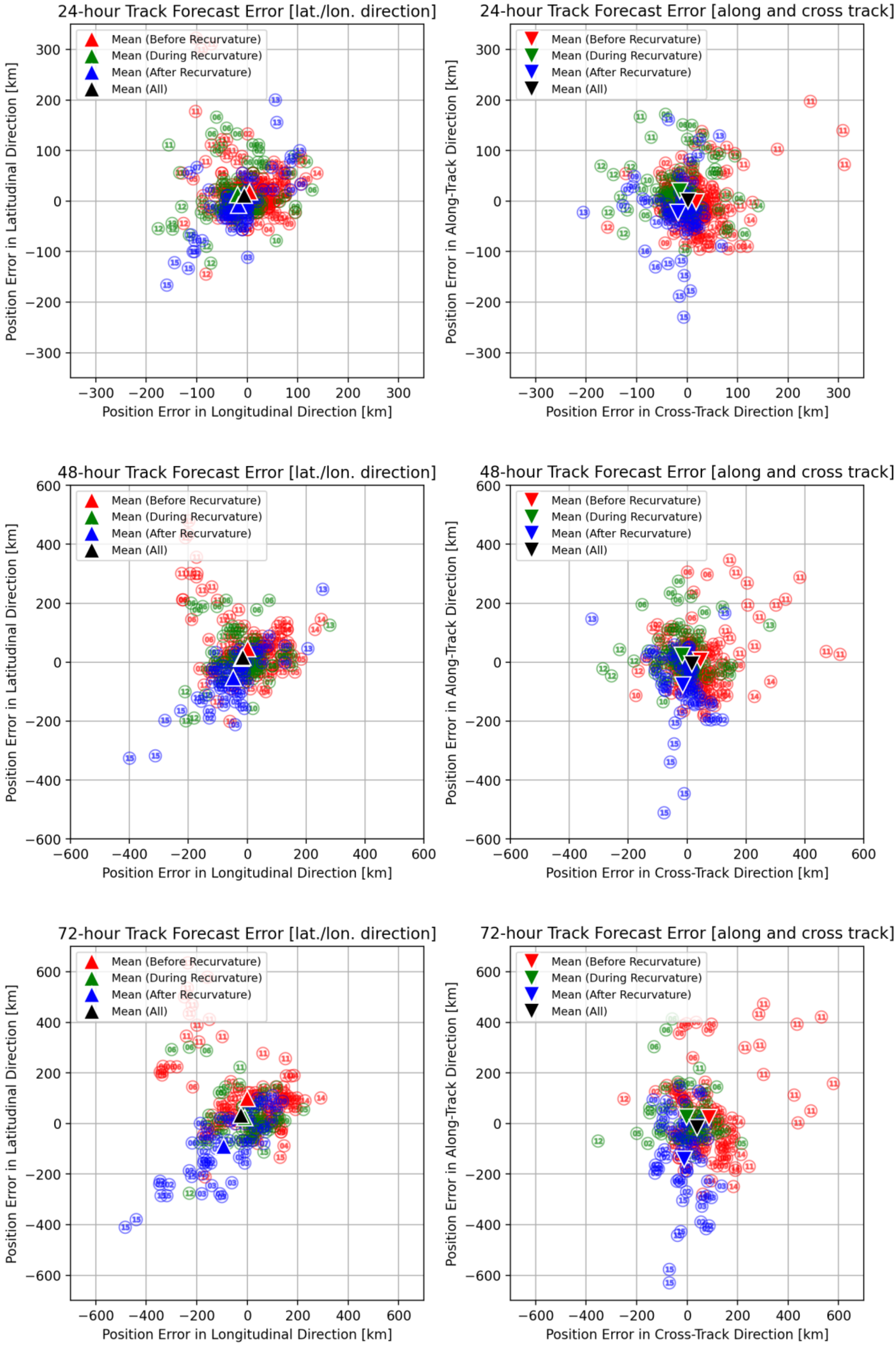
# Appendix 5
# Other Verification Charts



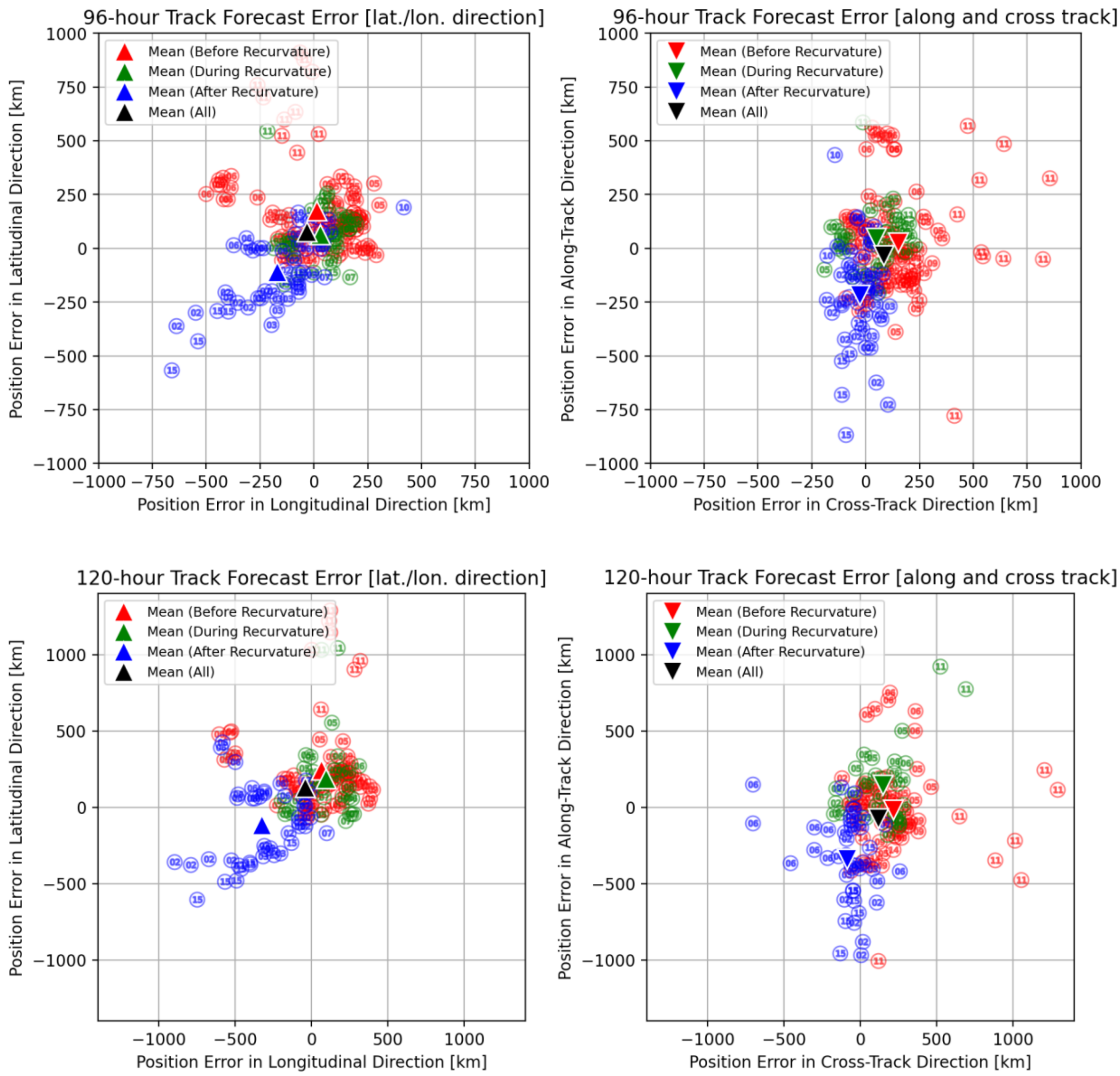

Histograms of RSMC 24-, 48- and 72 hour forecast position errors




Histograms of RSMC 96-hour, 120-hour and all lead time forecast position errors



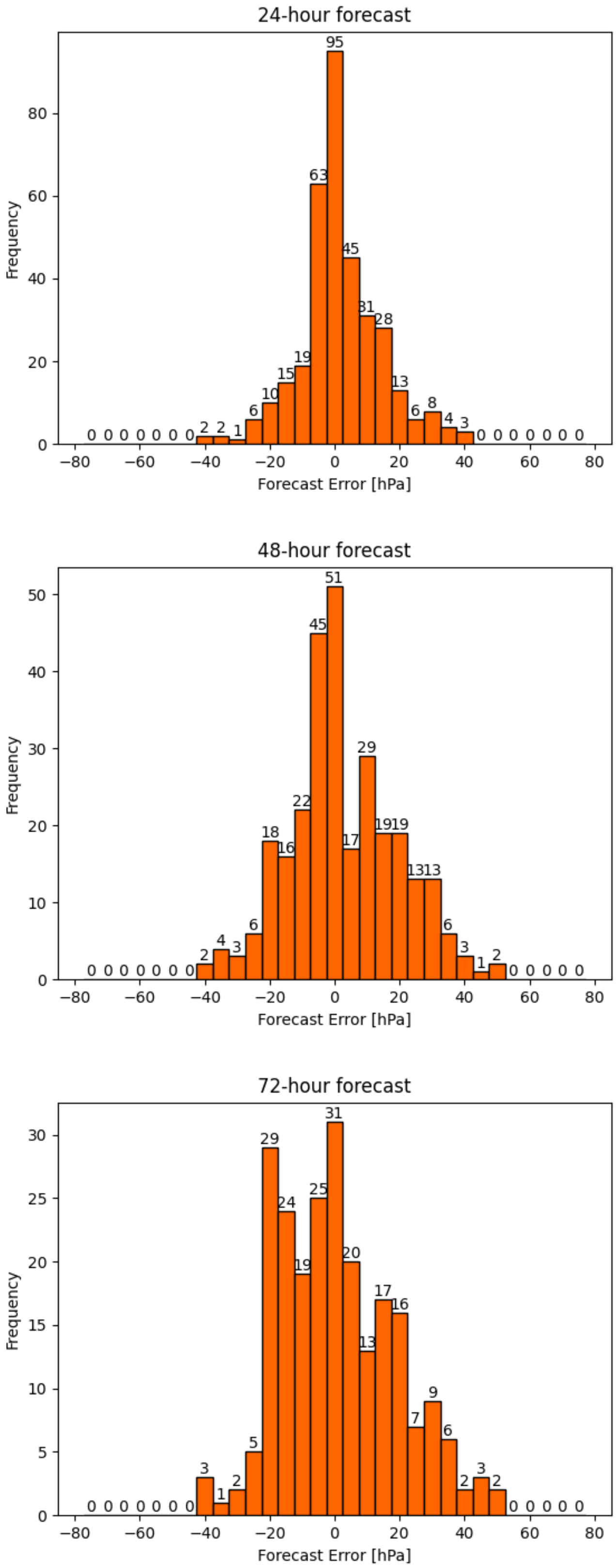

Scatter diagrams of RSMC position errors for 24-, 48- and 72-hour forecast in longitudinal/latitudinal and cross/along-track directions: Red, green and blue circles with TC number and triangles denote biases for each initial time and mean biases in the stages before, during and after recurvature, respectively. Black triangles indicate mean bias for all initial time.



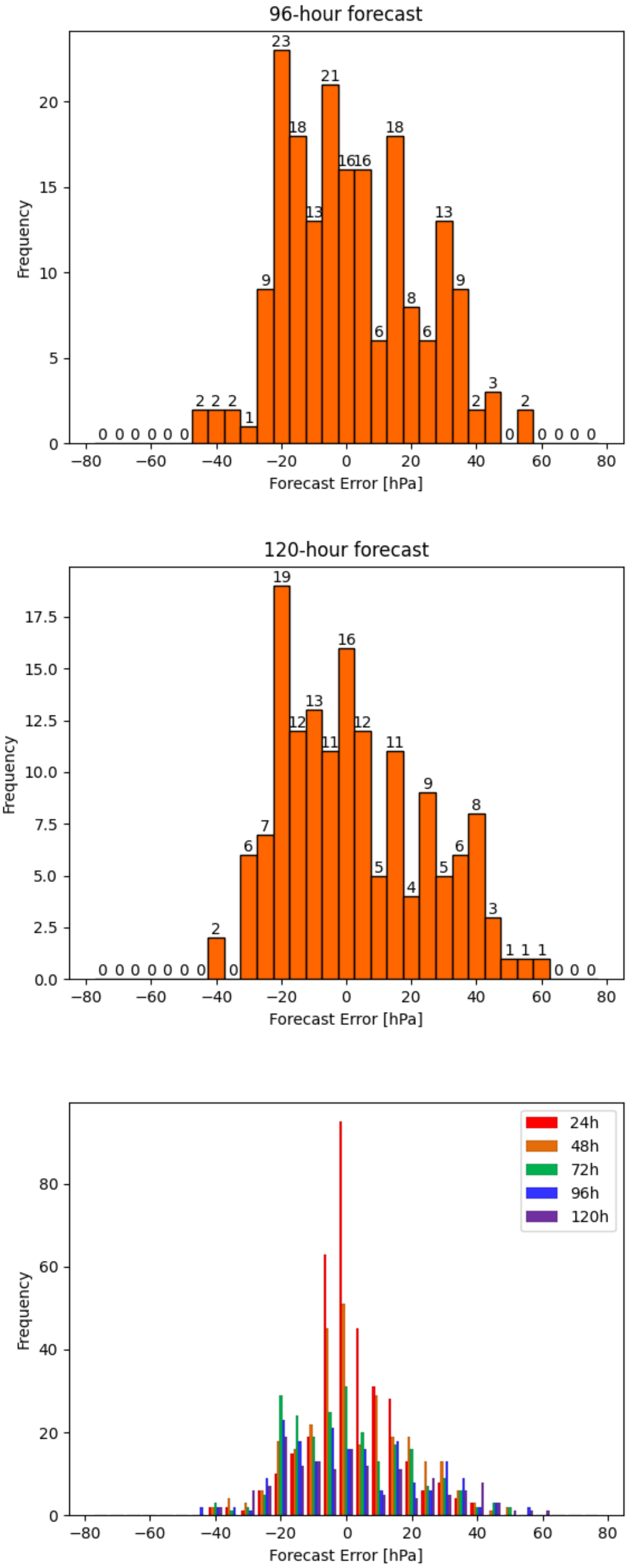

Scatter diagrams of RSMC position errors for 96- and 120-hour forecast in longitudinal/latitudinal and cross/along-track directions : Red, green and blue circles with TC number and triangles denote biases for each initial time and mean biases in the stages before, during and after recurvature, respectively. Black triangles indicate mean bias for all initial time.

Annual mean errors, RMSEs and mean improvement ratios of RSMC maximum wind speed forecasts

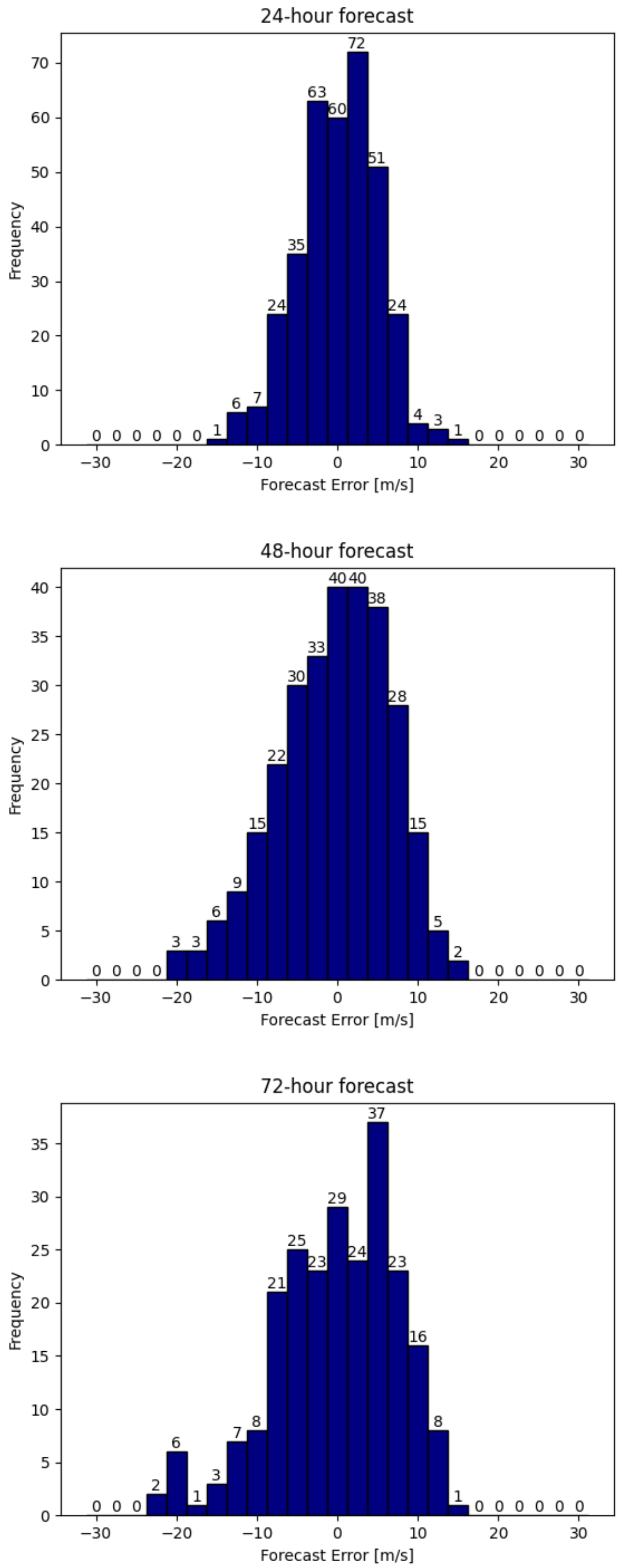
| Tropical Cyclone | | | 24-hour Forecast | | | | 48-hour Forecast | | | | 72-hour Forecast | | | | 96-hour Forecast | | | | 120-hour Forecast | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Error (m/s) | RMSE (m/s) | Num. | Impr. (%) | Error (m/s) | RMSE (m/s) | Num. | Impr. (%) | Error (m/s) | RMSE (m/s) | Num. | Impr. (%) | Error (m/s) | RMSE (m/s) | Num. | Impr. (%) | Error (m/s) | RMSE (m/s) | Num. | Impr. (%) |
| TS | Sanvu | (2301) | -1.3 | 1.8 | 2 | 76 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Mawar | (2302) | 0.3 | 6.2 | 50 | 6 | 0.6 | 8.1 | 46 | 19 | 1.9 | 7.2 | 42 | 40 | 2.6 | 7.1 | 38 | 47 | 2.7 | 7.4 | 34 | 49 |
| TY | Guchol | (2303) | -1.5 | 3.8 | 20 | 13 | -0.5 | 4.3 | 16 | 40 | 2.6 | 4.8 | 12 | 39 | 7.1 | 8.4 | 8 | -56 | 10.3 | 10.4 | 4 | -613 |
| STS | Talim | (2304) | 0.3 | 1.9 | 9 | 53 | 2.1 | 3.3 | 5 | 23 | 15.4 | 15.4 | 1 | -1011 | - | - | 0 | - | - | - | 0 | - |
| TY | Doksuri | (2305) | 0.6 | 4.3 | 28 | 39 | -0.4 | 5.6 | 24 | 43 | -0.5 | 4.9 | 20 | 61 | -3.2 | 7.0 | 16 | 49 | -1.5 | 5.9 | 12 | 47 |
| TY | Khanun | (2306) | 1.6 | 5.0 | 49 | -5 | 2.6 | 7.3 | 45 | 9 | 4.1 | 8.8 | 41 | 7 | 4.0 | 10.3 | 37 | -13 | 2.3 | 12.9 | 33 | -75 |
| TY | Lan | (2307) | -0.7 | 5.1 | 33 | -1 | -1.1 | 6.0 | 29 | 28 | -0.6 | 5.5 | 25 | 41 | 1.6 | 4.9 | 21 | 40 | 1.8 | 4.3 | 17 | 31 |
| TY | Dora | (2308) | 2.9 | 4.1 | 7 | 65 | 6.9 | 7.6 | 3 | 64 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Saola | (2309) | -1.4 | 5.6 | 34 | 31 | -0.9 | 6.5 | 30 | 49 | 1.1 | 6.6 | 26 | 54 | -0.7 | 8.9 | 22 | 47 | -5.7 | 12.1 | 18 | 40 |
| STS | Damrey | (2310) | -0.4 | 3.1 | 14 | 12 | -1.3 | 3.4 | 10 | 41 | -3.0 | 3.5 | 6 | 63 | -5.1 | 5.8 | 2 | 48 | - | - | 0 | - |
| TY | Haikui | (2311) | 2.6 | 5.3 | 25 | 13 | 1.2 | 5.3 | 21 | 31 | 0.3 | 5.4 | 17 | 25 | -5.9 | 7.1 | 13 | 4 | -5.4 | 7.5 | 9 | 1 |
| TS | Kirogi | (2312) | 2.6 | 3.6 | 10 | 45 | 3.9 | 5.0 | 6 | 68 | 2.6 | 2.6 | 2 | 88 | - | - | 0 | - | - | - | 0 | - |
| TS | Yun-yeung | (2313) | 1.6 | 2.0 | 8 | -6 | 3.2 | 3.4 | 4 | 32 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Koinu | (2314) | -3.5 | 6.0 | 34 | 10 | -8.7 | 11.4 | 30 | -10 | -11.5 | 13.9 | 26 | -15 | -12.2 | 15.8 | 21 | -30 | -11.3 | 16.1 | 17 | -41 |
| TY | Bolaven | (2315) | 0.6 | 6.0 | 24 | -2 | -0.4 | 7.2 | 20 | 26 | -2.3 | 6.6 | 16 | 43 | -3.0 | 8.1 | 12 | 35 | 1.0 | 6.0 | 8 | 37 |
| TS | Sanba | (2316) | 2.6 | 3.2 | 4 | -31 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Jelawat | (2317) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| Annual Mean (Total) | | | 0.1 | 5.1 | 351 | 17 | -0.4 | 7.2 | 289 | 26 | -0.2 | 7.9 | 234 | 30 | -0.6 | 9.2 | 190 | 22 | -0.8 | 10.4 | 152 | 14 |



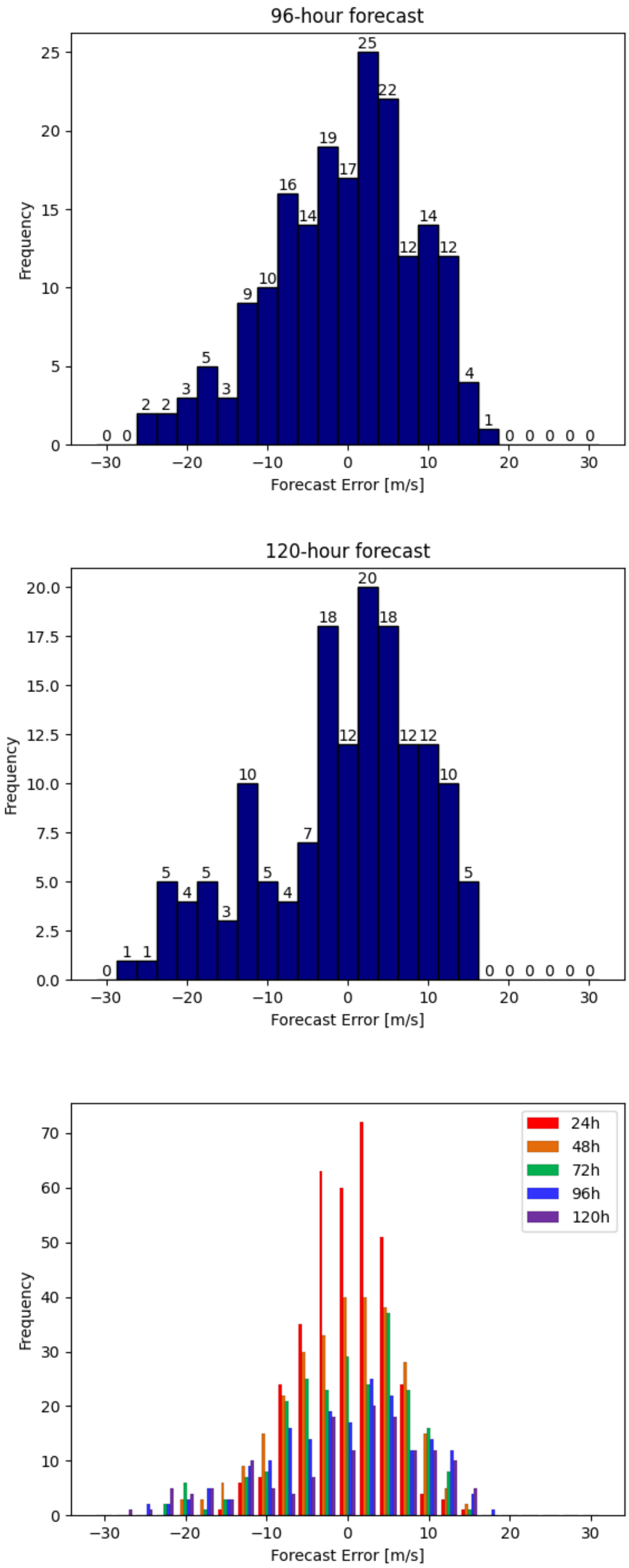

Histograms of RSMC 24-, 48- and 72-hour pressure forecast errors



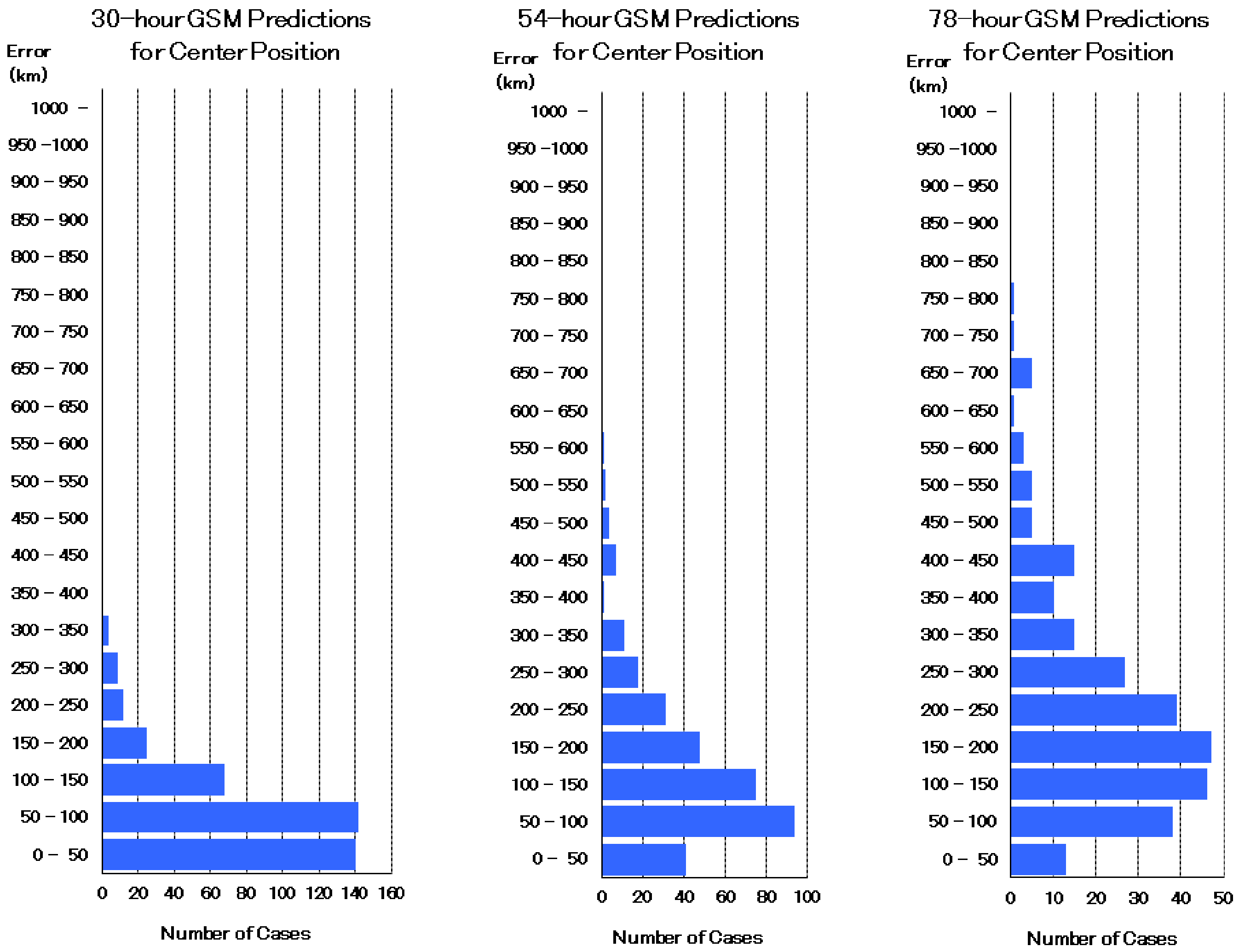

Histograms of RSMC 96-hour, 120-hour and all lead time pressure forecast errors



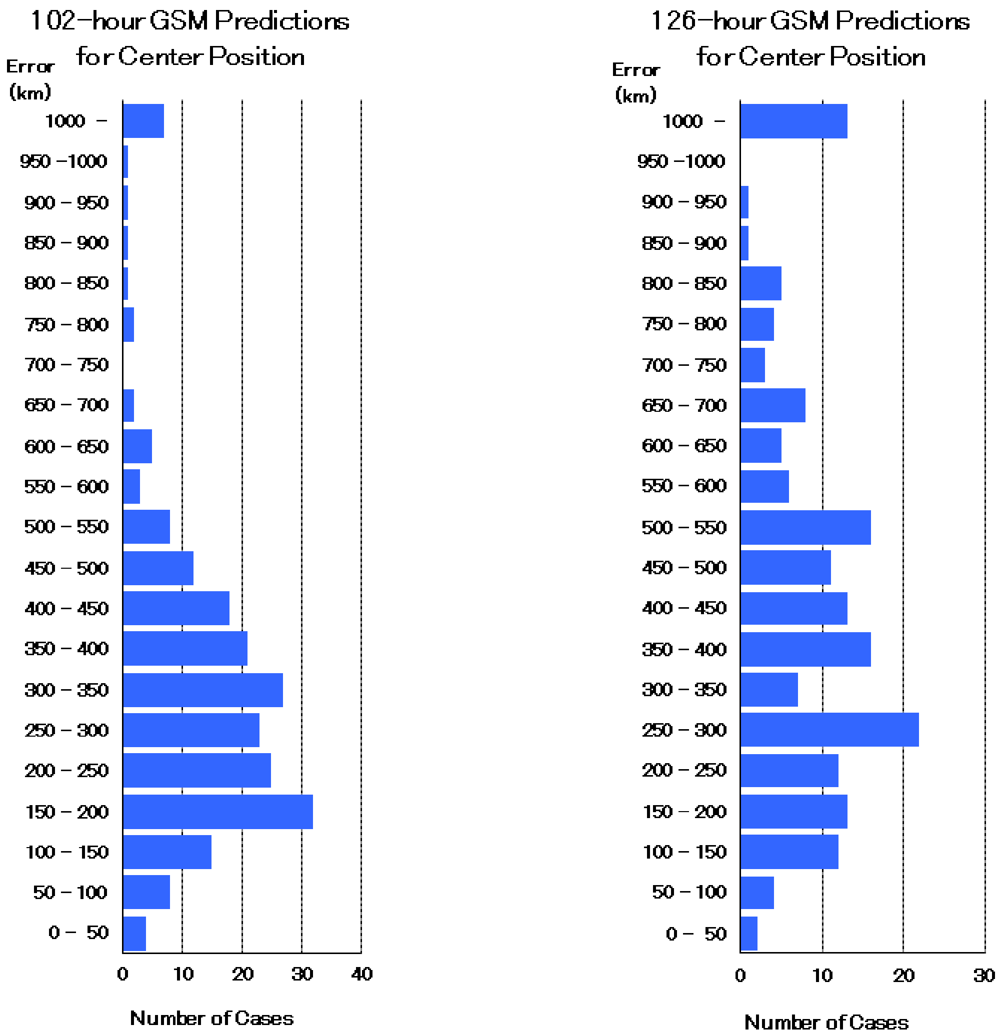

Histograms of RSMC 24-, 48- and 72-hour maximum wind speed forecast errors



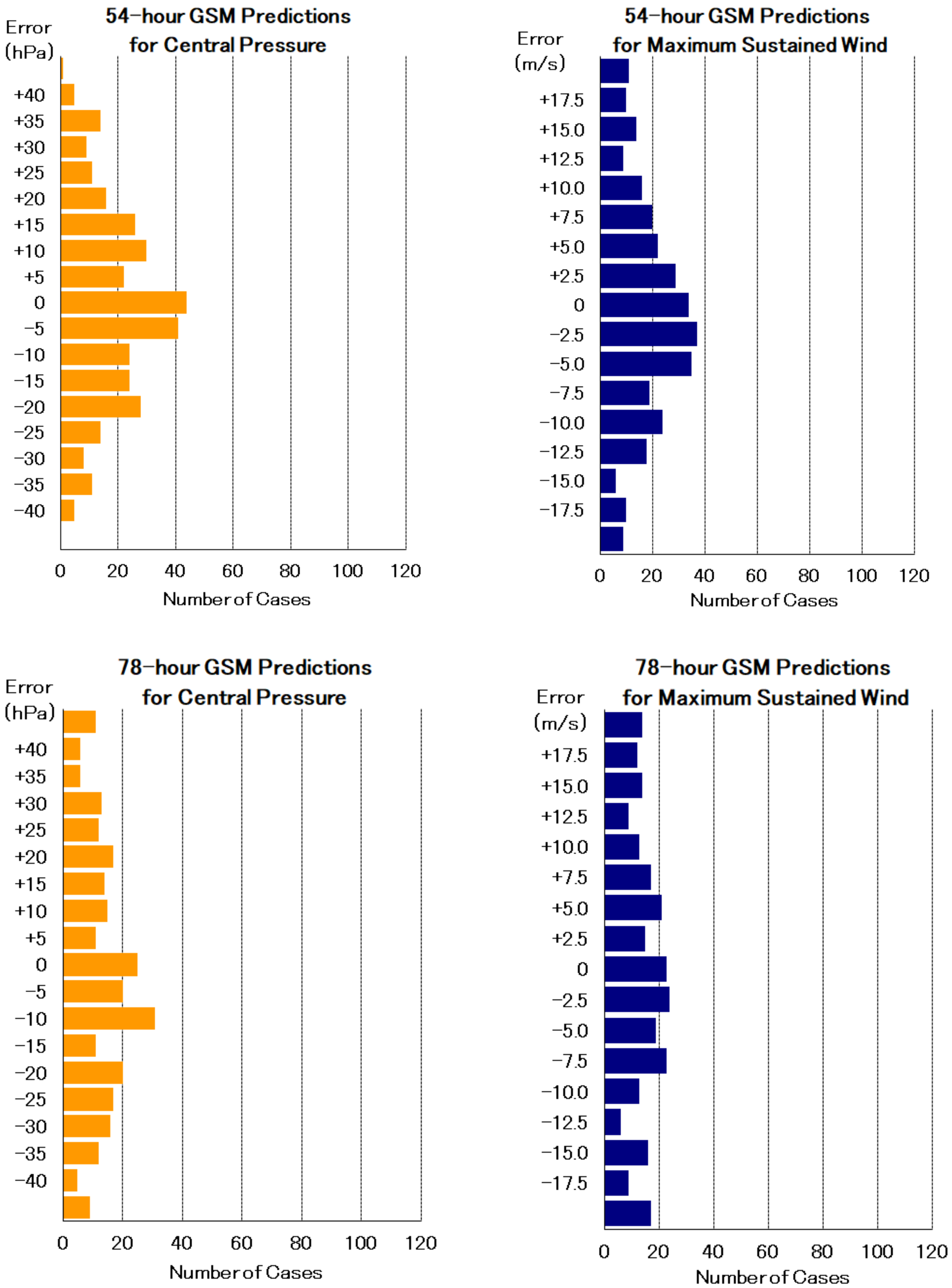

Histograms of RSMC 96-hour, 120-hour and all lead time maximum wind speed forecast errors



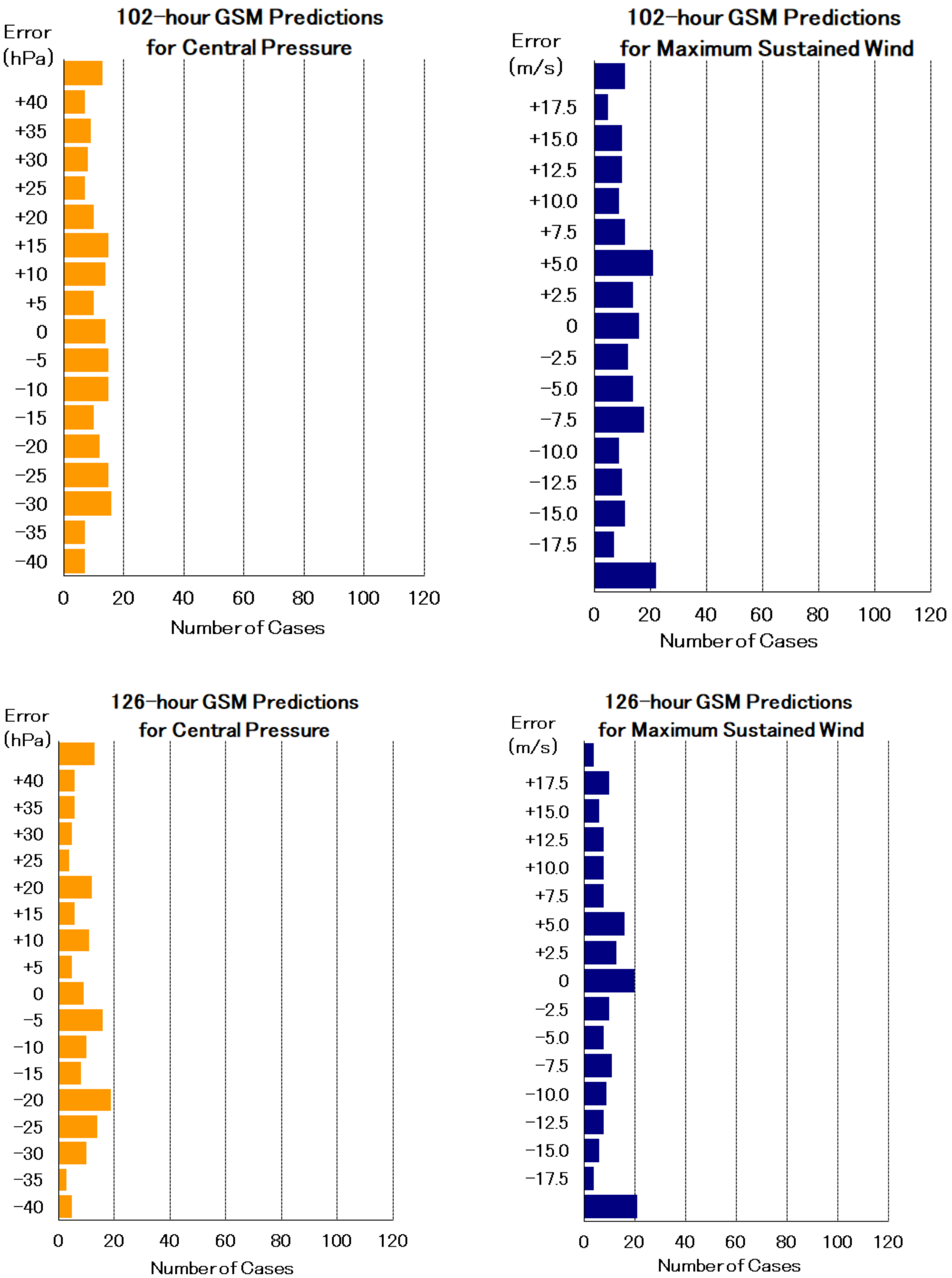

Histograms of GSM position errors for 30-, 54-, and 78-hour prediction




Histograms of GSM position errors for 102- and 126-hour prediction




Histograms of GSM intensity errors for (top) 54- and (bottom) 78-hour prediction




Histograms of GSM intensity errors for (top) 102- and (bottom) 126-hour prediction

# Appendix 6
# Code Forms of RSMC Products

## (1) RSMC Tropical Cyclone Advisory (WTPQ50-55 RJTD)

WTPQii RJTD YYGGgg
RSMC TROPICAL CYCLONE ADVISORY
NAME class ty-No. name (common-No.)
ANALYSIS
PSTN YYGGgg UTC LaLa.La N LoLoLo.Lo E (or W) confidence
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
50KT RdRdRd NM (or 50KT RdRdRd NM octant RdRdRd NM octant)
30KT RdRdRd NM (or 30KT RdRdRd NM octant RdRdRd NM octant)
FORECAST
24HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
Ft1Ft1HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
GUST VgVgVg KT
MXWD VmVmVm KT
Ft2Ft2HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
Ft3Ft3HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
Ft4Ft4Ft4HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT=

**Notes:**

a. Underlined parts are fixed.

b. Abbreviations

| | | |
|---|---|---|
| PSTN | : | Position |
| MOVE | : | Movement |
| PRES | : | Pressure |
| MXWD | : | Maximum wind |
| HF | : | Hour forecast |

c. Symbolic letters

| | | |
|---|---|---|
| i i | : | '20', '21', '22', '23', '24' or '25' |
| YYGGgg | : | Time of observation submitting the data for analysis in UTC |
| class | : | Intensity classification of the tropical cyclone 'TY', 'STS', 'TS' or 'TD' |
| ty-No. | : | Domestic identification number of the tropical cyclone adopted in Japan given in four digits (same as the |

| | | |
|---|---|---|
| | | international identification number) |
| name | : | Name assigned to the tropical cyclone from the name list prepared by the Typhoon Committee |
| common-No. | : | International identification number of the tropical cyclones given in four digits |
| LaLa.La | : | Latitude of the center position in "ANALYSIS" part |
| LoLoLo.Lo | : | Longitude of the center position in "ANALYSIS" part |
| confidence | : | Confidence of the center position. 'GOOD', 'FAIR' or 'POOR' |
| direction | : | Direction of movement given in 16 azimuthal direction such as 'N', 'NNE', 'NE' and 'ENE' |
| SpSpSp | : | Speed of movement |
| PPPP | : | Central pressure |
| VmVmVm | : | Maximum sustained wind |
| VgVgVg | : | Maximum gust wind |
| RdRdRd | : | Radii of 30knots and 50knots wind |
| octant | : | Eccentric distribution of wind given in 8 azimuthal direction such as 'NORTH', 'NORTHEAST' and 'EAST' |
| Ft1Ft1 | : | 48 (00, 06, 12 and 18 UTC) or 45 (03, 09, 15 and 21 UTC) |
| Ft2Ft2 | : | 72 (00, 06, 12 and 18 UTC) or 69 (03, 09, 15 and 21 UTC) |
| Ft3Ft3 | : | 96 (00, 06, 12 and 18 UTC) or 93 (03, 09, 15 and 21 UTC) |
| Ft4Ft4 Ft4 | : | 120 (00, 06, 12 and 18 UTC) or 117 (03, 09, 15 and 21 UTC) |
| YYGGgg$_F$ | : | Time in UTC on which the forecast is valid |
| LaLa.La$_F$ | : | Latitude of the center of 70% probability circle in "FORECAST" part |
| LoLoLo.Lo$_F$ | : | Longitude of the center of 70% probability circle in "FORECAST" part |
| FrFrFr | : | Radius of 70% probability circle |

d. MOVE is optionally described as 'ALMOST STATIONARY' or '(direction) SLOWLY', depending on the speed of movement.

**Example:**

```
WTPQ50 RJTD 080000
RSMC TROPICAL CYCLONE ADVISORY
NAME    TY 1919 HAGIBIS (1919)
ANALYSIS
PSTN    080000UTC 16.9N 143.8E GOOD
MOVE    WNW 13KT
PRES    915HPA
MXWD    105KT
GUST    150KT
50KT    100NM
30KT    350NM EAST 240NM WEST
FORECAST
24HF    090000UTC 19.8N 140.0E 60NM 70%
MOVE    NW 10KT
PRES    915HPA
MXWD    105KT
GUST    150KT
48HF    100000UTC 22.8N 138.4E 90NM 70%
MOVE    NNW 08KT
PRES    915HPA
MXWD    105KT
GUST    150KT
72HF    110000UTC 26.5N 136.3E 120NM 70%
MOVE    NNW 10KT
PRES    925HPA
MXWD    100KT
GUST    140KT
96HF    120000UTC 31.6N 135.9E 170NM 70%
MOVE    N 13KT
PRES    940HPA
MXWD    090KT
GUST    130KT
120HF 130000UTC 37.5N 142.5E 240NM 70%
MOVE    NE 20KT
PRES    980HPA
MXWD    060KT
GUST    085KT =
```

## (2) RSMC Guidance for Forecast by GSM (FXPQ20-25 RJTD)

FXPQ i i RJTD YYGGgg
RSMC GUIDANCE FOR FORECAST
NAME class ty-No. name (common-No.)
PSTN YYGGgg UTC LaLa.La N LoLoLo.Lo E (or W)
PRES PPPP HPA

MXWD WWW KT
FORECAST BY GLOBAL MODEL
TIME PSTN PRES MXWD
(CHANGE FROM T=0)
T=006 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=012 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=018 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
:
T=132 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT=

**Notes:**

a. Underlined parts are fixed.

b. Symbolic letters

| | | |
|---|---|---|
| i i | : | '20', '21', '22', '23', '24' or '25' |
| YYGGgg | : | Initial time of the model in UTC |
| class | : | Intensity classification of the tropical cyclone 'T', 'STS', 'TS' or 'TD' |
| PPPP | : | Central pressure in hPa |
| WWW | : | Maximum wind speed in knots |
| a | : | Sign of ppp and www ( +, - or blank ) |
| ppp | : | Absolute value of change in central pressure from T=0, in hPa |
| www | : | Absolute value of change in maximum wind speed from T=0, in knots |

**Example:**

```
FXPQ20 RJTD 180600
RSMC GUIDANCE FOR FORECAST
NAME TY 0001DAMREY (0001)
PSTN 180000UTC 15.2N 126.3E
PRES    905HPA
MXWD    105KT
FORECAST BY GLOBAL MODEL
TIME        PSTN        PRES        MXWD
                      (CHANGE FROM T=0)
T=006 15.4N 125.8E +018HPA -008KT
T=012 15.5N 125.6E +011HPA -011KT
T=018 15.8N 125.7E +027HPA -028KT
                   :
                   :
T=132 20.7N 128.8E +021HPA -022KT=
```

## (3) RSMC Guidance for Forecast by GEPS (FXPQ30-35 RJTD)

FXPQii RJTD YYGGgg
RSMC GUIDANCE FOR FORECAST
NAME class ty-No. name (common-No.)
PSTN YYGGgg UTC LaLa.La N LoLoLo.Lo E (or W)
PRES PPPP HPA
MXWD WWW KT
FORECAST BY GLOBAL ENSEMBLE PREDICTION SYSTEM
TIME PSTN PRES MXWD
(CHANGE FROM T=0)
T=006 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=012 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=018 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
:
T=132 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT=

**Notes:**

a. Underlined parts are fixed.

b. Symbolic letters

| | | |
|---|---|---|
| ii | : | '30', '31', '32', '33', '34' or '35' |
| YYGGgg | : | Initial time of the model in UTC |
| class | : | Intensity classification of the tropical cyclone 'T', 'STS', 'TS' or 'TD' |
| PPPP | : | Central pressure in hPa |
| WWW | : | Maximum wind speed in knots |
| a | : | Sign of ppp and www ( +, - or blank ) |
| ppp | : | Absolute value of change in central pressure from T=0, in hPa |
| www | : | Absolute value of change in maximum wind speed from T=0, in knots |

**Example:**

```
FXPQ30 RJTD 231200
RSMC GUIDANCE FOR FORECAST
NAME TY 1826 YUTU (1826)
PSTN 231200UTC 12.0N 149.6E
PRES    965HPA
MXWD    75KT
FORECAST BY GLOBAL ENSEMBLE PREDICTION SYSTEM
TIME        PSTN        PRES        MXWD
                        (CHANGE FROM T=0)
T=006 12.7N 149.1E -002HPA +001KT
T=012 13.2N 148.3E -001HPA +004KT
T=018 13.8N 147.6E -005HPA +004KT
                  :
                  :
T=132 18.0N 129.9E -033HPA +030KT=
```

## (4) RSMC Prognostic Reasoning (WTPQ30-35 RJTD)

**Example:**

WTPQ30 RJTD 231200
RSMC TROPICAL CYCLONE PROGNOSTIC REASONING
REASONING NO.10 FOR TY 1826 YUTU (1826)
1.GENERAL COMMENTS
TY YUTU IS LOCATED AT 12.0N, 149.6E. INFORMATION ON THE CURRENT POSITION IS BASED ON ANIMATED MSI. POSITIONAL ACCURACY IS GOOD. THE SYSTEM IS IN A FAVORABLE ENVIRONMENT FOR DEVELOPMENT UNDER THE INFLUENCE OF HIGH SSTS, HIGH TCHP AND WEAK VWS. THIS HAS CAUSED THE SYSTEM TO DEVELOP OVER THE LAST SIX HOURS. HOWEVER, THE INFLUENCE OF DRY AIR IS UNFAVORABLE FOR SYSTEM DEVELOPMENT. INFORMATION ON CURRENT INTENSITY IS BASED ON DVORAK INTENSITY ANALYSES.
2.SYNOPTIC SITUATION
THE SYSTEM IS MOVING WESTWARD ALONG THE SOUTHERN PERIPHERY OF A MID-LEVEL SUB-TROPICAL HIGH. ANIMATED MSI SHOWS THE APPEARANCE OF AN EYE. WATER VAPOR IMAGERY SHOWS DRY AIR IN THE DIRECTION OF THE MOVEMENT. DMSP-F18/SSMIS 89 GHZ MICROWAVE IMAGERY SHOWS THE SYSTEM HAS A BAND WITH CURVATURE INDICATING THE CSC.
3.TRACK FORECAST
THE SYSTEM WILL MOVE NORTHWESTWARD ALONG THE PERIPHERY OF A MID-LEVEL SUB-TROPICAL HIGH UNTIL FT12. THE SYSTEM WILL THEN MOVE WEST-NORTHWESTWARD ALONG THE PERIPHERY OF A MID-LEVEL SUB-TROPICAL HIGH UNTIL FT120. THE JMA TRACK FORECAST IS BASED ON GSM PREDICTIONS, AND REFERENCE TO OTHER NWP MODELS. JMA TRACK FORECAST CONFIDENCE IS FAIR UNTIL FT48 BUT LOW THEREAFTER DUE TO SIGNIFICANT DIFFERENCES AMONG NUMERICAL MODEL OUTPUTS.
4.INTENSITY FORECAST
THE SYSTEM WILL DEVELOP UNTIL FT48 DUE TO THE INFLUENCE OF INTERACTION WITH HIGH SSTS, HIGH TCHP, WEAK VWS AND GOOD UPPER LEVEL OUTFLOW. THE SYSTEM WILL THEN MAINTAIN ITS INTENSITY UNTIL FT72 DUE TO THE INFLUENCE OF INTERACTION WITH HIGH SSTS, HIGH TCHP AND DRY AIR. THE JMA INTENSITY FORECAST IS BASED ON GUIDANCE DATA. =

## (5) RSMC Tropical Cyclone Best Track (AXPQ20 RJTD)

```
AXPQ20 RJTD YYGGgg
RSMC TROPICAL CYCLONE BEST TRACK
NAME ty-No. name (common-No.)
PERIOD FROM MMMDDTTUTC TO MMMDDTTUTC
DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT    DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT
DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT    DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT
                         :
```

:

DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT    DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT
REMARKS[1)]
TD FORMATION    AT MMMDDTTUTC
FROM TD TO TS    AT MMMDDTTUTC
:
:
DISSIPATION    AT MMMDDTTUTC=

**Notes:**

a. Underlined parts are fixed.

b. [1)] REMARKS is given optionally.

c. Symbolic letters

| | | |
|---|---|---|
| MMM | : | Month in UTC given such as 'JAN' and 'FEB' |
| DD | : | Date in UTC |
| TT | : | Hour in UTC |
| PPP | : | Central pressure |
| WWW | : | Maximum wind speed |

**Example:**

AXPQ20 RJTD 020600

RSMC TROPICAL CYCLONE BEST TRACK
NAME 0001 DAMREY (0001)
PERIOD FROM OCT1300UTC TO OCT2618UTC
1300 10.8N 155.5E 1008HPA //KT    1306 10.9N 153.6E 1006HPA //KT
1312 11.1N 151.5E 1004HPA //KT    1318 11.5N 149.8E 1002HPA //KT
1400 11.9N 148.5E 1000HPA //KT    1406 12.0N 146.8E 998HPA 35KT
:
:
1712 14.6N 129.5E 905HPA 105KT    1718 14.7N 128.3E 905HPA 105KT
:
:
2612 32.6N 154.0E 1000HPA //KT    2618 33.8N 157.4E 1010HPA //KT
REMARKS
TD FORMATION AT OCT1300UTC
FROM TD TO TS AT OCT1406UTC
FROM TS TO STS AT OCT1512UTC
FROM STS TO TY AT OCT1600UTC
FROM TY TO STS AT OCT2100UTC
FROM STS TO TS AT OCT2112UTC
FROM TS TO L AT OCT2506UTC
DISSIPATION AT OCT2700UTC=

## (6) Tropical Cyclone Advisory for SIGMET (FKPQ30-35 RJTD)

FKPQ i i RJTD YYGGgg
TC ADVISORY

| | |
|---|---|
| DTG: | yyyymmdd/time Z |
| TCAC: | TOKYO |
| TC: | name |
| NR: | number |
| PSN: | N LaLa.LaLa E LoLoLo.LoLo |
| MOV: | direction SpSpSp KT |
| C: | PPPP HPA |
| MAX WIND: | WWW KT |
| FCST PSN +6HR: | YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo* |
| FCST MAX WIND +6HR: | WWW KT* |
| FCST PSN +12HR: | YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo |
| FCST MAX WIND +12HR: | WWW KT |
| FCST PSN +18HR: | YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo* |
| FCST MAX WIND +18HR: | YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo* |

| | |
|---|---|
| FCST PSN +24HR: | YY/GGgg Z N LaLa.LaLa E LoLoLo.LoLo |
| FCST MAX WIND +24HR: | WWW KT |
| RMK: | NIL = |
| NXT MSG: | yyyymmdd/time Z |

* 6 hour and 18 hour forecasts are added from 22 May 2008.

**Notes:**

a. Underlined parts are fixed.

b. Abbreviations

| | | |
|---|---|---|
| DTG | : | Date and time |
| TCAC | : | Tropical Cyclone Advisory Centre |
| TC | : | Tropical Cyclone |
| NR | : | Number |
| PSN | : | Position |
| MOV | : | Movement |
| C | : | Central pressure |
| MAX WIND | : | Maximum wind |
| FCST | : | Forecast |
| RMK | : | Remarks |
| NXT MSG | : | Next message |

c. Symbolic letters

| | | |
|---|---|---|
| i i | : | '30', '31', '32', '33', '34' or '35' |
| YYGGgg | : | Date(YY), hour(GG) and minute(gg) in UTC (Using “Z”) |
| yyyymmdd/time | : | Year(yyyy), month(mm), date(dd), hour and minute (time) in UTC (Using “Z”) |
| name | : | Name assigned to the tropical cyclone by RSMC Tokyo-Typhoon Center |
| Number | : | Advisory number (starting with “01” for each cyclone) |
| LaLa.LaLa | : | Latitude of the center position |
| LoLoLo.LoLo | : | Longitude of the center position |
| direction | : | Direction of movement given in 16 azimuthal direction such as 'N', 'NNE', 'NE' and 'ENE' |
| SpSpSp | : | Speed of movement. “SLW” for less than 3 kt “STNR” for less than 1 kt. |
| PPPP | : | Central pressure |
| WWW | : | Maximum sustained wind |

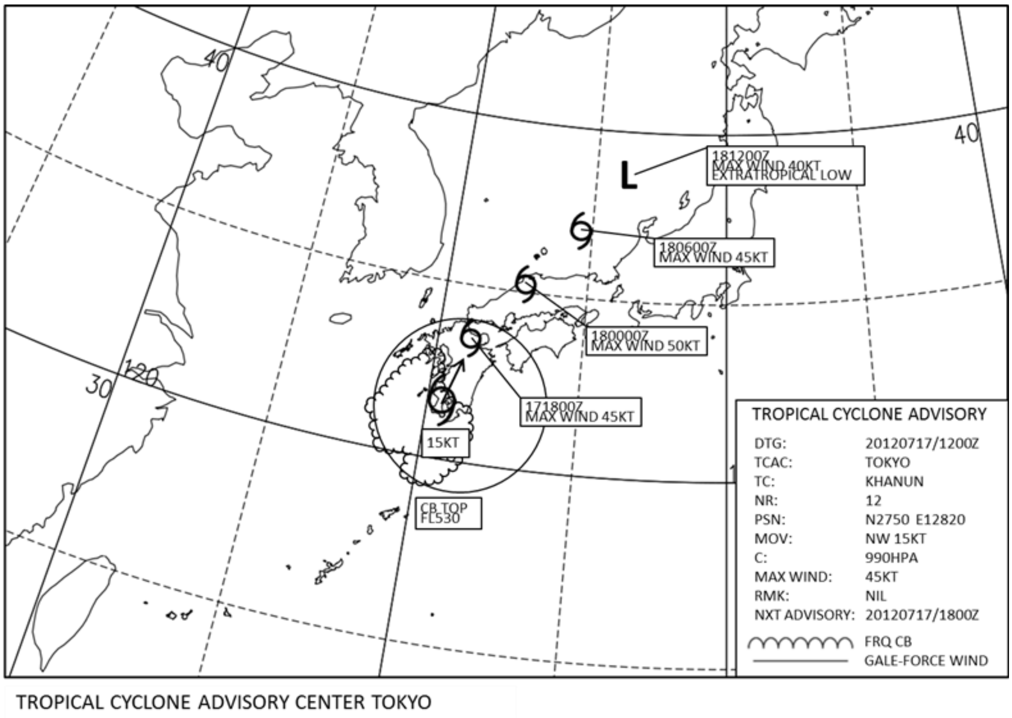
**Example:**

FKPQ30 RJTD 271200
TC ADVISORY

| | |
|---|---|
| DTG: | 20080927/1200Z |
| TCAC: | TOKYO |
| TC: | JANGMI |
| NR: | 15 |
| PSN: | N2120 E12425 |
| MOV: | NW 13KT |
| C: | 910HPA |
| MAX WIND: | 115KT |
| FCST PSN +6HR: | 27/1800Z N2200 E12330 |
| FCST MAX WIND +6HR: | 115KT |
| FCST PSN +12HR: | 28/0000Z N2240 E12250 |
| FCST MAX WIND +12HR: | 115KT |
| FCST PSN +18HR: | 28/0600Z N2340 E12205 |
| FCST MAX WIND +18HR: | 95KT |
| FCST PSN +24HR: | 28/1200Z N2440 E12105 |
| FCST MAX WIND +24HR: | 80KT |
| RMK: | NIL |
| NXT MSG: | 20080927/1800Z = |

### (7) Graphical Tropical Cyclone Advisory for SIGMET

**Example:**



# Appendix 7
# Specifications of JMA's NWP Models (GSM, GEPS)

The Global Spectral Model (GSM) and the Global Ensemble Prediction System (GEPS) are used in JMA as a primary basis for TC forecasts. The general specifications of GSM and GEPS are summarized in Table A7.1.

Table A7.1 Specifications of GSM and GEPS

| NWP Models | GSM (Global Spectral Model), TQ959L128 | GEPS (Global Ensemble Prediction System), TQ479L128 |
|---|---|---|
| Resolution | 13 km, 128 layers (Top: 0.01hPa) | 27 km, 128 layers (Top: 0.01hPa) |
| Area | Global | Global |
| Method for initial value | Global Data Assimilation System (Hybrid-4DVAR)<br>Outer resolution: TQ959L128<br>Inner resolution: TL319L128<br>Window: Init-3h to Init + 3h | Unperturbed condition: Truncated GSM initial condition<br>Initial perturbation: LETKF-based perturbation and SV-based perturbation<br>Ensemble size: 51 (50 perturbed members and 1 control member)<br>SV target areas: Northern Hemisphere (30 – 90°N), Tropics (30°S – 30°N), Southern Hemisphere (90 – 30°S) |
| Forecast length (initial times) | 264 hours (00, 12 UTC)<br>132 hours (06, 18 UTC) | 432 hours (12 UTC)<br>264 hours (00, UTC)<br>132 hours (06, 18 UTC) |
| Operational as from | 14 March 2023 | 14 March 2023 |

GSM (TQ959L128) has a horizontal resolution of approximately 13 km and 128 vertical layers. Details of the model can be found in JMA (2024) and Yonehara et al. (2023).

GEPS (TQ479L128) is an ensemble prediction system used for TC track forecasts up to five days ahead, one-week forecasts, early warning information on extreme weather, and one-month forecasts. It has 51 members and a horizontal resolution of approximately 27 km along with 128 vertical layers for the first 18 days of forecasts. Details of the system can be found in JMA (2024) and Ota et al. (2023). A combination of a Local Ensemble Transform Kalman Filter (LETKF; Hunt et al. 2007) and a singular vector (SV) method (Buizza and Palmer 1995) is employed for the initial perturbation setup. In addition, a stochastically perturbed physics tendency scheme (Buizza et al. 1999) is incorporated in consideration of model uncertainties associated with physical parameterizations, and a perturbation technique for sea surface temperature (SST) is incorporated to represent uncertainty in the prescribed SST.

[Recent upgrades to GSM, Global Data Assimilation System and GEPS]

GSM:

- Horizontal resolution enhancement from 20 to 13 km (March 2023)
- Replacement of the source data set for orographic ancillary files (March 2023)
- Revision of non-orographic gravity wave, boundary layer, orographic drag and radiation (March

2023)

- Improvement of lake surface process (March 2023)

Global Data Assimilation System:

- Enhancement of snow depth analysis (March 2023)
- Assimilation of Suomi-NPP, NOAA-20/VIIRS AMV was started (March 2023)
- Assimilation of AMV and CSR from GOES-18 was started (May 2023)
- Assimilation of AMV and CSR from Meteosat-10 switching from Meteosat-11 was started (May 2023)

GEPS:

- Incorporation of the latest GSM (March 2023)
- Enhancement of SST boundary conditions (March 2023)

[References]

Buizza, R., M. Miller, and T. N. Palmer, 1999: Stochastic representation of model uncertainties in the ECMWF Ensemble Prediction System. Quart. J. Roy. Meteor. Soc., 125, 2887–2908.

Buizza, R. and T. N. Palmer, 1995: The singular-vector structure of the atmospheric global circulation. J. Atmos. Sci., 52, 1434 – 1456.

Hunt, B. R., E. J. Kostelich and I. Szunyogh, 2007: Efficient data assimilation for spatiotemporal chaos: a local ensemble transform Kalman filter. Physica. D., 230, 112 – 126.

Japan Meteorological Agency, 2024: Outline of the Operational Numerical Weather Prediction at the Japan Meteorological Agency. Japan Meteorological Agency, Tokyo, Japan.

Ota, Y., J. Chiba, Y. Ichikawa, H. Oashi, T. Takakura and H. Yamaguchi, 2023: Upgrade of JMA's Global Ensemble Prediction System. WGNE Res. Activ. Earth system Modell., 53, 06.11-12.

Yonehara, H., Y. Kuroki, M. Ujiie, C. Matsukawa, T. Kanehama, R. Nagasawa, K. Ochi, M. Higuchi, Y. Ichikawa, R. Sekiguchi and S. Hirahara, 2023: Upgrade of JMA's Operational Global Numerical Weather Prediction System. WGNE Res. Activ. Earth system Modell., 53, 06.15-16.

# Appendix 8
# Products on WIS GISC Tokyo Server

(Available at https://www.wis-jma.go.jp/cms/)

## NWP products (GSM and GEPS with GRIB formatted data)

| Model | GSM | GSM | GSM |
|---|---|---|---|
| Area and resolution | Whole globe, 1.25°×1.25° | 20°S–60°N, 60°E–160°W<br>1.25°×1.25° | Whole globe, 2.5°×2.5° |
| Levels and elements | 10 hPa: Z, U, V, T<br>20 hPa: Z, U, V, T<br>30 hPa: Z, U, V, T<br>50 hPa: Z, U, V, T<br>70 hPa: Z, U, V, T<br>100 hPa: Z, U, V, T<br>150 hPa: Z, U, V, T<br>200 hPa: Z, U, V, T, ψ, χ<br>250 hPa: Z, U, V, T<br>300 hPa: Z, U, V, T, H, ω<br>400 hPa: Z, U, V, T, H, ω<br>500 hPa: Z, U, V, T, H, ω, ζ<br>600 hPa: Z, U, V, T, H, ω<br>700 hPa: Z, U, V, T, H, ω<br>850 hPa: Z, U, V, T, H, ω, ψ, χ<br>925 hPa: Z, U, V, T, H, ω<br>1000 hPa: Z, U, V, T, H, ω<br>Surface: P, U, V, T, H, R† | 10 hPa: Z, U, V, T<br>20 hPa: Z, U, V, T<br>30 hPa: Z, U, V, T<br>50 hPa: Z, U, V, T<br>70 hPa: Z, U, V, T<br>100 hPa: Z, U, V, T<br>150 hPa: Z, U, V, T<br>200 hPa: Z§, U§, V§, T§, ψ, χ<br>250 hPa: Z, U, V, T<br>300 hPa: Z, U, V, T, D<br>400 hPa: Z, U, V, T, D<br>500 hPa: Z§, U§, V§, T§, D§, ζ<br>700 hPa: Z§, U§, V§, T§, D§, ω<br>850 hPa: Z§, U§, V§, T§, D§, ω, ψ, χ<br>925 hPa: Z, U, V, T, D, ω<br>1000 hPa: Z, U, V, T, D<br>Surface: P¶, U¶, V¶, T¶, D¶, R¶ | 10 hPa: Z*, U*, V*, T*<br>20 hPa: Z*, U*, V*, T*<br>30 hPa: Z°, U°, V°, T°<br>50 hPa: Z°, U°, V°, T°<br>70 hPa: Z°, U°, V°, T°<br>100 hPa: Z°, U°, V°, T°<br>150 hPa: Z*, U*, V*, T*<br>200 hPa: Z, U, V, T<br>250 hPa: Z°, U°, V°, T°<br>300 hPa: Z, U, V, T, D*‡<br>400 hPa: Z*, U*, V*, T*, D*‡<br>500 hPa: Z, U, V, T, D*‡<br>700 hPa: Z, U, V, T, D<br>850 hPa: Z, U, V, T, D<br>1000 hPa: Z, U*, V*, T*, D*‡<br>Surface: P, U, V, T, D*‡, R† |
| Forecast hours | 0–84 every 6 hours and<br>96–192 every 12 hours<br>for 12UTC initial<br>† Except analysis | 0–84 (every 6 hours)<br>§ 96–192 (every 24 hours) for 12UTC initial<br>¶ 90–192 (every 6 hours) for 12UTC initial | 0–72 every 24 hours and<br>96–192 every 24 hours for 12UTC<br>° 0–120 for 12UTC<br>† Except analysis<br>* Analysis only |
| Initial times | 00, 06, 12, 18UTC | 00, 06, 12, 18UTC | 00UTC and 12UTC<br>‡ 00UTC only |

| Model | GEPS |
|---|---|
| Area and resolution | Whole globe, 2.5°×2.5° |
| Levels and elements | 250 hPa: μU, σU, μV, σV<br>500 hPa: μZ, σZ<br>850 hPa: μU, σU, μV, σV, μT, σT<br>1000 hPa: μZ, σZ<br>Surface: μP, σP |
| Forecast hours | 0–192 every 12 hours |
| Initial times | 00, 12UTC |

## NWP products (GSM and GEPS with GRIB2 formatted data)

| Model | GSM | GSM | GSM |
|---|---|---|---|
| Area and resolution | 5S-90N and 30E-165W,<br>Whole globe<br>0.25° × 0.25° | 5S-90N and 30E-165W,<br>Whole globe<br>0.5° × 0.5° | Whole globe<br>1.25° × 1.25° |
| Levels and elements | Surface: U, V, T, H, P, Ps, R, Cla, Clh, Clm, Cll | 10 hPa: Z, U, V, T, H, ω<br>20 hPa: Z, U, V, T, H, ω<br>30 hPa: Z, U, V, T, H, ω<br>50 hPa: Z, U, V, T, H, ω<br>70 hPa: Z, U, V, T, H, ω<br>100 hPa: Z, U, V, T, H, ω<br>150 hPa: Z, U, V, T, H, ω<br>200 hPa: Z, U, V, T, H, ω, ψ, χ<br>250 hPa: Z, U, V, T, H, ω<br>300 hPa: Z, U, V, T, H, ω<br>400 hPa: Z, U, V, T, H, ω<br>500 hPa: Z, U, V, T, H, ω, ζ<br>600 hPa: Z, U, V, T, H, ω<br>700 hPa: Z, U, V, T, H, ω<br>800 hPa: Z, U, V, T, H, ω<br>850 hPa: Z, U, V, T, H, ω, ψ, χ<br>900 hPa: Z, U, V, T, H, ω<br>925 hPa: Z, U, V, T, H, ω<br>950 hPa: Z, U, V, T, H, ω<br>975 hPa: Z, U, V, T, H, ω<br>1000 hPa: Z, U, V, T, H, ω<br>Surface: U, V, T, H, P, Ps, R, Cla, Clh, Clm, Cll | 10 hPa: Z, U, V, T<br>20 hPa: Z, U, V, T<br>30 hPa: Z, U, V, T<br>50 hPa: Z, U, V, T<br>70 hPa: Z, U, V, T<br>100 hPa: Z, U, V, T<br>150 hPa: Z, U, V, T<br>200 hPa: Z, U, V, T, ψ, χ<br>250 hPa: Z, U, V, T, ζ, ∇<br>300 hPa: Z, U, V, T, H, ω<br>400 hPa: Z, U, V, T, H, ω<br>500 hPa: Z, U, V, T, H, ω, ζ<br>600 hPa: Z, U, V, T, H, ω<br>700 hPa: Z, U, V, T, H, ω, ζ, ∇<br>850 hPa: Z, U, V, T, H, ω, ψ, χ<br>925 hPa: Z, U, V, T, H, ω, ζ, ∇<br>1000 hPa: Z, U, V, T, H, ω<br>Surface: P, U, V, T, H, R |
| Forecast hours | 0–132 (every 3 hours)<br>138–264 (every 6 hours) are available for 00 UTC and 12 UTC initial | 0–132 (every 3 hours)<br>138–264 (every 6 hours) are available for 00 UTC and 12 UTC initial | 0–132 (every 3 hours)<br>138–264 (every 6 hours) are available for 00 UTC and 12 UTC initial |
| Initial times | 00, 06, 12 and 18 UTC | 00, 06, 12 and 18 UTC | 00, 06, 12 and 18 UTC |

| Model | GEPS |
|---|---|
| Area and resolution | Whole globe, 1.25°×1.25° |
| Levels and elements | 250 hPa: μU, σU, μV, σV<br>500 hPa: μZ, σZ<br>850 hPa: μU, σU, μV, σV, μT, σT<br>1000 hPa: μZ, σZ<br>Surface: μP, σP<br>Probability of precipitation [1,5,10,25,50,100 mm/24hour],<br>Probability of 10m sustained wind and gusts[10,15,25 m/s],<br>Probability of temperature anomalies [±1, ±1.5, ±2σ] |
| Forecast hours | 0-264 every 12 hours |
| Initial times | 00UTC and 12UTC |

Notes:

| | | |
|---|---|---|
| Z: geopotential height | U: eastward wind | V: northward wind |
| T: temperature | D: dewpoint depression | H: relative humidity |
| ω: vertical velocity | ζ: vorticity | ψ: stream function |
| χ: velocity potential | ∇: divergence | P: sea level pressure |
| Ps: pressure | R: rainfall | Cla: total cloudiness |
| Clh: cloudiness (upper layer) | Clm: cloudiness (middle layer) | |
| Cll: cloudiness (lower layer) | | |

The prefixes μ and σ represent the average and standard deviation of ensemble prediction results respectively.
The symbols °, *, ¶, §, ‡ and † indicate limitations on forecast hours or initial time as shown in the tables.

## Other products

| Data | Contents / frequency (initial time) |
|---|---|
| Satellite products | High density atmospheric motion vectors (BUFR)<br>Himawari-8/9 (VIS, IR, WVx3: every hour), 60S-60N, 90E-170W<br>Clear Sky Radiance (CSR) data (BUFR)<br>Himawari-8/9 radiances and brightness temperatures<br>averaged over cloud-free pixels: every hour |
| Tropical cyclone Information | Tropical cyclone related information (BUFR)<br>• tropical cyclone analysis data (00, 06, 12 and 18 UTC) |
| Wave data | Global Wave Model (GRIB2)<br>• significant wave height<br>• prevailing wave period<br>• wave direction<br>Forecast hours:<br>0–84 every 6 hours (00, 06 and 18UTC)<br>0–84 every 6 hours and 96-192 every 12 hours (12 UTC) |
| Observational data | (a) Surface data (TAC/TDCF)<br>SYNOP, SHIP, BUOY: Mostly 4 times a day<br>(b) Upper-air data (TAC/TDCF)<br>TEMP (parts A-D), PILOT (parts A-D): Mostly twice a day |
| SATAID service | (a) Satellite imagery (SATAID)<br>Himawari-8/9<br>(b) Observation data (SATAID)<br>SYNOP, SHIP, METAR, TEMP (A, B) and ASCAT sea-surface wind<br>(c) NWP products (SATAID)<br>GSM<br>(Available at https://www.wis-jma.go.jp/cms/sataid/) |

# Appendix 9
# RSMC Tokyo Products and Services Provided Through the Internet

List of products provided on the Numerical Typhoon Prediction (NTP) website

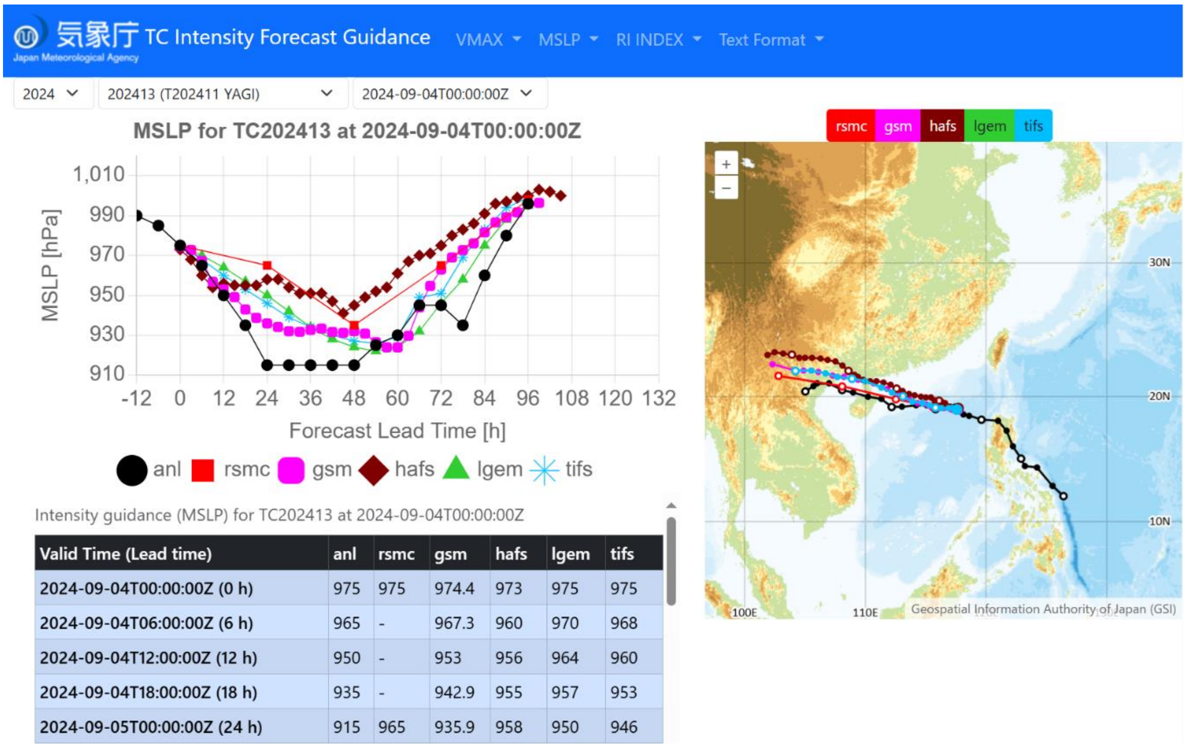
| Products | Frequency | Details |
|---|---|---|
| RSMC Advisories | | |
| RSMC TC Advisory | At least 8 times/day | • The Center's TC analysis and forecasts up to 120 hours ahead (linked to the JMA website at https://www.jma.go.jp/en/typh/) |
| Storm Wind Probability Map | 4 times/day | • Probabilistic forecast map for sustained wind of 50-kt or more for 1, 2, 3, 4 and 5 days ahead |
| Prognostic Reasoning | 4 times/day | • RSMC Tokyo Tropical Cyclone Prognostic Reasoning (WTPQ3X) |
| Graphical TC Advisory | 4 times/day | • Graphical TC Advisory including the Center's TC analysis, track and intensity forecasts up to 24-hours and horizontal extents of cumulonimbus cloud and cloud top height associated with TCs potentially affecting aviation safety (linked to the Tropical Cyclone Advisory Center Tokyo Website) |
| Remote Sensing | | |
| Satellite Analysis | At least 4 times/day | • Results and historical logs of the Center's TC analysis conducted using satellite images (Conventional Dvorak analysis and Early-stage Dvorak analysis) |
| Satellite Imagery | Every 10 minutes | • Satellite imagery of Himawari-8/9 (linked to the JMA website at https://www.jma.go.jp/bosai/map.html#elem=ir&lang=en&contents=himawari) |
| Satellite Microwave Products | | • TC snapshot images<br>• Warm-core-based TC intensity estimates<br>• Weighted consensus TC intensity estimates made using Dvorak analysis and satellite microwave warm-core-based intensity estimates |
| Sea-surface AMV (ASWind) | Every 10 / 30 minutes | • AMV-based Sea-surface Wind in the vicinity of TC (linked to the Meteorological Satellite Center web site) |
| Radar Composite Imagery | Every hour | • Radar composite imagery of the Typhoon Committee Regional Radar Network |
| Atmospheric Circulation | | |
| Weather Charts | 4 times/day | • Weather maps for surface analysis, 24- and 48-hour forecasts (linked to the JMA website at https://www.jma.go.jp/en/g3/) |
| NWP Multi Center Weather Charts | Twice/day | • Mean sea level pressure and 500 hPa Geopotential height (up to 168 hours) of deterministic NWP models from nine centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP, UKMO and JMA) |
| JMA GSM Analysis and Forecast | 4 times/day | • Upper-air analysis and forecast data based on JMA-GSM<br>- Streamlines at 850, 500 and 200 hPa<br>- Divergence at 200 hPa<br>- Velocity potential at 200 hPa<br>- Vertical Velocity in Pressure Coordinate at 500 hPa<br>- Dew Point Depression at 600 hPa<br>- Curvature Vorticity at 850 hPa<br>- Vertical wind shear between 200 and 850 hPa<br>- Sea Level Pressure<br>- Genesis Potential Index |
| MJO Phase Diagram | Daily | • MJO phase and amplitude diagram<br>• MJO Hovmöller diagram<br>(linked to the Tokyo Climate Center web site) |

| Products | Frequency | Details |
|---|---|---|
| Asian Monsoon Monitoring Indices | Daily, only during Apr. - Oct. | • Time series of vertical wind shear, OLR and other indices associated with SW Asian Monsoon (linked to the Tokyo Climate Center web site) |
| Ocean Condition | | |
| SST | Once/day | • Sea surface temperature and related differences from 24 hours ago |
| TCHP | Once/day | • Tropical cyclone heat potential and related differences from 24 hours ago |
| Numerical TC Prediction | | |
| Track Bulletin | 4 times/day | • RSMC Tokyo Tropical Cyclone Track Forecast Bulletin<br>- Track forecast by GSM (FXPQ2X)<br>- Track forecast by GEPS (FXPQ3X) |
| TC intensity (TIFS monitor) | 4 times/day | • TC Intensity prediction of TIFS, LGEM, HAFS and GSM |
| TC Track Prediction | 4 times/day | • TC track prediction of deterministic NWP models from nine centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP, UKMO and JMA)<br>• TC track prediction of EPS models from four centers (ECMWF, NCEP, UKMO and JMA) |
| TC Activity Prediction | Twice/day | • Two- and five-day TC activity prediction maps based on EPS models from four centers (ECMWF, UKMO, NCEP and JMA) and a related consensus |
| TC forecast Verification | 4 times/day | • Real-time verification of TC track and intensity forecast of numerical forecast models and related products. |
| Marine Forecast | | |
| Storm Surge Forecasts | 4 times/day | • Distribution maps of storm surge for the Center's TC track forecast and each of five TC track forecasts selected from GEPS ensemble members and maximum storm surge among these six TC track forecasts (up to 132 hours)<br>• Time-series storm surge forecast charts for the Center's TC track forecast and TC track forecasts from GEPS ensemble prediction (up to 132 hours)<br>• Time-series representations of sea levels, related anomalies, and wind and sea level pressure based on official forecasts for stations of Typhoon Committee Members (up to 132 hours)<br>• Time-series storm surge forecast charts for the Center's ensemble TC track forecasts with box-and-whisker plots and probabilities of 1-, 2- and 3m-exceeding storm surges (up to 132 hours) |
| Ocean Wave Forecasts | Twice/day | • Distribution maps for ensemble mean, maximum, probability of exceeding various thresholds and ensemble spread of wave height and period based on the Wave Ensemble System (WENS) (up to 264 hours)<br>• Time-series representations with box-and-whisker plots for wave height/period and probability of exceeding various wave height/period thresholds based on the WENS (up to 264 hours) |

List of services provided on the TC communication platform

| Services | Details |
|---|---|
| Advance notice | • Advance notice on TC status change from the Center<br>*Supplemental information to RSMC advisories (It may not be provided in certain situations and should not be considered as an official RSMC advisory and/or its replacement) |
| Enhanced communication | • A platform on which Committee Members can post inquiries or comments related to tropical cyclone analysis and forecasts |

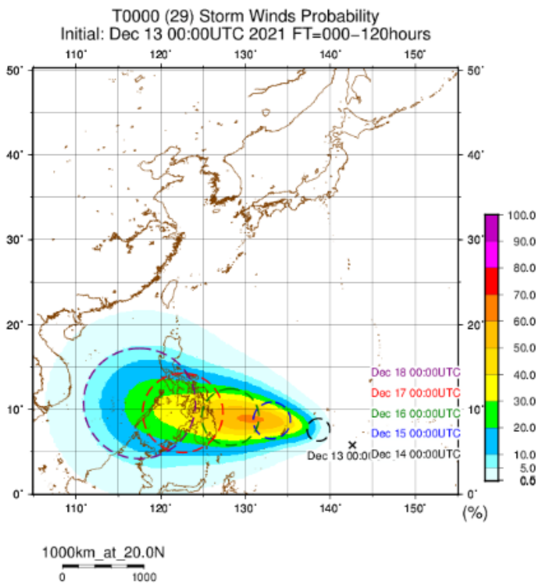
# RSMC Tokyo – Typhoon Center product examples




| Valid Time (Lead time) | anl | rsmc | gsm | hafs | lgem | tifs |
|---|---|---|---|---|---|---|
| 2024-09-04T00:00:00Z (0 h) | 975 | 975 | 974.4 | 973 | 975 | 975 |
| 2024-09-04T06:00:00Z (6 h) | 965 | - | 967.3 | 960 | 970 | 968 |
| 2024-09-04T12:00:00Z (12 h) | 950 | - | 953 | 956 | 964 | 960 |
| 2024-09-04T18:00:00Z (18 h) | 935 | - | 942.9 | 955 | 957 | 953 |
| 2024-09-05T00:00:00Z (24 h) | 915 | 965 | 935.9 | 958 | 950 | 946 |

**Website on the TIFS (Typhoon Intensity Forecast scheme based on SHIPS) monitor[11]**

The upper figure shows TIFS, LGEM, HAFS and GSM intensity prediction values at each initial time for individual TCs with analysis data in line graphs as well as a map of tracks. The table shows intensity prediction values at each valid time with analysis data.




Five-day storm wind probability product (50 kt and above)
for Tropical Depressions (TDs) expected to reach tropical storm (TS) intensity or higher within 24 hours.

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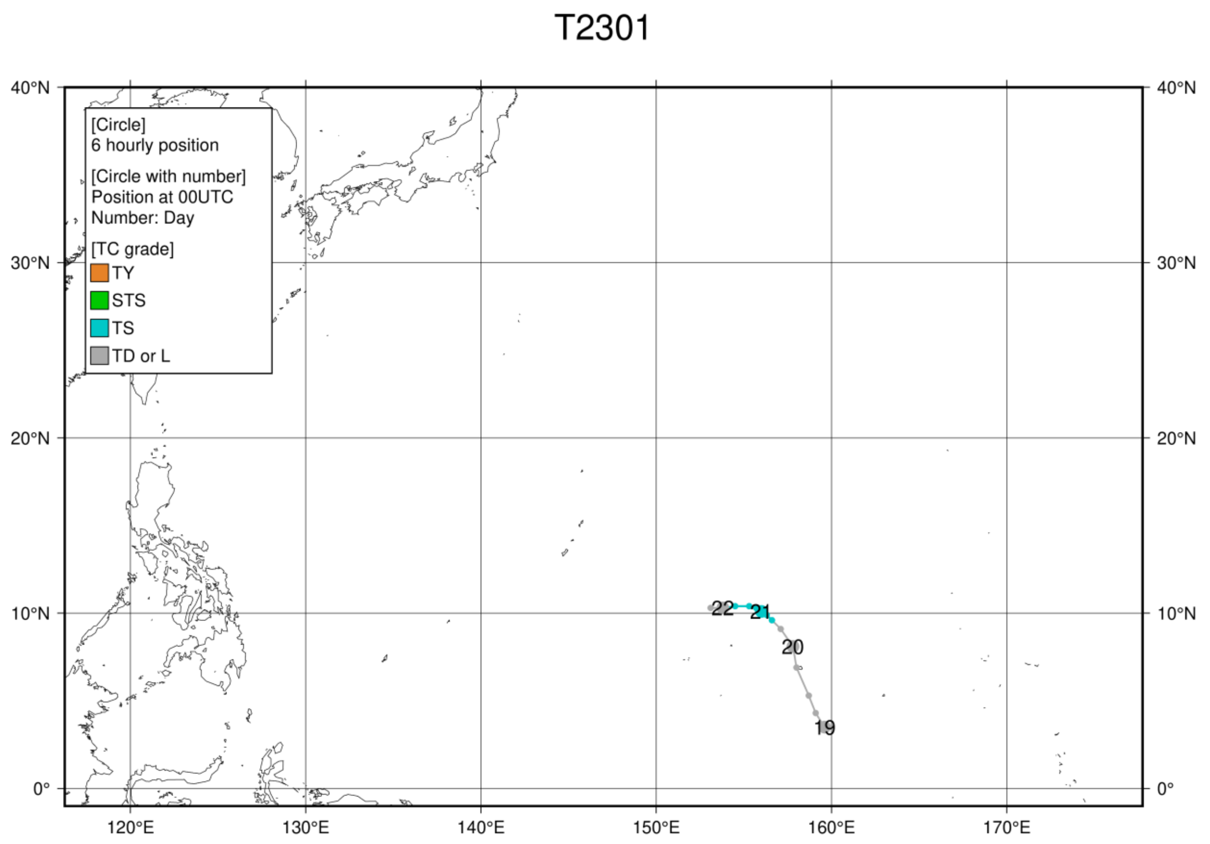
11 Website updated in March 2024.

# Appendix 10
# Tropical Cyclones in 2023

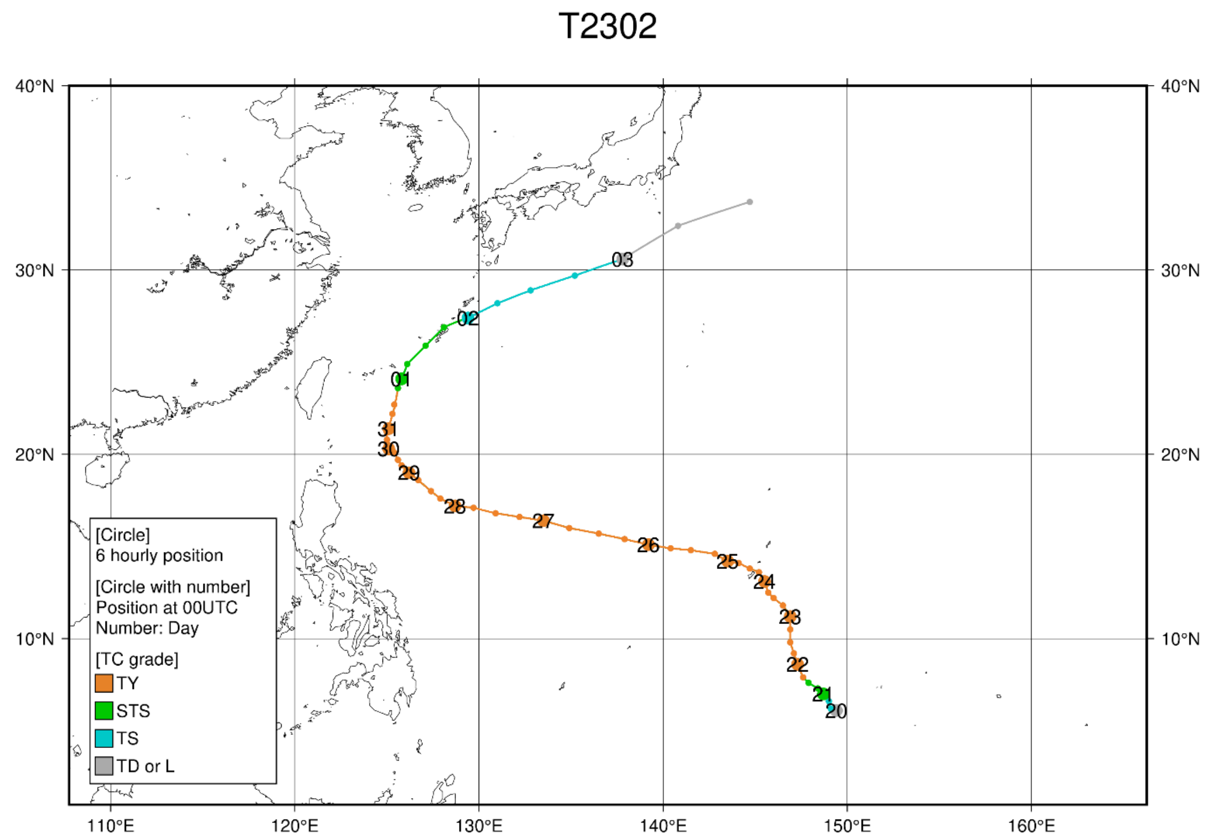
## SANVU (2301)

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.



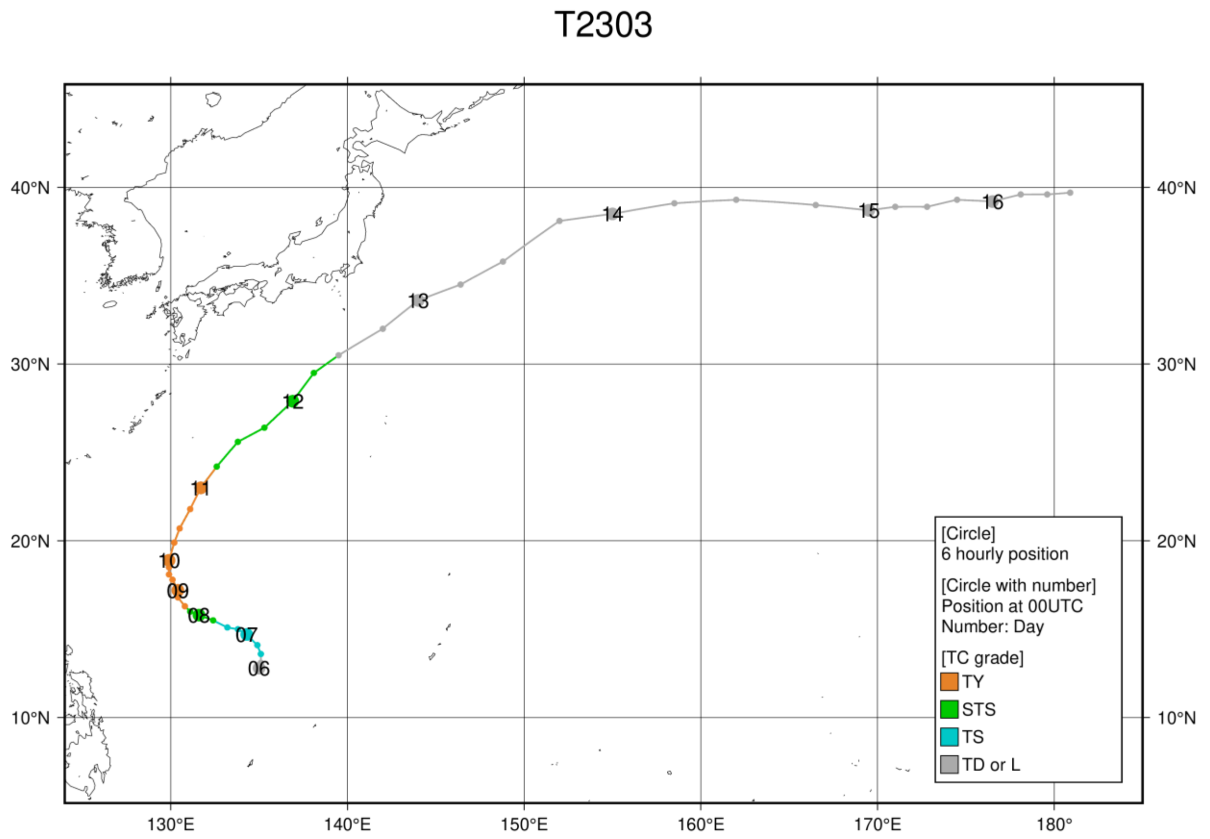
# MAWAR (2302)

MAWAR formed as a tropical depression (TD) over the sea around the Caroline Islands at 18 UTC on 19 May 203 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 was 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 at 00 UTC on 3 June. It dissipated over the sea east of Japan at 18 UTC on 3 June.



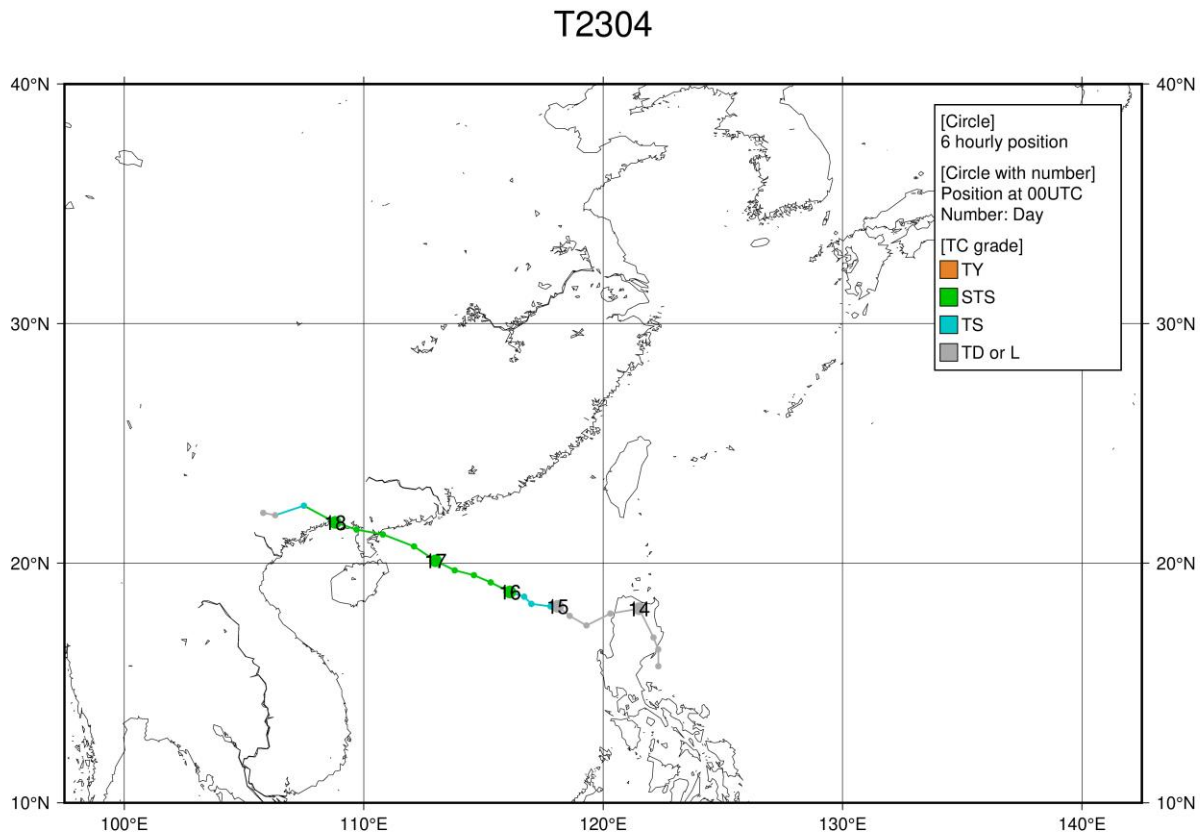
# Guchol (2303)

Guchol formed as a tropical depression (TD) over the sea east of the 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 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 the 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 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.



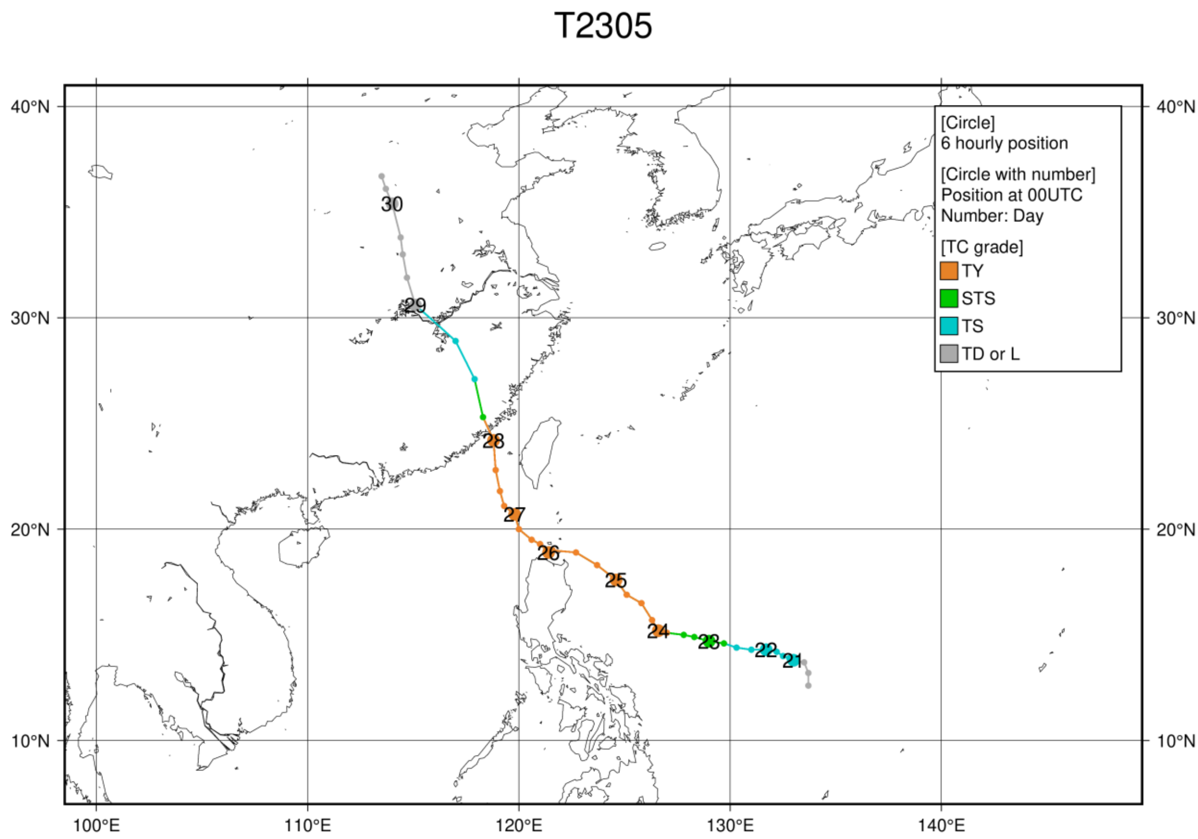
## TALIM (2304)

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.



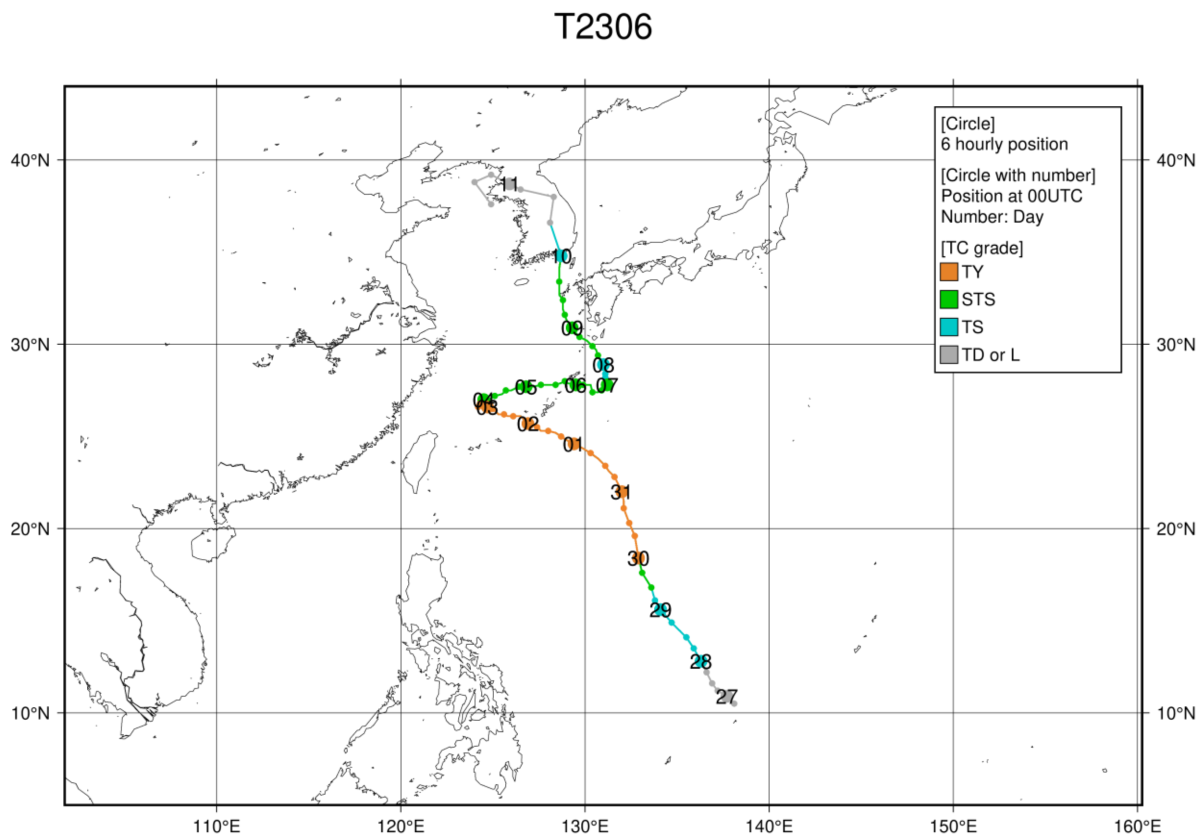
## DOKSURI (2305)

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.



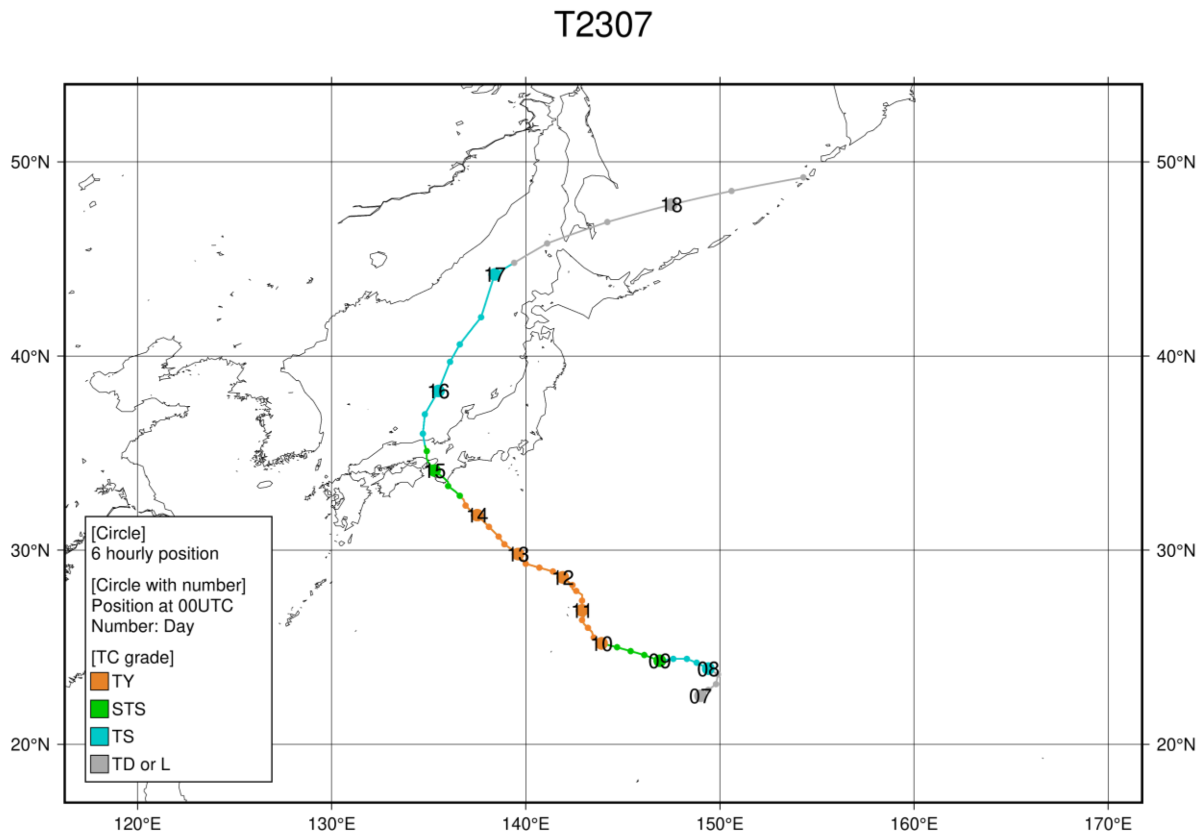
# KHANUN (2306)

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.



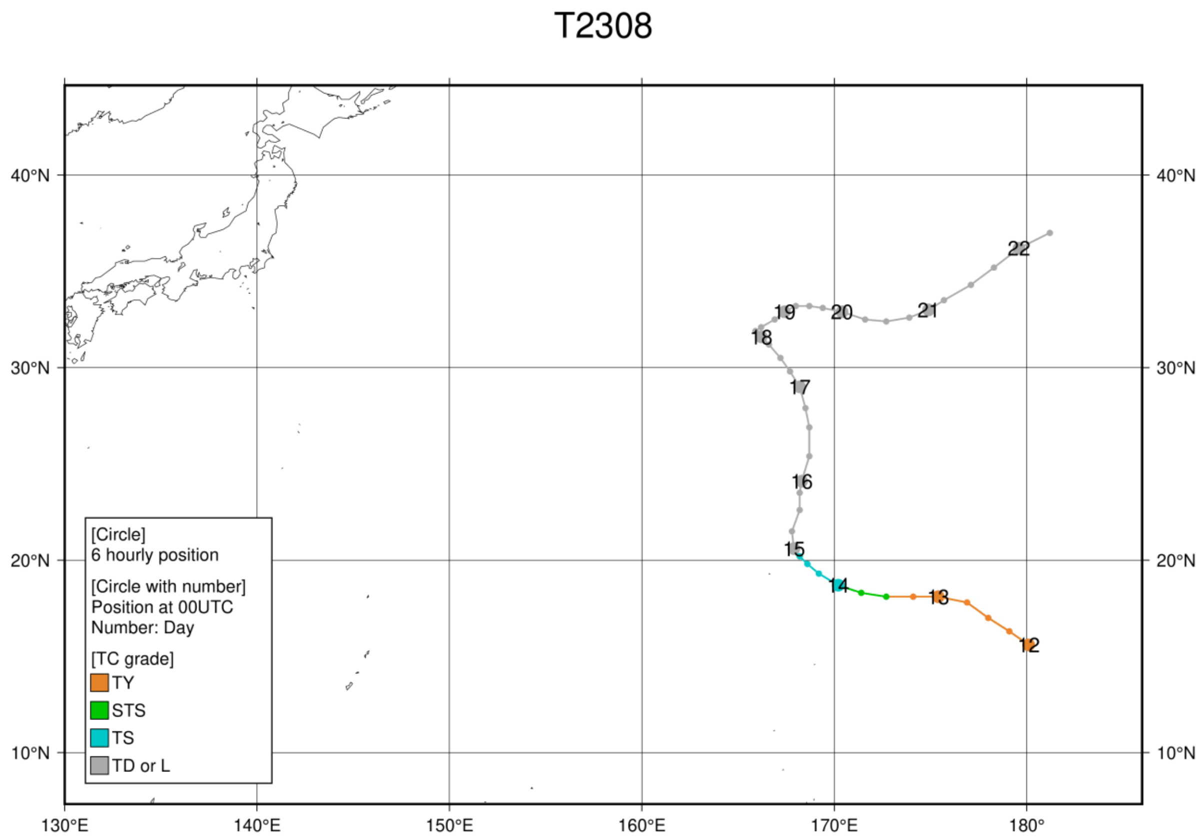
## LAN (2307)

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.



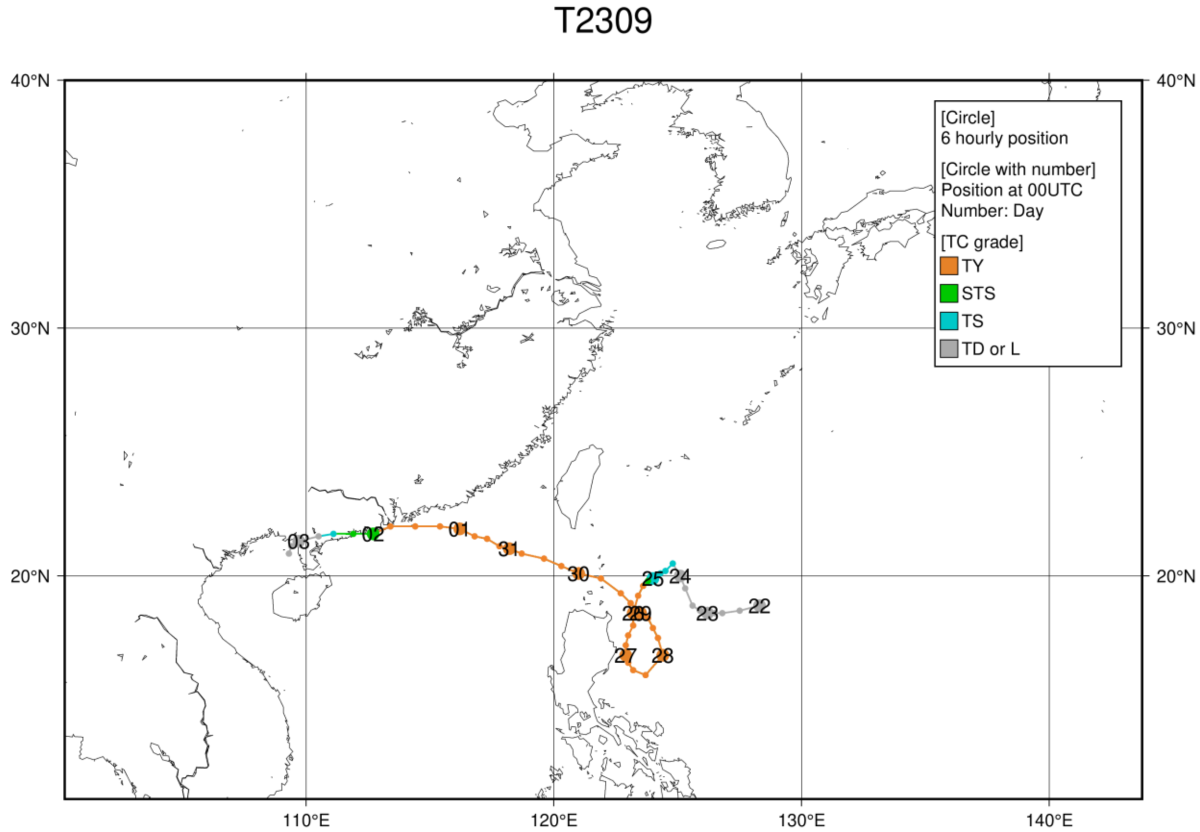
## DORA (2308)

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.



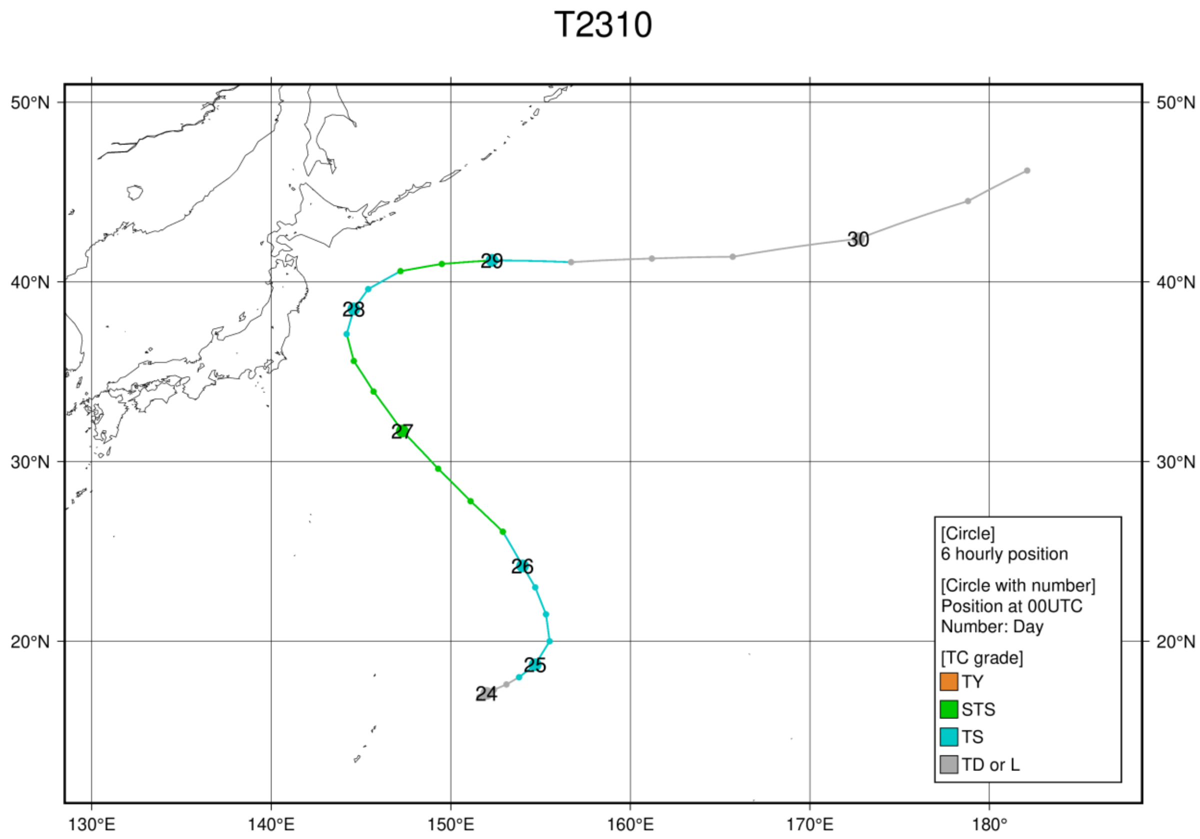
## SAOLA (2309)

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.



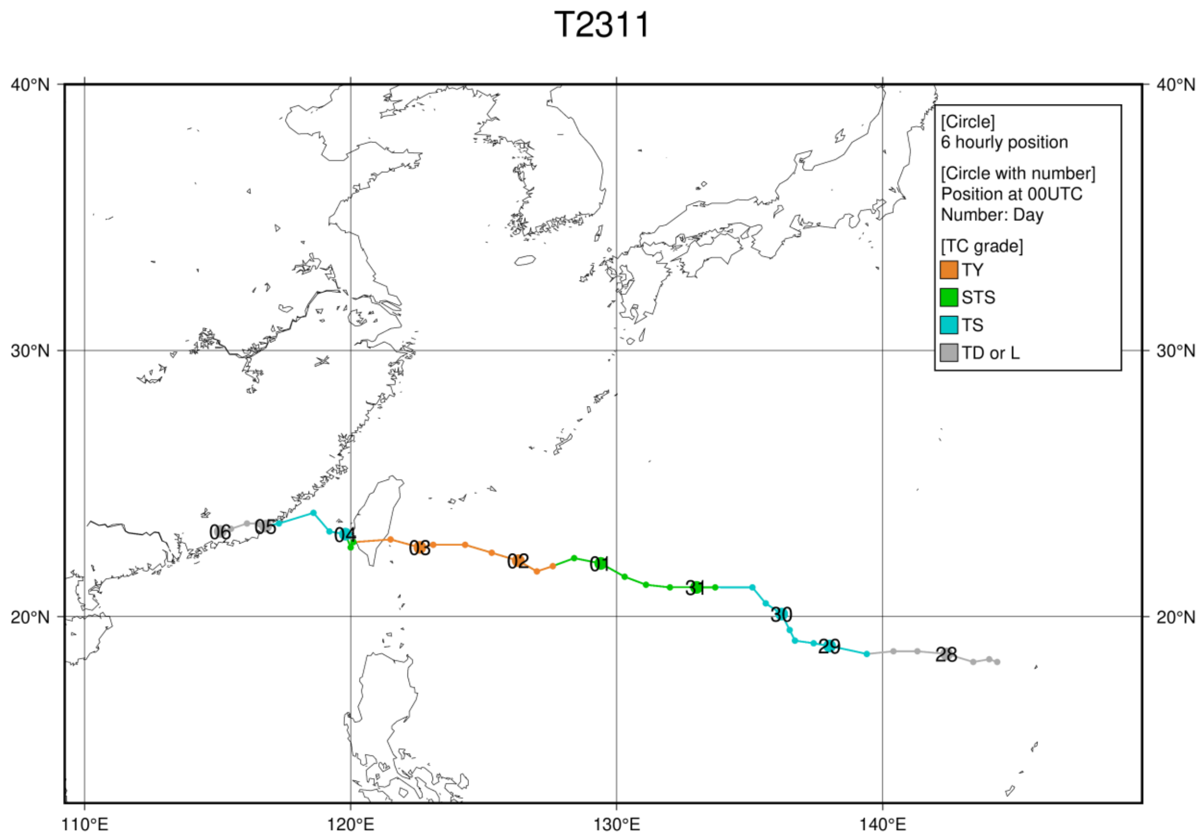
# DAMREY (2310)

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 Aleutians, it crossed longitude 180 degrees east before 12UTC the next day.



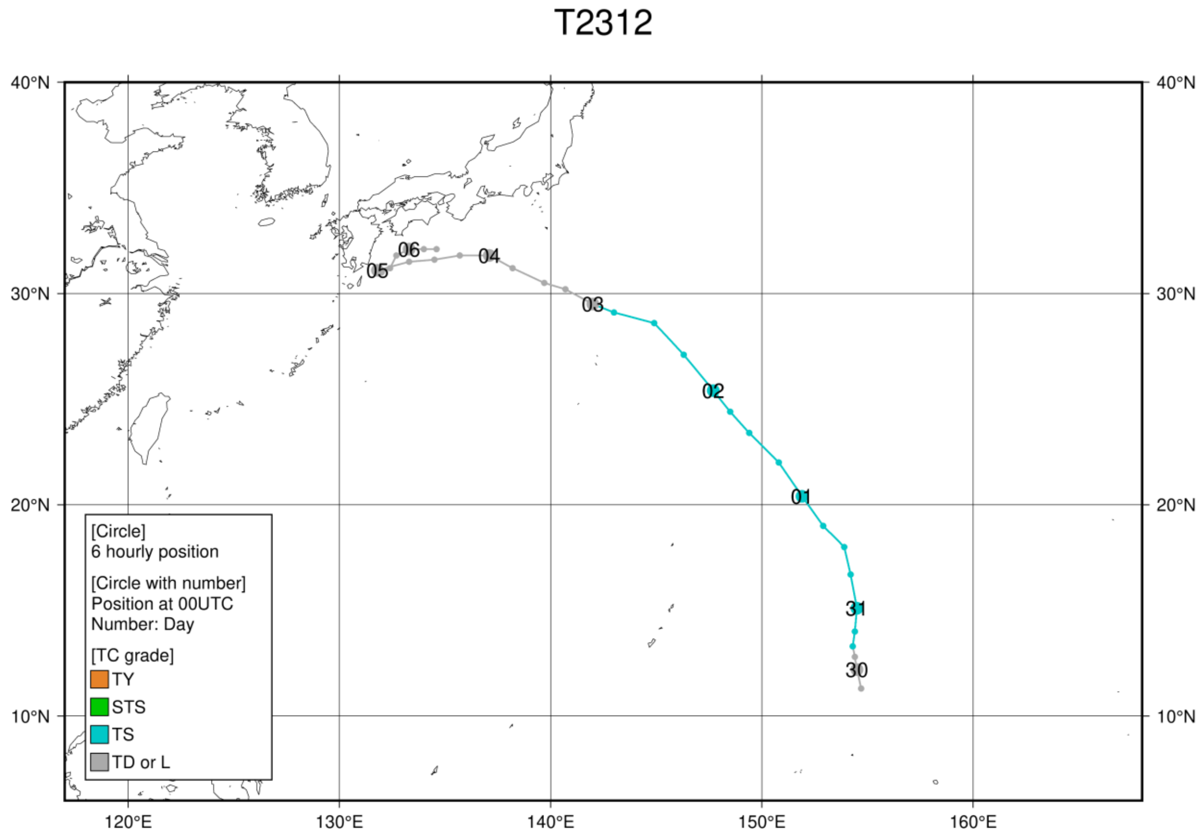
## HAIKUI (2311)

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.



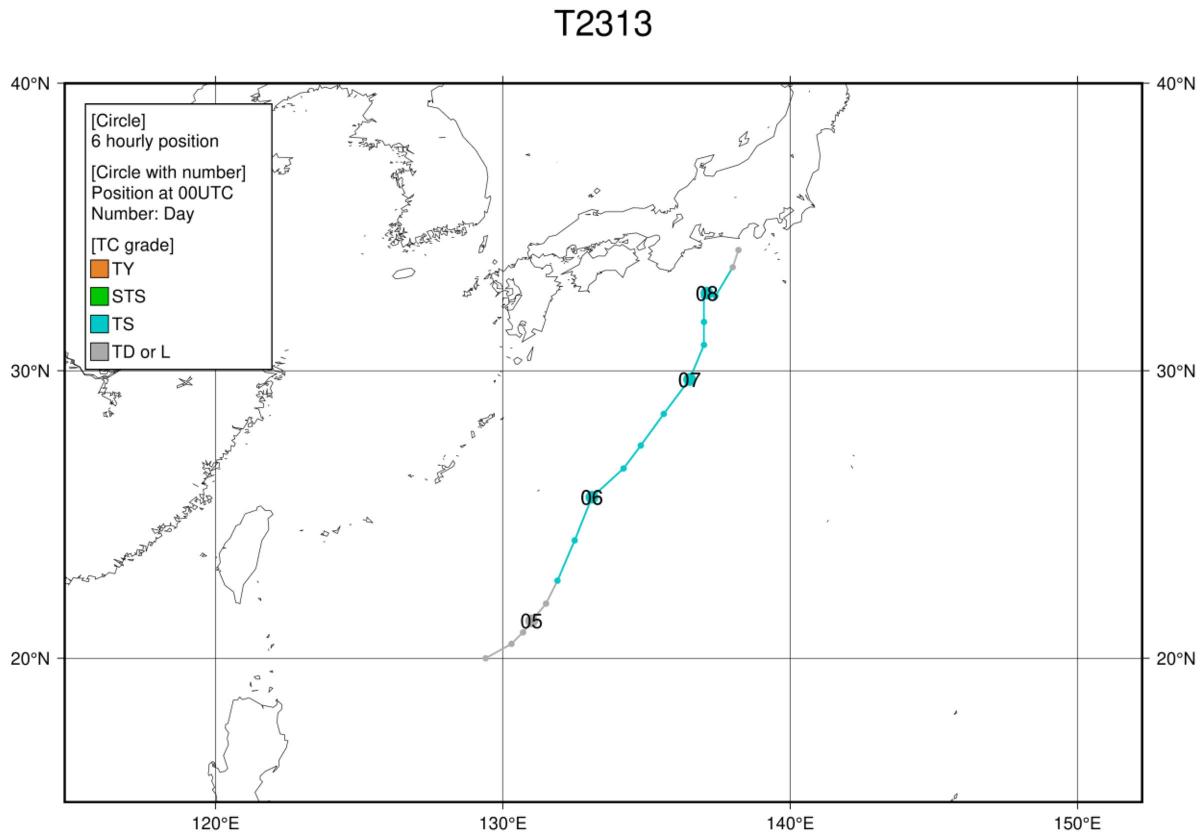
## KIROGI (2312)

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.



**YUN-YEUNG (2313)**

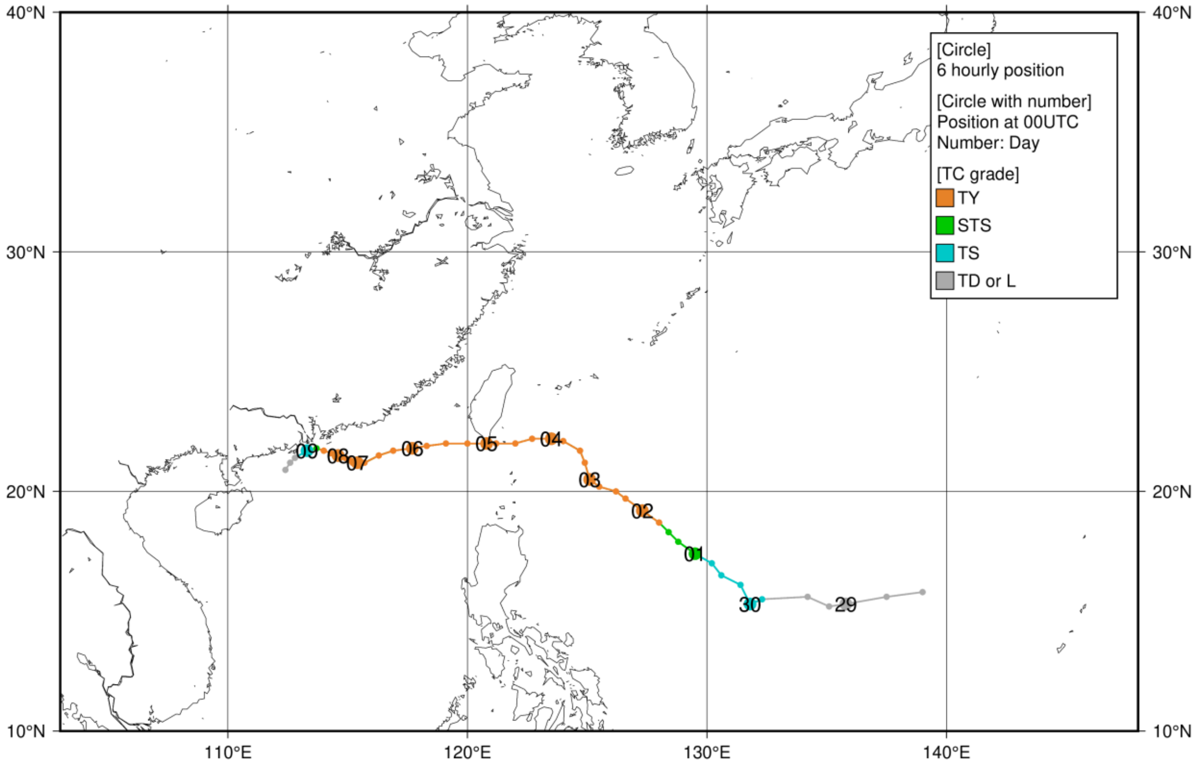
YUN-YEUNG formed as a tropical depression (TD) over the sea south of Okinawa at 06 UTC on 4 September 2023. It moved northeastward and was upgraded to tropical storm (TS) intensity over the sea south of Japan at 12 UTC the next day. Moving north-northeastward over the same waters, it reached its peak 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.



## KOINU (2314)

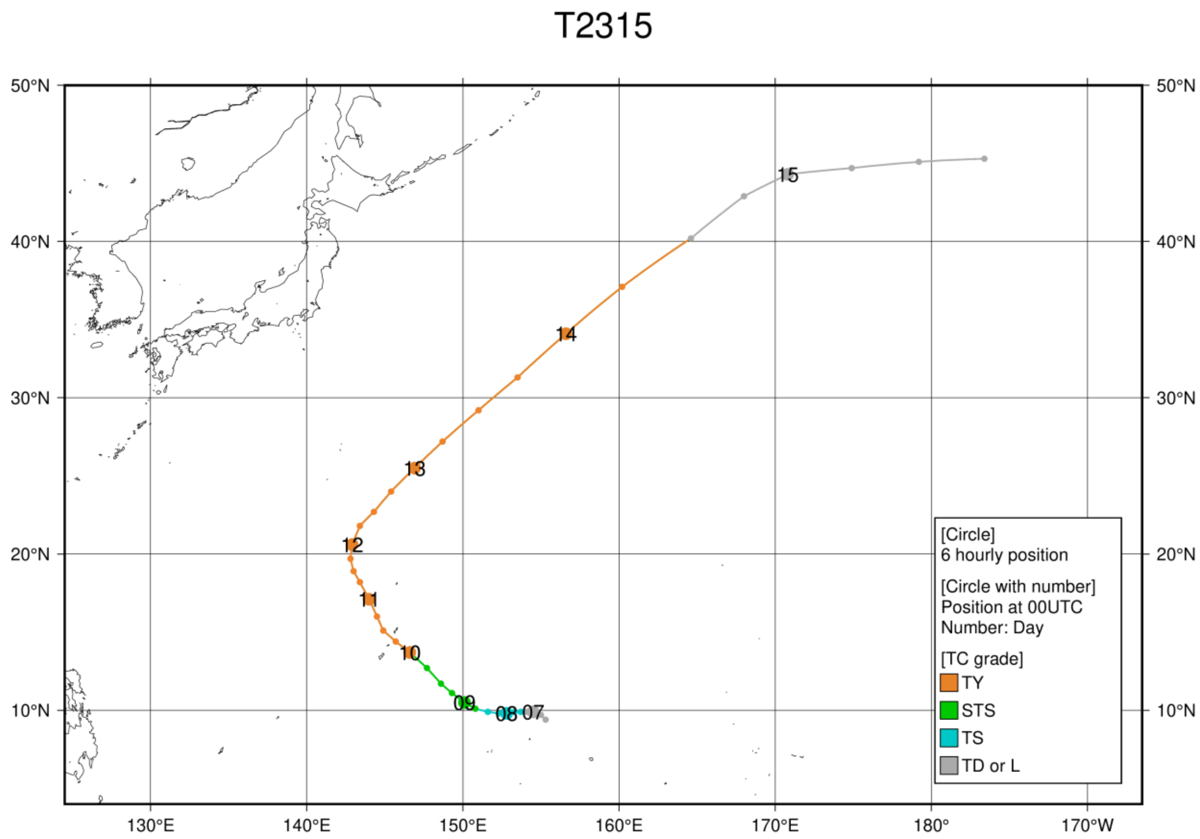
KOINU formed as a tropical depression (TD) over the sea east of the Philippines at 12 UTC on 28 September 2023 and moved westward. It was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on 29 September before turning sharply northwestward. It was upgraded to typhoon (TY) intensity 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.

T2314



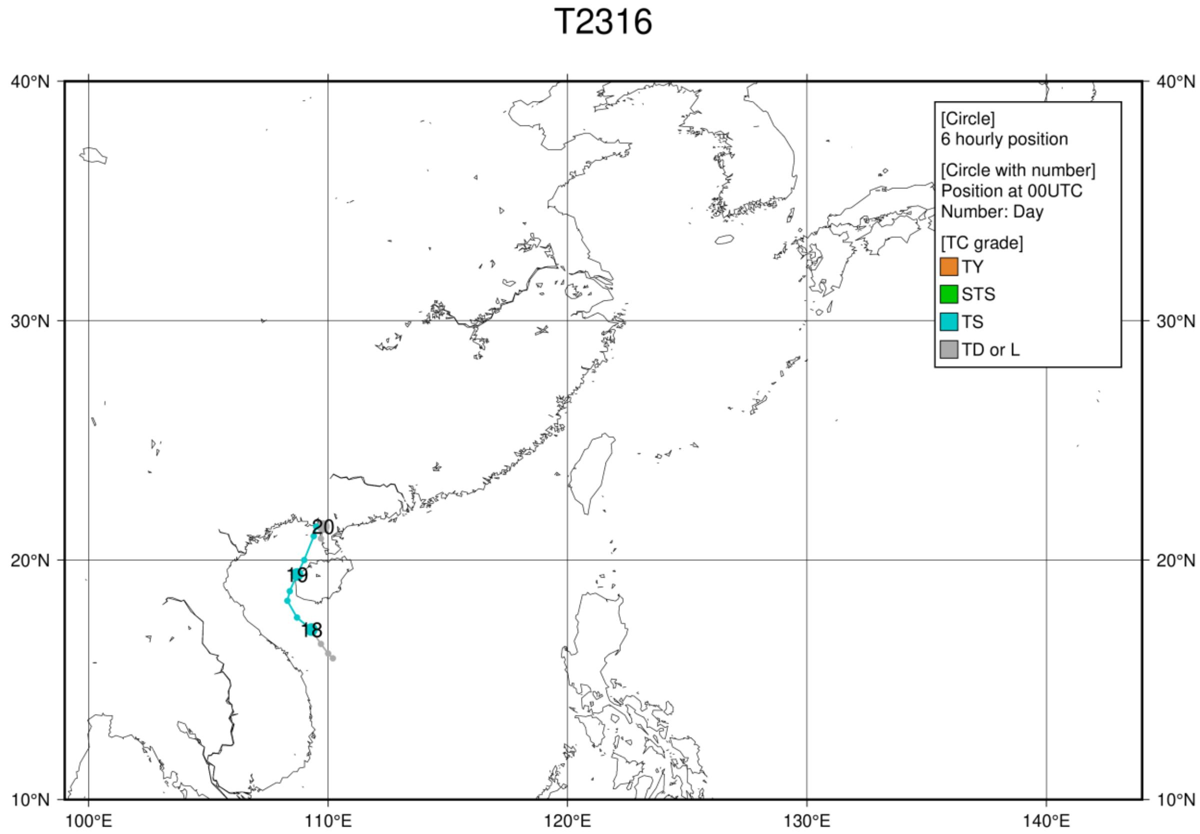
# BOLAVEN (2315)

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 Aleutians and crossed longitude 180 degrees east before 18 UTC the next day.



## 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.



# 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.