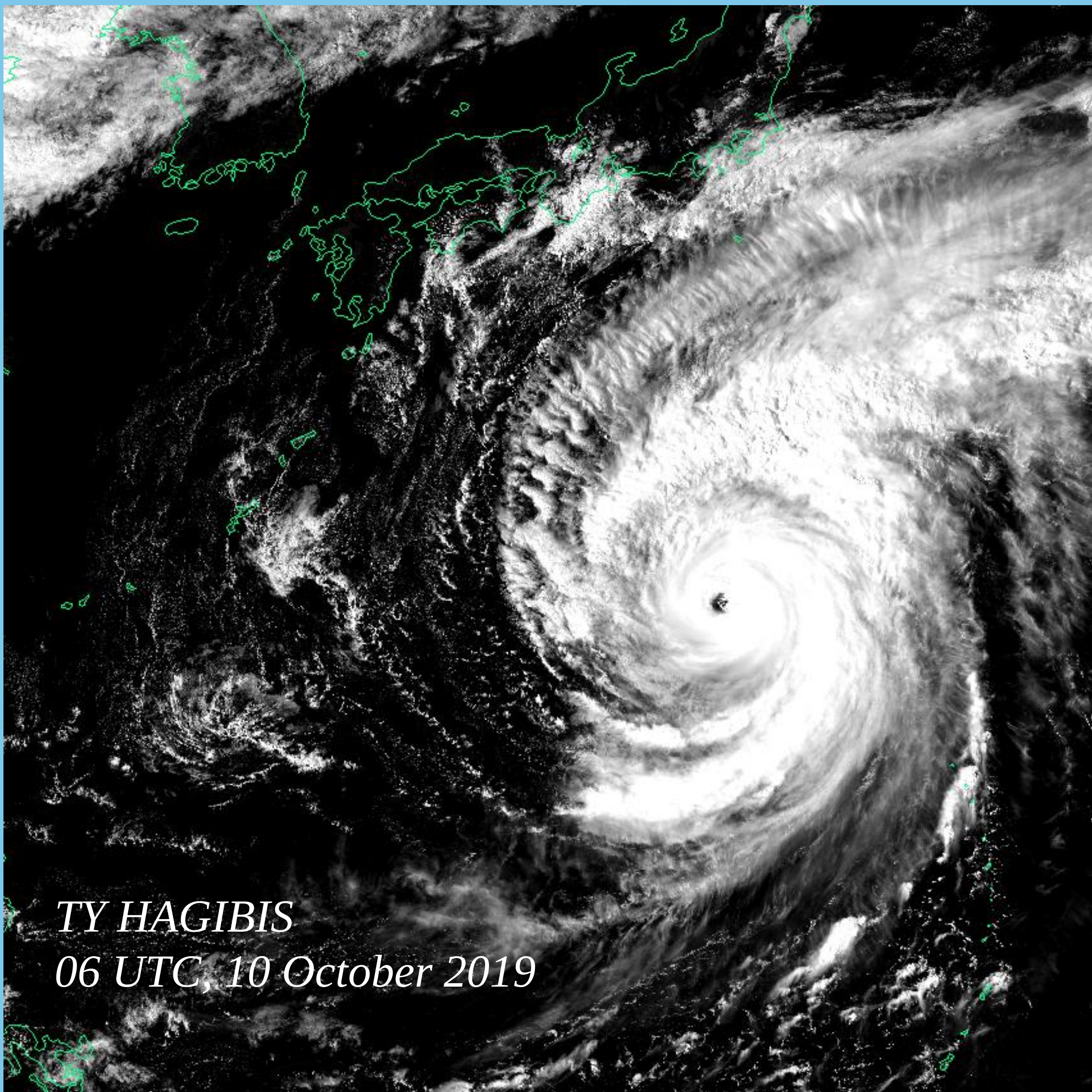
# Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2019




**Japan Meteorological Agency**

# Annual Report
# on the Activities of
# the RSMC Tokyo - Typhoon Center
# 2019

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 2019, Chapter 1 outlines routine operations performed at the Center and its operational products, while Chapter 2 reports on its major activities in 2019. Chapter 3 describes atmospheric and oceanic conditions in the tropics and notes the highlights of TC activity in 2019. 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 prediction. All tables and figures in this document are available on the Center's website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2019/index.html). Best-track data for 2019 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 2019

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.

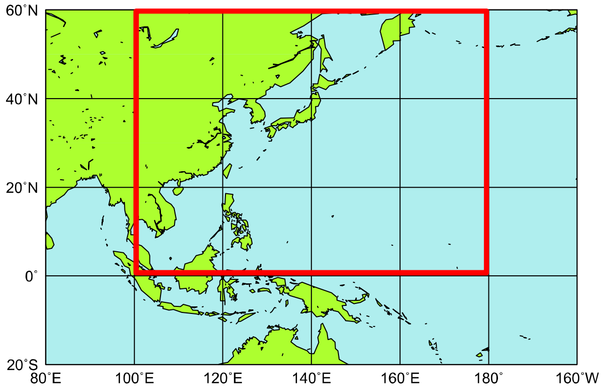



Figure 1.1
Area of responsibility of the RSMC Tokyo - Typhoon Center

## 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 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 Forecasts

The Center issues TC track forecasts with probability circle and intensity forecast up to 120 hours ahead (up from 72 hours since March 2019).

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 (TL959L100; upgraded on 18 March, 2014) has a horizontal resolution of approximately 20 km and 100 vertical layers, while GEPS (TL479L100; operational as of 19 January 2017) has 27 members with a horizontal resolution of approximately 40 km and

100 vertical layers. Using mainly GEPS, the Center extended its TC track forecast up to 120 hours ahead as of April 2009. Further details and recent model improvements are detailed in Appendix 6. 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 centers' 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 of the circle for all forecast times was statistically determined according to the direction and speed of TC movement based on the results of recent TC track forecast verification. In addition, those for 96- and 120-hour forecasts were statistically determined according to the confidence level based on the cumulative ensemble spread calculated using GEPS. In June 2019, the Center adopted the multiple ensemble method to determine the radius for all forecast times up to 120 hours according solely to the confidence level based on the cumulative ensemble spread calculated using multiple ensemble prediction systems (EPSs) consisting of European Centre for Medium-Range Weather Forecasts (ECMWF), National Centers for Environmental Prediction (NCEP) and United Kingdom Met Office (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 the one based on the Statistical Hurricane Intensity Prediction Scheme (SHIPS). The new scheme was developed by JMA and Meteorological Research Institute (MRI) of JMA and is known as TIFS (Typhoon Intensity Forecasting scheme based on SHIPS).

## 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 TC is expected to reach or exceed TS intensity in the area within 24 hours

RSMC products are continually issued while any TC of TS intensity or higher and any tropical depression expected to reach or exceed TS intensity within 24 hours exist in the Center's area of responsibility. Appendix 5 denotes the code forms of the bulletins.

(1) RSMC Tropical Cyclone Advisory for Three-day Forecasts (WTPQ20-25 RJTD: via GTS)

The RSMC Tropical Cyclone Advisory for Three-day Forecasts 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- and 72-hour forecasts[1] for TCs:

| | |
|---|---|
| Analysis | Center position |
| | Accuracy of center position determination |
| | Direction and speed of movement |
| | Central pressure |
| | Maximum sustained wind speed (10-minute average) |

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

| | |
|---|---|
| | Maximum gust wind speed<br>Radii of wind areas over 50 and 30 knots |
| 24-, 48- and 72-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 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[2] for TCs:

| | |
|---|---|
| Analysis | Center position<br>Accuracy of center position determination<br>Direction and speed of movement<br>Central pressure<br>Maximum sustained wind speed (10-minute average)<br>Maximum gust wind speed<br>Radii of wind areas over 50 and 30 knots |
| 24-, 48- 72-, 96- and 120-hour forecasts[2] | 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 |

(3) 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
Central pressure*
Maximum sustained wind speed*

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

(4) 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 GEPS mean six-hourly predictions up to 132 hours ahead and reports the following elements:

---

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

NWP prediction (T = 006 to 132)

| | |
|---|---|
| | Center position |
| | Central pressure* |
| | Maximum sustained wind speed* |

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

(5) SAREP (IUCC10 RJTD: via GTS)

The SAREP in BUFR format reports on the results of TC analysis including intensity information (i.e., the CI number) based on the Dvorak method. It is issued 30 minutes to an hour after observations made at 00, 03, 06, 09, 12, 15, 18 and 21 UTC, and reports the following elements:

| | |
|---|---|
| Himawari-8 imagery analysis | Center position |
| | Accuracy of center position determination |
| | Direction and speed of movement |
| | Mean diameter of overcast cloud |
| | Apparent past 24-hour change in intensity** |
| | Dvorak Intensity (CI, T, DT, MET, PT number) ** |
| | Cloud pattern type of the DT number** |
| | Trend of past 24-hour change** |
| | Cloud pattern type of the PT number** |
| | 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 at http://www.wmo.int/pages/prog/www/WMOCodes.html. The SAREP is provided in text format on the Numerical Typhoon Prediction (NTP) website (see 1.7).

(6) 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.

(7) 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 one and a half months after the termination of related issuance of the above RSMC bulletins.

(8) Tropical Cyclone Advisory for SIGMET (FKPQ30-35 RJTD: via AFTN)

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<br>Direction and speed of movement<br>Central pressure<br>Maximum sustained wind speed (10-minute average) |
| Forecast | Center position<br>Maximum sustained wind speed (10-minute average) |

### 1.4 Graphical Tropical Cyclone Advisory for SIGMET

In August 2015, the Center started providing graphical TCA in addition to text-format TCA in its role as the ICAO TCAC. Graphical TCA shows not only the text-format TCA information but also the horizontal extent of cumulonimbus cloud and cloud top height associated with TCs potentially affecting aviation safety. It is provided through the website where the specifications and text-format TCA are also available. This website is linked from the NTP website (see 1.7), and graphical TCA is also dispatched to World Area Forecast Centres (WAFCs).

### 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 new 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 Service (SATellite Animation and Interactive Diagnosis; https://www.wis-jma.go.jp/cms/sataid/) are also available from the server through WIS DAR. All products available via the new server are listed in Appendix 7.

### 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.htm. Since 12 November 2012, the website has provided experimental TC advisory information in Common Alert Protocol (CAP) format.

### 1.7 Numerical Typhoon Prediction Website

Since 1 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 wave height forecasting. All products available on the website are listed in Appendix 8.

# Chapter 2

# Major Activities of the RSMC Tokyo - Typhoon Center in 2019

## 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 2019 are listed in Table 2.1.

Table 2.1 Monthly and annual totals of products issued by the RSMC Tokyo - Typhoon Center in 2019

| Product | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **IUCC10** | 31 | 72 | 0 | 0 | 0 | 13 | 93 | 288 | 189 | 177 | 273 | 91 | 1227 |
| **WTPQ20-25** | 36 | 77 | 0 | 0 | 0 | 22 | 118 | 318 | 234 | 193 | 300 | 95 | 1393 |
| **WTPQ30-35** | 20 | 38 | 0 | 0 | 0 | 9 | 58 | 156 | 114 | 95 | 147 | 47 | 684 |
| **WTPQ50-55** | 2 | 26 | 0 | 0 | 0 | 22 | 118 | 318 | 234 | 193 | 300 | 95 | 1308 |
| **FXPQ20-25** | 18 | 38 | 0 | 0 | 0 | 10 | 58 | 156 | 114 | 95 | 147 | 47 | 683 |
| **FXPQ30-35** | 18 | 38 | 0 | 0 | 0 | 6 | 52 | 154 | 114 | 95 | 147 | 47 | 671 |
| **FKPQ30-35** | 18 | 38 | 0 | 0 | 0 | 11 | 58 | 156 | 115 | 96 | 147 | 47 | 571 |
| **AXPQ20** | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 3 | 2 | 6 | 6 | 4 | 25 |

Notes:

| | |
|---|---|
| IUCC10 RJTD | SAREP (BUFR format) |
| WTPQ20-25 RJTD | RSMC Tropical Cyclone Advisory for Three-day Forecasts |
| WTPQ30-35 RJTD | RSMC Prognostic Reasoning |
| WTPQ50-55 RJTD | RSMC Tropical Cyclone Advisory |
| FXPQ20-25 RJTD | RSMC Guidance for Forecast by Global Model |
| FXPQ30-35 RJTD | RSMC Guidance for Forecast by Global Ensemble Prediction System |
| FKPQ30-35 RJTD | Tropical Cyclone Advisory for SIGMET |
| AXPQ20 RJTD | RSMC Tropical Cyclone Best Track |

## 2.2 Publications

In April 2019, the 21st issue of the *RSMC Technical Review* was issued with the following areas of focus:

1. Determining Probability-Circle Radii of Tropical Cyclone Track Forecasts with Multiple Ensembles
2. Operational Use of the Typhoon Intensity Forecasting Scheme Based on SHIPS (TIFS) and Commencement of Five-day Tropical Cyclone Intensity Forecasts
3. Utilization of Estimated Sea Surface Wind Data Based on Himawari-8/9 Low-level AMVs for Tropical Cyclone Analysis

In December 2019, the Center published the *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2018*. 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.htm.

## 2.3 Typhoon Committee Attachment Training

The 19th Typhoon Committee Attachment Training course was held at JMA Headquarters from 18 to 29 November 2019.

The Center has organized ESCAP/WMO Typhoon Committee Attachment Training courses every 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. Forecasters from the Member countries of the Panel on Tropical Cyclones have also been invited since 2015 to enhance training collaboration between the Panel and the Committee. The 2019 attendees were Mr. Md. Bazlur Rashid from Bangladesh, Dr. Xinyan Lyu from China, Dr. Yin Lam Ng from Hong Kong, Ms. Sinthaly Chanthana from Lao P.D.R., Mr. Chan Wa Lok from Macao, Ms. Maziah Binti Mat from Malaysia, Ms. Ni Ni Khine from Myanmar, Ms. Premwadee Traitangwong from Thailand and Ms. Hien Thi Thu Vo from Viet Nam, as well as guest lecturer Dr. Balachandran Sethurathinam from the India Meteorological Department.

The training focused on practical knowledge and skills related to operational TC analysis and forecasting via lectures and exercises. The TC analysis course covered a range of subjects including interpretation of satellite imagery and Dvorak analysis techniques involving the use of the satellite analysis and viewer program (SATellite Animation and Interactive Diagnosis, or SATAID), and other analysis techniques based on microwave imagery, Doppler radar data and sea-surface AMV data. TC forecasting subjects included techniques involving the use of various types of guidance and information sources along with storm surge and wave forecasting. Presentations and exercises were also provided on public weather services, including the setting of warning criteria based on disaster statistics, key roles of quantitative precipitation estimation and forecasting techniques, appropriate provision of disaster risk reduction (DRR) information, and forecast skill evaluation, to enhance capacity in the development and implementation of effective warning systems in collaboration with DRR operators. Dr. Balachandran Sethurathinam also gave a lecture on the South Asian Monsoon and TCs in the Indian Ocean area. All attendees gave presentations to help JMA staff understand the current status of their meteorological and hydrological services, including those relating to TCs and warnings.

## 2.4 Monitoring of Observational Data Availability

The Center carried out regular monitoring of information exchanges for enhanced TC observation in accordance with the standard procedures stipulated in Section 6.2, Chapter 6 of *The Typhoon Committee Operational Manual (TOM) - Meteorological Component (WMO/TD-No. 196)*. Monitoring for the period from 1 January to 31 December 2019, was conducted for two TCs:

1. Tropical Storm (TS) Podul (1912), from 00 UTC 24 August to 00 UTC 29 August 2019
2. Typhoon (TY) Mitag (1918), from 00 UTC 28 September to 00 UTC 3 October 2019

The results were distributed to all Typhoon Committee Members in February 2020, and are also available on the WIS GISC Tokyo server at https://www.wis-jma.go.jp/monitoring/data/monitoring/.

## 2.5 Other Activities in 2019

### 2.5.1 Services Introduced in 2019

The Center introduced the services detailed below in 2019.

(1) 5-day tropical cyclone intensity forecasts

The Center extended tropical cyclone intensity forecasts up to 120 hours ahead on 14 March 2019, based on several tropical cyclone intensity forecast guidance products including the one based on the Statistical Hurricane Intensity Prediction Scheme (SHIPS). The new scheme is known as TIFS (the Typhoon Intensity Forecasting scheme based on SHIPS), and related information is added to existing RSMC Tropical Cyclone Advisory for five-day forecasts with GTS headings of WTPQ50-55 RJTD.

(2) Revision of probability circle radii for tropical cyclone track forecasts with multiple ensembles

On 12 June 2019, the Center revised its 70% probability circles based on cumulative ensemble spread calculated with multi-ensembles from four centers for all forecast times. The results of verification using tropical cyclone track data for T1903 - T1929 revealed that mean circle radii reduced by 15 - 20% and mean circle hit ratios reduced to be closer to 70% compared to before.

(3) Enhanced communication service on a trial basis

The Center set up a trial platform in 2019 for Committee Members to post inquiries and comments on tropical cyclone analysis and forecasts. (In response to requests from some Committee Members, the Center also began providing Advance Notices on this platform since 2020, and continued the trial for another year to obtain more Member feedback.)

### 2.5.2 Upgrades of Numerical Typhoon Prediction Website

The changes outlined below were made to the NTP website in July 2019.

(1) Atmospheric motion vector based Sea-surface Wind (ASWind)

The Meteorological Satellite Center of the Japan Meteorological Agency (JMA/MSC) has developed a method to estimate sea surface winds in the vicinity of tropical cyclones from Himawari-8/9 full-disk and Region 3 observation data. The estimation product is named Atmospheric motion vector based Sea-surface Wind (ASWind) and is provided every 30 minutes from full-disk observation and every 10 minutes from Target Area observation, respectively, with high accuracy for surrounding areas of strong winds (30 kt or higher) associated with tropical cyclones. A link to the ASWind web page was added.

(2) Expansion of contents related to atmospheric circulation data

Charts for streamline at 200 and 850 hPa, vertical wind shear between 200 and 850 hPa, divergence at 200 hPa and vorticity at 850 hPa were previously available only for the GSM analysis times. On 24 July 2019, charts for streamline at 500 hPa, velocity potential at 200 hPa, vertical velocity in pressure coordinates at 500 hPa, dew point depression at 600 hPa, sea level pressure and Genesis Potential Index (GPI) were made available with 12-hourly GSM forecast charts up to 132 hours ahead. These charts are expected to facilitate understanding of the large-scale atmospheric conditions and related development thereof for tropical cyclones.

(3) Madden-Julian Oscillation and summer monsoon activity

As Madden-Julian Oscillation (MJO) is a major element of intra-seasonal atmospheric variability in the tropics and affects the potential for tropical cyclogenesis, links to MJO phase diagrams as well as MJO Hovmöller diagrams have been added. Monitoring indices for the Asian Summer Monsoon - another factor closely linked to tropical cyclogenesis over the western North Pacific - have also been added for reference to monsoon activity.

(4) Probabilistic forecast map for storm winds

Probalility maps of storm wind (sustained wind of 50-kt or more) for the western North Pacific region are now available on the NTP website.

# Chapter 3

# Summary of the 2019 Typhoon Season

In 2019, 29 TCs of TS intensity or higher formed over the western North Pacific and the South China Sea. This total is above the climatological normal* frequency of 25.6. Among these 29 TCs, 17 reached TY intensity, 3 reached severe tropical storm (STS) intensity and 9 reached TS intensity (Table 3.1).

** Climatological normal is based on data for the period from 1981 to 2010.*

Table 3.1 List of tropical cyclones reaching TS intensity or higher in 2019

| Tropical Cyclone | | | Duration (UTC) (TS or higher) | | | | | Minimum Central Pressure (UTC) | lat (N) | long (E) | (hPa) | Max Wind (kt) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TS | Pabuk | (1901) | 010600 | Jan | - | 041800 | Jan | 031800 | 7.5 | 102.5 | 996 | 45 |
| TY | Wutip | (1902) | 191800 | Feb | - | 280600 | Feb | 231200 | 12.0 | 142.8 | 920 | 105 |
| TS | Sepat | (1903) | 271200 | Jun | - | 280600 | Jun | 280000 | 35.2 | 141.6 | 994 | 40 |
| TS | Mun | (1904) | 020600 | Jul | - | 040600 | Jul | 030600 | 19.5 | 108.4 | 992 | 35 |
| TS | Danas | (1905) | 160600 | Jul | - | 201800 | Jul | 181800 | 27.8 | 124.0 | 985 | 45 |
| TS | Nari | (1906) | 251800 | Jul | - | 270600 | Jul | 261800 | 33.4 | 135.9 | 998 | 35 |
| TS | Wipha | (1907) | 301800 | Jul | - | 031200 | Aug | 020600 | 21.1 | 109.0 | 985 | 45 |
| TY | Francisco | (1908) | 021200 | Aug | - | 070000 | Aug | 051200 | 31.2 | 133.0 | 970 | 70 |
| TY | Lekima | (1909) | 040600 | Aug | - | 121800 | Aug | 081200 | 24.3 | 125.0 | 925 | 105 |
| TY | Krosa | (1910) | 060600 | Aug | - | 161200 | Aug | 080600 | 22.1 | 140.6 | 965 | 75 |
| STS | Bailu | (1911) | 210600 | Aug | - | 251800 | Aug | 221800 | 17.2 | 127.3 | 985 | 50 |
| TS | Podul | (1912) | 280000 | Aug | - | 300000 | Aug | 290600 | 17.5 | 109.1 | 992 | 40 |
| TY | Lingling | (1913) | 020000 | Sep | - | 080000 | Sep | 050600 | 24.9 | 125.3 | 940 | 95 |
| TS | Kajiki | (1914) | 021200 | Sep | - | 031200 | Sep | 021200 | 17.2 | 108.4 | 996 | 35 |
| TY | Faxai | (1915) | 041800 | Sep | - | 100000 | Sep | 071800 | 30.2 | 140.5 | 955 | 85 |
| TS | Peipah | (1916) | 150000 | Sep | - | 161200 | Sep | 150000 | 15.4 | 149.7 | 1000 | 35 |
| TY | Tapah | (1917) | 190000 | Sep | - | 230000 | Sep | 201800 | 25.0 | 126.4 | 970 | 65 |
| TY | Mitag | (1918) | 280000 | Sep | - | 030600 | Oct | 301200 | 24.6 | 122.9 | 965 | 75 |
| TY | Hagibis | (1919) | 051800 | Oct | - | 130300 | Oct | 071200 | 16.1 | 146.6 | 915 | 105 |
| TY | Neoguri | (1920) | 170000 | Oct | - | 211200 | Oct | 191800 | 22.6 | 127.5 | 970 | 75 |
| TY | Bualoi | (1921) | 190600 | Oct | - | 251200 | Oct | 220600 | 18.2 | 144.4 | 935 | 100 |
| STS | Matmo | (1922) | 291800 | Oct | - | 310600 | Oct | 300600 | 13.2 | 110.7 | 992 | 50 |
| TY | Halong | (1923) | 021200 | Nov | - | 090000 | Nov | 051200 | 19.9 | 150.8 | 905 | 115 |
| TY | Nakri | (1924) | 051800 | Nov | - | 110000 | Nov | 080600 | 12.6 | 116.4 | 975 | 65 |
| TY | Fengshen | (1925) | 120000 | Nov | - | 171200 | Nov | 150600 | 20.1 | 142.7 | 965 | 85 |
| TY | Kalmaegi | (1926) | 141200 | Nov | - | 200000 | Nov | 181800 | 19.1 | 122.7 | 975 | 70 |
| STS | Fung-wong | (1927) | 200000 | Nov | - | 221200 | Nov | 210000 | 20.2 | 125.0 | 990 | 55 |
| TY | Kammuri | (1928) | 260000 | Nov | - | 051800 | Dec | 021200 | 12.9 | 124.7 | 950 | 90 |
| TY | Phanfone | (1929) | 221200 | Dec | - | 280000 | Dec | 241800 | 11.8 | 123.4 | 970 | 80 |

## 3.1 Atmospheric and Oceanographic Conditions in the Tropics

The El Niño event that emerged in autumn 2018 persisted until spring 2019, when remarkably positive Sea Surface Temperature (SST) anomalies were observed over most of the equatorial Pacific except for the area near Indonesia and east of 90°W. Remarkably positive SST anomalies were also observed in most of the Indian Ocean except near the southwestern coast of Australia. Tropical convection was enhanced from west of the date line to the central equatorial Pacific, and was suppressed from the northern tropical Indian Ocean to the Philippines.

In summer 2019, ENSO (El Niño-Southern Oscillation)-neutral conditions persisted, and positive SST anomalies were observed over the low latitudes in the western North Pacific. Asian summer monsoon activity was generally suppressed, while enhancement was seen in early and late August. In the lower troposphere, cyclonic circulation anomalies were seen over the area from the northern South China Sea to the area east of the Philippines and over low latitudes from 150°E to the dateline. The monsoon trough over Southeast Asia was stronger than normal in August. The extension of the North Pacific Subtropical High (NPSH) around Japan was generally weaker than normal, moving toward mainland Japan in early August and southern Japan in late August.

In autumn, positive SST anomalies were observed in the area east of 150°E in the tropical western North Pacific. Convective activity was enhanced over the 10°N latitude band in the western North Pacific.

Figure 3.1 shows monthly mean streamlines and Outgoing Longwave Radiation (OLR*, with lower values corresponding to stronger convective activity) and related anomalies at 850 hPa for November 2019, and the tracks of named TCs forming during the month. Three named TCs formed over the area around and to the east of the Mariana Islands along the 10 – 20˚N latitude band, where enhanced convection and lower-level wind convergence were seen.

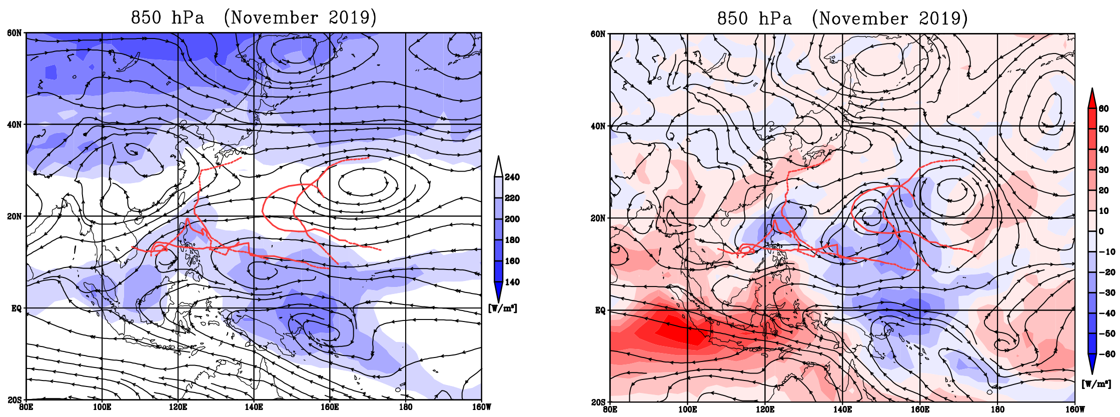



Figure 3.1 Monthly mean streamlines (lines with arrows) and OLR* (shading) (left) and related anomalies (right) at 850 hPa for November 2019. The tracks of the six named TCs forming in November are superimposed in red onto both figures.

To highlight atmospheric and oceanographic conditions, charts showing monthly mean SST anomalies for the western North Pacific and the South China Sea, monthly mean streamlines at 850 and 200 hPa, and OLRs* along with related anomalies for the months from January to December are available on the Center's website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2019/index.html).

** 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.*

## 3.2 Tropical Cyclones in 2019

A total of 29 named TCs formed over the western North Pacific and the South China Sea in 2019. Monthly and the climatological normal* numbers of named TC formations are shown in Figure 3.2, and the tracks of the 29 TCs are shown in Figure 3.3. Figure 3.4 shows the genesis points of the 29 TCs (dots) and related frequency distribution for past years (1951 - 2018).

** Climatological normal is based on data for the period from 1981 to 2010.*

No named TCs formed between March and mid-June, while 26 formed from July 1 onward. Six of these formed in November, matching the 1964 and 1991 maxima for the month since 1951 (Figure 3.2). During the months with no named TCs, convective activity in the western North Pacific remained suppressed in association with post-El Niño warming observed in SSTs in the Indian Ocean, and southwestern monsoon activity was low and delayed. Absence of TCs from March to mid-June is perhaps attributed to this situation. The November TC formations were supported by high SSTs in the tropical Pacific east of 160˚E, enhanced cyclonic vorticity between westerly winds along the equator in association with an active MJO phase, and equatorial waves and easterly winds in the tropical Pacific south of 20˚N.

The mean genesis point of named TCs was 16.2˚N and 134.4˚E, which deviated westward from that of the 30-year average** (16.2˚N and 136.7˚E) (see Figure 3.4). The mean genesis point of named TCs formed in summer (June to August) was 20.4˚N and 129.7˚E, with a west-northwestward deviation from that of the 30-year summer average** (18.4˚N and 134.9˚E), and that of named TCs formed in autumn (September to November) was 15.4˚N and 137.4˚E, which was almost the same as that of the 30-year autumn average** (15.9˚N and 137.8˚E). The summer deviation may be partly attributable to above-normal SSTs in seas east of the Philippines and associated active convection in the region.

The mean duration of TCs sustaining TS intensity or higher was 4.7 days, shorter than that of the 30-year average** (5.3 days). The mean duration of TCs sustaining TS intensity or higher formed in summer was 4.2 days, shorter than that of the 30-year average** (5.1 days), and the mean duration of TCs sustaining TS intensity or higher formed in autumn was 4.9 days, shorter than that of the 30-year average** (5.6 days).

*** The 30-year averaging period is from 1981 to 2010*

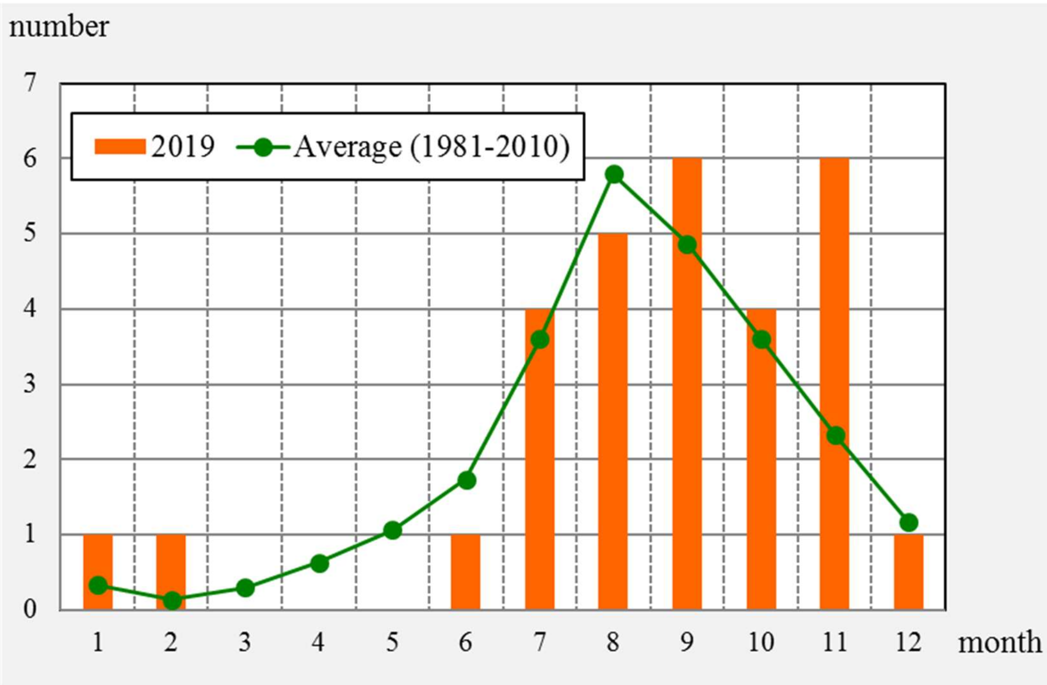



Figure 3.2 Monthly number of named TC formations for 2019 compared to the climatological normal

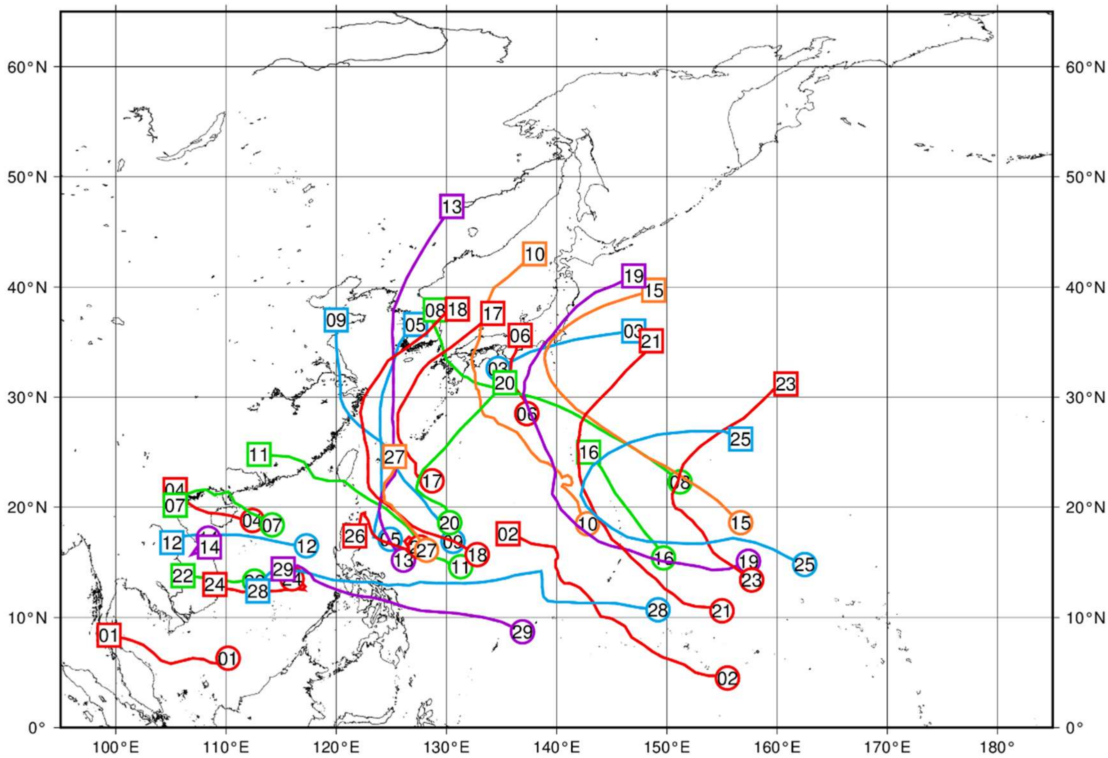



Figure 3.3 Tracks of the 29 named TCs forming in 2019. TC tracks for those with an intensity of TS or higher are shown.

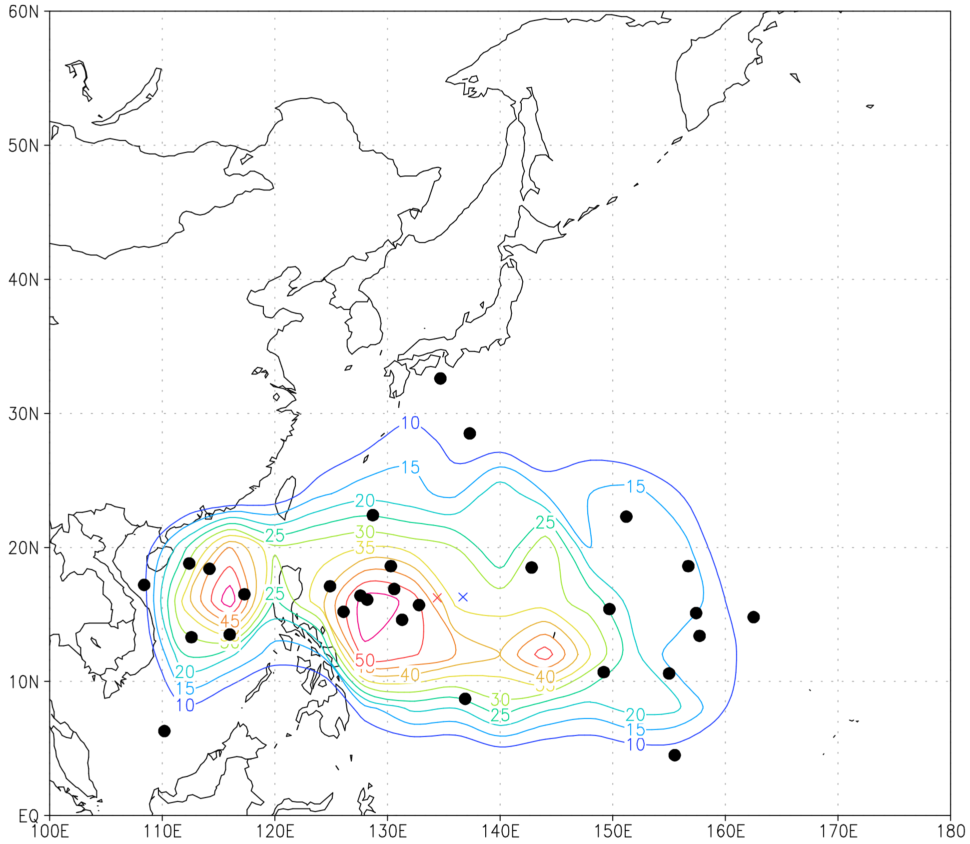



Figure 3.4 Genesis points of the 29 named TCs forming in 2019 (dots) and related frequency distribution for 1951 - 2018 (lines). Red and blue crosses show the mean genesis points of TCs forming in 2019 and the 30-year average period (1981 – 2010), respectively.

# Chapter 4

# Verification of Forecasts and Other Products in 2019

## 4.1 Verification of Operational Forecasts

Operational forecasts (i.e., official forecasts) for the 29 TCs of TS intensity or higher that formed in 2019 were verified using RSMC TC best track data. The verified elements were forecasts of the center position (up to five days ahead), central pressure and maximum sustained wind (up to five days ahead since March 2019). The position and intensity errors of operational forecasts for each named TC forming in 2019 are indicated 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 2019 were 80, 127, 190, 263 and 374 km for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively. The errors of 96-hour forecast in 2019 were compatible with lowest record in 2015, and those of 120-hour forecasts were the second lowest next to those in 2015.

The annual mean improvement ratios in relation to the climatology and persistence model (CLIPER)[3] since 2011 are shown in Figure 4.2 to support evaluation of the net improvement of operational forecasting performance less affected by the year-to-year fluctuations seen in Figure 4.1. 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 2019 were 49% (64% in 2018), 66% (73%), 65% (73%), 61% (69%) and 56% (66%), respectively.

The details of errors including improvement ratios to CLIPER for each named TC forming in 2019 are summarized in Table 4.1. Forecasts for Danas (1905), Neoguri (1920) and Halong (1923) were characterized by large errors. Those in forecasts for Danas (1905) were attributed to the fact that guidance models did not properly predict velocity changes from steering flow associated with the North Pacific Subtropical High and showed westward errors in the middle stage. Those in forecasts for Neoguri (1920) were attributed to the fact that guidance models did not properly predict the direction of movement in early

[3] As CLIPER prediction has been upgraded, prediction characteristics for 2019 differ from those in 2018 described in the previous RSMC report.

stage or acceleration after recurvature associated with an upper cold low. Those in forecasts for Halong (1923) were attributed to the fact that some guidance models showed a weaker North Pacific Subtropical High, which led to large track errors. Meanwhile, forecasts for Wipha (1907), Nakri (1924) and Phanfone (1929) showed relatively small errors.

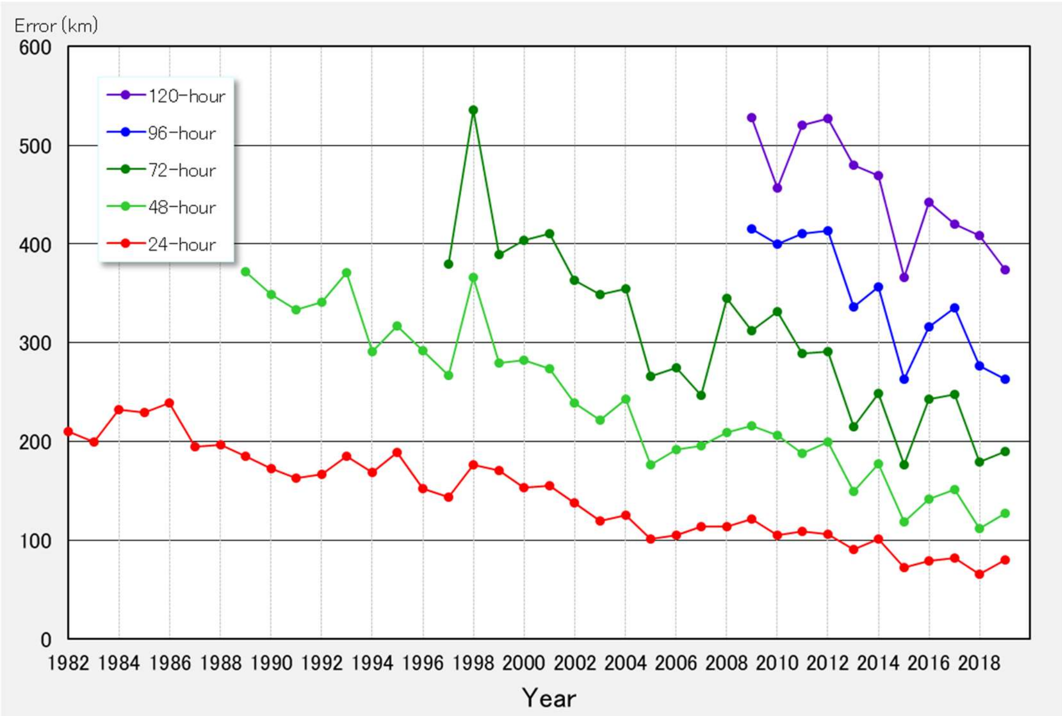



Figure 4.1 Annual mean position errors in 24-, 48-, 72-, 96- and 120-hour operational track forecasts

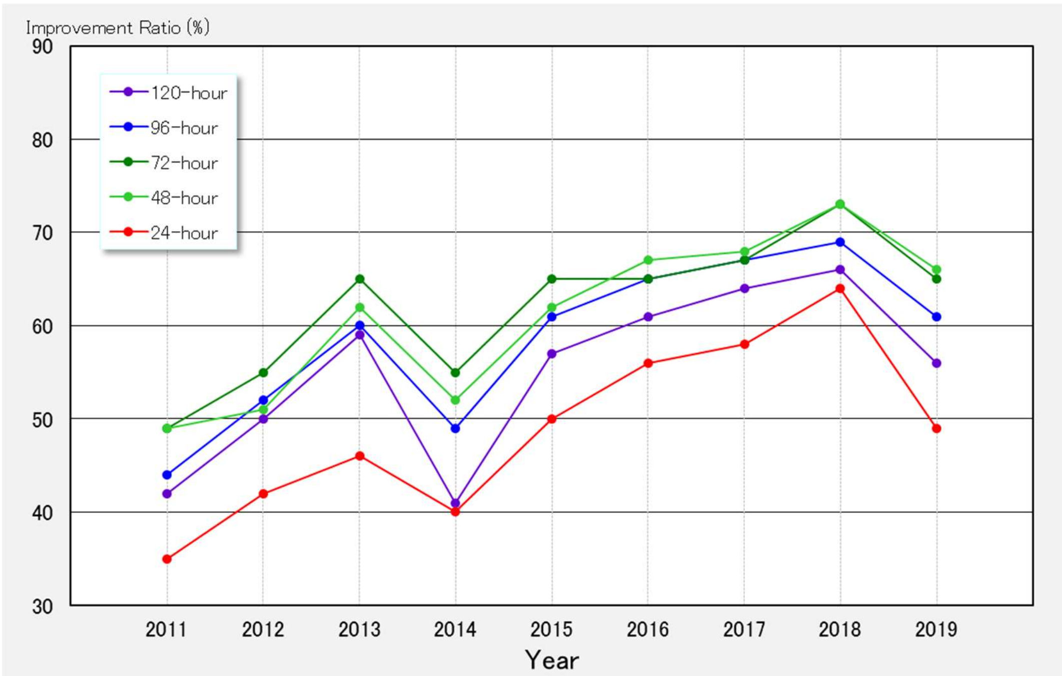



Figure 4.2 Annual mean improvement ratios in 24-, 48-, 72-, 96- and 120-hour operational track forecasts. As CLIPER prediction has been upgraded, prediction characteristics for 2019 differ from those in 2018 described in the previous RSMC report.

Table 4.1 Mean position errors of 24-, 48-, 72-, 96- and 120-hour operational forecasts for each named TC forming in 2019. S.D., Impr. and Num. represent the standard deviation of operational forecast position errors, the ratios of position errors in operational forecasts to those in CLIPER predictions 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 | Pabuk | (1901) | 64 | 26 | 10 | 55 | 99 | 39 | 6 | 36 | 137 | 22 | 2 | 66 | - | - | 0 | - | - | - | 0 | - |
| TY | Wutip | (1902) | 61 | 41 | 30 | 53 | 91 | 49 | 26 | 67 | 142 | 72 | 22 | 67 | 196 | 119 | 18 | 69 | 388 | 108 | 14 | 46 |
| TS | Sepat | (1903) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Mun | (1904) | 114 | 10 | 4 | -27 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Danas | (1905) | 150 | 106 | 14 | 41 | 288 | 120 | 10 | 54 | 455 | 102 | 6 | 59 | 608 | 15 | 2 | 71 | - | - | 0 | - |
| TS | Nari | (1906) | 133 | 11 | 2 | 15 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Wipha | (1907) | 47 | 27 | 11 | 60 | 45 | 14 | 6 | 80 | 41 | 18 | 2 | 87 | - | - | 0 | - | - | - | 0 | - |
| TY | Francisco | (1908) | 59 | 27 | 14 | 69 | 87 | 39 | 10 | 84 | 124 | 46 | 6 | 88 | 312 | 20 | 2 | 78 | - | - | 0 | - |
| TY | Lekima | (1909) | 68 | 35 | 30 | 40 | 139 | 70 | 26 | 38 | 198 | 114 | 22 | 40 | 286 | 132 | 18 | 35 | 351 | 171 | 14 | 30 |
| TY | Krosa | (1910) | 58 | 28 | 37 | 58 | 102 | 60 | 33 | 67 | 154 | 89 | 29 | 65 | 215 | 141 | 25 | 66 | 286 | 190 | 21 | 65 |
| STS | Bailu | (1911) | 89 | 56 | 14 | 44 | 106 | 33 | 10 | 76 | 147 | 37 | 6 | 75 | 214 | 66 | 2 | 67 | - | - | 0 | - |
| TS | Podul | (1912) | 137 | 38 | 4 | 29 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Lingling | (1913) | 56 | 34 | 20 | 69 | 120 | 69 | 16 | 73 | 179 | 90 | 12 | 71 | 196 | 176 | 8 | 75 | 260 | 146 | 4 | 81 |
| TS | Kajiki | (1914) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Faxai | (1915) | 66 | 48 | 17 | 71 | 83 | 49 | 12 | 83 | 119 | 41 | 7 | 81 | 267 | 67 | 3 | 64 | - | - | 0 | - |
| TS | Peipah | (1916) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Tapah | (1917) | 55 | 24 | 12 | 69 | 83 | 41 | 8 | 85 | 97 | 45 | 3 | 90 | - | - | 0 | - | - | - | 0 | - |
| TY | Mitag | (1918) | 63 | 19 | 17 | 65 | 83 | 39 | 13 | 82 | 191 | 83 | 9 | 76 | 220 | 100 | 5 | 83 | 230 | 0 | 1 | 85 |
| TY | Hagibis | (1919) | 64 | 30 | 26 | 59 | 105 | 56 | 22 | 72 | 156 | 67 | 18 | 74 | 278 | 104 | 14 | 57 | 463 | 96 | 10 | 39 |
| TY | Neoguri | (1920) | 196 | 118 | 13 | -10 | 388 | 91 | 8 | 21 | 976 | 94 | 3 | -87 | - | - | 0 | - | - | - | 0 | - |
| TY | Bualoi | (1921) | 55 | 30 | 21 | 59 | 124 | 40 | 16 | 62 | 222 | 47 | 12 | 60 | 328 | 50 | 8 | 61 | 352 | 72 | 4 | 75 |
| STS | Matmo | (1922) | 65 | 25 | 2 | -18 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Halong | (1923) | 110 | 137 | 22 | 15 | 117 | 116 | 18 | 60 | 199 | 100 | 13 | 54 | 476 | 316 | 9 | 9 | 829 | 460 | 5 | 5 |
| TY | Nakri | (1924) | 51 | 26 | 17 | 40 | 79 | 27 | 13 | 70 | 126 | 48 | 9 | 73 | 128 | 40 | 5 | 74 | 86 | 0 | 1 | 81 |
| TY | Fengshen | (1925) | 145 | 85 | 18 | 49 | 261 | 112 | 14 | 63 | 315 | 214 | 9 | 68 | 212 | 100 | 5 | 67 | 369 | 0 | 1 | 53 |
| TY | Kalmaegi | (1926) | 117 | 72 | 18 | 30 | 141 | 68 | 14 | 54 | 251 | 41 | 10 | 30 | 473 | 153 | 6 | -15 | 516 | 40 | 2 | 42 |
| STS | Fung-wong | (1927) | 131 | 32 | 6 | 25 | 401 | 30 | 2 | -63 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Kammuri | (1928) | 80 | 38 | 35 | 48 | 130 | 73 | 31 | 62 | 194 | 122 | 27 | 62 | 263 | 168 | 23 | 66 | 365 | 211 | 19 | 67 |
| TY | Phanfone | (1929) | 49 | 30 | 18 | 54 | 61 | 30 | 14 | 74 | 67 | 35 | 10 | 79 | 96 | 61 | 6 | 64 | 197 | 9 | 2 | 31 |
| Annual Mean (Total) | | | 80 | 66 | 432 | 49 | 127 | 95 | 328 | 66 | 190 | 144 | 237 | 65 | 263 | 173 | 159 | 61 | 374 | 226 | 98 | 56 |

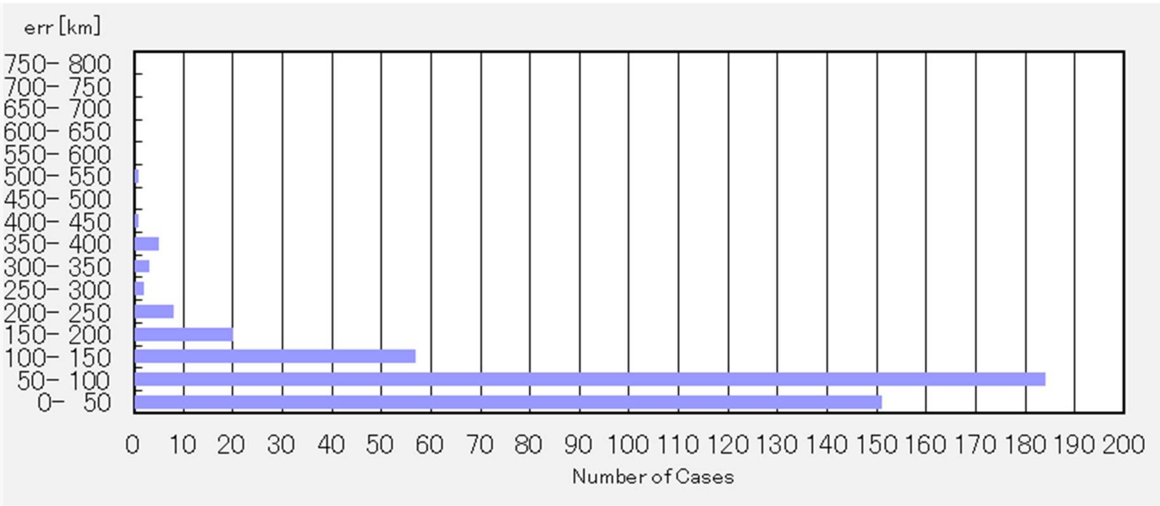



Figure 4.3 Histogram of 24-hour forecast position errors in 2019. (Histograms for 48-, 72-, 96- and 120-hour forecasts are available on the Center's website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2019/index.html)).

Figure 4.3 shows a histogram of 24-hour forecast position errors. About 91% (94% in 2018) of 24-hour forecasts, 94% (96%) of 48-hour forecasts, 97% (96%) of 72-hour forecasts, 92% (90%) of 96-hour forecasts and 90% (79%) of 120-hour forecasts had errors of less than 150, 300, 450, 500 and 600 km, respectively.

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 forming in 2019. Num. represents 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 | Pabuk | (1901) | 90 | 10 | 94 | 100 | 6 | 181 | 100 | 2 | 250 | - | 0 | - | - | 0 | - |
| TY | Wutip | (1902) | 83 | 30 | 100 | 88 | 26 | 184 | 91 | 22 | 256 | 100 | 18 | 430 | 100 | 14 | 609 |
| TS | Sepat | (1903) | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TS | Mun | (1904) | 25 | 4 | 106 | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TS | Danas | (1905) | 57 | 14 | 118 | 20 | 10 | 222 | 17 | 6 | 333 | 0 | 2 | 482 | - | 0 | - |
| TS | Nari | (1906) | 0 | 2 | 102 | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TS | Wipha | (1907) | 91 | 11 | 93 | 100 | 6 | 144 | 100 | 2 | 185 | - | 0 | - | - | 0 | - |
| TY | Francisco | (1908) | 71 | 14 | 82 | 90 | 10 | 144 | 100 | 6 | 241 | 100 | 2 | 426 | - | 0 | - |
| TY | Lekima | (1909) | 80 | 30 | 91 | 54 | 26 | 162 | 68 | 22 | 259 | 61 | 18 | 389 | 79 | 14 | 580 |
| TY | Krosa | (1910) | 76 | 37 | 81 | 76 | 33 | 143 | 72 | 29 | 226 | 72 | 25 | 315 | 86 | 21 | 435 |
| STS | Bailu | (1911) | 64 | 14 | 101 | 100 | 10 | 176 | 100 | 6 | 284 | 100 | 2 | 482 | - | 0 | - |
| TS | Podul | (1912) | 50 | 4 | 125 | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Lingling | (1913) | 65 | 20 | 90 | 75 | 16 | 164 | 83 | 12 | 272 | 88 | 8 | 426 | 100 | 4 | 625 |
| TS | Kajiki | (1914) | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Faxai | (1915) | 71 | 17 | 100 | 100 | 12 | 176 | 100 | 7 | 286 | 100 | 3 | 463 | - | 0 | - |
| TS | Peipah | (1916) | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Tapah | (1917) | 92 | 12 | 93 | 100 | 8 | 160 | 100 | 3 | 235 | - | 0 | - | - | 0 | - |
| TY | Mitag | (1918) | 88 | 17 | 89 | 100 | 13 | 152 | 56 | 9 | 235 | 80 | 5 | 348 | 100 | 1 | 519 |
| TY | Hagibis | (1919) | 73 | 26 | 82 | 73 | 22 | 144 | 72 | 18 | 216 | 57 | 14 | 315 | 40 | 10 | 422 |
| TY | Neoguri | (1920) | 31 | 13 | 114 | 0 | 8 | 194 | 0 | 3 | 309 | - | 0 | - | - | 0 | - |
| TY | Bualoi | (1921) | 81 | 21 | 86 | 38 | 16 | 144 | 42 | 12 | 232 | 50 | 8 | 315 | 100 | 4 | 532 |
| STS | Matmo | (1922) | 100 | 2 | 83 | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Halong | (1923) | 77 | 22 | 109 | 83 | 18 | 204 | 100 | 13 | 331 | 44 | 9 | 475 | 40 | 5 | 639 |
| TY | Nakri | (1924) | 82 | 17 | 84 | 92 | 13 | 135 | 89 | 9 | 202 | 100 | 5 | 270 | 100 | 1 | 370 |
| TY | Fengshen | (1925) | 33 | 18 | 90 | 14 | 14 | 155 | 44 | 9 | 251 | 80 | 5 | 359 | 100 | 1 | 519 |
| TY | Kalmaegi | (1926) | 44 | 18 | 116 | 79 | 14 | 196 | 80 | 10 | 285 | 33 | 6 | 398 | 50 | 2 | 519 |
| STS | Fung-wong | (1927) | 33 | 6 | 108 | 0 | 2 | 153 | - | 0 | - | - | 0 | - | - | 0 | - |
| TY | Kammuri | (1928) | 43 | 35 | 81 | 61 | 31 | 145 | 67 | 27 | 230 | 70 | 23 | 322 | 79 | 19 | 468 |
| TY | Phanfone | (1929) | 83 | 18 | 82 | 100 | 14 | 128 | 100 | 10 | 204 | 100 | 6 | 278 | 100 | 2 | 370 |
| Annual Mean (Total) | | | 69 | 432 | 93 | 72 | 328 | 162 | 75 | 237 | 249 | 72 | 159 | 363 | 80 | 98 | 509 |

Table 4.2 presents the mean hitting ratios and radii of 70% probability circles* provided in operational forecasts for each named TC forming in 2019. 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 93 km (110 km in 2018), and their hitting ratio was 69% (82%). The corresponding values for 48-hour forecasts were 162 km (203 km in 2018) and 72% (89%), those for 72-hour forecasts were 249 km (279 km in 2018) and 75% (82%), those for 96-hour forecasts were 363 km (419 km in 2018) and 72% (82%), and those for 120-hour forecasts were 509 km (610 km in 2018) and 80% (78%).

** Probability circle: a circular range in which a TC is expected to be located with a probability of 70% at each forecast time*

### 4.1.2 Central Pressure and Maximum Wind Speed

Figure 4.4 shows annual means of root mean square errors (RMSEs) for TC central pressure 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 are available on the Center's website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2019/index.html).

Operational TC intensity forecasts have improved recently after a long period with no notable enhancement, although year-to-year fluctuations exist, as seen in the slightly higher accuracy observed in

2019 compared to 2018. The annual mean RMSEs of central pressure for 24-, 48-, 72- 96- and 120-hour forecasts were 11.2 hPa (13.8 hPa in 2018), 15.1 hPa (18.7 hPa), 17.6 hPa (20.4 hPa) 18.2 hPa and 20.3 hPa, respectively. The corresponding values for maximum wind speed were 5.1 m/s (5.4 m/s in 2018), 7.1 m/s (6.9 m/s), 8.0 m/s (7.3 m/s), 8.4 m/s and 9.3 m/s, respectively.

Figure 4.5 shows annual mean improvement ratios for a guidance model based on climatology and persistence (Statistical Hurricane Intensity Forecast; SHIFOR) to highlight the net improvement of operational central pressure forecast performance less affected by the year-to-year fluctuations seen in Figure 4.4. The values are defined as

$$\left(\mathrm{RMSE(SHIFOR)} - \mathrm{RMSE(Operational)}\right) \ / \ \mathrm{RMSE(SHIFOR)},$$

with positive/negative values indicating better/worse operational forecasts than SHIFOR predictions. The values for maximum wind speed forecasts are available on the Center' website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2019/index.html). It can be seen that 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 20% (16% in 2018), 21% (9%), 14% (3% in 2018), 2% and -15%, respectively. The corresponding values of maximum wind were 17% (12% in 2018), 17% (18%), 16% (23%), -1% and -31%, respectively.

The details of errors in operational central pressure forecasts, including improvement ratios to SHIFOR for each named TC forming in 2019, are summarized in Table 4.3. The data for maximum wind speed forecasts are available on the Center's website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2019/index.html). Forecasts for Krosa (1910), Neoguri (1920) and Kammuri (1928) were characterized by large errors. For Krosa (1910), TC intensity in preliminary analysis was higher than that of the best track, which led to larger errors in prediction from intensity guidance models such as TIFS. For Neoguri (1920), the errors were attributed to the fact that guidance models did not predict rapid intensification after the middle stage due in part to intensification of upper-level divergence associated with an upper-level high. The errors for Kammuri (1928) were attributed to the fact that guidance models overestimated peak intensity in the middle stage. The large errors resulted in a negative annual mean of the improvement ratio for 120-hour pressure forecasts in 2019 due to a relatively large number of samples.

Figure 4.6 shows a histogram of maximum wind speed errors for 24-hour forecasts. Approximately 56% (64% in 2018) of 24-hour forecasts had errors of less than ±3.75 m/s, with figures of ±6.25 m/s for 66% (76%) of 48-hour forecasts, ±6.25 m/s for 58% (68%) of 72-hour forecasts, ±8.75 m/s for 66% of 96-hour forecasts and ±8.75 m/s for 57% of 120-hour forecasts.

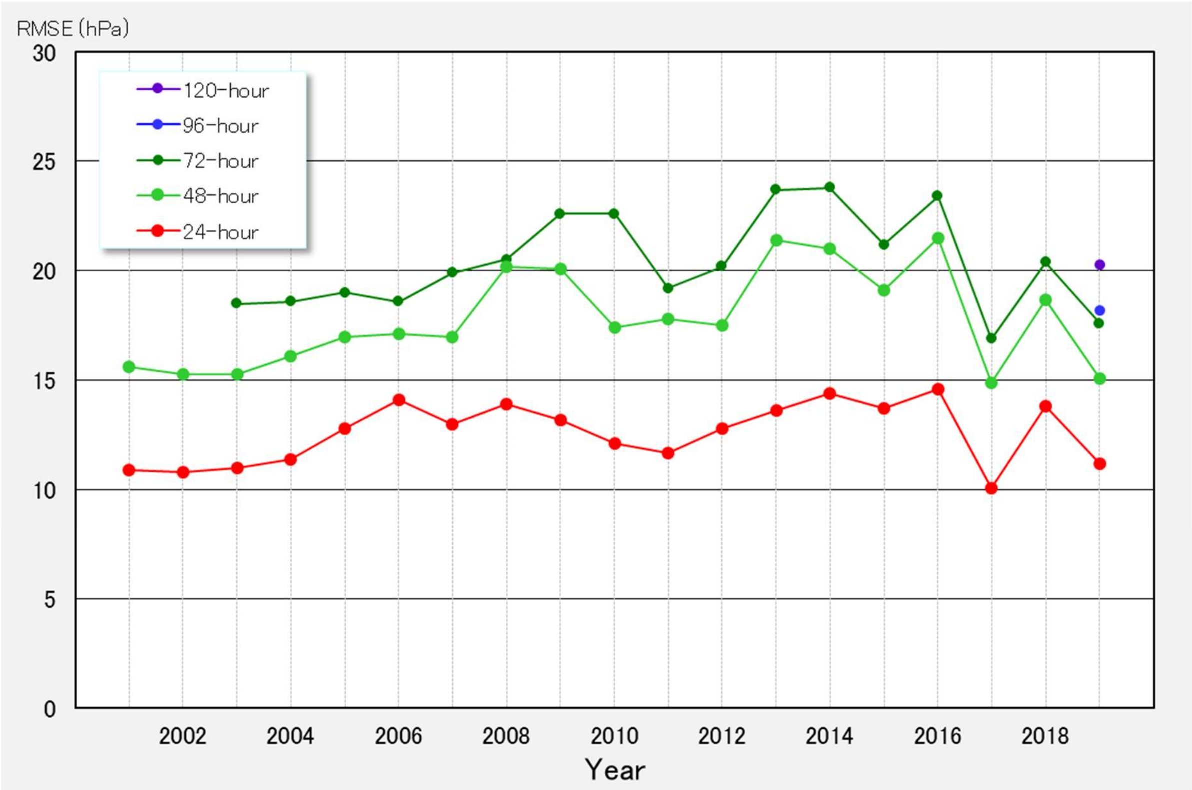



Figure 4.4 Annual RMSEs in 24-, 48-, 72-, 96- and 120-hour operational central pressure forecasts

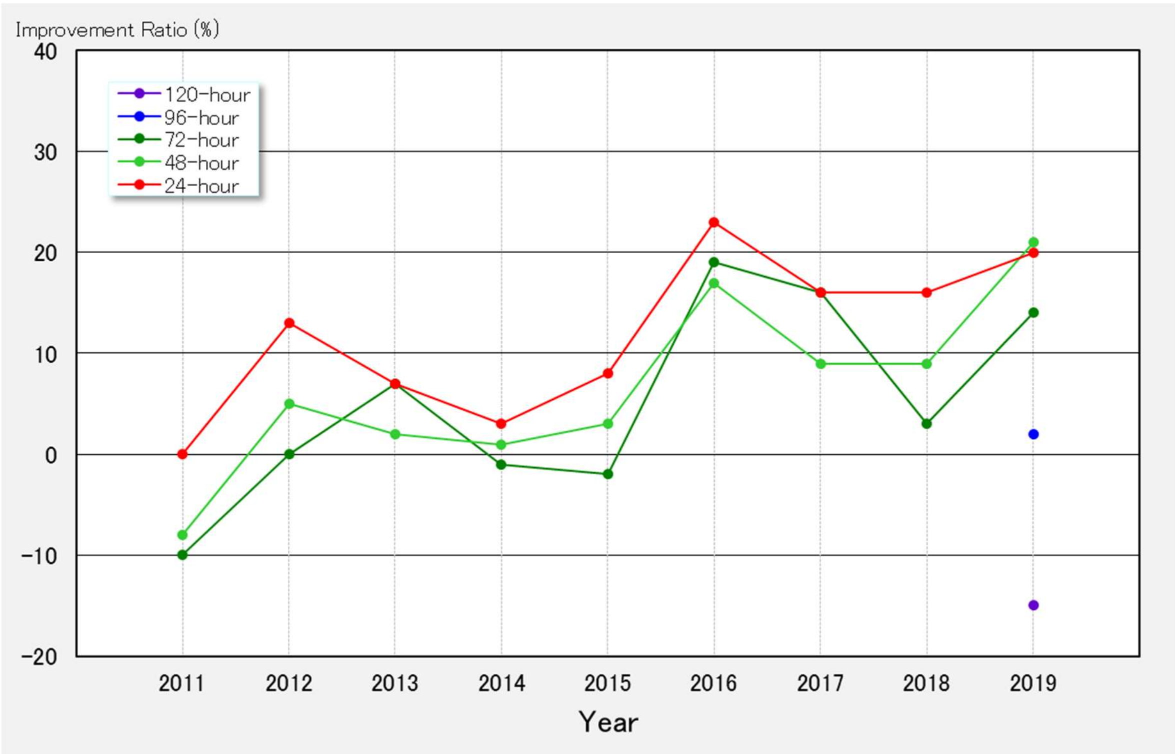



Figure 4.5 Annual mean improvement ratios in 24-, 48, 72-, 96- and 120-hour operational central pressure forecasts

Table 4.3 Mean intensity errors of 24-, 48-, 72-, 96- and 120-hour operational central pressure forecasts for each named TC forming in 2019. Impr. and Num. represent the ratios of RMSEs of operational forecasts to those of SHIFOR predictions and 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 | Pabuk | (1901) | -1.6 | 2.7 | 10 | 47 | -4.3 | 5.0 | 6 | 42 | -5.0 | 5.8 | 2 | 29 | | | | | | | | |
| TY | Wutip | (1902) | 5.2 | 14.4 | 30 | 29 | 10.4 | 17.4 | 26 | 36 | 15.0 | 18.3 | 22 | 35 | | | | | | | | |
| TS | Sepat | (1903) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Mun | (1904) | -0.5 | 1.7 | 4 | 77 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Danas | (1905) | -0.9 | 1.7 | 14 | 73 | -2.4 | 3.9 | 10 | 69 | -1.5 | 2.6 | 6 | 87 | -2.0 | 2.8 | 2 | 89 | - | - | 0 | - |
| TS | Nari | (1906) | 4.0 | 4.0 | 2 | 35 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TS | Wipha | (1907) | -0.4 | 2.8 | 11 | 63 | 0.2 | 2.5 | 6 | 82 | -2.0 | 2.0 | 2 | 90 | - | - | 0 | - | - | - | 0 | - |
| TY | Francisco | (1908) | 1.6 | 7.1 | 14 | 56 | -0.3 | 6.9 | 10 | 32 | -4.0 | 7.9 | 6 | 56 | -17.5 | 17.7 | 2 | 48 | - | - | 0 | - |
| TY | Lekima | (1909) | 4.1 | 7.9 | 30 | 42 | 5.3 | 14.9 | 26 | 23 | 11.1 | 21.3 | 22 | -2 | 13.2 | 21.4 | 18 | -6 | 11.3 | 14.4 | 14 | -1 |
| TY | Krosa | (1910) | -6.3 | 10.8 | 37 | -15 | -12.7 | 15.4 | 33 | -105 | -13.6 | 16.4 | 29 | -312 | -12.5 | 14.8 | 25 | -275 | -9.4 | 12.7 | 21 | -118 |
| STS | Bailu | (1911) | -2.3 | 4.7 | 14 | 52 | -5.1 | 7.4 | 10 | 65 | -2.7 | 6.0 | 6 | 81 | 2.0 | 2.8 | 2 | 92 | - | - | 0 | - |
| TS | Podul | (1912) | -2.5 | 2.6 | 4 | 78 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Lingling | (1913) | 0.9 | 10.5 | 20 | 19 | 7.2 | 16.1 | 16 | 13 | 10.0 | 21.0 | 12 | -25 | 11.3 | 14.8 | 8 | -83 | 10.5 | 10.5 | 4 | 7 |
| TS | Kajiki | (1914) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Faxai | (1915) | 7.5 | 8.6 | 17 | 20 | 13.0 | 15.5 | 12 | -16 | 18.9 | 22.0 | 7 | -97 | 14.3 | 15.5 | 3 | 33 | - | - | 0 | - |
| TS | Peipah | (1916) | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Tapah | (1917) | 2.8 | 6.5 | 12 | 13 | 2.5 | 9.0 | 8 | -9 | -3.3 | 5.8 | 3 | -14 | - | - | 0 | - | - | - | 0 | - |
| TY | Mitag | (1918) | -4.4 | 6.1 | 17 | 24 | -5.1 | 7.1 | 13 | 46 | -8.4 | 10.6 | 9 | 46 | -12.2 | 14.0 | 5 | 45 | -7.0 | 7.0 | 1 | 76 |
| TY | Hagibis | (1919) | 1.3 | 18.2 | 26 | 17 | 1.4 | 12.9 | 22 | 43 | -1.7 | 7.3 | 18 | 65 | -5.4 | 7.2 | 14 | 66 | -14.5 | 17.5 | 10 | -28 |
| TY | Neoguri | (1920) | 6.8 | 11.8 | 13 | 8 | 19.5 | 22.4 | 8 | -156 | 17.3 | 18.1 | 3 | -44 | - | - | 0 | - | - | - | 0 | - |
| TY | Bualoi | (1921) | -4.8 | 12.2 | 21 | -2 | -4.7 | 11.8 | 16 | 28 | -8.8 | 16.4 | 12 | 7 | -16.9 | 18.6 | 8 | 14 | -26.3 | 26.6 | 4 | 9 |
| STS | Matmo | (1922) | 4.0 | 4.5 | 2 | 72 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Halong | (1923) | 2.5 | 15.9 | 22 | 36 | 8.4 | 25.2 | 18 | 33 | 9.3 | 27.9 | 13 | 30 | 6.8 | 17.6 | 9 | 20 | 4.6 | 11.0 | 5 | 62 |
| TY | Nakri | (1924) | -4.0 | 6.6 | 17 | 29 | -6.8 | 10.3 | 13 | 38 | -4.2 | 8.4 | 9 | 51 | -5.8 | 8.8 | 5 | 52 | -21.0 | 21.0 | 1 | 18 |
| TY | Fengshen | (1925) | 2.6 | 5.6 | 18 | 49 | 4.1 | 8.2 | 14 | 49 | 5.0 | 8.0 | 9 | 19 | 5.0 | 8.7 | 5 | 34 | -5.0 | 5.0 | 1 | 83 |
| TY | Kalmaegi | (1926) | -0.4 | 10.4 | 18 | -19 | -4.1 | 14.8 | 14 | -5 | 2.9 | 18.3 | 10 | -35 | 14.7 | 16.9 | 6 | -70 | 10.5 | 16.3 | 2 | -3 |
| STS | Fung-wong | (1927) | -3.5 | 4.0 | 6 | 58 | -7.5 | 8.3 | 2 | 55 | - | - | 0 | - | - | - | 0 | - | - | - | 0 | - |
| TY | Kammuri | (1928) | -12.7 | 17.4 | 35 | -10 | -17.0 | 21.7 | 31 | -11 | -21.3 | 25.5 | 27 | -33 | -25.6 | 29.6 | 23 | -59 | -28.8 | 32.5 | 19 | -74 |
| TY | Phanfone | (1929) | -2.9 | 11.8 | 18 | 11 | 0.8 | 12.0 | 14 | 39 | 0.2 | 7.2 | 10 | 65 | -5.2 | 5.3 | 6 | 80 | -7.0 | 7.1 | 2 | 81 |
| Annual Mean (Total) | | | -0.8 | 11.2 | 432 | 20 | -0.8 | 15.1 | 328 | 21 | -0.9 | 17.6 | 237 | 14 | -5.1 | 18.2 | 141 | 2 | -9.5 | 20.3 | 84 | -15 |

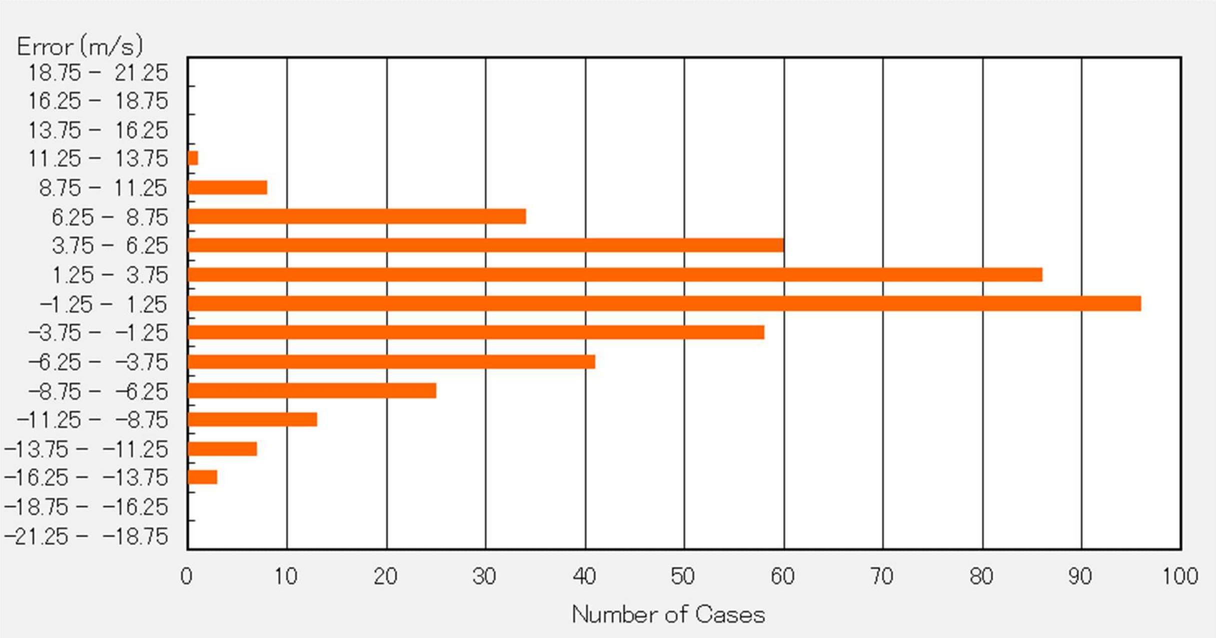



Figure 4.6 Histogram of 24-hour forecast maximum wind speed errors in 2019. (Histograms for 48-, 72-, 96- and 120-hour forecasts are also available on the Center's website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2019/index.html)).

## 4.2 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 6. 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.

### 4.2.1 GSM Prediction

#### 1) Center Position

GSM annual mean position errors observed since 1997 are presented in Figure 4.7. In 2019, the annual mean errors for 30-, 54-, 78-, 102- and 126-hour* predictions were 115 km (89 km in 2018), 180 km (145 km), 268 km (237 km), 385 km and 510 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 4.4.

* *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.*

Table 4.5 shows relative GSM performance compared with results obtained using the PER method*. 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 4.8). 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 47% (59% in 2018), 58% (70%), 68% (76%), 69% (75%), 70%

and 70% for 18-, 30-, 54-, 78-, 102- and 126-hour predictions, respectively.

About 75% (85% in 2018) of 30-hour predictions had errors of less than 150 km, while 85% (93%) of 54-hour predictions had errors of less than 300 km, and 85% (91%) of 78-hour predictions had errors of less than 450 km. Histograms showing the position errors of 30-, 54-, 78-, 102- and 126-hour predictions are available on the Center's website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2019/index.html).

** 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.*

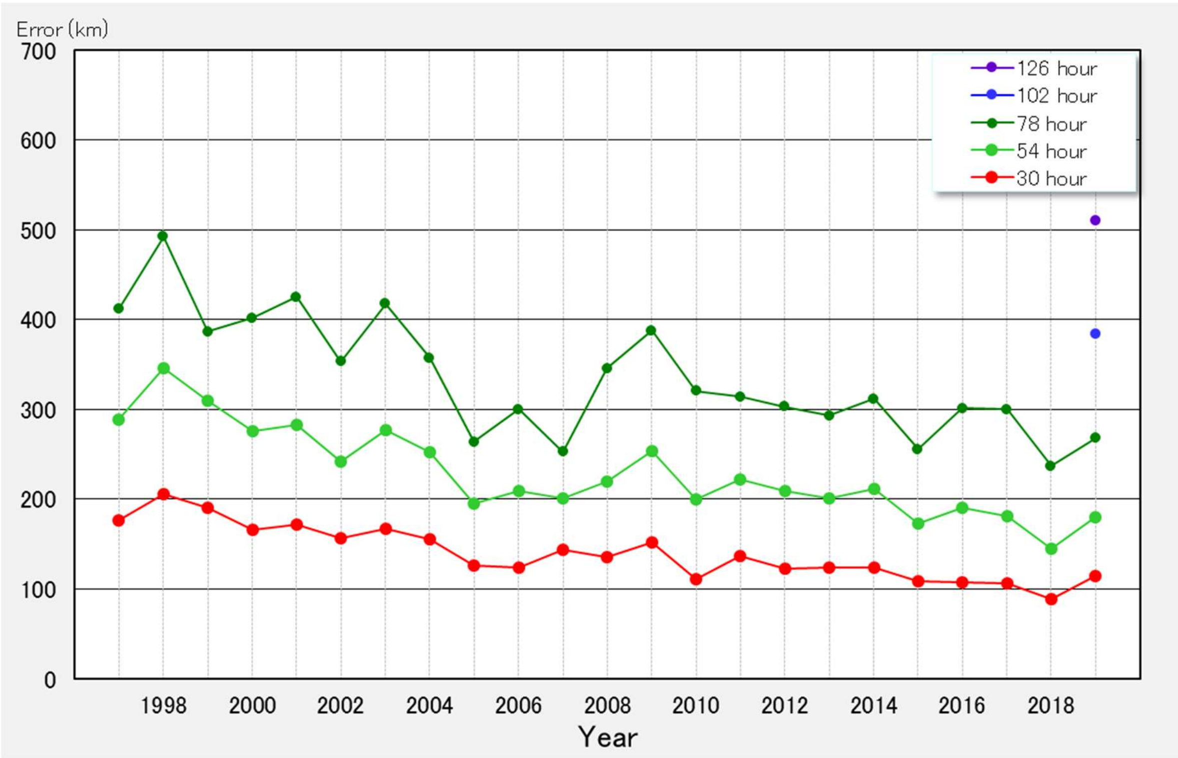



Figure 4.7 GSM annual mean position errors since 1997

Table 4.4 GSM mean position errors (km) for each named TC forming in 2019. 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 | PABUK | (1901) | 63.8 (15) | 66.0 (13) | 80.0 (11) | 112.0 (9) | 144.1 (7) | 151.0 (5) | 134.0 (3) | - (-) | - (-) | - (-) |
| TY | WUTIP | (1902) | 66.6 (35) | 80.1 (33) | 81.0 (31) | 91.8 (29) | 118.3 (27) | 162.7 (25) | 194.8 (23) | - (-) | - (-) | - (-) |
| TS | SEPAT | (1903) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TS | MUN | (1904) | 60.4 (7) | 122.8 (5) | 151.1 (3) | 135.1 (1) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TS | DANAS | (1905) | 124.4 (23) | 169.8 (21) | 221.8 (19) | 257.0 (17) | 348.7 (15) | 455.0 (13) | 509.4 (11) | 569.6 (9) | 658.9 (7) | 808.6 (5) |
| TS | NARI | (1906) | 49.1 (10) | 95.9 (8) | 160.1 (6) | 255.2 (3) | 362.5 (1) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TS | WIPHA | (1907) | 66.7 (14) | 71.0 (12) | 72.8 (10) | 84.2 (8) | 98.6 (6) | 63.6 (4) | 93.6 (1) | - (-) | - (-) | - (-) |
| TY | FRANCISCO | (1908) | 71.0 (19) | 97.5 (17) | 128.0 (15) | 172.8 (13) | 239.9 (11) | 282.3 (9) | 333.4 (7) | 389.6 (5) | 604.7 (3) | 752.6 (1) |
| TY | LEKIMA | (1909) | 70.1 (35) | 107.2 (33) | 158.6 (31) | 198.0 (29) | 242.9 (27) | 278.7 (25) | 322.0 (23) | 390.1 (21) | 484.6 (19) | 567.3 (17) |
| TY | KROSA | (1910) | 47.8 (42) | 66.3 (40) | 99.7 (38) | 142.9 (36) | 176.9 (34) | 227.3 (32) | 280.9 (30) | 328.2 (28) | 370.0 (26) | 420.1 (24) |
| STS | BAILU | (1911) | 114.0 (19) | 133.8 (17) | 144.5 (15) | 159.4 (13) | 161.2 (11) | 175.4 (9) | 195.5 (7) | 261.1 (5) | 426.5 (1) | - (-) |
| TS | PODUL | (1912) | 167.7 (14) | 322.7 (11) | 437.9 (8) | 635.4 (5) | 947.4 (3) | 1238.9 (3) | 1671.1 (1) | - (-) | - (-) | - (-) |
| TY | LINGLING | (1913) | 45.6 (23) | 58.4 (21) | 69.6 (19) | 77.0 (17) | 91.7 (15) | 143.2 (13) | 215.3 (11) | 304.1 (9) | 353.2 (7) | 488.1 (5) |
| TS | KAJIKI | (1914) | 114.6 (9) | 141.2 (7) | 177.3 (5) | 212.5 (3) | 221.8 (1) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TY | FAXAI | (1915) | 81.6 (29) | 130.4 (27) | 185.0 (25) | 256.1 (23) | 322.7 (21) | 374.8 (19) | 402.4 (14) | 386.7 (9) | 390.5 (6) | 364.1 (5) |
| TS | PEIPAH | (1916) | 237.7 (2) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TY | TAPAH | (1917) | 56.1 (19) | 78.4 (17) | 105.3 (15) | 116.7 (13) | 135.3 (11) | 136.1 (9) | 131.5 (7) | 145.3 (5) | 217.7 (3) | 287.9 (1) |
| TY | MITAG | (1918) | 80.0 (24) | 134.5 (22) | 194.3 (20) | 245.1 (18) | 306.0 (16) | 355.7 (14) | 452.9 (12) | 602.2 (10) | 821.9 (8) | 1044.4 (6) |
| TY | HAGIBIS | (1919) | 74.9 (30) | 99.4 (28) | 114.4 (26) | 131.5 (24) | 143.4 (22) | 133.4 (20) | 148.6 (18) | 206.1 (16) | 272.7 (14) | 362.9 (12) |
| TY | NEOGURI | (1920) | 151.8 (20) | 214.5 (18) | 303.1 (16) | 368.0 (14) | 483.1 (12) | 682.2 (10) | 964.1 (8) | 1348.3 (4) | 1363.6 (1) | - (-) |
| TY | BUALOI | (1921) | 63.4 (23) | 87.3 (21) | 106.3 (19) | 139.1 (17) | 187.4 (15) | 247.2 (13) | 313.8 (11) | 344.7 (9) | 321.2 (7) | 218.6 (5) |
| STS | MATMO | (1922) | 72.9 (7) | 115.6 (5) | 152.6 (3) | 218.7 (1) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TY | HALONG | (1923) | 111.6 (25) | 144.3 (23) | 156.4 (21) | 172.8 (19) | 207.9 (17) | 336.9 (15) | 549.6 (13) | 851.6 (11) | 1167.1 (9) | 1377.1 (7) |
| TY | NAKRI | (1924) | 49.5 (23) | 52.6 (21) | 70.5 (19) | 104.2 (17) | 148.3 (15) | 219.6 (13) | 305.6 (11) | 416.0 (9) | 498.9 (7) | 617.9 (4) |
| TY | FENGSHEN | (1925) | 102.4 (22) | 180.7 (20) | 264.8 (18) | 317.9 (16) | 387.1 (14) | 451.8 (12) | 390.4 (10) | 432.0 (8) | 626.3 (6) | 774.6 (4) |
| TY | KALMAEGI | (1926) | 140.1 (30) | 173.9 (28) | 203.8 (26) | 206.3 (24) | 208.8 (22) | 245.1 (20) | 328.0 (18) | 403.7 (16) | 446.6 (13) | 531.6 (11) |
| STS | FUNG-WONG | (1927) | 106.0 (12) | 196.2 (10) | 308.9 (8) | 497.9 (6) | 811.0 (3) | 1022.7 (1) | - (-) | - (-) | - (-) | - (-) |
| TY | KAMMURI | (1928) | 58.6 (38) | 77.0 (36) | 100.5 (34) | 119.7 (32) | 152.1 (30) | 177.8 (28) | 189.3 (26) | 221.2 (24) | 266.0 (22) | 310.3 (20) |
| TY | PHANFONE | (1929) | 66.8 (29) | 84.9 (27) | 103.7 (25) | 129.2 (23) | 153.1 (21) | 185.0 (19) | 190.2 (17) | 205.8 (15) | 212.8 (13) | 217.4 (11) |
| Annual Mean (Total) | | | 82.4 (598) | 114.6 (541) | 147.8 (486) | 180.3 (430) | 219.4 (377) | 268.0 (331) | 313.7 (282) | 384.7 (213) | 449.6 (172) | 510.4 (138) |

Table 4.5 Mean position errors (km) of GSM and PER method predictions for the 29 named TCs forming in 2019 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 | 84.8 | (330) | 70.8 | (165) | 93.4 | (103) | 82.4 | (598) |
| | PER | 146.9 | (330) | 144.4 | (165) | 206.5 | (103) | 156.5 | (598) |
| | IMPROV | 42.3 % | | 50.9 % | | 54.8 % | | 47.3 % | |
| T=30 | GSM | 119.8 | (288) | 94.9 | (154) | 130.0 | (99) | 114.6 | (541) |
| | PER | 230.4 | (288) | 269.1 | (154) | 397.0 | (99) | 271.9 | (541) |
| | IMPROV | 48.0 % | | 64.8 % | | 67.3 % | | 57.9 % | |
| T=42 | GSM | 154.3 | (245) | 120.7 | (144) | 171.2 | (97) | 147.8 | (486) |
| | PER | 340.1 | (245) | 392.4 | (144) | 600.3 | (97) | 407.5 | (486) |
| | IMPROV | 54.6 % | | 69.2 % | | 71.5 % | | 63.7 % | |
| T=54 | GSM | 189.0 | (209) | 157.3 | (130) | 193.3 | (91) | 180.3 | (430) |
| | PER | 478.0 | (209) | 532.0 | (130) | 780.6 | (91) | 558.4 | (430) |
| | IMPROV | 60.5 % | | 70.4 % | | 75.2 % | | 67.7 % | |
| T=66 | GSM | 223.2 | (174) | 196.2 | (118) | 243.9 | (85) | 219.4 | (377) |
| | PER | 600.9 | (174) | 691.2 | (118) | 965.0 | (85) | 711.3 | (377) |
| | IMPROV | 62.9 % | | 71.6 % | | 74.7 % | | 69.2 % | |
| T=78 | GSM | 264.0 | (148) | 240.1 | (106) | 314.0 | (77) | 268.0 | (331) |
| | PER | 754.8 | (148) | 825.7 | (106) | 1171.9 | (77) | 874.6 | (331) |
| | IMPROV | 65.0 % | | 70.9 % | | 73.2 % | | 69.4 % | |
| T=90 | GSM | 282.0 | (118) | 281.5 | (91) | 404.9 | (73) | 313.7 | (282) |
| | PER | 886.5 | (118) | 960.5 | (91) | 1387.8 | (73) | 1040.1 | (282) |
| | IMPROV | 68.2 % | | 70.7 % | | 70.8 % | | 69.8 % | |
| T=102 | GSM | 331.6 | (87) | 320.2 | (63) | 522.6 | (63) | 384.7 | (213) |
| | PER | 1030.9 | (87) | 1209.3 | (63) | 1642.1 | (63) | 1264.4 | (213) |
| | IMPROV | 67.8 % | | 73.5 % | | 68.2 % | | 69.6 % | |
| T=114 | GSM | 354.3 | (69) | 401.0 | (53) | 632.6 | (50) | 449.6 | (172) |
| | PER | 1209.2 | (69) | 1299.6 | (53) | 2044.8 | (50) | 1480.0 | (172) |
| | IMPROV | 70.7 % | | 69.1 % | | 69.1 % | | 69.6 % | |
| T=126 | GSM | 407.7 | (57) | 474.2 | (42) | 699.6 | (39) | 510.4 | (138) |
| | PER | 1330.7 | (57) | 1455.3 | (42) | 2475.1 | (39) | 1692.1 | (138) |
| | IMPROV | 69.4 % | | 67.4 % | | 71.7 % | | 69.8 % | |

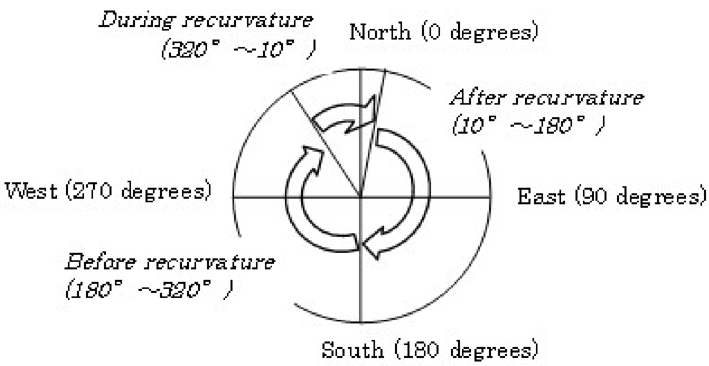
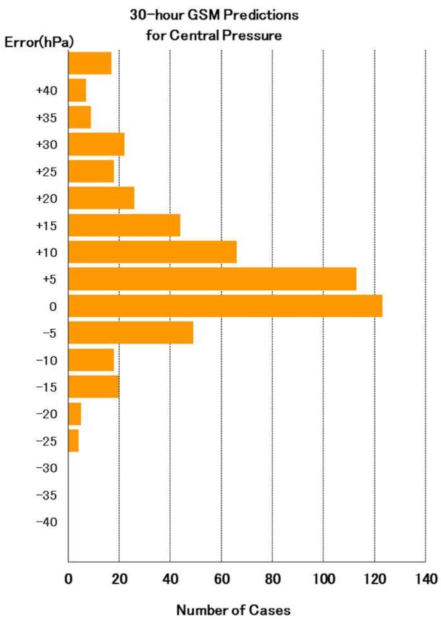



Figure 4.8 Definition of the stages before, during and after recurvature based on the direction of TC movement.

## 2) Central Pressure and Maximum Wind Speed

The mean errors of 30-, 54-, 78-, 102- and 126-hour GSM central pressure predictions in 2019 were +7.6 hPa (+11.4 hPa in 2018), +9.2 hPa (+12.6 hPa), +11.3 hPa (+12.9 hPa), +7.6 hPa and +4.5 hPa, respectively. Their root mean square errors (RMSEs) were 16.1 hPa (21.0 hPa in 2018) for 30-hour predictions, 20.3 hPa (24.4 hPa) for 54-hour predictions, 24.0 hPa (27.6 hPa) for 78-hour predictions, 22.7 hPa for 102-hour predictions and 19.7 hPa for 126-hour predictions. The biases for 30-, 54-, 78-, 102- and 126-hour maximum wind speed predictions were -6.6 m/s (-8.3 m/s in 2018) with a RMSE of 9.5 m/s (11.1 m/s), -7.2 m/s (-8.8 m/s) with a RMSE of 11.7 m/s (12.9 m/s), -8.3 m/s (-8.8 m/s) with a RMSE of 13.6 m/s (13.9 m/s), -6.8 m/s with a RMSE of 13.1 m/s and -5.4 m/s with a RMSE of 11.4 m/s, respectively.

Figure 4.9 shows histograms of central pressure errors and maximum wind speed errors in 30-hour GSM predictions. It can be seen that the GSM has a small positive bias for central pressure prediction (left) and tends to underestimate the wind speed of TCs (right). This underestimation occurs because the model's current horizontal resolution (about 20 km) is not fine enough to produce the TC core structure, especially when the TC is intense and small.



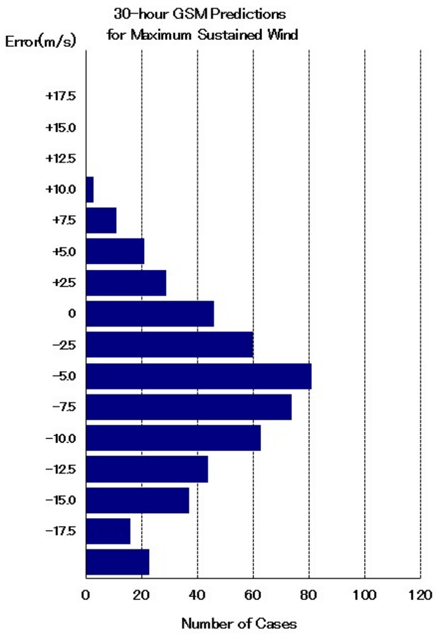




Figure 4.9 Error distribution of GSM 30-hour intensity predictions in 2019. The figure on the left shows error distribution for central pressure, while the one on the right shows that for maximum wind speed (the error distributions of 54-, 78-, 102- and 126-hour predictions are available on the Center's website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2019/index.html)).

### 4.2.2 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 4.10. In 2019, 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 4.6. The annual means of ensemble mean position errors for 30-, 54-, 78-, 102- and 126-hour predictions were 129 km (115 km with the GSM), 201 km (180 km), 281 km (268 km), 357 km (385 km) and 466 km (510 km), respectively.

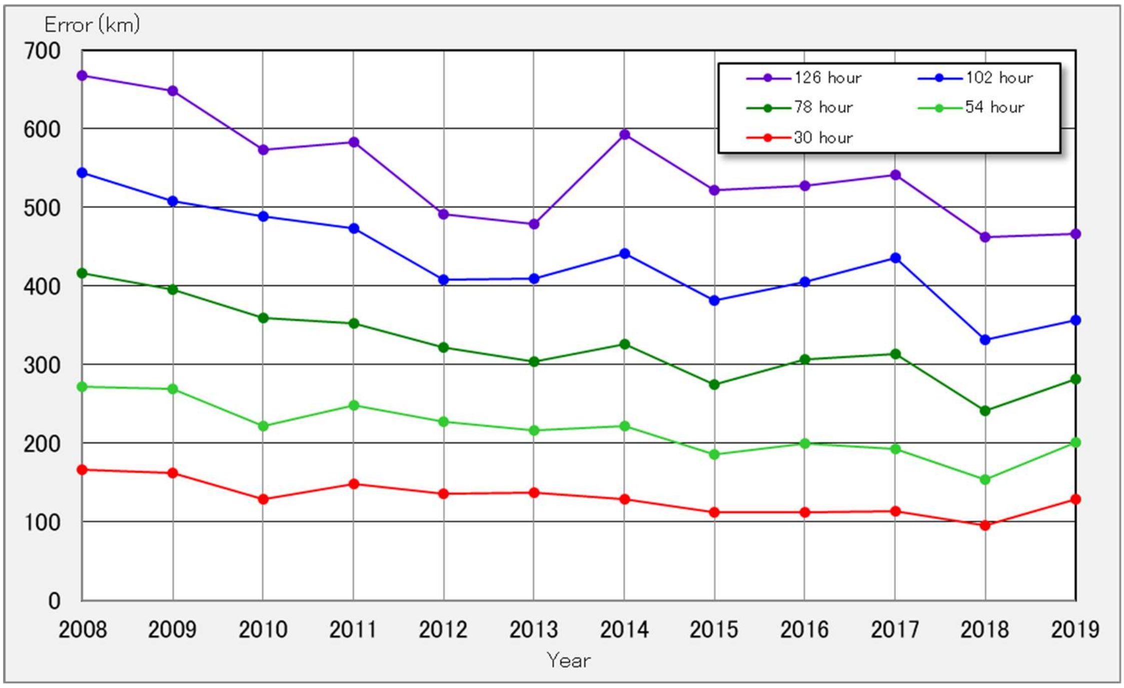



Figure 4.10 GEPS and TEPS annual mean position errors since 2008

### 2) Spread-Skill Relationship

Although position errors of GEPS ensemble mean forecasts were larger than those of the GSM in short-range forecasts, GEPS provides useful information on the reliability of TC track forecasts with its ensemble spread. Figure 4.11 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. The figure shows that significant errors were seen in 2019 only when GEPS predicted large spreads.

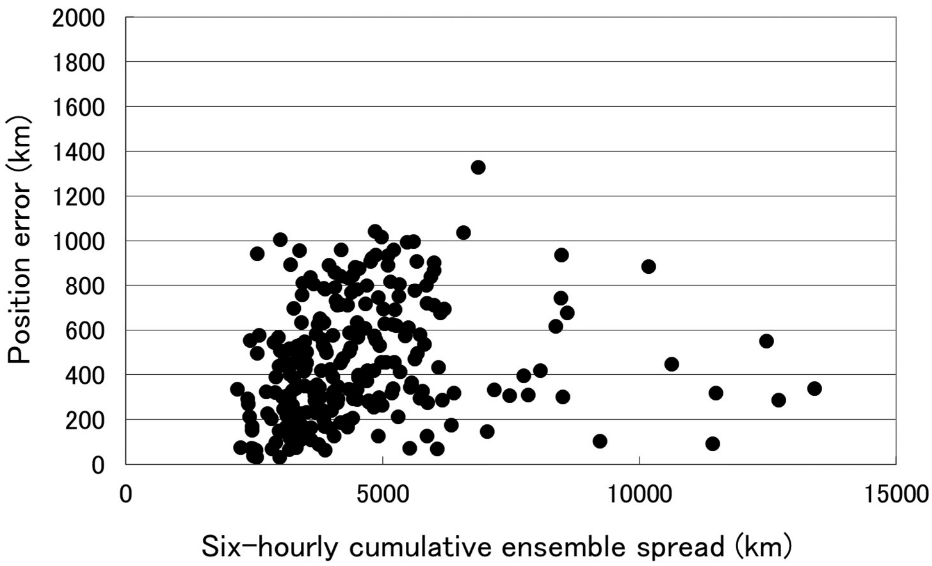



Figure 4.11 Relationship between six-hourly cumulative ensemble spread in TC position forecasts (km) and ensemble mean forecast position errors (km) in 126-hour predictions in 2019.

Table 4.6 Mean position errors (km) of GEPS ensemble mean forecasts for each named TC forming in 2019. 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 | PABUK | (1901) | 79.3 (15) | 86.4 (13) | 95.2 (11) | 101.5 (9) | 130.1 (7) | 138.8 (5) | 130.6 (3) | 135.2 (1) | - (-) | - (-) |
| TY | WUTIP | (1902) | 73.6 (35) | 94.7 (33) | 108.5 (31) | 119.4 (29) | 148.9 (27) | 194.4 (25) | 228.0 (23) | 243.0 (21) | 279.5 (19) | 391.0 (17) |
| TS | SEPAT | (1903) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TS | MUN | (1904) | 80.5 (7) | 135.1 (5) | 167.6 (3) | 156.3 (1) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TS | DANAS | (1905) | 135.8 (23) | 196.9 (21) | 255.5 (19) | 287.7 (17) | 381.3 (15) | 493.3 (13) | 576.4 (11) | 672.8 (9) | 804.9 (7) | 916.7 (4) |
| TS | NARI | (1906) | 59.3 (10) | 96.6 (8) | 128.8 (6) | 141.1 (2) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TS | WIPHA | (1907) | 73.9 (14) | 66.2 (12) | 75.0 (10) | 94.7 (8) | 96.8 (5) | 59.5 (2) | - (-) | - (-) | - (-) | - (-) |
| TY | FRANCISCO | (1908) | 72.2 (19) | 106.3 (17) | 141.2 (15) | 190.2 (13) | 258.0 (11) | 309.4 (9) | 396.3 (7) | 505.6 (5) | 711.0 (3) | 903.8 (1) |
| TY | LEKIMA | (1909) | 77.5 (35) | 118.7 (33) | 166.4 (31) | 207.1 (29) | 251.0 (27) | 286.4 (25) | 330.9 (23) | 391.6 (21) | 447.3 (19) | 504.9 (17) |
| TY | KROSA | (1910) | 52.0 (42) | 72.4 (40) | 104.7 (38) | 140.0 (36) | 180.7 (34) | 232.2 (32) | 291.4 (30) | 342.6 (28) | 384.7 (26) | 438.0 (24) |
| STS | BAILU | (1911) | 122.1 (19) | 145.5 (17) | 162.1 (15) | 173.7 (13) | 166.2 (11) | 204.0 (9) | 245.8 (7) | 293.6 (4) | 386.1 (1) | - (-) |
| TS | PODUL | (1912) | 193.3 (14) | 360.4 (12) | 547.7 (10) | 764.4 (8) | 1044.2 (6) | 1263.0 (4) | 1639.1 (1) | - (-) | - (-) | - (-) |
| TY | LINGLING | (1913) | 51.4 (23) | 65.2 (21) | 87.7 (19) | 102.2 (17) | 108.4 (15) | 153.1 (13) | 200.2 (11) | 275.0 (9) | 414.8 (7) | 586.0 (5) |
| TS | KAJIKI | (1914) | 98.8 (9) | 112.9 (7) | 185.0 (5) | 247.4 (3) | 182.7 (1) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TY | FAXAI | (1915) | 91.4 (29) | 125.0 (27) | 165.7 (25) | 222.0 (23) | 271.1 (20) | 309.8 (17) | 339.3 (13) | 348.3 (7) | 327.2 (5) | 276.0 (5) |
| TS | PEIPAH | (1916) | 407.1 (1) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TY | TAPAH | (1917) | 51.5 (18) | 70.1 (16) | 87.6 (14) | 104.4 (12) | 114.8 (10) | 131.9 (8) | 160.4 (6) | 219.2 (4) | 307.7 (2) | 127.5 (1) |
| TY | MITAG | (1918) | 100.0 (24) | 154.4 (22) | 217.6 (20) | 264.0 (18) | 319.5 (16) | 371.7 (14) | 439.1 (12) | 539.6 (10) | 672.6 (8) | 807.2 (6) |
| TY | HAGIBIS | (1919) | 79.6 (30) | 104.0 (28) | 123.2 (26) | 141.5 (24) | 149.1 (22) | 136.4 (20) | 137.3 (18) | 181.9 (16) | 236.5 (14) | 323.9 (12) |
| TY | NEOGURI | (1920) | 165.4 (17) | 262.4 (15) | 364.1 (13) | 462.7 (11) | 606.1 (9) | 850.0 (7) | 1088.7 (4) | 1669.5 (1) | - (-) | - (-) |
| TY | BUALOI | (1921) | 75.5 (23) | 103.1 (21) | 128.0 (19) | 165.2 (17) | 218.1 (15) | 279.5 (13) | 354.1 (11) | 388.2 (9) | 380.1 (7) | 351.6 (5) |
| STS | MATMO | (1922) | 77.9 (7) | 131.8 (5) | 183.4 (3) | 257.9 (1) | - (-) | - (-) | - (-) | - (-) | - (-) | - (-) |
| TY | HALONG | (1923) | 126.6 (24) | 179.5 (22) | 197.2 (20) | 192.6 (18) | 163.8 (16) | 216.0 (14) | 328.5 (12) | 468.8 (10) | 567.3 (8) | 740.8 (6) |
| TY | NAKRI | (1924) | 55.9 (23) | 53.0 (21) | 66.4 (19) | 97.9 (17) | 142.7 (15) | 213.3 (13) | 280.7 (11) | 354.8 (9) | 424.0 (7) | 399.2 (5) |
| TY | FENGSHEN | (1925) | 113.9 (22) | 212.3 (20) | 301.8 (18) | 361.1 (16) | 414.9 (14) | 455.4 (12) | 406.9 (10) | 314.5 (8) | 232.0 (6) | 210.7 (4) |
| TY | KALMAEGI | (1926) | 148.0 (30) | 195.3 (28) | 234.5 (26) | 252.6 (24) | 272.3 (22) | 317.3 (20) | 378.3 (18) | 441.0 (16) | 441.9 (14) | 444.0 (11) |
| STS | FUNG-WONG | (1927) | 128.9 (12) | 244.4 (10) | 376.3 (8) | 609.4 (6) | 875.0 (4) | 986.8 (2) | - (-) | - (-) | - (-) | - (-) |
| TY | KAMMURI | (1928) | 58.0 (38) | 74.1 (36) | 96.0 (34) | 110.9 (32) | 143.9 (30) | 185.4 (28) | 242.5 (26) | 320.4 (24) | 423.9 (22) | 546.4 (20) |
| TY | PHANFONE | (1929) | 84.5 (27) | 123.0 (25) | 151.4 (23) | 183.8 (21) | 199.3 (19) | 209.0 (17) | 216.6 (15) | 237.5 (13) | 257.0 (11) | 276.8 (9) |
| All Mean (Total) | | | 90.9 (590) | 128.5 (535) | 166.7 (481) | 201.3 (425) | 238.9 (371) | 281.1 (322) | 314.3 (272) | 356.9 (225) | 407.1 (186) | 466.0 (152) |

To add reliability information to TC track forecasts, JMA has introduced a reliability index in which the categories A, B and C represent the highest, middle and lowest levels of reliability, respectively. The index is based on the six-hourly cumulative ensemble spread at each forecast time. The category levels were set from the results of the pre-operational running of GEPS so that the category frequencies are 40%, 40% and 20%, respectively. Table 4.7 shows ensemble mean forecast errors classified with the reliability index. Theoretically, mean position errors with higher reliability should be smaller than those with lower reliability throughout forecast times with sufficient samples in an ideal EPS. The table shows that GEPS provides appropriate reliability information on 2019 TC track forecasts except for 126-hour predictions.

Table 4.7 Ensemble mean forecast position errors (km) in 2019 classified with six-hourly cumulative ensemble spread at each forecast time. The number of samples is given in parentheses.

| Time | Reliability Index | | | | | |
|---|---|---|---|---|---|---|
| | A | | B | | C | |
| T=30 | 82.1 | (148) | 123.6 | (268) | 170.1 | (211) |
| T=54 | 143.3 | (191) | 227.0 | (202) | 270.4 | (152) |
| T=78 | 216.2 | (173) | 316.3 | (173) | 360.0 | (97) |
| T=102 | 315.2 | (139) | 401.8 | (141) | 446.9 | (63) |
| T=126 | 343.0 | (99) | 539.5 | (111) | 510.0 | (38) |

## 4.3 Verification for Other Guidance Models

### 4.3.1 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 eight other centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP and UKMO). These models (as well as the Meteo France (FRN) model and the Naval Research Laboratory (NRL) 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 4.12 and 4.13 show the results of the verification for center positions and 72-hour intensity forecasts by WGNE.

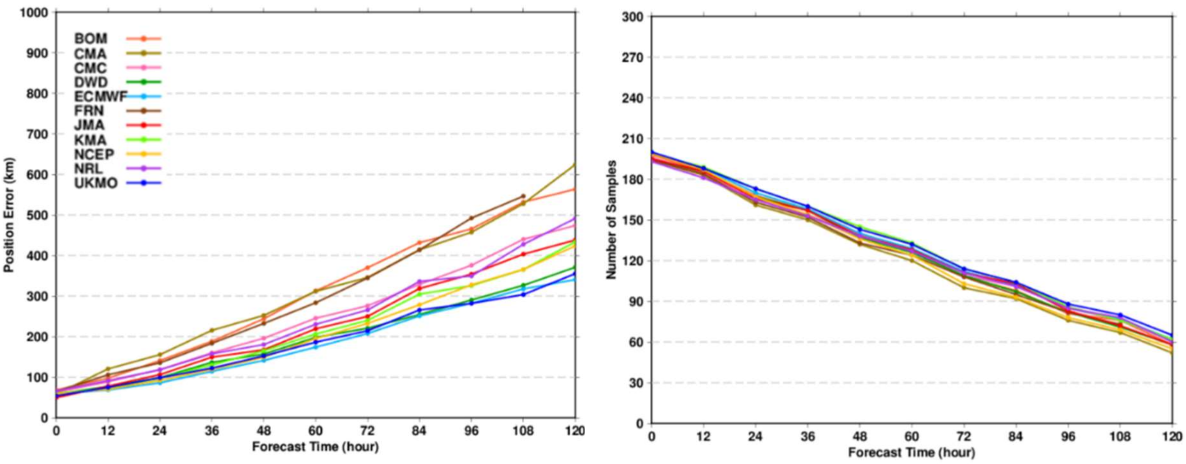



Figure 4.12 (Left) Positional errors for 2019 named TCs. The tropical depression (TD) stage of targeted TCs is also included in this verification. (Right) Sample numbers.

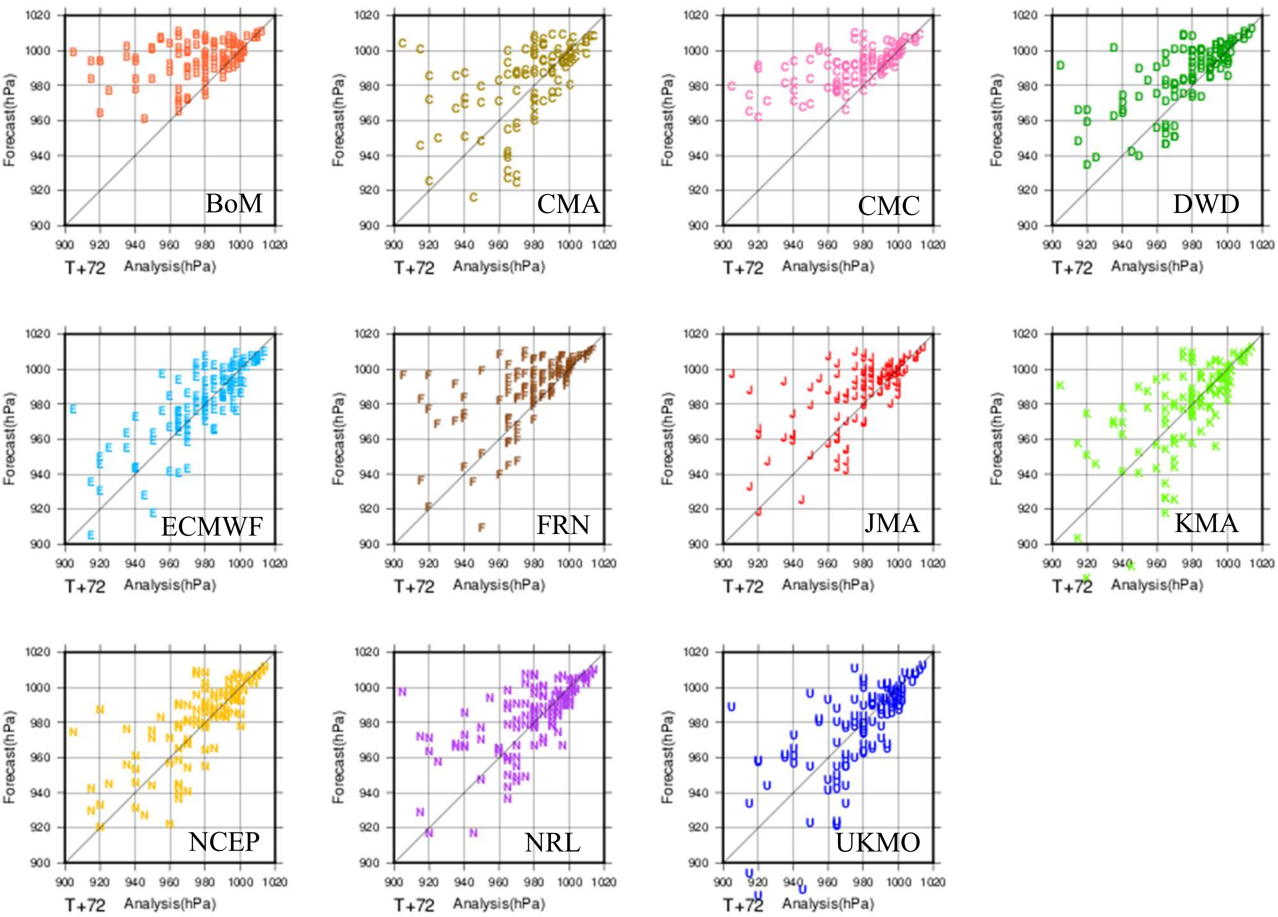



Figure 4.13 Scatter diagrams of 72-hour TC center pressure forecasts from 11 deterministic models for 2019. The tropical depression (TD) stage of targeted TCs is also included in this verification.

### 4.3.2 Verification of Intensity Guidance Models

Table 4.8 shows mean central pressure errors in TIFS and LGEM (Logistic Growth Equation Model) intensity guidance and related consensus. Values for maximum wind speed forecasts are available on the Center's website (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2019/index.html).

Table 4.8 Mean error and RMSE of central pressure forecasts from intensity guidance models produced by the Center in 2019. 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 | -1.4 | 12.5 | 433 | -1.9 | 15.4 | 333 | -0.5 | 17.0 | 247 | -1.3 | 15.6 | 163 | -2.6 | 14.9 | 100 |
| | LGEM | 0.7 | 13.5 | 433 | 0.4 | 16.6 | 333 | -0.6 | 17.3 | 247 | -3.6 | 14.8 | 163 | - | - | 0 |
| Consensus method | TIFS&LGEM | -0.3 | 12.7 | 433 | -0.8 | 15.6 | 333 | -0.6 | 16.8 | 247 | -2.5 | 14.7 | 163 | - | - | 0 |

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

JMA produces Atmospheric Motion Vectors (AMVs) using successive satellite imagery from the Himawari-8 geostationary satellite. AMVs are derived from 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 the 700 hPa level) to estimate such winds in the vicinity of TCs. The ASWinds product is derived at intervals of 10 – 30 minutes with frequent and wide-ranging wind distribution information. Figure 4.14 shows ASWind distributions derived using Himawari-8 full-disk and Region 3 observations for TS Nari (1906). 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 imagery together with surface wind observations from 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) bands with respect to ASCAT wind data in the vicinity of 29 TCs occurring in 2019 (Table 4.8). Wind speed biases of ASWinds data from full-disk and Region 3 observations were small at -0.8 to -0.4 m/s and -0.8 to -0.1 m/s, respectively. It should be noted that the bias ASWinds from Visible observation is the smallest among the three. In terms of vector difference, ASWind values from Visible observation are smaller than those from Short-wave Infrared and Infrared observations, which indicates their superior accuracy for low-level cloud detection.

The wide coverage of ASWinds data from full-disk observations (Figure 4.15) is expected to support wind monitoring for TCs and other meteorological phenomena. JMA will continue to verify these data and extend application to areas outside TCs.

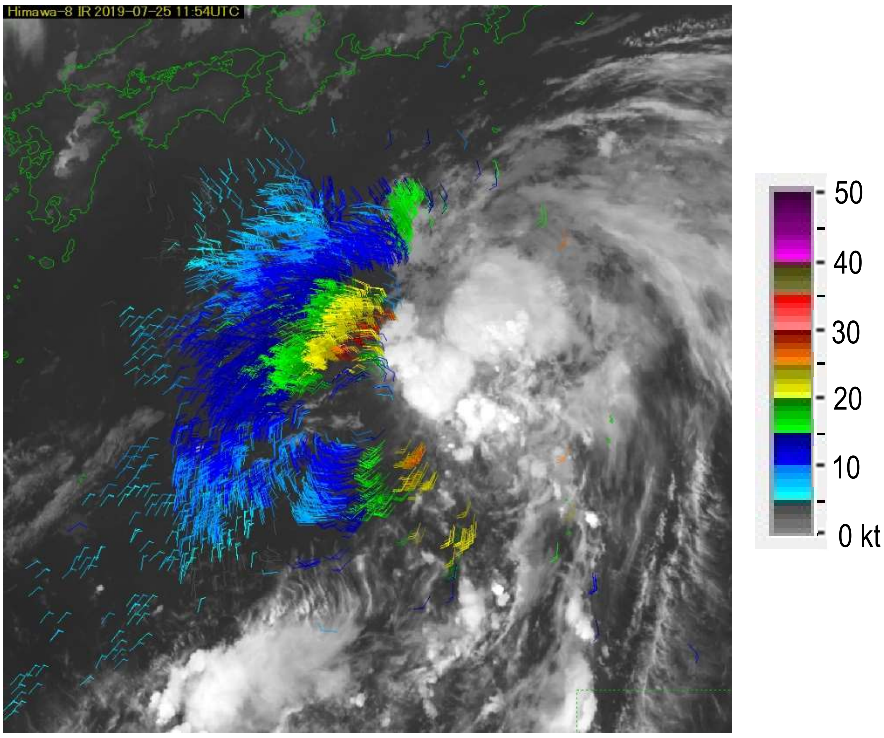



Figure 4.14 ASWinds derived from a series of full-disk Himawari-8 Visible images (B03) and Short-wave Infrared (B07) images for TS Nari (1906) for 12 UTC on 25 July 2019.

Table 4.9 Vector Differences (VDs) and biases of ASWinds (0.85 < QI) with reference to ASCAT winds within a square of 20 degrees centered at the TC center for 29 TCs in 2019.

**(a) ASWind (Full-Disk)**

| | Number of collocations | Vector Difference [m/s] | Bias [m/s] |
|---|---|---|---|
| B03 (VIS) | 430,053 | 1.92 | -0.43 |
| B07 (SWIR) | 398,125 | 2.33 | -0.72 |
| B13 (IR) | 371,253 | 2.32 | -0.78 |

**(b) ASWind (Region 3)**

| | Number of collocations | Vector Difference [m/s] | Bias [m/s] |
|---|---|---|---|
| B03 (VIS) | 861,955 | 3.12 | -0.05 |
| B07 (SWIR) | 1,027,912 | 3.63 | -0.42 |
| B13 (IR) | 705856 | 3.61 | -0.74 |

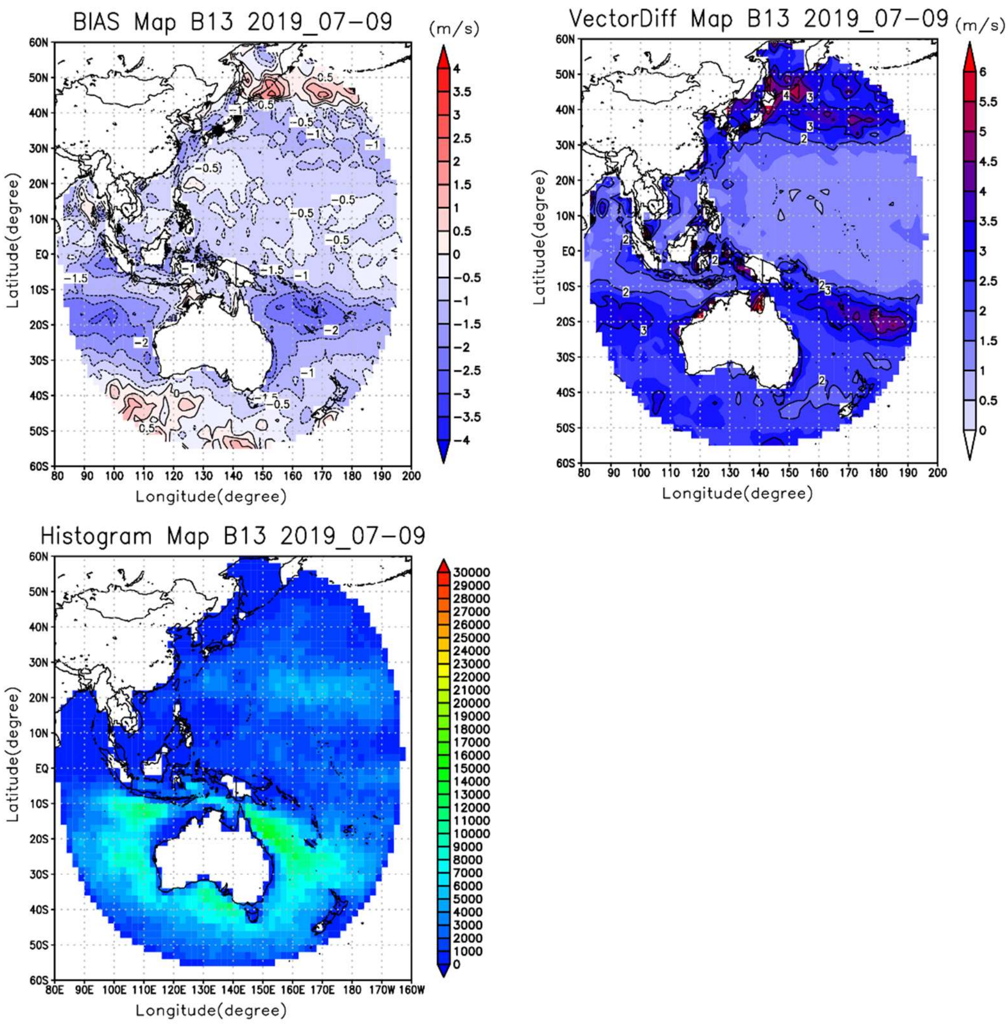



Figure 4.15 Spatial distribution of biases and Vector Differences (VDs) for full-disk ASWinds derived from Infrared (B13) imagery to with respect to ASCAT winds for July - September 2019.

## 4.5 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 4.16 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 MSLP estimates and Dvorak MSLP estimates (CONSENSUS) for TY Faxai (1915).

Table 4.10 shows the results of AMSU and ATMS estimate verification with respect to JMA best-track data for 2015 - 2019 together with Dvorak TC intensity estimates and CONSENSUS. The biases and root mean square errors (RMSEs) of AMSU estimates are -3.1 to 2.7 hPa and 10.0 to 13.8 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 five years, which is attributed to the benefits of independent information from the satellite microwave observation. The RMSE for ATMS estimates is 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 are 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. JMA plans to be using data from AMSU-A on board MetOp-C polar-orbiting satellite for TC intensity estimation by the 2021 TC season.

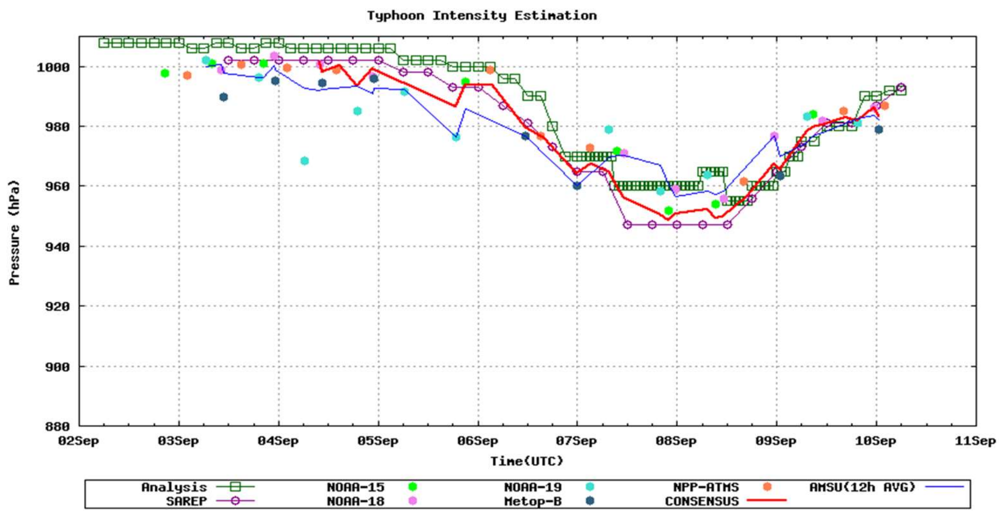



Figure 4.16 Time-series representation of Dvorak MSLP estimates, microwave-based MSLP estimates (AMSU and ATMS), CONSENSUS between Dvorak and AMSU/ATMS estimates and JMA analysis for TY Faxai (1915) on the Numerical Typhoon Prediction (NTP) website

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 five years (2015 - 2019); (b) as per (a) but for ATMS estimates

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

| Year | | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|
| BIAS (hPa) | AMSU | 1.3 | 2.7 | -2.9 | -3.1 | -2.5 |
| | Dvorak | 0.1 | -2.1 | -2.0 | -0.4 | -2.9 |
| | Consensus | **0.3** | **-0.8** | **-2.6** | **-1.5** | **-3.2** |
| RMSE (hPa) | AMSU | 12.8 | 13.8 | 10.0 | 12.4 | 11.7 |
| | Dvorak | 7.5 | 9.6 | 7.2 | 7.0 | 9.2 |
| | Consensus | **6.8** | **8.2** | **6.7** | **6.7** | **7.6** |
| Number of Data | | 819 | 595 | 569 | 680 | 645 |

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

| Year | | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|
| BIAS (hPa) | AMSU | 3.0 | 4.1 | 1.8 | 0.9 | 1.9 |
| | Dvorak | -0.5 | -1.4 | -2.0 | -0.9 | -3.7 |
| | Consensus | **0.8** | **0.3** | **-0.7** | **-0.3** | **-1.9** |
| RMSE (hPa) | AMSU | 11.9 | 13.0 | 8.7 | 11.4 | 9.9 |
| | Dvorak | 7.8 | 8.5 | 7.9 | 7.9 | 9.7 |
| | Consensus | **6.1** | **7.1** | **6.3** | **7.0** | **7.1** |
| Number of Data | | 229 | 190 | 193 | 244 | 219 |

### 4.6 Verification of Storm Surge Prediction

Storm surge predictions have been provided since 2011 via the Numerical Typhoon Prediction website to Typhoon Committee Members within the framework of the Storm Surge Watch Scheme (SSWS) (for details of the storm surge model, refer to Hasegawa et al. (2012) on the Center's website). Verification of deterministic storm surge prediction 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) for all named TCs in 2019. Hourly hindcast data (from FT = -5 to FT = 0) and forecast data (from FT = 1 to FT = 72) were compared with observation data.

In addition, a multi-scenario prediction method was incorporated into the model in June 2016 to support the provision of more useful risk management information (Hasegawa et al., 2017). Verification of multi-scenario predictions was conducted on data from a station in Legaspi Port (Philippines) for TY Kammuri (1928).

Table 4.11 Stations used for verification

| | Station | Abbreviation | Member |
|---|---|---|---|
| 1 | Quarry Bay | QB | Hong Kong |
| 2 | Langkawi | LK | Malaysia |
| 3 | Legaspi Port | LG | Philippines |
| 4 | Manila South Harbor | ML | Philippines |
| 5 | Subic Bay | SB | Philippines |
| 6 | Apra Harbor | AP | U.S.A. |
| 7 | Qui Nhon | QN | Viet Nam |
| 8 | Vung Tau | VT | Viet Nam |

Table 4.12 Maximum storm surges observed at the eight stations for each named TC forming in 2019 (unit: m). Slashes indicate missing observation data.

| | T1901 | T1902 | T1903 | T1904 | T1905 | T1906 | T1907 | T1908 | T1909 | T1910 |
|---|---|---|---|---|---|---|---|---|---|---|
| QB | 0.27 | 0.18 | 0.07 | 0.19 | 0.22 | −0.08 | 0.46 | 0.23 | 0.18 | 0.18 |
| LK | 0.15 | 0.15 | / | / | / | / | / | 0.27 | 0.40 | 0.40 |
| LG | 0.13 | 0.17 | 0.16 | 0.08 | 0.17 | 0.09 | 0.10 | 0.12 | 0.15 | 0.15 |
| ML | 0.07 | 0.02 | −0.02 | 0.06 | 0.15 | −0.07 | 0.12 | 0.16 | 0.20 | 0.20 |
| SB | 0.03 | 0.07 | 0.04 | 0.09 | 0.07 | −0.03 | 0.07 | 0.11 | 0.17 | 0.17 |
| AP | −0.03 | 0.12 | 0.12 | 0.10 | 0.12 | 0.09 | 0.07 | 0.07 | 0.11 | 0.12 |
| QN | / | 0.03 | 0.05 | 0.09 | 0.09 | −0.01 | 0.15 | 0.13 | 0.18 | 0.18 |
| VT | 0.40 | 0.12 | 0.19 | 0.19 | 0.23 | 0.13 | 0.29 | 0.29 | 0.23 | 0.23 |

| | T1911 | T1912 | T1913 | T1914 | T1915 | T1916 | T1917 | T1918 | T1919 | T1920 |
|---|---|---|---|---|---|---|---|---|---|---|
| QB | 0.10 | 0.05 | 0.12 | 0.12 | 0.08 | 0.12 | 0.46 | 0.07 | 0.18 | 0.20 |
| LK | 0.29 | 0.19 | 0.24 | 0.24 | 0.18 | 0.20 | 0.13 | 0.12 | 0.04 | −0.01 |
| LG | 0.18 | 0.06 | 0.08 | 0.08 | 0.09 | 0.10 | 0.06 | 0.03 | 0.12 | 0.08 |
| ML | 0.16 | 0.07 | 0.15 | 0.15 | 0.13 | 0.21 | 0.16 | 0.13 | 0.07 | 0.08 |
| SB | 0.05 | 0.06 | 0.10 | 0.03 | 0.10 | 0.11 | 0.07 | 0.03 | 0.03 | 0.01 |
| AP | 0.12 | 0.11 | 0.16 | 0.11 | 0.16 | 0.08 | 0.09 | 0.10 | 0.19 | 0.09 |
| QN | 0.03 | 0.04 | 0.09 | 0.09 | 0.06 | 0.06 | 0.10 | 0.01 | −0.05 | 0.14 |
| VT | 0.11 | 0.13 | 0.12 | 0.03 | 0.09 | 0.25 | 0.14 | 0.35 | 0.15 | 0.31 |

| | T1921 | T1922 | T1923 | T1924 | T1925 | T1926 | T1927 | T1928 | T1929 |
|---|---|---|---|---|---|---|---|---|---|
| QB | 0.19 | 0.13 | 0.29 | 0.29 | 0.16 | 0.31 | 0.26 | 0.27 | 0.22 |
| LK | −0.01 | 0.02 | 0.07 | 0.07 | 0.02 | 0.01 | −0.04 | −0.08 | −0.04 |
| LG | 0.06 | 0.05 | 0.07 | 0.08 | 0.16 | 0.16 | 0.11 | 1.01 | 0.16 |
| ML | 0.11 | 0.11 | 0.27 | 0.27 | 0.25 | 0.25 | 0.17 | 0.14 | 0.09 |
| SB | 0.04 | 0.01 | 0.22 | 0.22 | 0.12 | 0.10 | 0.08 | 0.07 | 0.05 |
| AP | 0.11 | 0.04 | 0.13 | 0.12 | 0.07 | 0.07 | 0.06 | 0.11 | 0.07 |
| QN | 0.10 | 0.38 | 0.16 | 0.15 | 0.13 | 0.03 | 0.07 | 0.11 | −0.01 |
| VT | 0.29 | 0.14 | 0.19 | 0.19 | 0.20 | 0.20 | 0.13 | 0.33 | 0.00 |

### 4.6.1 Deterministic Prediction

Storm surges exceeding a meter in height were observed in Legaspi Port (Philippines) in 2019 (Table 4.12). Figure 4.17 shows scatter diagrams of model storm surges (hindcast and forecast) against observation data. Verification results (Figure 4.17, right) indicate that the model underestimated storm surges for some cases in 2019, although results from past Annual Reports indicate a tendency for overestimation because the typhoon bogus, which expresses wind and pressure fields based on parametric TC modeling, does not incorporate consideration of structural changes and wind reduction caused by land topography. The cases of underestimation correspond to the storm surge event caused by TY Kammuri, and are described below in the "Multi-scenario Prediction" section.

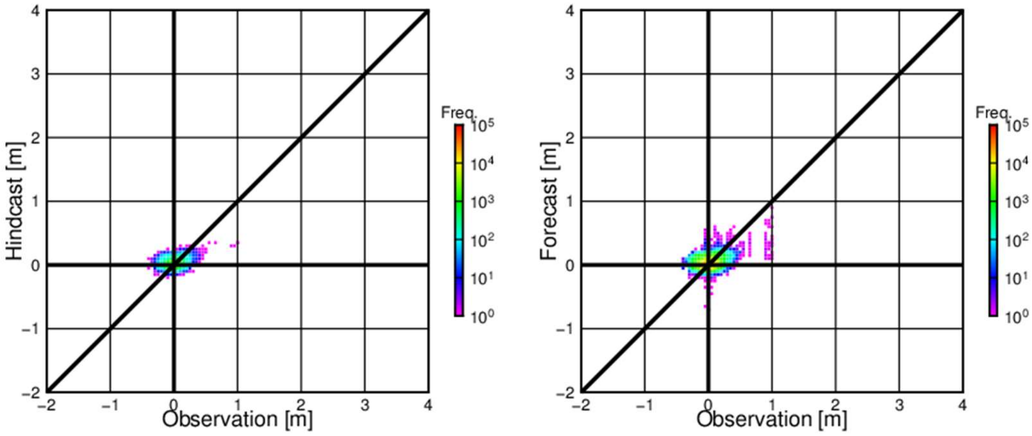



Figure 4.17 Scatter diagrams of model storm surges against observation data from eight stations for all named TCs forming in 2019 (left: hindcast; right: forecast)

The verification shown above is insufficient for evaluation of model accuracy for typhoons because the number of available observations is limited and most stations did not observe storm surges. Accordingly, additional verification was conducted using data from stations in Japan, where sufficient observation data are available and typhoons frequently approach or make landfall. Although the characteristics of model forecasts may vary by region, the storm surge model is considered to have comparable accuracy at storm surge watch scheme stations.

Figure 4.18 shows scatter diagrams of modeled storm surges (forecast) against observation data from 207 stations (operated by JMA, the Port Authority, the Japan Coast Guard and the Geospatial Information Authority of Japan) in Japan. The verification period is 2019, and typhoon cases are extracted. Ten typhoons approached and five made landfall on Japan. Forecasts for Japan tended to overestimate storm surges, as seen from storm surge watch scheme stations. However, the model sometimes underestimated storm surges attributed mainly to wave setup (red circles). Naturally, errors increase with lead time. Especially for the third day, the figure shows extreme overestimation and underestimation attributed mainly to typhoon track errors.

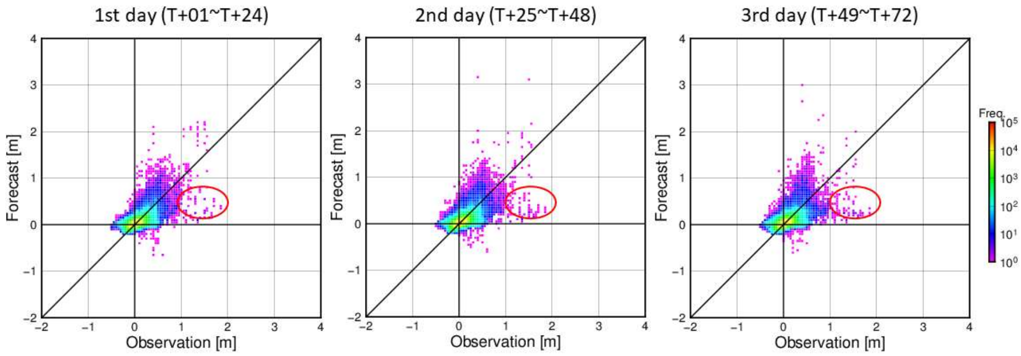



Figure 4.18 Scatter diagrams of model storm surges (forecast) against observation data from 207 stations (operated by JMA, the Port Authority, the Japan Coast Guard and the Geospatial Information Authority of Japan) in Japan for typhoons in 2019. All plots are three-hourly maximum values.

### 4.6.2 Multi-Scenario Prediction

TY Kammuri (1928) hit the southern part of Luzon Island in December 2019 with a maximum wind speed of 45 m/s and a minimum pressure of 950 hPa. Figure 4.19 shows the analysis track and predicted tracks (official and five selected instances) for TY Kammuri covering the 24-hour period before the peak of a storm surge in Legaspi Port. TY Kammuri landed near Legaspi Port with a track similar to that of scenarios 2 and 4. The official forecast track was shifted northward of the analysis track, leading to limited success in the prediction of peak tide and surge. The maximum storm tide values for Legaspi Port in the scenarios 2 and 4 were 0.75 and 0.74 m, respectively (Figure 4.20), while the corresponding maximum storm surges were 0.80 and 0.81 m, respectively. Scenarios 2 and 4 thus underestimated the maximum storm tide and surge (observed maximum storm tide: 1.09 m over mean sea level; maximum storm surge: 1.01 m). This is attributed to typhoon track error and model scheme error. Here, errors regarding the timing of typhoon passage significantly affected storm tide errors. Accordingly, SSWS products should be used in consideration of the time range associated with typhoon passage.

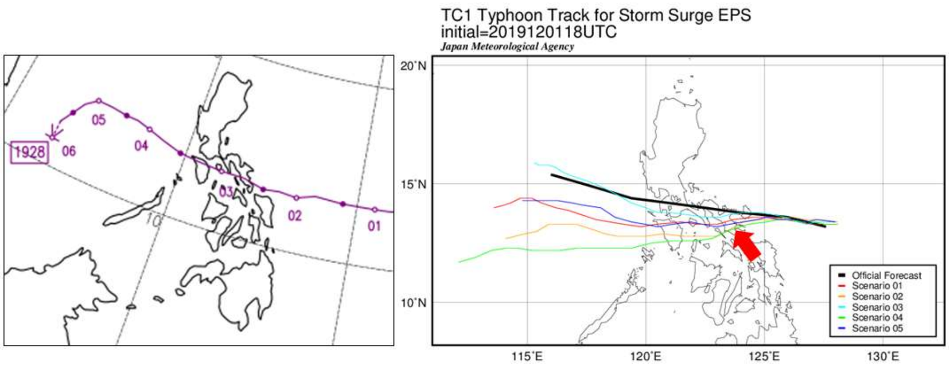



Figure 4.19 Analysis track (left) and predicted tracks (right) for TY Kammuri. In the figure on the right, colored lines show the five selected tracks and the bold black line shows the official JMA forecast. The red arrow shows Legaspi Port.

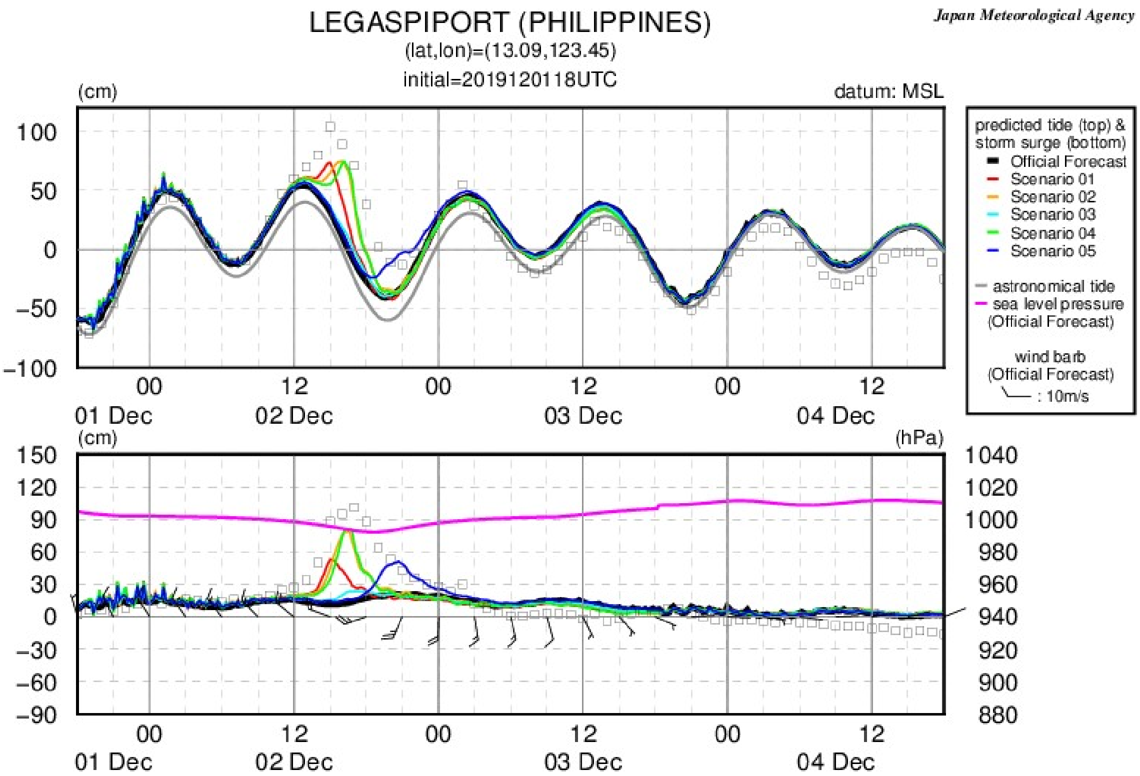



Figure 4.20 Time-series representation of storm tide and astronomical tide (top), storm surge, sea level pressure and surface wind (bottom) for Legaspi Port (Philippines). Squares show hourly observation values.

[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.

# Appendices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# RSMC Tropical Cyclone Best Track Data in 2019

## Pabuk (1901)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Dec. 31/06 | 7.6 | 111.9 | 1004 | - | 0.5 | TD |
| 31/12 | 7.3 | 111.3 | 1004 | - | 1.0 | TD |
| 31/18 | 7.0 | 111.1 | 1004 | - | 1.0 | TD |
| Jan. 01/00 | 6.6 | 110.7 | 1004 | - | 1.0 | TD |
| 01/06 | 6.3 | 110.2 | 1000 | 35 | 1.5 | TS |
| 01/12 | 6.0 | 109.9 | 1000 | 35 | 1.5 | TS |
| 01/18 | 5.8 | 109.5 | 1000 | 35 | 2.0 | TS |
| 02/00 | 5.9 | 108.6 | 1000 | 35 | 2.0 | TS |
| 02/06 | 6.2 | 108.0 | 1000 | 35 | 2.0 | TS |
| 02/12 | 6.3 | 107.0 | 1000 | 35 | 2.0 | TS |
| 02/18 | 6.0 | 105.8 | 1000 | 35 | 2.0 | TS |
| 03/00 | 5.8 | 105.0 | 1000 | 35 | 2.0 | TS |
| 03/06 | 6.1 | 104.1 | 1000 | 35 | 2.0 | TS |
| 03/12 | 6.8 | 103.4 | 998 | 40 | 2.5 | TS |
| 03/18 | 7.5 | 102.5 | 996 | 45 | 3.0 | TS |
| 04/00 | 7.9 | 101.5 | 996 | 45 | 3.0 | TS |
| 04/06 | 8.1 | 100.8 | 996 | 45 | 3.0 | TS |
| 04/12 | 8.2 | 100.1 | 1000 | 40 | 3.0 | TS |
| 04/18 | 8.4 | 99.4 | 1006 | - | - | Out |

## Wutip (1902)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Feb. 18/12 | 4.7 | 162.5 | 1006 | - | 0.5 | TD |
| 18/18 | 4.8 | 161.2 | 1004 | - | 0.5 | TD |
| 19/00 | 5.2 | 159.8 | 1006 | - | 1.0 | TD |
| 19/06 | 4.9 | 158.4 | 1004 | - | 1.5 | TD |
| 19/12 | 4.5 | 156.6 | 1004 | - | 2.0 | TD |
| 19/18 | 4.5 | 155.5 | 1000 | 35 | 2.5 | TS |
| 20/00 | 4.7 | 154.6 | 994 | 45 | 3.0 | TS |
| 20/06 | 4.7 | 153.8 | 992 | 50 | 3.5 | STS |
| 20/12 | 5.0 | 152.6 | 985 | 60 | 3.5 | STS |
| 20/18 | 5.7 | 151.6 | 980 | 65 | 4.0 | TY |
| 21/00 | 6.1 | 150.5 | 975 | 70 | 4.0 | TY |
| 21/06 | 6.4 | 149.6 | 960 | 80 | 5.0 | TY |
| 21/12 | 6.9 | 148.7 | 960 | 80 | 5.0 | TY |
| 21/18 | 7.5 | 147.9 | 960 | 80 | 5.0 | TY |
| 22/00 | 8.2 | 146.8 | 960 | 80 | 5.0 | TY |
| 22/06 | 9.2 | 146.2 | 960 | 80 | 5.0 | TY |
| 22/12 | 9.9 | 145.0 | 960 | 80 | 5.0 | TY |
| 22/18 | 10.1 | 144.0 | 960 | 80 | 5.0 | TY |
| 23/00 | 10.6 | 143.7 | 955 | 85 | 5.5 | TY |
| 23/06 | 11.4 | 143.3 | 940 | 95 | 6.0 | TY |
| 23/12 | 12.0 | 142.8 | 920 | 105 | 7.0 | TY |
| 23/18 | 12.4 | 142.4 | 920 | 105 | 7.0 | TY |
| 24/00 | 12.7 | 142.1 | 920 | 105 | 7.0 | TY |
| 24/06 | 12.9 | 141.7 | 940 | 95 | 6.0 | TY |
| 24/12 | 13.1 | 141.2 | 940 | 95 | 6.0 | TY |
| 24/18 | 13.1 | 140.7 | 940 | 95 | 6.0 | TY |
| 25/00 | 13.4 | 140.4 | 935 | 100 | 6.5 | TY |
| 25/06 | 13.8 | 140.2 | 935 | 100 | 6.5 | TY |
| 25/12 | 14.2 | 140.1 | 935 | 100 | 6.5 | TY |
| 25/18 | 14.6 | 139.9 | 935 | 100 | 6.5 | TY |
| 26/00 | 14.9 | 139.9 | 950 | 90 | 5.5 | TY |
| 26/06 | 15.2 | 139.9 | 940 | 95 | 6.0 | TY |
| 26/12 | 15.4 | 140.1 | 950 | 85 | 6.0 | TY |
| 26/18 | 15.7 | 140.1 | 955 | 80 | 6.0 | TY |
| 27/00 | 16.0 | 140.0 | 965 | 70 | 5.5 | TY |
| 27/06 | 16.4 | 139.8 | 970 | 65 | 5.0 | TY |
| 27/12 | 16.5 | 139.0 | 980 | 55 | 4.5 | STS |
| 27/18 | 16.7 | 137.7 | 990 | 50 | 4.0 | STS |
| 28/00 | 17.2 | 136.7 | 996 | 40 | 3.5 | TS |
| 28/06 | 17.6 | 135.6 | 1004 | - | 3.0 | TD |
| 28/12 | 18.2 | 135.0 | 1010 | - | 2.5 | TD |
| 28/18 | 18.6 | 134.6 | 1010 | - | 2.5 | TD |
| Mar. 01/00 | 19.1 | 134.4 | 1012 | - | 2.0 | TD |
| 01/06 | 19.4 | 134.2 | 1010 | - | - | TD |
| 01/12 | 19.7 | 134.0 | 1012 | - | - | TD |
| 01/18 | 19.6 | 134.0 | 1010 | - | - | TD |
| 02/00 | 19.4 | 133.9 | 1010 | - | - | TD |
| 02/06 | 18.9 | 133.1 | 1008 | - | - | TD |
| 02/12 | | | | | | Dissip. |

## Sepat (1903)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Jun. 24/12 | 17.9 | 127.7 | 1008 | - | 0.5 | TD |
| 24/18 | 18.4 | 127.8 | 1006 | - | 0.5 | TD |
| 25/00 | 18.9 | 127.9 | 1006 | - | 0.5 | TD |
| 25/06 | 19.4 | 128.0 | 1006 | - | 0.5 | TD |
| 25/12 | 19.8 | 128.1 | 1006 | - | 0.0 | TD |
| 25/18 | 20.5 | 128.2 | 1006 | - | 0.5 | TD |
| 26/00 | 21.4 | 128.4 | 1004 | - | 0.5 | TD |
| 26/06 | 22.9 | 128.8 | 1004 | - | 1.0 | TD |
| 26/12 | 24.8 | 129.5 | 1004 | - | 1.5 | TD |
| 26/18 | 26.4 | 130.0 | 1004 | - | 1.5 | TD |
| 27/00 | 28.4 | 130.4 | 1002 | - | 1.5 | TD |
| 27/06 | 30.8 | 132.0 | 1000 | - | 1.5 | TD |
| 27/12 | 32.6 | 134.7 | 998 | 35 | 2.0 | TS |
| 27/18 | 34.1 | 137.6 | 996 | 40 | 2.0 | TS |
| 28/00 | 35.2 | 141.6 | 994 | 40 | 2.0 | TS |
| 28/06 | 36.0 | 147.0 | 992 | - | 2.0 | L |
| 28/12 | 37.0 | 151.0 | 992 | - | 2.0 | L |
| 28/18 | 38.0 | 154.3 | 994 | - | - | L |
| 29/00 | 39.0 | 156.3 | 994 | - | - | L |
| 29/06 | 39.8 | 158.5 | 998 | - | - | L |
| 29/12 | 41.0 | 160.1 | 1002 | - | - | L |
| 29/18 | 42.2 | 160.8 | 1004 | - | - | L |
| 30/00 | 43.8 | 161.6 | 1004 | - | - | L |
| 30/06 | 44.3 | 163.3 | 1004 | - | - | L |
| 30/12 | 45.0 | 165.5 | 1004 | - | - | L |
| 30/18 | 46.1 | 168.2 | 1004 | - | - | L |
| Jul. 01/00 | 47.4 | 169.9 | 1004 | - | - | L |
| 01/06 | 49.3 | 172.2 | 1004 | - | - | L |
| 01/12 | 51.3 | 174.3 | 1002 | - | - | L |
| 01/18 | 53.6 | 176.7 | 1002 | - | - | L |
| 02/00 | 57.2 | 178.7 | 1002 | - | - | L |
| 02/06 | 59.5 | 179.5 | 1002 | - | - | L |
| 02/12 | 61.1 | 182.0 | 1002 | - | - | Out |

## Mun (1904)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Jul. 01/18 | 18.0 | 114.0 | 998 | - | 0.0 | TD |
| 02/00 | 18.5 | 113.3 | 998 | - | 0.5 | TD |
| 02/06 | 18.8 | 112.4 | 994 | 35 | 1.0 | TS |
| 02/12 | 18.9 | 111.5 | 994 | 35 | 1.5 | TS |
| 02/18 | 19.2 | 110.6 | 994 | 35 | 1.5 | TS |
| 03/00 | 19.4 | 109.5 | 994 | 35 | 1.5 | TS |
| 03/06 | 19.5 | 108.4 | 992 | 35 | 2.0 | TS |
| 03/12 | 19.9 | 107.3 | 992 | 35 | 2.0 | TS |
| 03/18 | 20.3 | 106.7 | 994 | 35 | 2.0 | TS |
| 04/00 | 20.8 | 106.2 | 994 | 35 | 1.5 | TS |
| 04/06 | 21.6 | 105.4 | 998 | - | 1.5 | TD |
| 04/12 | 22.3 | 104.5 | 1000 | - | - | TD |
| 04/18 | 23.1 | 103.8 | 1000 | - | - | TD |
| 05/00 | | | | | | Dissip. |

## Danas (1905)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Jul. 14/00 | 12.6 | 136.7 | 1004 | - | 0.0 | TD |
| 14/06 | 13.3 | 135.3 | 1004 | - | 0.0 | TD |
| 14/12 | 14.0 | 134.3 | 1004 | - | 0.0 | TD |
| 14/18 | 15.0 | 133.2 | 1002 | - | 0.5 | TD |
| 15/00 | 15.6 | 132.1 | 1002 | - | 0.5 | TD |
| 15/06 | 16.4 | 131.2 | 1000 | - | 1.0 | TD |
| 15/12 | 16.9 | 129.5 | 1000 | - | 1.5 | TD |
| 15/18 | 17.0 | 127.5 | 998 | - | 2.0 | TD |
| 16/00 | 17.0 | 126.0 | 998 | - | 2.0 | TD |
| 16/06 | 17.1 | 124.9 | 994 | 35 | 2.0 | TS |
| 16/12 | 17.2 | 123.9 | 994 | 35 | 2.0 | TS |
| 16/18 | 17.3 | 123.4 | 994 | 35 | 2.0 | TS |
| 17/00 | 18.1 | 123.5 | 994 | 35 | 2.0 | TS |
| 17/06 | 19.0 | 123.7 | 994 | 35 | 2.0 | TS |
| 17/12 | 20.5 | 124.1 | 992 | 35 | 2.0 | TS |
| 17/18 | 21.9 | 124.1 | 992 | 35 | 2.0 | TS |
| 18/00 | 23.6 | 124.1 | 990 | 40 | 2.0 | TS |
| 18/06 | 25.7 | 124.1 | 990 | 40 | 2.0 | TS |
| 18/12 | 26.5 | 124.0 | 990 | 40 | 2.0 | TS |
| 18/18 | 27.8 | 124.0 | 985 | 45 | 2.0 | TS |
| 19/00 | 29.0 | 124.0 | 985 | 45 | 2.0 | TS |
| 19/06 | 30.3 | 124.2 | 985 | 45 | 2.0 | TS |
| 19/12 | 31.8 | 124.7 | 985 | 45 | 2.0 | TS |
| 19/18 | 33.1 | 125.2 | 985 | 40 | 1.5 | TS |
| 20/00 | 34.2 | 125.5 | 985 | 40 | 1.5 | TS |
| 20/06 | 34.8 | 125.7 | 990 | 40 | 1.5 | TS |
| 20/12 | 35.7 | 126.3 | 994 | 35 | 1.5 | TS |
| 20/18 | 36.6 | 127.2 | 996 | - | 1.0 | TD |
| 21/00 | 37.9 | 128.5 | 998 | - | 1.0 | TD |
| 21/06 | 39.0 | 129.6 | 998 | - | 0.5 | TD |
| 21/12 | 40.2 | 130.4 | 998 | - | 0.5 | L |
| 21/18 | 41.1 | 131.4 | 996 | - | - | L |
| 22/00 | 41.4 | 131.9 | 996 | - | - | L |
| 22/06 | 41.7 | 132.1 | 998 | - | - | L |
| 22/12 | 42.0 | 132.9 | 1000 | - | - | L |
| 22/18 | 42.3 | 134.4 | 1000 | - | - | L |
| 23/00 | 42.6 | 135.7 | 1002 | - | - | L |
| 23/06 | 43.1 | 137.1 | 1002 | - | - | L |
| 23/12 | | | | | | Dissip. |

## Nari (1906)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Jul. 24/00 | 23.0 | 137.0 | 1008 | - | 0.5 | TD |
| 24/06 | 23.5 | 137.5 | 1006 | - | 0.5 | TD |
| 24/12 | 24.3 | 137.8 | 1006 | - | 0.5 | TD |
| 24/18 | 25.3 | 137.8 | 1006 | - | 0.5 | TD |
| 25/00 | 26.3 | 137.7 | 1006 | - | 1.0 | TD |
| 25/06 | 26.5 | 137.5 | 1004 | - | 1.5 | TD |
| 25/12 | 27.5 | 137.5 | 1006 | - | 1.5 | TD |
| 25/18 | 28.5 | 137.3 | 1002 | 35 | 2.0 | TS |
| 26/00 | 29.7 | 137.1 | 1000 | 35 | 2.0 | TS |
| 26/06 | 30.9 | 136.2 | 1000 | 35 | 2.0 | TS |
| 26/12 | 32.0 | 135.8 | 1000 | 35 | 2.0 | TS |
| 26/18 | 33.4 | 135.9 | 998 | 35 | 2.0 | TS |
| 26/22 | 34.1 | 136.3 | 1000 | 35 | - | TS |
| 27/00 | 34.7 | 136.4 | 1000 | 35 | 2.0 | TS |
| 27/06 | 35.6 | 136.7 | 1004 | - | 1.5 | TD |
| 27/12 | 36.0 | 138.3 | 1008 | - | 1.5 | TD |
| 27/18 | 36.6 | 139.8 | 1008 | - | 1.5 | TD |
| 28/00 | 36.9 | 142.0 | 1010 | - | 1.5 | L |
| 28/06 | 37.6 | 143.7 | 1010 | - | 1.0 | L |
| 28/12 | 38.2 | 145.7 | 1010 | - | - | L |
| 28/18 | 38.7 | 147.7 | 1010 | - | - | L |
| 29/00 | 39.3 | 149.8 | 1010 | - | - | L |
| 29/06 | 39.8 | 151.6 | 1008 | - | - | L |
| 29/12 | 40.5 | 152.9 | 1010 | - | - | L |
| 29/18 | | | | | | Dissip. |

## Wipha (1907)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Jul. 30/00 | 17.1 | 116.0 | 1002 | - | 0.5 | TD |
| 30/06 | 17.6 | 115.4 | 998 | - | 1.0 | TD |
| 30/12 | 18.0 | 114.8 | 996 | - | 1.5 | TD |
| 30/18 | 18.4 | 114.2 | 994 | 35 | 2.0 | TS |
| 31/00 | 18.8 | 113.7 | 994 | 35 | 2.0 | TS |
| 31/06 | 19.2 | 112.9 | 992 | 35 | 2.0 | TS |
| 31/12 | 19.5 | 112.2 | 992 | 35 | 2.5 | TS |
| 31/18 | 20.1 | 111.4 | 990 | 40 | 2.5 | TS |
| Aug. 01/00 | 20.4 | 110.8 | 990 | 40 | 2.5 | TS |
| 01/06 | 21.0 | 110.5 | 990 | 40 | 2.5 | TS |
| 01/12 | 21.4 | 110.2 | 990 | 40 | 2.5 | TS |
| 01/18 | 21.2 | 109.4 | 990 | 40 | 2.5 | TS |
| 02/00 | 21.2 | 109.1 | 990 | 40 | 2.5 | TS |
| 02/06 | 21.1 | 109.0 | 985 | 45 | 3.0 | TS |
| 02/12 | 21.6 | 108.2 | 990 | 40 | 3.5 | TS |
| 02/18 | 21.5 | 107.3 | 992 | 35 | 3.5 | TS |
| 03/00 | 21.2 | 106.5 | 992 | 35 | 3.0 | TS |
| 03/06 | 20.8 | 106.2 | 992 | 35 | 2.5 | TS |
| 03/12 | 20.2 | 105.4 | 994 | - | 2.0 | TD |
| 03/18 | 19.7 | 104.4 | 996 | - | 2.0 | TD |
| 04/00 | 20.7 | 102.8 | 998 | - | 1.5 | TD |
| 04/06 | 20.5 | 102.1 | 998 | - | - | TD |
| 04/12 | | | | | | Dissip. |

## Francisco (1908)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Aug. 01/00 | 17.4 | 154.7 | 1002 | - | 0.5 | TD |
| 01/06 | 18.1 | 154.4 | 1002 | - | 0.5 | TD |
| 01/12 | 18.7 | 154.1 | 1002 | - | 0.5 | TD |
| 01/18 | 19.5 | 153.5 | 1000 | - | 1.0 | TD |
| 02/00 | 20.3 | 152.9 | 1000 | - | 1.0 | TD |
| 02/06 | 21.3 | 152.1 | 1000 | - | 1.5 | TD |
| 02/12 | 22.3 | 151.2 | 998 | 35 | 2.0 | TS |
| 02/18 | 23.3 | 150.0 | 998 | 35 | 2.0 | TS |
| 03/00 | 24.3 | 148.6 | 998 | 35 | 2.5 | TS |
| 03/06 | 25.1 | 147.4 | 996 | 40 | 3.0 | TS |
| 03/12 | 25.9 | 146.1 | 996 | 40 | 3.0 | TS |
| 03/15 | 26.3 | 145.3 | 996 | 40 | - | TS |
| 03/18 | 26.7 | 144.6 | 992 | 45 | 3.0 | TS |
| 03/21 | 27.1 | 143.9 | 990 | 50 | - | STS |
| 04/00 | 27.6 | 143.1 | 990 | 50 | 3.0 | STS |
| 04/03 | 28.1 | 142.3 | 990 | 50 | - | STS |
| 04/06 | 28.6 | 141.4 | 990 | 50 | 3.0 | STS |
| 04/12 | 29.2 | 140.1 | 985 | 55 | 3.5 | STS |
| 04/18 | 29.9 | 138.2 | 980 | 60 | 4.0 | STS |
| 05/00 | 30.4 | 136.2 | 980 | 60 | 4.0 | STS |
| 05/06 | 30.8 | 134.6 | 980 | 60 | 4.0 | STS |
| 05/09 | 31.0 | 133.8 | 975 | 65 | - | TY |
| 05/12 | 31.2 | 133.0 | 970 | 70 | 4.5 | TY |
| 05/15 | 31.4 | 132.4 | 970 | 70 | - | TY |
| 05/18 | 31.8 | 131.9 | 970 | 70 | 4.5 | TY |
| 05/20 | 31.9 | 131.5 | 970 | 70 | - | TY |
| 05/21 | 32.1 | 131.3 | 975 | 65 | - | TY |
| 06/00 | 32.8 | 130.6 | 992 | 45 | 4.0 | TS |
| 06/03 | 33.4 | 130.0 | 996 | 40 | - | TS |
| 06/06 | 34.0 | 129.8 | 998 | 35 | 3.5 | TS |
| 06/12 | 35.1 | 129.5 | 1000 | 35 | 3.0 | TS |
| 06/18 | 36.7 | 128.8 | 1000 | 35 | 2.5 | TS |
| 07/00 | 37.9 | 129.0 | 1000 | - | 2.5 | TD |
| 07/06 | 38.7 | 129.2 | 1002 | - | - | TD |
| 07/12 | 39.6 | 129.7 | 1002 | - | - | TD |
| 07/18 | 40.8 | 130.9 | 1000 | - | - | TD |
| 08/00 | 41.5 | 132.7 | 1000 | - | - | TD |
| 08/06 | 42.5 | 135.3 | 1000 | - | - | TD |
| 08/12 | 42.8 | 137.1 | 1000 | - | - | TD |
| 08/18 | 43.0 | 139.5 | 996 | - | - | L |
| 09/00 | 42.9 | 142.0 | 1000 | - | - | L |
| 09/06 | 41.9 | 145.5 | 1002 | - | - | L |
| 09/12 | 41.0 | 148.7 | 1002 | - | - | L |
| 09/18 | 40.6 | 152.0 | 1004 | - | - | L |
| 10/00 | 40.3 | 155.5 | 1006 | - | - | L |
| 10/06 | 40.0 | 159.2 | 1006 | - | - | L |
| 10/12 | 40.2 | 163.1 | 1006 | - | - | L |
| 10/18 | 41.0 | 167.1 | 1006 | - | - | L |
| 11/00 | 41.5 | 170.1 | 1006 | - | - | L |
| 11/06 | 42.5 | 172.2 | 1006 | - | - | L |
| 11/12 | | | | | | Dissip. |

## Lekima (1909)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Aug. 02/06 | 14.5 | 134.3 | 1002 | - | 0.0 | TD |
| 02/12 | 14.4 | 133.8 | 1002 | - | 0.0 | TD |
| 02/18 | 14.3 | 133.3 | 1000 | - | 0.0 | TD |
| 03/00 | 14.3 | 132.8 | 1000 | - | 0.0 | TD |
| 03/06 | 14.5 | 132.3 | 1000 | - | 0.5 | TD |
| 03/12 | 15.0 | 131.9 | 1000 | - | 1.0 | TD |
| 03/18 | 15.7 | 131.5 | 998 | - | 1.5 | TD |
| 04/00 | 16.3 | 131.0 | 998 | - | 2.0 | TD |
| 04/06 | 16.9 | 130.6 | 994 | 35 | 2.5 | TS |
| 04/12 | 17.5 | 130.2 | 994 | 40 | 2.5 | TS |
| 04/18 | 17.7 | 130.1 | 994 | 40 | 3.0 | TS |
| 05/00 | 17.9 | 130.0 | 994 | 40 | 3.0 | TS |
| 05/06 | 18.0 | 129.9 | 990 | 45 | 3.0 | TS |
| 05/12 | 18.2 | 129.8 | 990 | 45 | 3.5 | TS |
| 05/18 | 18.5 | 129.5 | 985 | 50 | 3.5 | STS |
| 06/00 | 18.8 | 129.3 | 985 | 50 | 4.0 | STS |
| 06/06 | 19.2 | 129.0 | 980 | 55 | 4.0 | STS |
| 06/12 | 19.5 | 128.7 | 975 | 65 | 4.5 | TY |
| 06/18 | 19.9 | 128.4 | 970 | 70 | 5.0 | TY |
| 07/00 | 20.4 | 128.1 | 960 | 75 | 5.0 | TY |
| 07/06 | 21.0 | 127.6 | 950 | 80 | 6.0 | TY |
| 07/12 | 21.6 | 127.0 | 940 | 90 | 6.5 | TY |
| 07/18 | 22.1 | 126.5 | 935 | 95 | 6.5 | TY |
| 07/21 | 22.4 | 126.2 | 935 | 95 | - | TY |
| 08/00 | 22.7 | 126.0 | 935 | 95 | 6.5 | TY |
| 08/03 | 23.2 | 125.7 | 935 | 95 | - | TY |
| 08/06 | 23.6 | 125.4 | 930 | 100 | 6.5 | TY |
| 08/09 | 24.0 | 125.2 | 930 | 100 | - | TY |
| 08/12 | 24.3 | 125.0 | 925 | 105 | 7.0 | TY |
| 08/15 | 24.9 | 124.8 | 925 | 105 | - | TY |
| 08/18 | 25.5 | 124.5 | 935 | 95 | 7.0 | TY |
| 08/21 | 26.0 | 124.0 | 935 | 95 | - | TY |
| 09/00 | 26.4 | 123.4 | 940 | 90 | 7.0 | TY |
| 09/06 | 27.1 | 122.5 | 940 | 90 | 6.5 | TY |
| 09/12 | 27.5 | 122.0 | 940 | 90 | 5.5 | TY |
| 09/18 | 28.2 | 121.3 | 950 | 85 | 5.5 | TY |
| 10/00 | 29.1 | 120.7 | 970 | 60 | 5.0 | STS |
| 10/06 | 29.9 | 120.4 | 975 | 50 | 4.5 | STS |
| 10/12 | 30.8 | 120.4 | 980 | 45 | 4.0 | TS |
| 10/18 | 32.3 | 120.3 | 980 | 45 | 3.5 | TS |
| 11/00 | 33.6 | 120.1 | 980 | 45 | 3.0 | TS |
| 11/06 | 35.0 | 120.0 | 980 | 45 | 2.5 | TS |
| 11/12 | 35.9 | 120.0 | 980 | 45 | 2.0 | TS |
| 11/18 | 37.1 | 120.1 | 980 | 40 | 1.5 | TS |
| 12/00 | 37.8 | 119.6 | 985 | 35 | 1.0 | TS |
| 12/06 | 37.9 | 119.5 | 985 | 35 | 1.0 | TS |
| 12/12 | 36.9 | 119.6 | 990 | 35 | 1.0 | TS |
| 12/18 | 37.0 | 120.0 | 992 | - | 1.0 | TD |
| 13/00 | 37.2 | 120.0 | 996 | - | - | TD |
| 13/06 | 38.1 | 120.5 | 996 | - | - | TD |
| 13/12 | 38.6 | 120.9 | 998 | - | - | TD |
| 13/18 | 38.9 | 121.1 | 998 | - | - | TD |
| 14/00 | 38.8 | 121.4 | 1000 | - | - | L |
| 14/06 | 38.8 | 121.5 | 1000 | - | - | L |
| 14/12 | 38.6 | 121.7 | 998 | - | - | L |
| 14/18 | 38.4 | 121.9 | 996 | - | - | L |
| 15/00 | | | | | | Dissip. |

## Krosa (1910)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Aug. 05/00 | 15.6 | 147.7 | 1004 | - | - | TD |
| 05/06 | 16.1 | 146.5 | 1000 | - | - | TD |
| 05/12 | 16.8 | 145.2 | 1000 | - | 0.0 | TD |
| 05/18 | 17.5 | 144.0 | 1000 | - | 0.5 | TD |
| 06/00 | 18.0 | 143.4 | 1000 | - | 1.0 | TD |
| 06/06 | 18.5 | 142.8 | 998 | 35 | 1.5 | TS |
| 06/12 | 18.9 | 142.4 | 996 | 40 | 2.0 | TS |
| 06/18 | 19.7 | 142.1 | 992 | 45 | 2.5 | TS |
| 07/00 | 20.5 | 141.9 | 990 | 50 | 3.0 | STS |
| 07/06 | 21.1 | 141.4 | 990 | 50 | 3.5 | STS |
| 07/12 | 21.5 | 141.0 | 980 | 60 | 3.5 | STS |
| 07/18 | 21.7 | 140.8 | 975 | 65 | 4.0 | TY |
| 08/00 | 21.9 | 140.5 | 970 | 70 | 4.5 | TY |
| 08/06 | 22.1 | 140.6 | 965 | 75 | 5.0 | TY |
| 08/12 | 22.1 | 140.7 | 965 | 75 | 5.0 | TY |
| 08/18 | 22.0 | 141.0 | 965 | 75 | 5.0 | TY |
| 09/00 | 22.0 | 141.1 | 965 | 75 | 5.0 | TY |
| 09/06 | 22.0 | 141.3 | 965 | 75 | 5.0 | TY |
| 09/12 | 22.2 | 141.4 | 965 | 75 | 5.0 | TY |
| 09/18 | 22.3 | 141.4 | 965 | 70 | 4.5 | TY |
| 10/00 | 22.7 | 141.3 | 965 | 70 | 4.5 | TY |
| 10/06 | 22.9 | 141.0 | 965 | 65 | 4.5 | TY |
| 10/12 | 22.8 | 140.7 | 965 | 65 | 4.5 | TY |
| 10/18 | 22.7 | 140.5 | 965 | 65 | 4.0 | TY |
| 11/00 | 23.1 | 140.3 | 965 | 65 | 4.0 | TY |
| 11/06 | 23.6 | 139.8 | 965 | 65 | 4.0 | TY |
| 11/12 | 24.0 | 139.2 | 965 | 60 | 3.5 | STS |
| 11/18 | 24.2 | 138.5 | 965 | 60 | 3.5 | STS |
| 12/00 | 24.7 | 138.0 | 965 | 60 | 3.5 | STS |
| 12/06 | 25.0 | 137.7 | 970 | 50 | 3.5 | STS |
| 12/12 | 25.9 | 137.1 | 970 | 50 | 3.5 | STS |
| 12/18 | 26.8 | 136.4 | 970 | 50 | 3.5 | STS |
| 13/00 | 27.4 | 135.2 | 970 | 50 | 3.5 | STS |
| 13/06 | 27.6 | 134.7 | 970 | 50 | 3.5 | STS |
| 13/12 | 28.1 | 134.3 | 970 | 50 | 3.5 | STS |
| 13/18 | 28.3 | 133.5 | 965 | 55 | 3.5 | STS |
| 13/21 | 28.4 | 133.4 | 965 | 55 | - | STS |
| 14/00 | 28.8 | 133.2 | 965 | 55 | 3.5 | STS |
| 14/03 | 29.1 | 133.1 | 965 | 55 | - | STS |
| 14/06 | 29.6 | 133.1 | 965 | 55 | 3.5 | STS |
| 14/09 | 30.1 | 133.0 | 965 | 55 | - | STS |
| 14/12 | 30.6 | 132.9 | 965 | 55 | 3.5 | STS |
| 14/15 | 30.8 | 132.7 | 965 | 55 | - | STS |
| 14/18 | 31.7 | 132.6 | 970 | 55 | 3.5 | STS |
| 14/21 | 32.2 | 132.6 | 975 | 55 | - | STS |
| 15/00 | 32.7 | 132.4 | 975 | 50 | 3.0 | STS |
| 15/02 | 33.4 | 132.3 | 975 | 50 | - | STS |
| 15/03 | 33.6 | 132.3 | 975 | 50 | - | STS |
| 15/06 | 34.3 | 132.6 | 978 | 45 | 2.5 | TS |
| 15/09 | 35.3 | 133.0 | 978 | 45 | - | TS |
| 15/12 | 36.2 | 133.1 | 980 | 45 | 2.0 | TS |
| 15/18 | 38.0 | 133.5 | 980 | 45 | 2.0 | TS |
| 16/00 | 39.9 | 134.3 | 980 | 45 | 2.0 | TS |
| 16/06 | 40.9 | 135.6 | 980 | 45 | 2.0 | TS |
| 16/12 | 43.0 | 138.0 | 984 | - | 1.5 | L |
| 16/18 | 43.7 | 138.5 | 986 | - | - | L |
| 17/00 | 44.4 | 140.1 | 990 | - | - | L |
| 17/06 | 44.7 | 140.5 | 994 | - | - | L |
| 17/12 | 45.1 | 141.0 | 1000 | - | - | L |
| 17/18 | | | | | | Dissip. |

## Bailu (1911)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Aug. 19/12 | 13.0 | 134.0 | 1006 | - | 0.0 | TD |
| 19/18 | 13.1 | 133.9 | 1004 | - | 0.5 | TD |
| 20/00 | 13.4 | 133.8 | 1004 | - | 1.0 | TD |
| 20/06 | 13.7 | 133.5 | 1002 | - | 1.0 | TD |
| 20/12 | 14.1 | 133.2 | 1002 | - | 1.5 | TD |
| 20/18 | 14.3 | 132.8 | 1000 | - | 1.5 | TD |
| 21/00 | 14.5 | 132.3 | 1000 | - | 1.5 | TD |
| 21/06 | 14.6 | 131.3 | 998 | 35 | 2.0 | TS |
| 21/12 | 14.8 | 130.4 | 998 | 35 | 2.0 | TS |
| 21/18 | 15.2 | 129.8 | 996 | 35 | 2.5 | TS |
| 22/00 | 15.4 | 129.1 | 994 | 40 | 2.5 | TS |
| 22/06 | 15.7 | 128.5 | 994 | 40 | 2.5 | TS |
| 22/12 | 16.3 | 127.8 | 990 | 45 | 3.0 | TS |
| 22/18 | 17.2 | 127.3 | 985 | 50 | 3.0 | STS |
| 23/00 | 18.3 | 126.4 | 985 | 50 | 3.0 | STS |
| 23/06 | 19.1 | 125.4 | 985 | 50 | 3.0 | STS |
| 23/12 | 19.9 | 124.5 | 985 | 50 | 3.0 | STS |
| 23/18 | 20.7 | 123.0 | 985 | 50 | 3.0 | STS |
| 24/00 | 21.5 | 121.8 | 985 | 50 | 3.0 | STS |
| 24/06 | 22.4 | 120.7 | 985 | 50 | 3.0 | STS |
| 24/12 | 22.4 | 119.3 | 990 | 50 | 3.0 | STS |
| 24/18 | 22.7 | 118.0 | 994 | 40 | 3.0 | TS |
| 25/00 | 24.1 | 117.1 | 994 | 40 | 2.5 | TS |
| 25/06 | 24.6 | 115.7 | 994 | 40 | 2.5 | TS |
| 25/12 | 24.7 | 114.2 | 996 | 35 | 2.5 | TS |
| 25/18 | 24.8 | 113.0 | 998 | - | 2.0 | TD |
| 26/00 | 25.3 | 112.1 | 1000 | - | - | TD |
| 26/06 | 25.7 | 111.1 | 1000 | - | - | TD |
| 26/12 | | | | | | Dissip. |

## Podul (1912)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Aug. 24/06 | 8.4 | 142.5 | 1004 | - | 0.0 | TD |
| 24/12 | 8.1 | 140.0 | 1006 | - | 0.0 | TD |
| 24/18 | 8.3 | 138.6 | 1006 | - | 0.5 | TD |
| 25/00 | 11.0 | 137.7 | 1006 | - | 1.0 | TD |
| 25/06 | 12.0 | 136.9 | 1004 | - | 0.5 | TD |
| 25/12 | 12.4 | 135.5 | 1004 | - | 0.5 | TD |
| 25/18 | 12.5 | 133.6 | 1002 | - | 0.5 | TD |
| 26/00 | 12.8 | 132.2 | 1002 | - | 1.0 | TD |
| 26/06 | 13.1 | 130.8 | 1000 | - | 1.0 | TD |
| 26/12 | 13.5 | 129.5 | 1002 | - | 1.5 | TD |
| 26/18 | 13.5 | 128.2 | 1002 | - | 2.0 | TD |
| 27/00 | 14.4 | 126.5 | 1002 | - | 2.0 | TD |
| 27/06 | 15.4 | 124.2 | 1000 | - | 2.0 | TD |
| 27/12 | 16.0 | 121.9 | 1002 | - | 2.0 | TD |
| 27/18 | 16.1 | 119.6 | 1000 | - | 2.5 | TD |
| 28/00 | 16.5 | 117.3 | 998 | 35 | 3.0 | TS |
| 28/06 | 16.6 | 116.0 | 996 | 40 | 3.0 | TS |
| 28/12 | 16.9 | 114.5 | 994 | 40 | 3.0 | TS |
| 28/18 | 17.2 | 113.2 | 994 | 40 | 3.0 | TS |
| 29/00 | 17.5 | 111.1 | 994 | 40 | 3.0 | TS |
| 29/06 | 17.5 | 109.1 | 992 | 40 | 3.0 | TS |
| 29/12 | 17.6 | 108.3 | 992 | 40 | 3.0 | TS |
| 29/18 | 17.4 | 106.3 | 994 | 35 | 2.5 | TS |
| 30/00 | 16.8 | 105.1 | 994 | - | 2.0 | TD |
| 30/06 | 16.7 | 103.3 | 996 | - | 1.5 | TD |
| 30/12 | 16.7 | 102.7 | 996 | - | 1.5 | TD |
| 30/18 | 17.3 | 102.6 | 998 | - | 1.0 | TD |
| 31/00 | 17.9 | 102.1 | 1000 | - | 0.5 | TD |
| 31/06 | | | | | | Dissip. |

## Lingling (1913)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Aug. 31/00 | 6.2 | 133.7 | 1006 | - | 0.0 | TD |
| 31/06 | 7.0 | 132.9 | 1004 | - | 0.0 | TD |
| 31/12 | 8.0 | 132.0 | 1006 | - | 0.0 | TD |
| 31/18 | 9.0 | 131.3 | 1004 | - | 0.0 | TD |
| Sep. 01/00 | 10.8 | 130.2 | 1006 | - | 0.5 | TD |
| 01/06 | 12.6 | 129.1 | 1004 | - | 0.0 | TD |
| 01/12 | 13.8 | 127.7 | 1002 | - | 0.5 | TD |
| 01/18 | 14.4 | 126.9 | 1002 | - | 0.5 | TD |
| 02/00 | 15.2 | 126.1 | 1000 | 35 | 1.0 | TS |
| 02/06 | 16.7 | 125.0 | 1000 | 35 | 1.5 | TS |
| 02/12 | 18.0 | 124.3 | 998 | 40 | 2.0 | TS |
| 02/18 | 18.9 | 124.0 | 994 | 45 | 2.0 | TS |
| 03/00 | 19.7 | 123.9 | 992 | 50 | 2.5 | STS |
| 03/06 | 20.6 | 124.0 | 990 | 55 | 3.0 | STS |
| 03/12 | 21.3 | 124.2 | 985 | 60 | 3.0 | STS |
| 03/18 | 21.7 | 124.4 | 980 | 65 | 3.5 | TY |
| 04/00 | 22.0 | 124.6 | 975 | 70 | 4.5 | TY |
| 04/06 | 22.4 | 124.9 | 970 | 75 | 4.5 | TY |
| 04/12 | 22.9 | 125.3 | 965 | 80 | 4.5 | TY |
| 04/15 | 23.3 | 125.4 | 960 | 80 | - | TY |
| 04/18 | 23.5 | 125.4 | 955 | 85 | 5.0 | TY |
| 04/21 | 23.8 | 125.3 | 950 | 85 | - | TY |
| 05/00 | 24.2 | 125.3 | 950 | 85 | 5.5 | TY |
| 05/03 | 24.5 | 125.3 | 945 | 90 | - | TY |
| 05/06 | 24.9 | 125.3 | 940 | 95 | 6.0 | TY |
| 05/09 | 25.4 | 125.3 | 940 | 95 | - | TY |
| 05/12 | 25.7 | 125.2 | 940 | 95 | 6.0 | TY |
| 05/15 | 26.2 | 125.2 | 940 | 95 | - | TY |
| 05/18 | 26.8 | 125.2 | 945 | 90 | 6.0 | TY |
| 05/21 | 27.3 | 125.2 | 945 | 90 | - | TY |
| 06/00 | 28.0 | 125.1 | 950 | 85 | 6.0 | TY |
| 06/06 | 29.6 | 125.2 | 955 | 80 | 5.0 | TY |
| 06/12 | 31.4 | 125.2 | 960 | 75 | 5.0 | TY |
| 06/18 | 33.6 | 125.2 | 965 | 70 | 5.0 | TY |
| 07/00 | 35.8 | 125.1 | 970 | 65 | 4.5 | TY |
| 07/06 | 37.9 | 125.2 | 975 | 60 | 4.0 | STS |
| 07/12 | 40.8 | 126.4 | 985 | 50 | 3.5 | STS |
| 07/18 | 44.4 | 128.5 | 985 | 45 | 3.0 | TS |
| 08/00 | 47.3 | 130.5 | 984 | - | 2.5 | L |
| 08/06 | 48.8 | 132.8 | 982 | - | - | L |
| 08/12 | 51.1 | 137.2 | 982 | - | - | L |
| 08/18 | 52.7 | 140.4 | 976 | - | - | L |
| 09/00 | 53.9 | 143.4 | 976 | - | - | L |
| 09/06 | 54.0 | 147.7 | 972 | - | - | L |
| 09/12 | 54.6 | 151.2 | 972 | - | - | L |
| 09/18 | 55.2 | 155.6 | 976 | - | - | L |
| 10/00 | 55.6 | 162.6 | 980 | - | - | L |
| 10/06 | 57.1 | 166.4 | 980 | - | - | L |
| 10/12 | 57.4 | 168.4 | 980 | - | - | L |
| 10/18 | 58.0 | 170.6 | 978 | - | - | L |
| 11/00 | 58.3 | 171.9 | 978 | - | - | L |
| 11/06 | 58.5 | 173.6 | 974 | - | - | L |
| 11/12 | 59.1 | 176.6 | 972 | - | - | L |
| 11/18 | 59.4 | 179.4 | 972 | - | - | L |
| 12/00 | 60.1 | 183.1 | 970 | - | - | Out |

## Kajiki (1914)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Aug. 30/00 | 18.2 | 126.3 | 1008 | - | 0.0 | TD |
| 30/06 | 18.1 | 125.9 | 1006 | - | 0.0 | TD |
| 30/12 | 18.1 | 125.0 | 1006 | - | 0.0 | TD |
| 30/18 | 18.1 | 123.8 | 1006 | - | 0.0 | TD |
| 31/00 | 18.3 | 122.7 | 1006 | - | 0.0 | TD |
| 31/06 | 19.5 | 121.9 | 1004 | - | 0.0 | TD |
| 31/12 | 19.0 | 120.5 | 1004 | - | 0.5 | TD |
| 31/18 | 19.3 | 118.6 | 1002 | - | 0.5 | TD |
| Sep. 01/00 | 19.0 | 117.3 | 1002 | - | 0.5 | TD |
| 01/06 | 19.0 | 115.4 | 1000 | - | 1.0 | TD |
| 01/12 | 19.0 | 113.6 | 1000 | - | 1.0 | TD |
| 01/18 | 18.9 | 112.4 | 1000 | - | 1.5 | TD |
| 02/00 | 18.7 | 111.4 | 998 | - | 2.0 | TD |
| 02/06 | 18.4 | 109.3 | 998 | - | 2.5 | TD |
| 02/12 | 17.2 | 108.4 | 996 | 35 | 2.0 | TS |
| 02/18 | 16.4 | 107.4 | 996 | 35 | 2.5 | TS |
| 03/00 | 15.7 | 106.9 | 998 | 35 | 2.5 | TS |
| 03/06 | 16.0 | 107.8 | 998 | 35 | 2.0 | TS |
| 03/12 | 16.4 | 108.5 | 998 | - | 1.5 | TD |
| 03/18 | 16.7 | 108.0 | 998 | - | 1.0 | TD |
| 04/00 | 16.7 | 107.9 | 998 | - | 0.5 | TD |
| 04/06 | 16.7 | 108.0 | 998 | - | 0.0 | TD |
| 04/12 | 16.6 | 108.8 | 998 | - | 0.0 | TD |
| 04/18 | 17.2 | 109.2 | 1000 | - | 0.0 | TD |
| 05/00 | 17.6 | 110.2 | 1000 | - | 0.0 | TD |
| 05/06 | 18.2 | 111.6 | 1000 | - | 0.0 | TD |
| 05/12 | 19.1 | 112.8 | 1000 | - | 0.5 | TD |
| 05/18 | 19.6 | 113.0 | 1000 | - | 0.5 | TD |
| 06/00 | 19.4 | 112.3 | 1000 | - | 0.5 | TD |
| 06/06 | 18.6 | 112.5 | 1000 | - | 0.5 | TD |
| 06/12 | | | | | | Dissip. |

## Faxai (1915)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Sep. 02/00 | 15.9 | 167.9 | 1010 | - | 0.5 | TD |
| 02/06 | 16.2 | 166.6 | 1008 | - | 0.5 | TD |
| 02/12 | 16.5 | 165.4 | 1008 | - | 0.5 | TD |
| 02/18 | 16.8 | 164.3 | 1008 | - | 1.0 | TD |
| 03/00 | 17.0 | 163.0 | 1008 | - | 1.0 | TD |
| 03/06 | 17.1 | 161.8 | 1006 | - | 1.0 | TD |
| 03/12 | 17.2 | 161.0 | 1008 | - | 1.0 | TD |
| 03/18 | 17.5 | 160.2 | 1006 | - | 1.5 | TD |
| 04/00 | 17.8 | 159.4 | 1008 | - | 1.5 | TD |
| 04/06 | 18.0 | 158.5 | 1006 | - | 1.5 | TD |
| 04/12 | 18.3 | 157.5 | 1004 | - | 2.0 | TD |
| 04/18 | 18.6 | 156.7 | 1002 | 35 | 2.0 | TS |
| 05/00 | 19.1 | 156.1 | 1000 | 35 | 2.0 | TS |
| 05/06 | 19.7 | 155.5 | 998 | 40 | 2.5 | TS |
| 05/12 | 20.6 | 154.6 | 996 | 40 | 2.5 | TS |
| 05/18 | 21.6 | 153.2 | 994 | 40 | 2.5 | TS |
| 06/00 | 22.6 | 151.6 | 992 | 45 | 2.5 | TS |
| 06/06 | 23.7 | 149.9 | 990 | 50 | 3.0 | STS |
| 06/12 | 24.6 | 148.1 | 985 | 55 | 3.5 | STS |
| 06/18 | 25.7 | 146.5 | 980 | 60 | 4.0 | STS |
| 07/00 | 26.7 | 145.0 | 975 | 65 | 4.5 | TY |
| 07/03 | 27.3 | 144.1 | 970 | 70 | - | TY |
| 07/06 | 27.9 | 143.3 | 970 | 70 | 5.0 | TY |
| 07/09 | 28.4 | 142.6 | 965 | 75 | - | TY |
| 07/12 | 28.9 | 141.8 | 960 | 80 | 5.5 | TY |
| 07/15 | 29.5 | 141.2 | 960 | 80 | - | TY |
| 07/18 | 30.2 | 140.5 | 955 | 85 | 5.5 | TY |
| 07/21 | 30.8 | 140.0 | 955 | 85 | - | TY |
| 08/00 | 31.5 | 139.5 | 955 | 85 | 5.5 | TY |
| 08/03 | 32.2 | 139.2 | 955 | 85 | - | TY |
| 08/06 | 33.0 | 139.0 | 955 | 85 | 5.5 | TY |
| 08/09 | 33.5 | 138.9 | 955 | 85 | - | TY |
| 08/12 | 34.1 | 139.0 | 955 | 85 | 5.5 | TY |
| 08/15 | 34.7 | 139.3 | 960 | 80 | - | TY |
| 08/17 | 35.1 | 139.5 | 960 | 80 | - | TY |
| 08/18 | 35.3 | 139.7 | 960 | 80 | 5.0 | TY |
| 08/19 | 35.5 | 139.9 | 960 | 80 | - | TY |
| 08/21 | 35.9 | 140.3 | 960 | 80 | - | TY |
| 09/00 | 36.4 | 140.9 | 970 | 75 | 4.5 | TY |
| 09/03 | 36.9 | 141.6 | 975 | 70 | - | TY |
| 09/06 | 37.4 | 142.4 | 980 | 65 | 4.0 | TY |
| 09/12 | 38.3 | 144.3 | 985 | 60 | 3.5 | STS |
| 09/18 | 39.0 | 146.4 | 990 | 55 | 3.5 | STS |
| 10/00 | 39.7 | 148.8 | 992 | - | 3.0 | L |
| 10/06 | 40.5 | 151.5 | 996 | - | 2.5 | L |
| 10/12 | 41.3 | 155.0 | 998 | - | 2.0 | L |
| 10/18 | 42.3 | 158.2 | 1000 | - | - | L |
| 11/00 | 43.2 | 162.7 | 1000 | - | - | L |
| 11/06 | 44.5 | 168.7 | 1002 | - | - | L |
| 11/12 | 46.8 | 175.9 | 1002 | - | - | L |
| 11/18 | | | | | | Dissip. |

## Peipah (1916)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Sep. 12/18 | 11.7 | 159.2 | 1006 | - | - | TD |
| 13/00 | 11.9 | 158.5 | 1008 | - | 0.5 | TD |
| 13/06 | 12.2 | 157.1 | 1006 | - | 1.0 | TD |
| 13/12 | 12.6 | 155.7 | 1008 | - | 1.5 | TD |
| 13/18 | 12.8 | 154.3 | 1006 | - | 1.5 | TD |
| 14/00 | 13.2 | 152.9 | 1006 | - | 1.5 | TD |
| 14/06 | 13.5 | 151.7 | 1004 | - | 1.5 | TD |
| 14/12 | 13.9 | 151.2 | 1004 | - | 2.0 | TD |
| 14/18 | 14.3 | 150.5 | 1002 | - | 2.0 | TD |
| 15/00 | 15.4 | 149.7 | 1000 | 35 | 2.0 | TS |
| 15/06 | 16.6 | 149.0 | 1000 | 35 | 2.0 | TS |
| 15/12 | 17.7 | 148.0 | 1000 | 35 | 2.0 | TS |
| 15/18 | 19.5 | 146.7 | 1000 | 35 | 2.0 | TS |
| 16/00 | 21.3 | 145.3 | 1000 | 35 | 2.0 | TS |
| 16/06 | 23.5 | 144.1 | 1000 | 35 | 2.0 | TS |
| 16/12 | 25.0 | 142.9 | 1002 | - | 1.5 | TD |
| 16/18 | 27.0 | 142.4 | 1002 | - | 1.5 | TD |
| 17/00 | 28.9 | 142.7 | 1004 | - | - | TD |
| 17/06 | | | | | | Dissip. |

## Tapah (1917)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Sep. 17/00 | 20.0 | 128.7 | 1000 | - | 0.0 | TD |
| 17/06 | 20.8 | 128.7 | 998 | - | 0.0 | TD |
| 17/12 | 21.1 | 128.8 | 998 | - | 0.0 | TD |
| 17/18 | 21.4 | 128.9 | 998 | - | 0.0 | TD |
| 18/00 | 21.4 | 128.9 | 998 | - | 0.0 | TD |
| 18/06 | 21.9 | 129.0 | 998 | - | 0.5 | TD |
| 18/12 | 22.3 | 129.7 | 998 | - | 0.5 | TD |
| 18/18 | 22.7 | 129.4 | 998 | - | 0.5 | TD |
| 19/00 | 22.4 | 128.7 | 996 | 35 | 1.0 | TS |
| 19/06 | 22.4 | 128.6 | 994 | 35 | 1.0 | TS |
| 19/12 | 23.1 | 128.2 | 992 | 40 | 1.5 | TS |
| 19/18 | 22.8 | 127.4 | 990 | 40 | 1.5 | TS |
| 20/00 | 23.1 | 127.2 | 985 | 45 | 2.0 | TS |
| 20/06 | 23.1 | 127.2 | 980 | 50 | 2.5 | STS |
| 20/12 | 24.0 | 127.2 | 980 | 50 | 3.0 | STS |
| 20/15 | 24.5 | 126.7 | 975 | 60 | - | STS |
| 20/18 | 25.0 | 126.4 | 970 | 65 | 3.0 | TY |
| 20/21 | 25.5 | 126.1 | 970 | 65 | - | TY |
| 21/00 | 26.2 | 125.7 | 970 | 65 | 3.5 | TY |
| 21/03 | 26.7 | 125.6 | 970 | 65 | - | TY |
| 21/06 | 27.3 | 125.6 | 970 | 65 | 3.5 | TY |
| 21/09 | 27.9 | 125.6 | 970 | 65 | - | TY |
| 21/12 | 28.5 | 125.6 | 970 | 65 | 3.5 | TY |
| 21/15 | 29.0 | 125.8 | 970 | 65 | - | TY |
| 21/18 | 29.5 | 126.1 | 970 | 65 | 3.5 | TY |
| 21/21 | 30.2 | 126.5 | 970 | 65 | - | TY |
| 22/00 | 31.1 | 127.0 | 975 | 60 | 3.0 | STS |
| 22/03 | 31.9 | 127.4 | 975 | 60 | - | STS |
| 22/06 | 32.6 | 127.9 | 975 | 60 | 3.0 | STS |
| 22/09 | 33.2 | 128.5 | 975 | 60 | - | STS |
| 22/12 | 33.9 | 129.5 | 980 | 55 | 2.5 | STS |
| 22/15 | 34.5 | 130.4 | 980 | 55 | - | STS |
| 22/18 | 35.2 | 131.3 | 985 | 50 | 2.5 | STS |
| 22/21 | 36.3 | 132.7 | 990 | 45 | - | TS |
| 23/00 | 37.6 | 134.2 | 992 | - | 2.0 | L |
| 23/06 | 39.6 | 137.5 | 992 | - | - | L |
| 23/12 | 41.0 | 139.8 | 996 | - | - | L |
| 23/18 | | | | | | Dissip. |

## Mitag (1918)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Sep. 24/12 | 9.6 | 155.0 | 1012 | - | 0.0 | TD |
| 24/18 | 9.7 | 154.1 | 1010 | - | 0.0 | TD |
| 25/00 | 9.9 | 153.2 | 1010 | - | 0.0 | TD |
| 25/06 | 10.3 | 152.2 | 1008 | - | 0.5 | TD |
| 25/12 | 10.7 | 151.0 | 1010 | - | 1.0 | TD |
| 25/18 | 10.9 | 149.4 | 1008 | - | 0.5 | TD |
| 26/00 | 11.4 | 147.3 | 1010 | - | 0.5 | TD |
| 26/06 | 11.6 | 145.1 | 1008 | - | 0.5 | TD |
| 26/12 | 11.9 | 143.1 | 1010 | - | 1.0 | TD |
| 26/18 | 12.4 | 141.1 | 1008 | - | 0.5 | TD |
| 27/00 | 13.0 | 139.2 | 1008 | - | 1.0 | TD |
| 27/06 | 13.5 | 137.6 | 1006 | - | 1.5 | TD |
| 27/12 | 14.2 | 136.0 | 1006 | - | 1.5 | TD |
| 27/18 | 14.9 | 134.4 | 1004 | - | 2.0 | TD |
| 28/00 | 15.7 | 132.8 | 1000 | 35 | 2.0 | TS |
| 28/06 | 16.9 | 130.7 | 998 | 40 | 2.0 | TS |
| 28/12 | 17.4 | 129.2 | 996 | 40 | 2.0 | TS |
| 28/18 | 17.8 | 127.9 | 992 | 45 | 2.0 | TS |
| 29/00 | 18.3 | 126.9 | 990 | 50 | 2.5 | STS |
| 29/06 | 19.2 | 125.9 | 985 | 55 | 2.5 | STS |
| 29/12 | 20.1 | 124.8 | 980 | 60 | 3.0 | STS |
| 29/18 | 20.9 | 123.7 | 975 | 60 | 3.5 | STS |
| 30/00 | 21.7 | 123.0 | 970 | 65 | 4.0 | TY |
| 30/03 | 22.2 | 122.9 | 970 | 70 | - | TY |
| 30/06 | 22.9 | 122.9 | 970 | 70 | 4.5 | TY |
| 30/09 | 23.7 | 122.9 | 970 | 70 | - | TY |
| 30/12 | 24.6 | 122.9 | 965 | 75 | 5.0 | TY |
| 30/15 | 25.4 | 122.8 | 965 | 75 | - | TY |
| 30/18 | 26.1 | 122.6 | 965 | 75 | 5.0 | TY |
| Oct. 01/00 | 27.4 | 122.4 | 970 | 70 | 5.0 | TY |
| 01/06 | 28.6 | 122.2 | 980 | 60 | 4.5 | STS |
| 01/12 | 29.9 | 122.5 | 980 | 60 | 4.0 | STS |
| 01/18 | 30.6 | 122.9 | 985 | 55 | 3.5 | STS |
| 02/00 | 32.0 | 123.9 | 990 | 50 | 3.0 | STS |
| 02/06 | 33.3 | 124.7 | 990 | 50 | 3.0 | STS |
| 02/12 | 34.4 | 126.3 | 990 | 45 | 3.0 | TS |
| 02/18 | 35.8 | 128.2 | 994 | 40 | 3.0 | TS |
| 03/00 | 37.6 | 129.9 | 992 | 40 | 3.0 | TS |
| 03/06 | 38.0 | 131.0 | 988 | - | 3.0 | L |
| 03/12 | 38.7 | 132.6 | 988 | - | - | L |
| 03/18 | 38.8 | 134.5 | 988 | - | - | L |
| 04/00 | 39.1 | 136.5 | 992 | - | - | L |
| 04/06 | 38.9 | 138.5 | 992 | - | - | L |
| 04/12 | 38.6 | 140.9 | 994 | - | - | L |
| 04/18 | 39.1 | 143.5 | 996 | - | - | L |
| 05/00 | 39.6 | 146.1 | 998 | - | - | L |
| 05/06 | 40.9 | 148.9 | 998 | - | - | L |
| 05/12 | 43.4 | 151.7 | 1000 | - | - | L |
| 05/18 | | | | | | Dissip. |

## Hagibis (1919)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Oct. 04/18 | 15.7 | 164.4 | 1008 | - | 0.5 | TD |
| 05/00 | 15.0 | 162.7 | 1006 | - | 1.0 | TD |
| 05/06 | 15.3 | 161.1 | 1004 | - | 1.5 | TD |
| 05/12 | 15.2 | 159.4 | 1004 | - | 1.5 | TD |
| 05/18 | 15.1 | 157.4 | 1000 | 35 | 2.0 | TS |
| 06/00 | 14.4 | 155.6 | 992 | 45 | 2.5 | TS |
| 06/06 | 14.3 | 154.1 | 985 | 55 | 3.0 | STS |
| 06/12 | 14.6 | 153.0 | 970 | 70 | 3.5 | TY |
| 06/18 | 14.9 | 151.2 | 955 | 80 | 4.5 | TY |
| 07/00 | 15.1 | 149.6 | 940 | 90 | 5.0 | TY |
| 07/06 | 15.5 | 148.2 | 925 | 100 | 5.5 | TY |
| 07/12 | 16.1 | 146.6 | 915 | 105 | 6.0 | TY |
| 07/18 | 16.5 | 144.9 | 915 | 105 | 6.5 | TY |
| 08/00 | 16.9 | 143.8 | 915 | 105 | 6.5 | TY |
| 08/06 | 17.7 | 142.7 | 915 | 105 | 6.5 | TY |
| 08/12 | 18.4 | 141.8 | 915 | 105 | 6.5 | TY |
| 08/18 | 19.3 | 140.9 | 915 | 105 | 6.5 | TY |
| 09/00 | 19.8 | 140.4 | 915 | 105 | 7.0 | TY |
| 09/06 | 20.6 | 140.0 | 915 | 105 | 7.0 | TY |
| 09/12 | 21.2 | 139.6 | 915 | 105 | 7.0 | TY |
| 09/18 | 22.0 | 139.7 | 915 | 105 | 7.0 | TY |
| 10/00 | 23.2 | 139.9 | 915 | 105 | 7.0 | TY |
| 10/06 | 24.4 | 139.5 | 915 | 105 | 7.0 | TY |
| 10/12 | 25.3 | 139.0 | 920 | 100 | 7.0 | TY |
| 10/18 | 26.3 | 138.6 | 925 | 95 | 6.5 | TY |
| 11/00 | 27.5 | 138.1 | 935 | 90 | 6.0 | TY |
| 11/06 | 28.8 | 137.5 | 935 | 90 | 6.0 | TY |
| 11/12 | 29.9 | 137.1 | 945 | 85 | 5.5 | TY |
| 11/15 | 30.3 | 137.0 | 945 | 85 | - | TY |
| 11/18 | 30.8 | 137.1 | 945 | 85 | 5.5 | TY |
| 11/21 | 31.4 | 137.1 | 945 | 85 | - | TY |
| 12/00 | 32.0 | 137.4 | 950 | 80 | 5.0 | TY |
| 12/03 | 32.8 | 137.6 | 950 | 80 | - | TY |
| 12/06 | 33.7 | 138.2 | 950 | 80 | 5.0 | TY |
| 12/09 | 34.6 | 138.7 | 955 | 80 | - | TY |
| 12/12 | 35.6 | 139.6 | 965 | 70 | 4.5 | TY |
| 12/15 | 36.9 | 140.6 | 970 | 65 | - | TY |
| 12/18 | 38.2 | 141.8 | 975 | 60 | 4.0 | STS |
| 12/21 | 39.5 | 143.5 | 975 | 60 | - | STS |
| 13/00 | 40.1 | 145.1 | 975 | 60 | 3.5 | STS |
| 13/03 | 41.0 | 147.0 | 980 | - | - | L |
| 13/06 | 41.9 | 149.8 | 984 | - | - | L |
| 13/12 | 44.0 | 155.9 | 988 | - | - | L |
| 13/18 | 47.0 | 163.3 | 984 | - | - | L |
| 14/00 | 51.6 | 170.6 | 980 | - | - | L |
| 14/06 | 54.3 | 175.9 | 970 | - | - | L |
| 14/12 | 56.4 | 179.7 | 956 | - | - | L |
| 14/18 | 57.4 | 182.0 | 954 | - | - | Out |

## Neoguri (1920)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Oct. 15/00 | 15.8 | 136.4 | 1010 | - | 0.5 | TD |
| 15/06 | 16.0 | 135.5 | 1008 | - | 0.5 | TD |
| 15/12 | 16.4 | 134.6 | 1008 | - | 0.5 | TD |
| 15/18 | 16.8 | 133.8 | 1004 | - | 1.0 | TD |
| 16/00 | 17.3 | 132.9 | 1006 | - | 1.0 | TD |
| 16/06 | 17.8 | 132.0 | 1004 | - | 1.0 | TD |
| 16/12 | 18.1 | 131.2 | 1006 | - | 1.0 | TD |
| 16/18 | 18.3 | 130.6 | 1008 | - | 1.5 | TD |
| 17/00 | 18.6 | 130.3 | 1002 | 35 | 2.0 | TS |
| 17/06 | 19.0 | 130.2 | 1002 | 35 | 2.0 | TS |
| 17/12 | 19.3 | 130.2 | 1002 | 35 | 2.0 | TS |
| 17/18 | 19.6 | 130.1 | 1000 | 40 | 2.5 | TS |
| 18/00 | 19.8 | 130.0 | 998 | 45 | 2.5 | TS |
| 18/06 | 20.0 | 129.9 | 998 | 45 | 2.5 | TS |
| 18/12 | 20.3 | 129.4 | 998 | 45 | 2.5 | TS |
| 18/18 | 20.6 | 128.7 | 992 | 50 | 3.0 | STS |
| 19/00 | 21.0 | 128.0 | 990 | 55 | 3.5 | STS |
| 19/06 | 21.6 | 127.3 | 985 | 60 | 4.0 | STS |
| 19/12 | 21.8 | 127.3 | 975 | 70 | 4.5 | TY |
| 19/18 | 22.6 | 127.5 | 970 | 75 | 5.0 | TY |
| 20/00 | 23.4 | 127.9 | 970 | 75 | 5.0 | TY |
| 20/06 | 24.4 | 128.9 | 975 | 70 | 5.0 | TY |
| 20/12 | 25.4 | 129.9 | 980 | 65 | 4.5 | TY |
| 20/15 | 26.3 | 130.6 | 980 | 65 | - | TY |
| 20/18 | 27.1 | 131.3 | 985 | 60 | 4.0 | STS |
| 21/00 | 28.8 | 133.0 | 985 | 60 | 3.5 | STS |
| 21/06 | 30.2 | 134.3 | 990 | 55 | 3.0 | STS |
| 21/12 | 31.3 | 135.3 | 998 | - | 2.5 | L |
| 21/18 | 32.1 | 136.7 | 998 | - | - | L |
| 22/00 | 32.1 | 137.9 | 1004 | - | - | L |
| 22/06 | | | | | | Dissip. |

## Bualoi (1921)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Oct. 18/06 | 8.7 | 161.2 | 1008 | - | 0.5 | TD |
| 18/12 | 8.9 | 159.9 | 1008 | - | 0.5 | TD |
| 18/18 | 9.4 | 157.7 | 1008 | - | 0.5 | TD |
| 19/00 | 10.2 | 156.4 | 1006 | - | 1.0 | TD |
| 19/06 | 10.6 | 155.0 | 1000 | 35 | 1.5 | TS |
| 19/12 | 10.9 | 153.9 | 998 | 40 | 2.0 | TS |
| 19/18 | 11.0 | 152.6 | 994 | 45 | 2.5 | TS |
| 20/00 | 11.3 | 151.5 | 990 | 50 | 3.0 | STS |
| 20/06 | 12.1 | 150.6 | 985 | 55 | 3.5 | STS |
| 20/12 | 12.6 | 149.8 | 975 | 65 | 4.0 | TY |
| 20/18 | 13.5 | 149.0 | 970 | 70 | 4.5 | TY |
| 21/00 | 14.1 | 148.2 | 965 | 75 | 4.5 | TY |
| 21/06 | 14.7 | 147.6 | 955 | 85 | 5.0 | TY |
| 21/12 | 15.4 | 146.8 | 955 | 85 | 5.0 | TY |
| 21/18 | 16.3 | 146.0 | 955 | 85 | 5.5 | TY |
| 22/00 | 17.1 | 145.0 | 950 | 90 | 5.5 | TY |
| 22/06 | 18.2 | 144.4 | 935 | 100 | 6.5 | TY |
| 22/12 | 19.2 | 143.6 | 935 | 100 | 6.5 | TY |
| 22/18 | 20.3 | 143.1 | 935 | 100 | 6.5 | TY |
| 23/00 | 21.7 | 142.4 | 950 | 90 | 5.5 | TY |
| 23/06 | 22.8 | 142.1 | 940 | 95 | 5.5 | TY |
| 23/12 | 24.0 | 142.0 | 950 | 90 | 5.5 | TY |
| 23/15 | 24.8 | 142.0 | 950 | 90 | - | TY |
| 23/18 | 25.6 | 141.9 | 955 | 85 | 5.5 | TY |
| 23/21 | 26.1 | 142.0 | 960 | 80 | - | TY |
| 24/00 | 26.9 | 142.1 | 960 | 80 | 5.0 | TY |
| 24/03 | 27.6 | 142.2 | 970 | 75 | - | TY |
| 24/06 | 28.4 | 142.6 | 970 | 75 | 4.5 | TY |
| 24/12 | 29.6 | 143.7 | 970 | 75 | 4.5 | TY |
| 24/18 | 30.9 | 145.0 | 975 | 70 | 4.5 | TY |
| 25/00 | 32.4 | 146.3 | 980 | 65 | 4.5 | TY |
| 25/06 | 34.1 | 148.1 | 985 | 60 | 4.0 | STS |
| 25/12 | 35.1 | 148.6 | 996 | - | 4.0 | L |
| 25/18 | 36.6 | 149.0 | 1004 | - | 3.5 | L |
| 26/00 | 38.5 | 149.4 | 1004 | - | - | L |
| 26/06 | | | | | | Dissip. |

## Matmo (1922)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Oct. 28/18 | 11.9 | 116.6 | 1004 | - | 1.0 | TD |
| 29/00 | 12.4 | 115.7 | 1004 | - | 1.5 | TD |
| 29/06 | 13.0 | 114.8 | 1002 | - | 1.5 | TD |
| 29/12 | 13.3 | 113.9 | 1002 | - | 2.0 | TD |
| 29/18 | 13.3 | 112.6 | 1000 | 35 | 2.5 | TS |
| 30/00 | 13.3 | 111.5 | 994 | 45 | 2.5 | TS |
| 30/06 | 13.2 | 110.7 | 992 | 50 | 3.0 | STS |
| 30/12 | 13.3 | 110.2 | 992 | 50 | 3.5 | STS |
| 30/18 | 13.5 | 108.9 | 994 | 50 | 3.5 | STS |
| 31/00 | 13.7 | 107.2 | 1000 | 35 | 3.0 | TS |
| 31/06 | 13.8 | 106.1 | 1002 | - | 2.5 | TD |
| 31/12 | 14.0 | 105.2 | 1006 | - | 2.0 | TD |
| 31/18 | 13.7 | 104.0 | 1008 | - | 1.5 | TD |
| Nov. 01/00 | | | | | | Dissip. |

## Halong (1923)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Nov. 01/12 | 9.6 | 162.2 | 1004 | - | 0.5 | TD |
| 01/18 | 10.7 | 160.8 | 1004 | - | 0.5 | TD |
| 02/00 | 11.7 | 159.7 | 1004 | - | 1.0 | TD |
| 02/06 | 12.6 | 158.6 | 1002 | - | 1.0 | TD |
| 02/12 | 13.4 | 157.7 | 1000 | 35 | 1.5 | TS |
| 02/18 | 14.0 | 156.9 | 1000 | 35 | 2.0 | TS |
| 03/00 | 14.7 | 155.9 | 1000 | 35 | 2.0 | TS |
| 03/06 | 15.4 | 154.8 | 998 | 40 | 2.0 | TS |
| 03/12 | 15.9 | 154.2 | 994 | 45 | 2.5 | TS |
| 03/18 | 16.6 | 153.8 | 992 | 50 | 3.0 | STS |
| 04/00 | 17.1 | 153.6 | 985 | 60 | 3.5 | STS |
| 04/06 | 17.8 | 153.2 | 980 | 65 | 4.0 | TY |
| 04/12 | 18.3 | 152.7 | 975 | 70 | 5.0 | TY |
| 04/18 | 18.8 | 152.3 | 960 | 80 | 5.0 | TY |
| 05/00 | 19.1 | 151.9 | 950 | 90 | 6.0 | TY |
| 05/06 | 19.7 | 151.3 | 935 | 100 | 6.5 | TY |
| 05/12 | 19.9 | 150.8 | 905 | 115 | 7.5 | TY |
| 05/18 | 20.3 | 150.6 | 905 | 115 | 7.5 | TY |
| 06/00 | 20.8 | 150.5 | 905 | 115 | 7.5 | TY |
| 06/06 | 21.2 | 150.5 | 905 | 115 | 7.5 | TY |
| 06/12 | 21.7 | 150.7 | 920 | 105 | 6.0 | TY |
| 06/18 | 22.3 | 151.0 | 940 | 95 | 6.0 | TY |
| 07/00 | 23.1 | 151.2 | 955 | 85 | 5.5 | TY |
| 07/06 | 23.9 | 151.5 | 960 | 80 | 5.5 | TY |
| 07/12 | 24.6 | 152.1 | 970 | 75 | 5.5 | TY |
| 07/18 | 25.5 | 153.0 | 975 | 70 | 5.0 | TY |
| 08/00 | 26.8 | 154.8 | 980 | 65 | 4.5 | TY |
| 08/06 | 28.1 | 157.0 | 990 | 55 | 4.0 | STS |
| 08/12 | 29.6 | 158.6 | 994 | 45 | 3.5 | TS |
| 08/18 | 30.7 | 159.7 | 1000 | 35 | 3.0 | TS |
| 09/00 | 31.2 | 160.8 | 1004 | - | 2.5 | L |
| 09/06 | 31.9 | 162.7 | 1006 | - | - | L |
| 09/12 | 32.3 | 164.7 | 1008 | - | - | L |
| 09/18 | 32.4 | 166.6 | 1008 | - | - | L |
| 10/00 | 32.5 | 168.4 | 1008 | - | - | L |
| 10/06 | 32.7 | 170.2 | 1008 | - | - | L |
| 10/12 | | | | | | Dissip. |

## Nakri (1924)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Nov. 04/00 | 12.7 | 113.7 | 1006 | - | 0.0 | TD |
| 04/06 | 13.3 | 114.0 | 1004 | - | 0.0 | TD |
| 04/12 | 13.4 | 114.2 | 1004 | - | 0.0 | TD |
| 04/18 | 13.5 | 114.4 | 1004 | - | 0.5 | TD |
| 05/00 | 13.6 | 114.8 | 1004 | - | 0.5 | TD |
| 05/06 | 13.7 | 115.3 | 1002 | - | 1.0 | TD |
| 05/12 | 13.7 | 115.8 | 1000 | - | 1.0 | TD |
| 05/18 | 13.5 | 116.0 | 998 | 35 | 1.5 | TS |
| 06/00 | 13.4 | 116.2 | 996 | 35 | 2.0 | TS |
| 06/06 | 13.2 | 116.4 | 994 | 40 | 2.0 | TS |
| 06/12 | 13.2 | 116.6 | 994 | 40 | 2.5 | TS |
| 06/18 | 13.3 | 116.8 | 992 | 45 | 3.0 | TS |
| 07/00 | 13.2 | 116.9 | 990 | 50 | 3.5 | STS |
| 07/06 | 13.0 | 117.0 | 985 | 55 | 3.5 | STS |
| 07/12 | 12.8 | 117.2 | 980 | 60 | 3.5 | STS |
| 07/18 | 12.6 | 117.0 | 980 | 60 | 4.0 | STS |
| 08/00 | 12.5 | 117.1 | 980 | 60 | 4.0 | STS |
| 08/06 | 12.6 | 116.4 | 975 | 65 | 4.0 | TY |
| 08/12 | 12.5 | 115.7 | 975 | 65 | 4.0 | TY |
| 08/18 | 12.5 | 115.3 | 980 | 60 | 4.0 | STS |
| 09/00 | 12.4 | 114.6 | 980 | 60 | 3.5 | STS |
| 09/06 | 12.4 | 113.7 | 980 | 60 | 3.5 | STS |
| 09/12 | 12.3 | 113.1 | 980 | 55 | 3.0 | STS |
| 09/18 | 12.4 | 112.4 | 985 | 55 | 3.0 | STS |
| 10/00 | 12.3 | 111.5 | 985 | 55 | 3.0 | STS |
| 10/06 | 12.5 | 110.8 | 985 | 55 | 3.0 | STS |
| 10/12 | 12.6 | 110.1 | 990 | 50 | 3.0 | STS |
| 10/18 | 12.8 | 109.5 | 996 | 40 | 2.5 | TS |
| 11/00 | 13.0 | 109.0 | 1002 | - | 2.0 | TD |
| 11/06 | 13.3 | 107.8 | 1006 | - | 1.5 | TD |
| 11/12 | | | | | | Dissip. |

## Fengshen (1925)

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| Nov. 09/18 | 12.6 | 173.4 | 1004 | - | 0.0 | TD |
| 10/00 | 13.0 | 171.9 | 1006 | - | 0.0 | TD |
| 10/06 | 13.3 | 170.5 | 1004 | - | 0.0 | TD |
| 10/12 | 13.3 | 169.5 | 1006 | - | 0.0 | TD |
| 10/18 | 13.3 | 168.9 | 1004 | - | 0.5 | TD |
| 11/00 | 13.5 | 168.2 | 1006 | - | 0.5 | TD |
| 11/06 | 14.0 | 166.6 | 1004 | - | 1.0 | TD |
| 11/12 | 14.1 | 165.4 | 1004 | - | 1.0 | TD |
| 11/18 | 14.7 | 164.1 | 1004 | - | 1.5 | TD |
| 12/00 | 14.8 | 162.5 | 1000 | 35 | 1.5 | TS |
| 12/06 | 15.4 | 161.1 | 1000 | 35 | 2.0 | TS |
| 12/12 | 16.2 | 159.6 | 1000 | 35 | 2.0 | TS |
| 12/18 | 16.8 | 158.0 | 998 | 40 | 2.0 | TS |
| 13/00 | 17.2 | 156.0 | 998 | 40 | 2.5 | TS |
| 13/06 | 16.9 | 154.5 | 998 | 40 | 3.0 | TS |
| 13/12 | 16.7 | 153.2 | 996 | 45 | 3.0 | TS |
| 13/18 | 16.7 | 151.8 | 992 | 50 | 3.0 | STS |
| 14/00 | 16.8 | 149.9 | 992 | 50 | 3.0 | STS |
| 14/06 | 16.9 | 148.2 | 992 | 50 | 3.0 | STS |
| 14/12 | 17.3 | 146.4 | 990 | 55 | 3.0 | STS |
| 14/18 | 18.1 | 145.0 | 985 | 60 | 4.0 | STS |
| 15/00 | 19.1 | 143.7 | 975 | 75 | 5.0 | TY |
| 15/06 | 20.1 | 142.7 | 965 | 85 | 5.0 | TY |
| 15/12 | 21.1 | 142.2 | 965 | 85 | 5.5 | TY |
| 15/18 | 22.4 | 142.5 | 965 | 85 | 5.5 | TY |
| 16/00 | 23.7 | 143.2 | 965 | 85 | 5.5 | TY |
| 16/06 | 24.9 | 144.7 | 965 | 85 | 5.5 | TY |
| 16/12 | 25.9 | 146.7 | 965 | 85 | 5.5 | TY |
| 16/18 | 26.6 | 149.2 | 970 | 80 | 5.5 | TY |
| 17/00 | 26.9 | 152.2 | 980 | 70 | 5.5 | TY |
| 17/06 | 26.9 | 155.2 | 990 | 60 | 4.5 | STS |
| 17/12 | 26.2 | 156.7 | 1004 | - | 4.0 | L |
| 17/18 | 25.0 | 157.8 | 1008 | - | 3.5 | L |
| 18/00 | 24.0 | 158.5 | 1014 | - | 3.0 | L |
| 18/06 | | | | | | Dissip. |

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| **Kalmaegi (1926)** | | | | | | |
| Nov. 09/18 | 14.3 | 136.0 | 1004 | - | 0.0 | TD |
| 10/00 | 14.1 | 135.7 | 1004 | - | 0.5 | TD |
| 10/06 | 13.9 | 135.5 | 1004 | - | 0.0 | TD |
| 10/12 | 13.7 | 135.2 | 1004 | - | 0.5 | TD |
| 10/18 | 13.5 | 134.9 | 1002 | - | 0.0 | TD |
| 11/00 | 13.4 | 134.5 | 1004 | - | 0.0 | TD |
| 11/06 | 13.3 | 133.9 | 1002 | - | 0.5 | TD |
| 11/12 | 12.6 | 133.3 | 1004 | - | 0.5 | TD |
| 11/18 | 12.0 | 132.9 | 1002 | - | 0.5 | TD |
| 12/00 | 11.6 | 132.6 | 1004 | - | 0.0 | TD |
| 12/06 | 11.7 | 132.0 | 1002 | - | 0.5 | TD |
| 12/12 | 12.0 | 131.1 | 1004 | - | 1.0 | TD |
| 12/18 | 12.3 | 130.1 | 1002 | - | 1.5 | TD |
| 13/00 | 12.6 | 129.2 | 1002 | - | 2.0 | TD |
| 13/06 | 12.8 | 128.4 | 1002 | - | 2.0 | TD |
| 13/12 | 13.0 | 128.5 | 1002 | - | 2.0 | TD |
| 13/18 | 13.2 | 128.6 | 1002 | - | 2.0 | TD |
| 14/00 | 14.6 | 128.7 | 1002 | - | 2.0 | TD |
| 14/06 | 15.8 | 127.6 | 1002 | - | 2.0 | TD |
| 14/12 | 16.4 | 127.6 | 1000 | 35 | 2.5 | TS |
| 14/18 | 16.9 | 127.2 | 1000 | 35 | 2.5 | TS |
| 15/00 | 17.3 | 126.6 | 1000 | 35 | 2.5 | TS |
| 15/06 | 16.9 | 126.2 | 1000 | 35 | 2.5 | TS |
| 15/12 | 16.8 | 126.3 | 1000 | 35 | 2.5 | TS |
| 15/18 | 16.6 | 126.4 | 1000 | 35 | 2.5 | TS |
| 16/00 | 16.2 | 126.7 | 1000 | 35 | 2.5 | TS |
| 16/06 | 15.9 | 126.6 | 1000 | 35 | 2.5 | TS |
| 16/12 | 16.2 | 126.3 | 1000 | 35 | 2.5 | TS |
| 16/18 | 16.3 | 126.0 | 1000 | 35 | 2.5 | TS |
| 17/00 | 16.5 | 125.5 | 1000 | 35 | 2.5 | TS |
| 17/06 | 16.7 | 124.9 | 998 | 40 | 2.5 | TS |
| 17/12 | 17.0 | 124.0 | 996 | 45 | 2.5 | TS |
| 17/18 | 17.3 | 123.6 | 996 | 45 | 2.5 | TS |
| 18/00 | 17.6 | 123.3 | 992 | 50 | 3.0 | STS |
| 18/06 | 18.1 | 123.1 | 985 | 60 | 3.5 | STS |
| 18/12 | 18.8 | 122.9 | 980 | 65 | 3.5 | TY |
| 18/18 | 19.1 | 122.7 | 975 | 70 | 4.5 | TY |
| 19/00 | 19.2 | 122.6 | 975 | 70 | 4.5 | TY |
| 19/06 | 19.5 | 122.6 | 975 | 70 | 4.5 | TY |
| 19/12 | 19.4 | 122.3 | 975 | 70 | 4.5 | TY |
| 19/18 | 18.4 | 122.1 | 1000 | 45 | 4.0 | TS |
| 20/00 | 17.4 | 121.7 | 1006 | - | 3.5 | TD |
| 20/06 | 16.6 | 121.0 | 1006 | - | 3.0 | TD |
| 20/12 | 15.8 | 120.0 | 1006 | - | 2.5 | TD |
| 20/18 | 15.1 | 119.2 | 1008 | - | 2.0 | TD |
| 21/00 | 14.6 | 118.4 | 1008 | - | - | TD |
| 21/06 | 13.8 | 117.3 | 1008 | - | - | TD |
| 21/12 | 13.0 | 116.2 | 1010 | - | - | TD |
| 21/18 | 12.1 | 115.1 | 1008 | - | - | TD |
| 22/00 | 11.4 | 114.0 | 1010 | - | - | TD |
| 22/06 | | | | | | Dissip. |

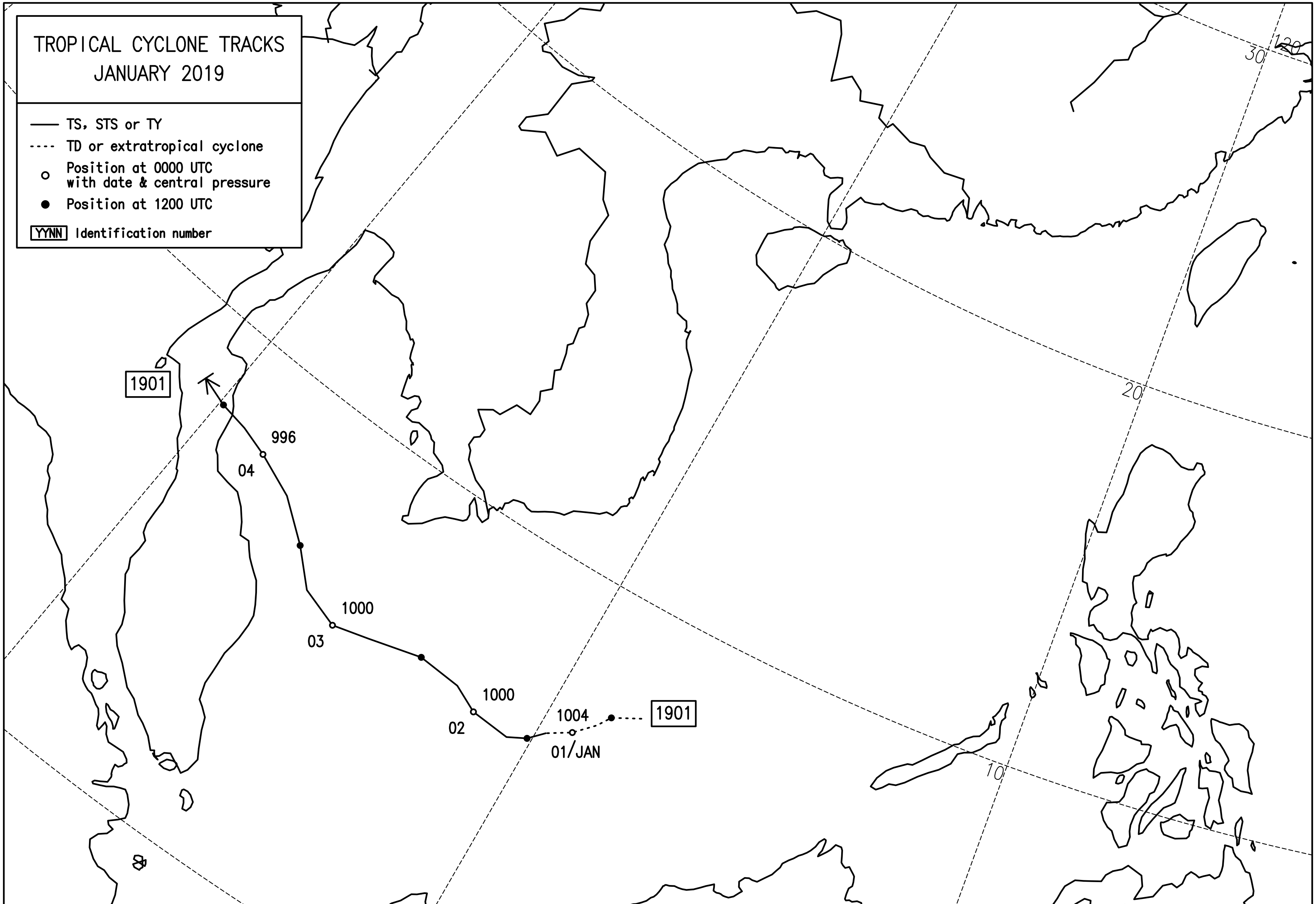
| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| **Fung-wong (1927)** | | | | | | |
| Nov. 17/12 | 10.6 | 143.6 | 1008 | - | - | TD |
| 17/18 | 11.0 | 142.0 | 1006 | - | 0.0 | TD |
| 18/00 | 11.5 | 140.5 | 1008 | - | 0.0 | TD |
| 18/06 | 12.0 | 138.8 | 1006 | - | 0.5 | TD |
| 18/12 | 12.3 | 137.0 | 1008 | - | 0.5 | TD |
| 18/18 | 12.4 | 134.9 | 1006 | - | 0.5 | TD |
| 19/00 | 13.1 | 132.9 | 1004 | - | 1.0 | TD |
| 19/06 | 14.0 | 131.1 | 1002 | - | 1.5 | TD |
| 19/12 | 14.7 | 130.0 | 1002 | - | 2.0 | TD |
| 19/18 | 15.3 | 128.8 | 1002 | - | 2.0 | TD |
| 20/00 | 16.1 | 128.2 | 1000 | 35 | 2.5 | TS |
| 20/06 | 17.6 | 127.2 | 998 | 40 | 2.5 | TS |
| 20/12 | 19.0 | 126.0 | 994 | 45 | 2.5 | TS |
| 20/18 | 19.6 | 125.4 | 992 | 50 | 3.0 | STS |
| 21/00 | 20.2 | 125.0 | 990 | 55 | 3.5 | STS |
| 21/06 | 20.5 | 124.4 | 990 | 55 | 3.5 | STS |
| 21/12 | 21.3 | 124.3 | 994 | 50 | 3.5 | STS |
| 21/18 | 22.2 | 124.4 | 994 | 50 | 3.5 | STS |
| 22/00 | 22.9 | 125.0 | 996 | 45 | 3.0 | TS |
| 22/06 | 23.7 | 125.4 | 1002 | 35 | 3.0 | TS |
| 22/12 | 24.6 | 125.3 | 1010 | - | 2.5 | TD |
| 22/18 | 25.1 | 125.3 | 1010 | - | 2.0 | TD |
| 23/00 | 25.2 | 125.5 | 1012 | - | - | TD |
| 23/06 | 25.3 | 125.6 | 1012 | - | - | TD |
| 23/12 | 26.0 | 125.9 | 1014 | - | - | TD |
| 23/18 | 28.4 | 125.6 | 1014 | - | - | L |
| 24/00 | 30.0 | 126.2 | 1014 | - | - | L |
| 24/06 | 30.2 | 127.7 | 1012 | - | - | L |
| 24/12 | 31.1 | 131.6 | 1016 | - | - | L |
| 24/18 | 31.7 | 134.1 | 1014 | - | - | L |
| 25/00 | 32.8 | 136.7 | 1014 | - | - | L |
| 25/06 | | | | | | Dissip. |

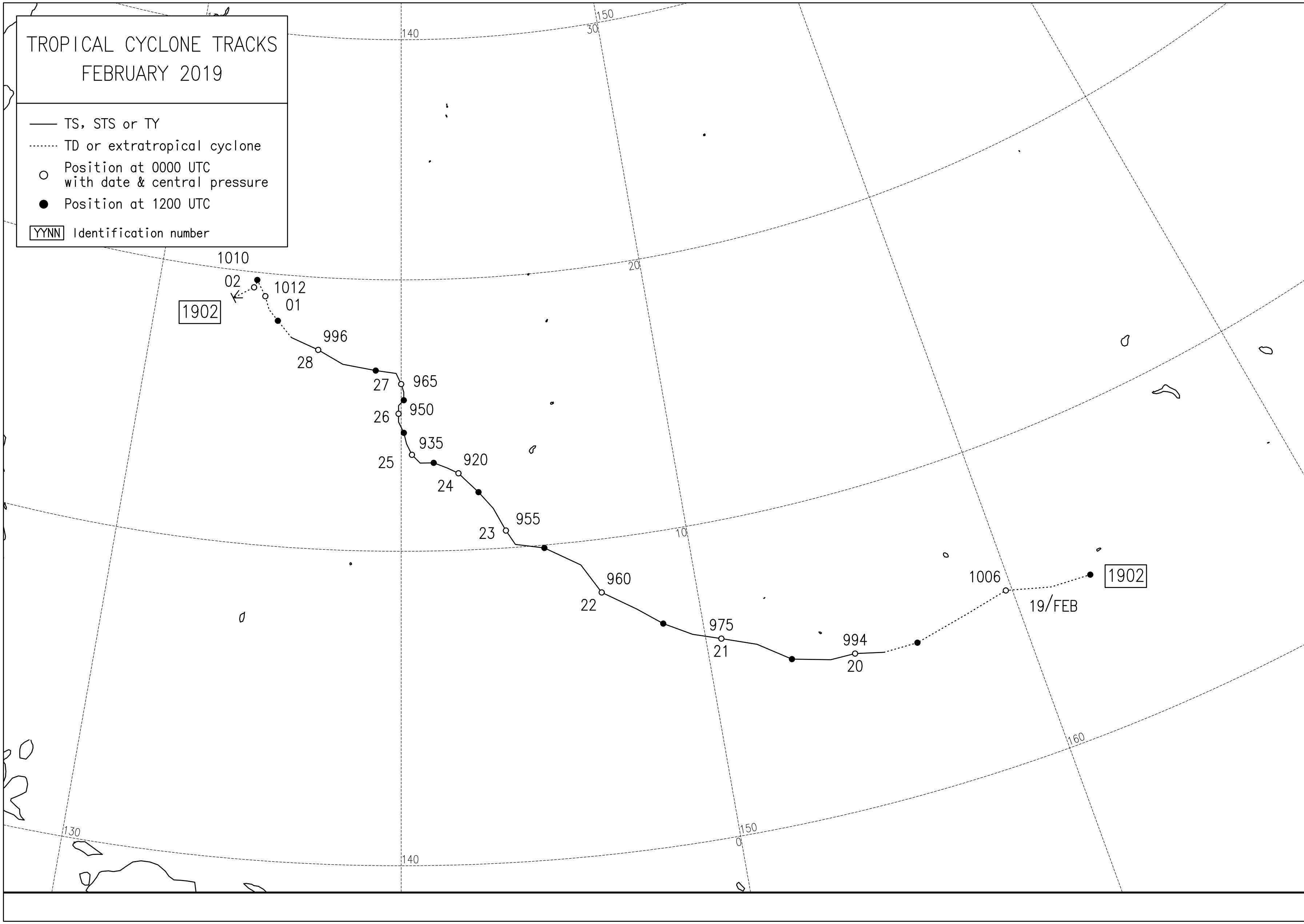
| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| **Kammuri (1928)** | | | | | | |
| Nov. 24/12 | 8.6 | 159.7 | 1004 | - | 0.5 | TD |
| 24/18 | 8.7 | 158.6 | 1004 | - | 0.5 | TD |
| 25/00 | 8.8 | 157.0 | 1004 | - | 0.5 | TD |
| 25/06 | 9.2 | 155.2 | 1002 | - | 0.5 | TD |
| 25/12 | 9.9 | 153.6 | 1004 | - | 1.0 | TD |
| 25/18 | 10.2 | 151.3 | 1002 | - | 1.5 | TD |
| 26/00 | 10.7 | 149.2 | 1000 | 35 | 2.0 | TS |
| 26/06 | 10.9 | 147.4 | 998 | 40 | 2.0 | TS |
| 26/12 | 11.3 | 145.3 | 998 | 40 | 2.0 | TS |
| 26/18 | 11.3 | 143.4 | 994 | 45 | 2.5 | TS |
| 27/00 | 11.3 | 142.1 | 992 | 50 | 2.5 | STS |
| 27/06 | 11.4 | 141.0 | 992 | 50 | 3.0 | STS |
| 27/12 | 11.4 | 140.0 | 990 | 55 | 3.5 | STS |
| 27/18 | 11.5 | 139.2 | 985 | 60 | 4.0 | STS |
| 28/00 | 11.9 | 138.8 | 980 | 65 | 4.0 | TY |
| 28/06 | 12.7 | 138.7 | 980 | 65 | 4.5 | TY |
| 28/12 | 13.4 | 138.7 | 980 | 65 | 4.5 | TY |
| 28/18 | 14.2 | 138.6 | 975 | 70 | 4.5 | TY |
| 29/00 | 14.1 | 138.0 | 975 | 70 | 5.0 | TY |
| 29/06 | 14.0 | 137.3 | 975 | 70 | 5.0 | TY |
| 29/12 | 13.9 | 136.7 | 975 | 70 | 5.0 | TY |
| 29/18 | 13.8 | 136.1 | 975 | 70 | 5.0 | TY |
| 30/00 | 13.6 | 135.5 | 975 | 70 | 5.5 | TY |
| 30/06 | 13.4 | 134.6 | 970 | 75 | 5.5 | TY |
| 30/12 | 13.2 | 133.3 | 970 | 75 | 5.5 | TY |
| 30/18 | 13.1 | 131.8 | 970 | 75 | 5.5 | TY |
| Dec. 01/00 | 13.1 | 131.0 | 970 | 75 | 5.0 | TY |
| 01/06 | 13.1 | 130.2 | 970 | 75 | 5.0 | TY |
| 01/12 | 13.1 | 129.2 | 970 | 75 | 4.5 | TY |
| 01/18 | 13.2 | 127.6 | 970 | 75 | 4.5 | TY |
| 02/00 | 12.9 | 126.6 | 960 | 80 | 5.0 | TY |
| 02/06 | 13.0 | 125.6 | 955 | 85 | 5.0 | TY |
| 02/12 | 12.9 | 124.7 | 950 | 90 | 5.5 | TY |
| 02/18 | 13.2 | 123.5 | 950 | 90 | 5.5 | TY |
| 03/00 | 13.2 | 122.2 | 960 | 80 | 5.0 | TY |
| 03/06 | 13.3 | 120.8 | 975 | 70 | 4.5 | TY |
| 03/12 | 13.4 | 119.7 | 980 | 65 | 4.0 | TY |
| 03/18 | 13.7 | 118.6 | 985 | 60 | 3.5 | STS |
| 04/00 | 14.0 | 117.6 | 992 | 50 | 3.0 | STS |
| 04/06 | 14.2 | 116.8 | 992 | 50 | 3.0 | STS |
| 04/12 | 14.2 | 116.1 | 994 | 45 | 2.5 | TS |
| 04/18 | 14.3 | 115.2 | 1000 | 35 | 2.0 | TS |
| 05/00 | 14.3 | 114.3 | 1002 | 35 | 1.5 | TS |
| 05/06 | 13.8 | 113.7 | 1002 | 35 | 1.5 | TS |
| 05/12 | 13.1 | 113.3 | 1004 | 35 | 1.5 | TS |
| 05/18 | 12.4 | 112.9 | 1008 | - | - | TD |
| 06/00 | 11.4 | 112.9 | 1008 | - | - | TD |
| 06/06 | | | | | | Dissip. |

| Date/Time (UTC) | Center position Lat (N) | Lon (E) | Central pressure (hPa) | Max wind (kt) | CI num. | Grade |
|---|---|---|---|---|---|---|
| **Phanfone (1929)** | | | | | | |
| Dec. 19/12 | 4.7 | 151.4 | 1006 | - | 0.0 | TD |
| 19/18 | 4.6 | 150.0 | 1004 | - | 0.0 | TD |
| 20/00 | 4.6 | 148.8 | 1006 | - | 0.0 | TD |
| 20/06 | 4.6 | 147.6 | 1004 | - | 0.0 | TD |
| 20/12 | 4.6 | 146.3 | 1004 | - | 0.0 | TD |
| 20/18 | 4.6 | 145.1 | 1004 | - | 0.5 | TD |
| 21/00 | 4.8 | 143.7 | 1004 | - | 0.5 | TD |
| 21/06 | 5.2 | 142.5 | 1004 | - | 0.5 | TD |
| 21/12 | 5.6 | 141.5 | 1004 | - | 1.0 | TD |
| 21/18 | 6.0 | 140.7 | 1004 | - | 1.5 | TD |
| 22/00 | 6.5 | 139.7 | 1004 | - | 1.5 | TD |
| 22/06 | 7.4 | 138.4 | 1002 | - | 1.5 | TD |
| 22/12 | 8.7 | 136.9 | 1002 | 35 | 1.5 | TS |
| 22/18 | 9.6 | 135.0 | 1002 | 35 | 2.0 | TS |
| 23/00 | 10.0 | 133.4 | 1000 | 40 | 2.5 | TS |
| 23/06 | 10.2 | 132.1 | 998 | 45 | 3.0 | TS |
| 23/12 | 10.4 | 130.7 | 996 | 50 | 3.5 | STS |
| 23/18 | 10.5 | 129.1 | 992 | 55 | 4.0 | STS |
| 24/00 | 10.6 | 127.8 | 985 | 65 | 4.5 | TY |
| 24/06 | 10.9 | 126.4 | 980 | 70 | 4.5 | TY |
| 24/12 | 11.4 | 124.9 | 975 | 75 | 5.0 | TY |
| 24/18 | 11.8 | 123.4 | 970 | 80 | 5.0 | TY |
| 25/00 | 11.9 | 122.4 | 975 | 75 | 4.5 | TY |
| 25/06 | 12.1 | 121.3 | 980 | 70 | 4.5 | TY |
| 25/12 | 12.5 | 120.1 | 985 | 65 | 4.0 | TY |
| 25/18 | 12.8 | 119.3 | 992 | 55 | 3.5 | STS |
| 26/00 | 13.1 | 118.6 | 985 | 65 | 3.5 | TY |
| 26/06 | 13.4 | 118.0 | 975 | 75 | 3.5 | TY |
| 26/12 | 13.9 | 117.7 | 985 | 65 | 3.5 | TY |
| 26/18 | 14.3 | 117.2 | 990 | 60 | 3.5 | STS |
| 27/00 | 14.5 | 116.9 | 992 | 55 | 3.5 | STS |
| 27/06 | 14.7 | 116.5 | 996 | 50 | 3.5 | STS |
| 27/12 | 14.6 | 116.0 | 998 | 45 | 3.5 | TS |
| 27/18 | 14.5 | 115.7 | 1002 | 35 | 3.0 | TS |
| 28/00 | 14.4 | 115.2 | 1006 | - | 2.5 | TD |
| 28/06 | 14.4 | 114.0 | 1008 | - | 2.0 | TD |
| 28/12 | 14.4 | 113.0 | 1010 | - | 1.5 | TD |
| 28/18 | 14.4 | 112.2 | 1012 | - | 1.0 | TD |
| 29/00 | 14.3 | 111.7 | 1012 | - | 1.0 | TD |
| 29/06 | | | | | | Dissip. |

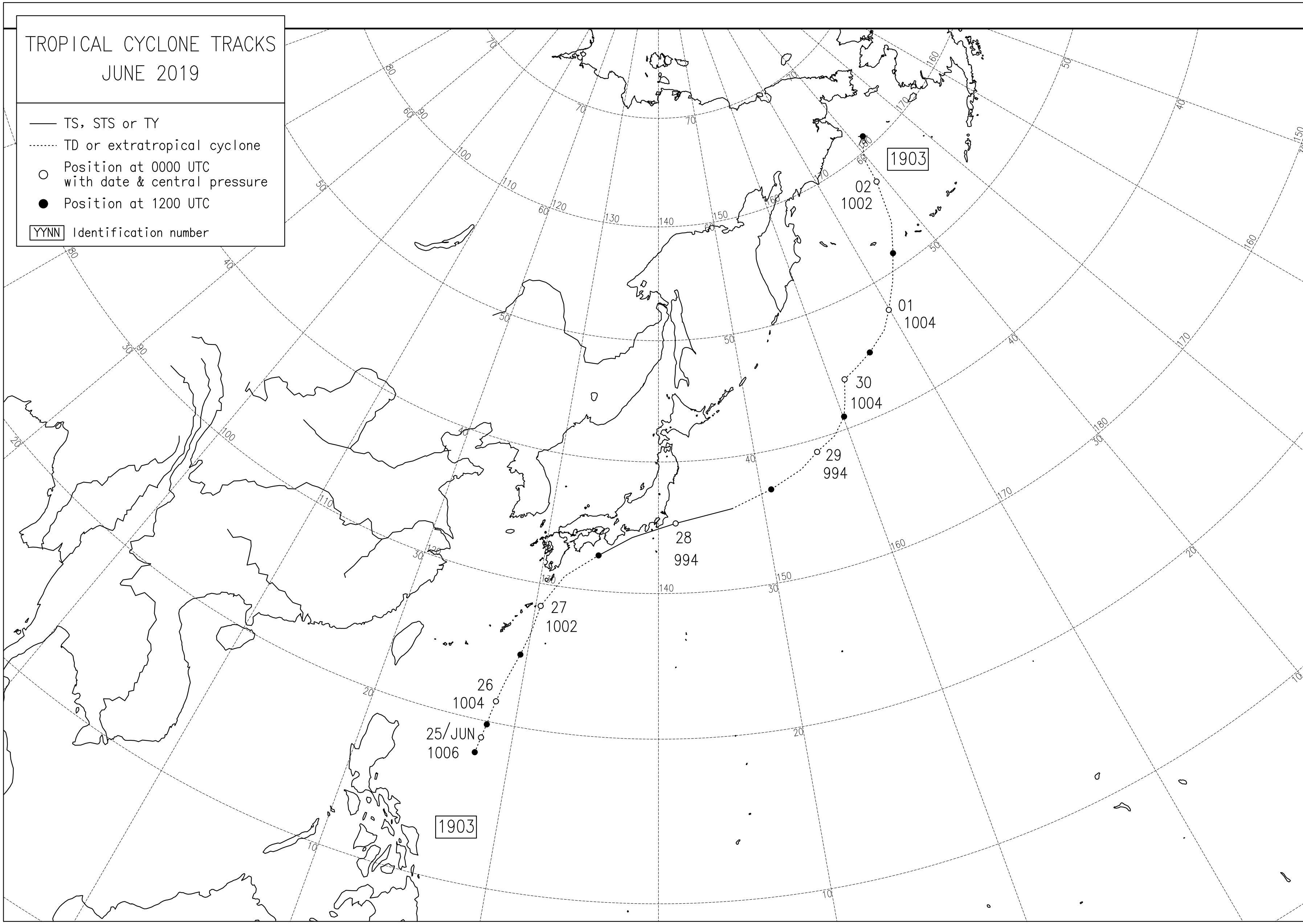
**Appendix 2**

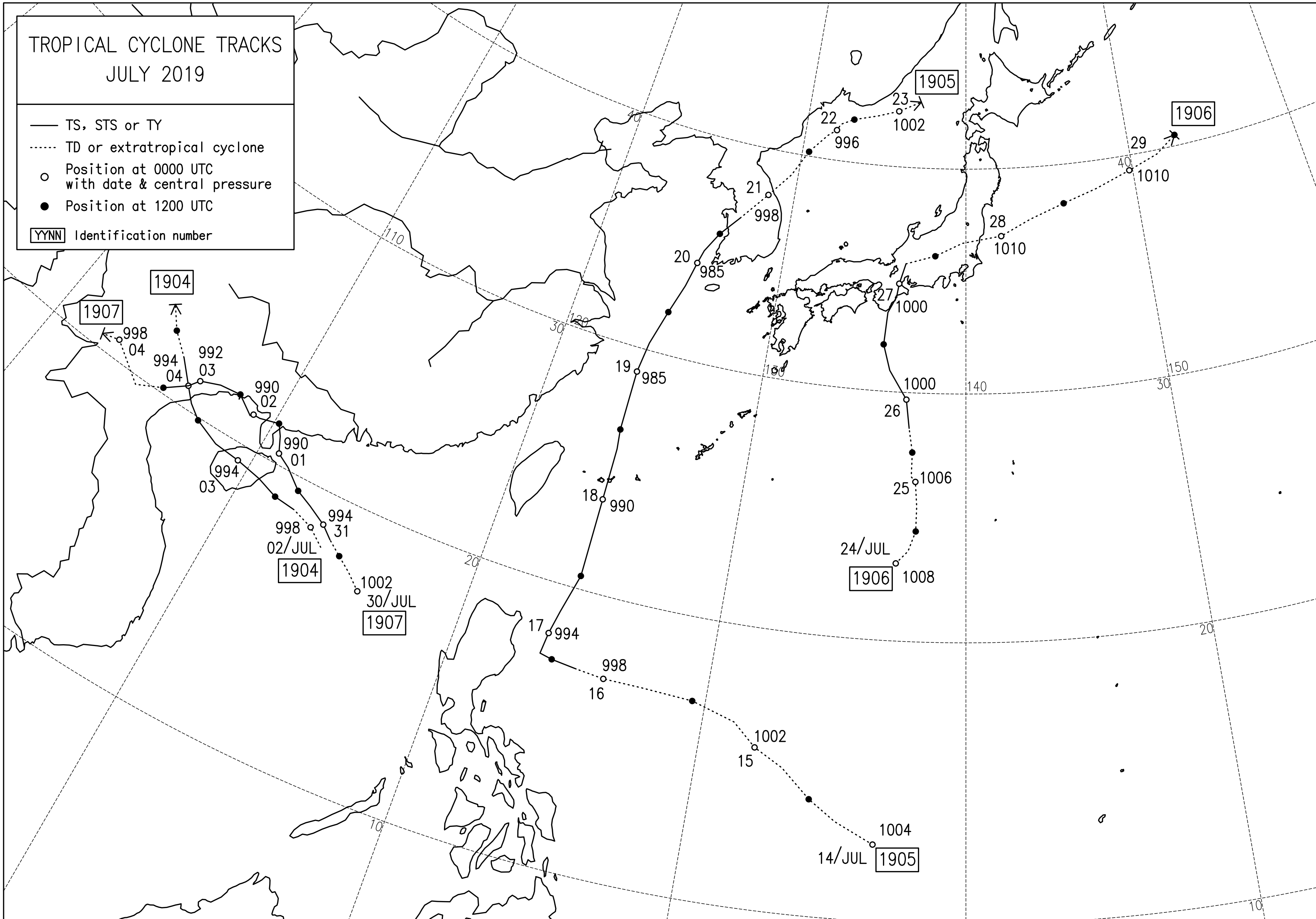
# Monthly Tracks of Tropical Cyclones in 2019

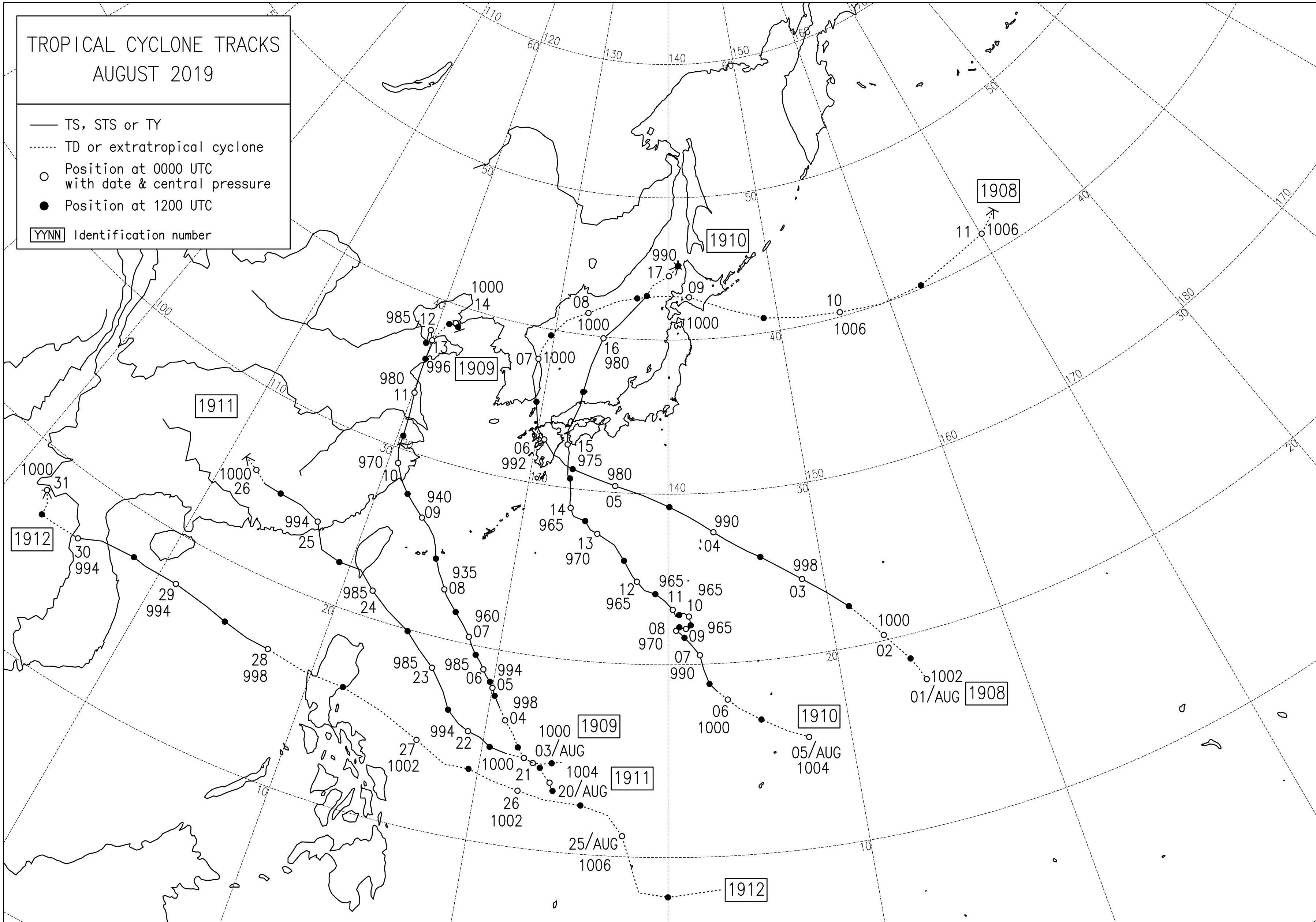

TROPICAL CYCLONE TRACKS
JANUARY 2019
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1901
996
04
1000
03
1000
02
1004
01/JAN
1901
30
120
20
10

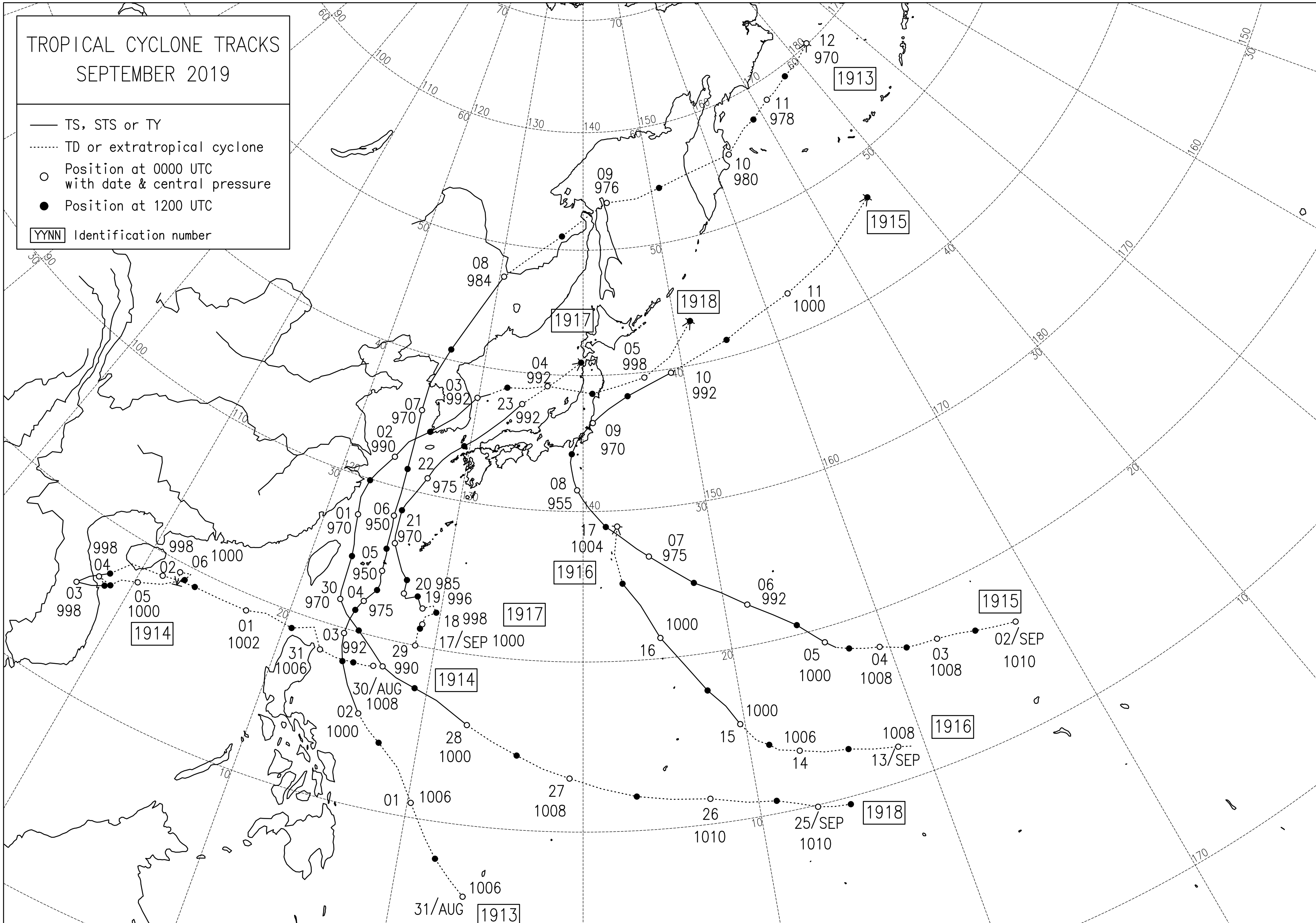


TROPICAL CYCLONE TRACKS
FEBRUARY 2019
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
1902
1902
19/FEB
1006
994
20
975
21
960
22
955
23
920
24
935
25
950
26
965
27
996
28
1012
01
1010
02
130
140
150
160
140
150
30
20
10
0

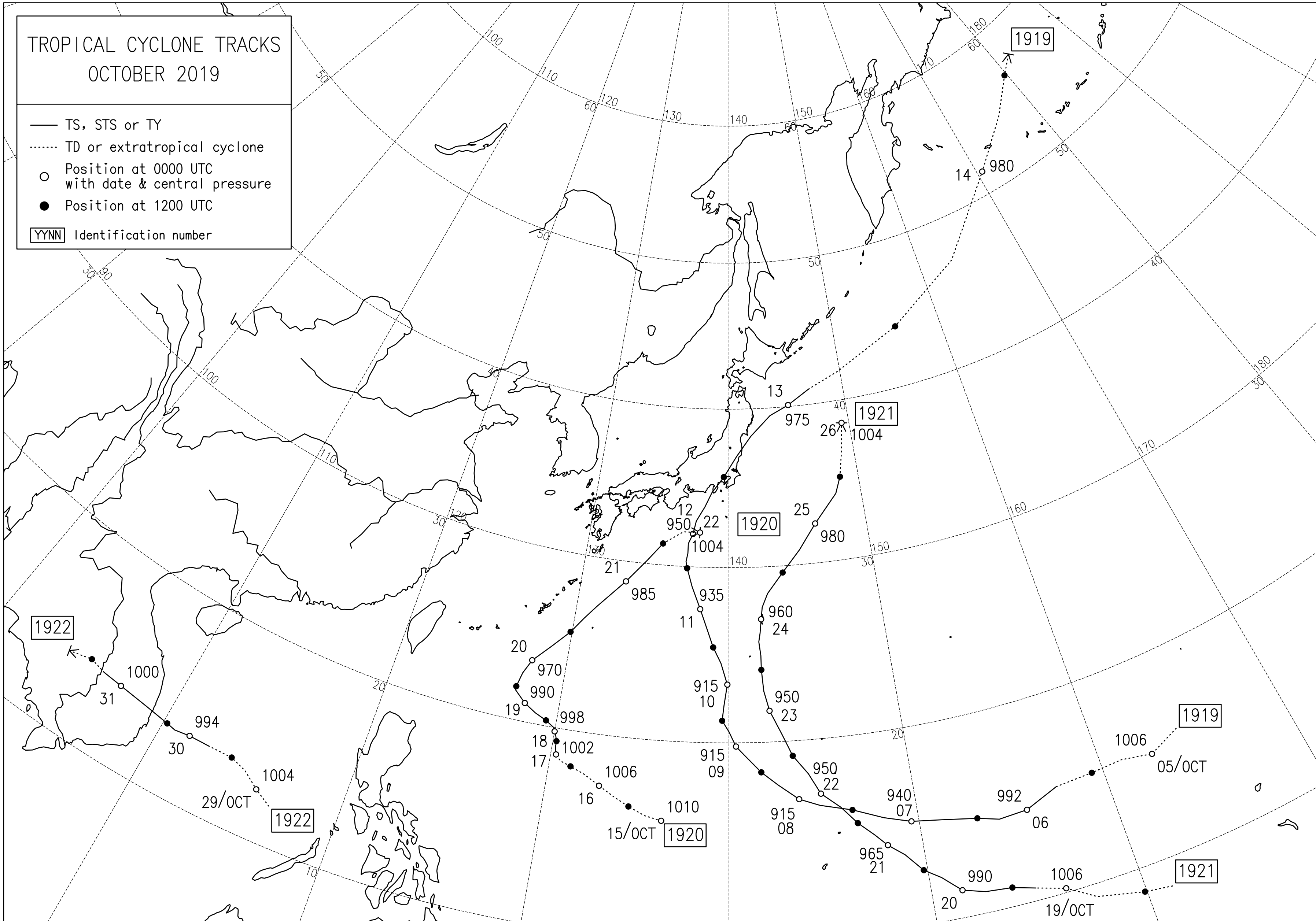

TROPICAL CYCLONE TRACKS
JUNE 2019
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1903
02
1002
01
1004
30
1004
29
994
28
994
27
1002
26
1004
25/JUN
1006
1903


TROPICAL CYCLONE TRACKS
JULY 2019
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1904
1907
1905
1906
998
04
994
04
992
03
990
02
990
01
994
03
998
02/JUL
994
31
1002
30/JUL
17
994
998
16
1002
15
1004
14/JUL
18
990
19
985
20
985
21
998
22
996
23
1002
24/JUL
1008
25
1006
26
1000
27
1000
28
1010
1010
29

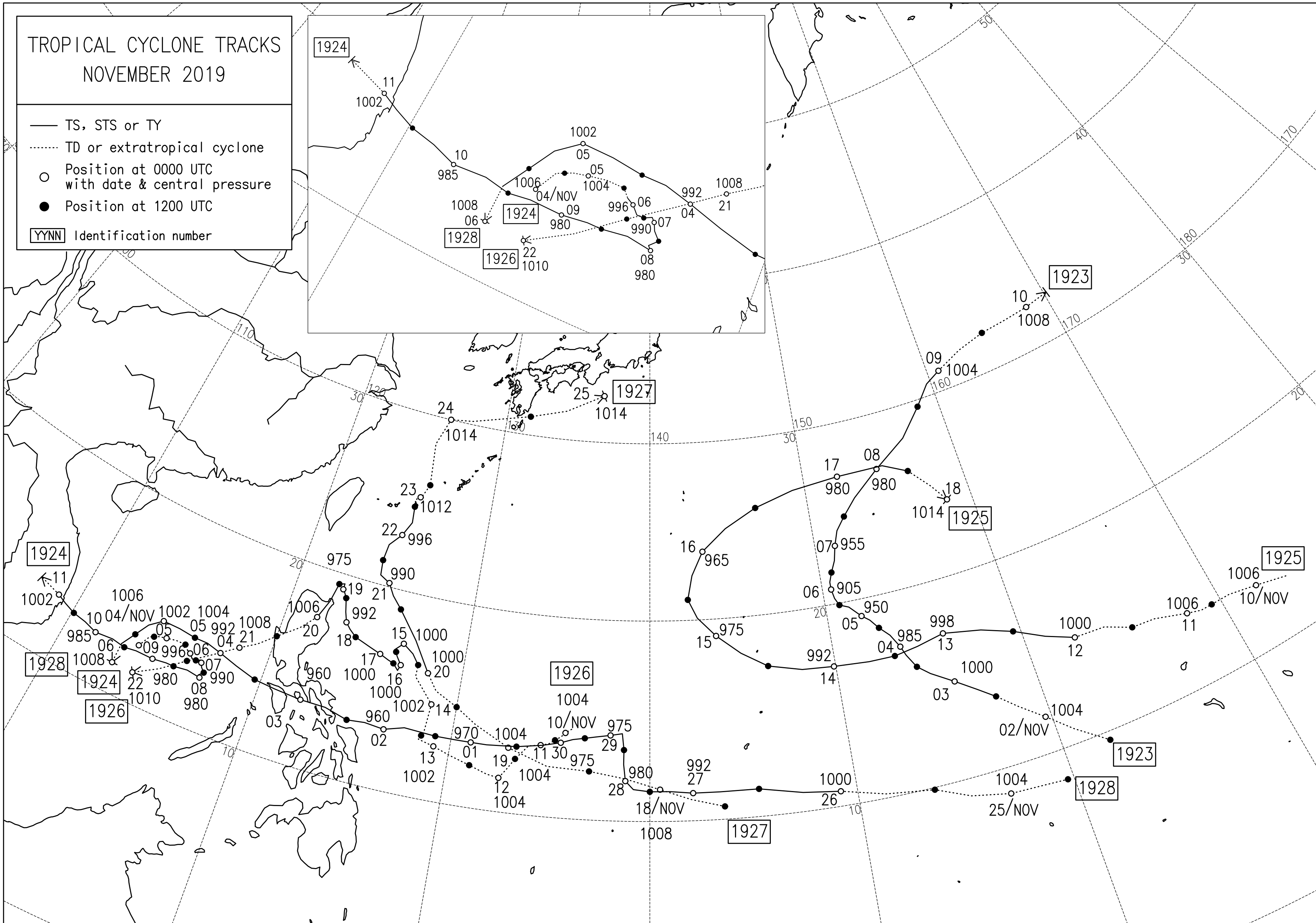

TROPICAL CYCLONE TRACKS
AUGUST 2019
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
1908
1909
1910
1911
1912
01/AUG
03/AUG
05/AUG
20/AUG
25/AUG

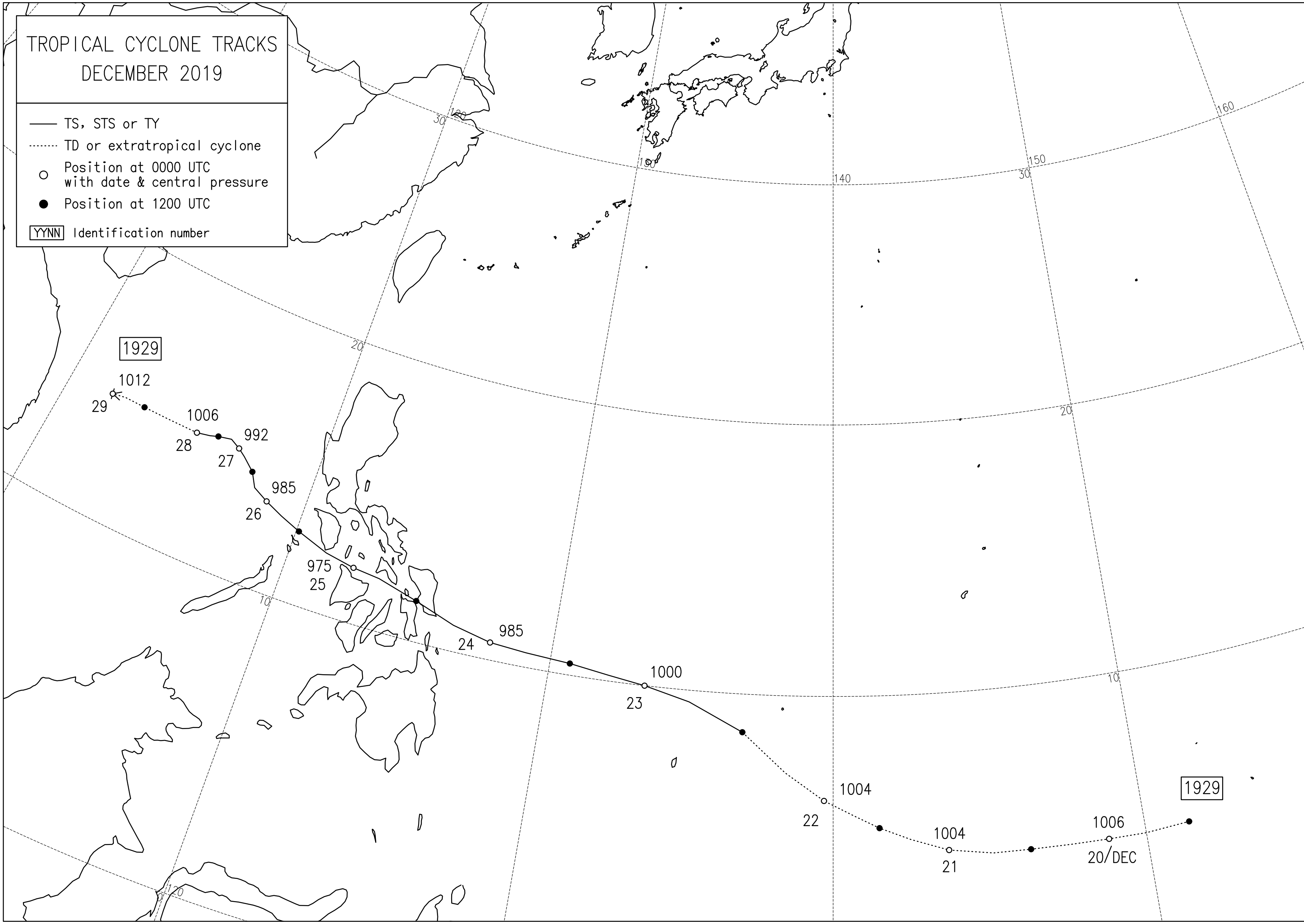


TROPICAL CYCLONE TRACKS
SEPTEMBER 2019
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
1913
31/AUG
1006
01
1006
02
1000
03
992
04
975
05
950
06
950
07
970
08
984
09
976
10
980
11
978
12
970
1914
29
990
30/AUG
1008
31
1006
01
1002
02
998
03
998
04
998
05
1000
06
1000
1915
02/SEP
1010
03
1008
04
1008
05
1000
06
992
07
975
08
955
09
970
10
992
11
1000
1916
13/SEP
1008
14
1006
15
1000
16
1000
17
1004
1917
17/SEP
1000
18
998
19
996
20
985
21
970
22
975
23
992
1918
25/SEP
1010
26
1010
27
1008
28
1000
29
990
30
970
01
970
02
990
03
992
04
992
05
998



TROPICAL CYCLONE TRACKS
OCTOBER 2019
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
1919
14 980
13
975
1006
05/OCT
992
06
940
07
915
08
915
09
915
10
935
11
12
950
1920
1010
15/OCT
16
1006
17
1002
18
998
19
990
20
970
985
21
22
1004
1921
1006
19/OCT
990
20
965
21
950
22
950
23
960
24
980
25
26
1004
1922
1004
29/OCT
994
30
1000
31


TROPICAL CYCLONE TRACKS
NOVEMBER 2019
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1923
1924
1925
1926
1927
1928



TROPICAL CYCLONE TRACKS
DECEMBER 2019
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1929
1012
29
1006
28
992
27
985
26
975
25
985
24
1000
23
1004
22
1004
21
1006
20/DEC
1929

## Appendix 3

# Errors of Track and Intensity Forecasts for Each Tropical Cyclone in 2019

| Date/Time (UTC) | Center Position (km) T=00 | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt) T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TS Pabuk (1901)** | | | | | | | | | | | | | | | | |
| Jan. 01/06 | 33 | 70 | 113 | 114 | | | -4 | -4 | -2 | | | 5 | 5 | 0 | | |
| 01/12 | 33 | 33 | 56 | 159 | | | 0 | 0 | -8 | | | 0 | 0 | 10 | | |
| 01/18 | 65 | 90 | 70 | | | | 0 | -4 | | | | 0 | 5 | | | |
| 02/00 | 0 | 92 | 65 | | | | -2 | -6 | | | | 5 | 10 | | | |
| 02/06 | 11 | 105 | 124 | | | | -2 | -4 | | | | 5 | 5 | | | |
| 02/12 | 0 | 63 | 167 | | | | 0 | -8 | | | | 0 | 10 | | | |
| 02/18 | 22 | 25 | | | | | 2 | | | | | -5 | | | | |
| 03/00 | 35 | 78 | | | | | -2 | | | | | 0 | | | | |
| 03/06 | 40 | 40 | | | | | -2 | | | | | 0 | | | | |
| 03/12 | 80 | 50 | | | | | -6 | | | | | 5 | | | | |
| 03/18 | 74 | | | | | | | | | | | | | | | |
| 04/00 | 0 | | | | | | | | | | | | | | | |
| 04/06 | 47 | | | | | | | | | | | | | | | |
| 04/12 | 22 | | | | | | | | | | | | | | | |
| mean | 33 | 64 | 99 | 137 | -- | -- | -2 | -4 | -5 | | | 2 | 6 | 5 | | |
| sample | 14 | 10 | 6 | 2 | 0 | 0 | 10 | 6 | 2 | | | 10 | 6 | 2 | | |

| Date/Time (UTC) | Center Position (km) T=00 | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt) T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TY Wutip (1902)** | | | | | | | | | | | | | | | | |
| Feb. 19/18 | 80 | 87 | 86 | 46 | 11 | 284 | 12 | 20 | 0 | | | -15 | -15 | 0 | | |
| 20/00 | 22 | 35 | 40 | 62 | 22 | 205 | 10 | 5 | -5 | | | -10 | -5 | 0 | | |
| 20/06 | 25 | 68 | 91 | 104 | 57 | 217 | 20 | 0 | 10 | | | -15 | -5 | -10 | | |
| 20/12 | 0 | 40 | 25 | 64 | 125 | 274 | 5 | -10 | 30 | | | -5 | 5 | -20 | | |
| 20/18 | 0 | 70 | 95 | 56 | 218 | 355 | -5 | -10 | 30 | | | 0 | 5 | -20 | | |
| 21/00 | 0 | 56 | 112 | 105 | 279 | 462 | -5 | -5 | 30 | | | 0 | 0 | -20 | | |
| 21/06 | 0 | 40 | 79 | 148 | 303 | 470 | -10 | 10 | 10 | | | 5 | -10 | -10 | | |
| 21/12 | 0 | 33 | 49 | 179 | 331 | 473 | -10 | 30 | 10 | | | 5 | -20 | -10 | | |
| 21/18 | 25 | 62 | 31 | 218 | 376 | 508 | -10 | 30 | 10 | | | 5 | -20 | -10 | | |
| 22/00 | 0 | 65 | 46 | 217 | 375 | 544 | -5 | 30 | 20 | | | 0 | -20 | -20 | | |
| 22/06 | 0 | 50 | 86 | 235 | 319 | 443 | 10 | 10 | 20 | | | -10 | -10 | -20 | | |
| 22/12 | 0 | 16 | 83 | 220 | 333 | 468 | 30 | 10 | 20 | | | -20 | -10 | -20 | | |
| 22/18 | 0 | 40 | 109 | 160 | 164 | 427 | 30 | 10 | 20 | | | -20 | -10 | -20 | | |
| 23/00 | 0 | 40 | 100 | 120 | 85 | 305 | 35 | 20 | 5 | | | -25 | -20 | -10 | | |
| 23/06 | 0 | 45 | 112 | 133 | 151 | | 10 | 20 | 25 | | | -10 | -20 | -20 | | |
| 23/12 | 0 | 64 | 101 | 93 | 156 | | -15 | 15 | 15 | | | 5 | -15 | -10 | | |
| 23/18 | 0 | 60 | 63 | 31 | 132 | | 0 | 20 | 15 | | | -5 | -20 | -10 | | |
| 24/00 | 0 | 55 | 46 | 54 | 91 | | 15 | 20 | 27 | | | -15 | -20 | -25 | | |
| 24/06 | 0 | 33 | 31 | 147 | | | 15 | 30 | 24 | | | -20 | -30 | -25 | | |
| 24/12 | 0 | 35 | 32 | 246 | | | 15 | 20 | 14 | | | -20 | -25 | -15 | | |
| 24/18 | 0 | 25 | 97 | 256 | | | 25 | 25 | 6 | | | -25 | -25 | -15 | | |
| 25/00 | 0 | 11 | 136 | 225 | | | -10 | 0 | -6 | | | 0 | 0 | 5 | | |
| 25/06 | 0 | 25 | 165 | | | | 0 | -5 | | | | -5 | 5 | | | |
| 25/12 | 0 | 22 | 201 | | | | -10 | -10 | | | | 0 | 10 | | | |
| 25/18 | 0 | 58 | 185 | | | | -5 | -15 | | | | 0 | 10 | | | |
| 26/00 | 0 | 106 | 180 | | | | 10 | 0 | | | | -5 | 0 | | | |
| 26/06 | 0 | 193 | | | | | 5 | | | | | 0 | | | | |
| 26/12 | 0 | 165 | | | | | 0 | | | | | 5 | | | | |
| 26/18 | 0 | 108 | | | | | 0 | | | | | 0 | | | | |
| 27/00 | 11 | 115 | | | | | -6 | | | | | 10 | | | | |
| 27/06 | 35 | | | | | | | | | | | | | | | |
| 27/12 | 86 | | | | | | | | | | | | | | | |
| 27/18 | 54 | | | | | | | | | | | | | | | |
| 28/00 | 15 | | | | | | | | | | | | | | | |
| mean | 10 | 61 | 91 | 142 | 196 | 388 | 5 | 10 | 15 | | | -6 | -10 | -14 | | |
| sample | 34 | 30 | 26 | 22 | 18 | 14 | 30 | 26 | 22 | | | 30 | 26 | 22 | | |

| Date/Time | | Center Position (km) | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TS Sepat (1903)** | | | | | | | | | | | | | | | | |
| Jun. 27/12 | 0 | | | | | | | | | | | | | | | |
| 27/18 | 0 | | | | | | | | | | | | | | | |
| 28/00 | 11 | | | | | | | | | | | | | | | |
| mean | 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| sample | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Date/Time | | Center Position (km) | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TS Mun (1904)** | | | | | | | | | | | | | | | | |
| Jul. 02/06 | 0 | 123 | | | | | 2 | | | | | 0 | | | | |
| 02/12 | 0 | 120 | | | | | 0 | | | | | 0 | | | | |
| 02/18 | 0 | 115 | | | | | -2 | | | | | 0 | | | | |
| 03/00 | 0 | 96 | | | | | -2 | | | | | 0 | | | | |
| 03/06 | 39 | | | | | | | | | | | | | | | |
| 03/12 | 0 | | | | | | | | | | | | | | | |
| 03/18 | 15 | | | | | | | | | | | | | | | |
| 04/00 | 0 | | | | | | | | | | | | | | | |
| mean | 7 | 114 | -- | -- | -- | -- | 0 | -- | -- | -- | -- | 0 | -- | -- | -- | -- |
| sample | 8 | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |

| Date/Time | | Center Position (km) | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TS Danas (1905)** | | | | | | | | | | | | | | | | |
| Jul. 16/06 | 85 | 53 | 449 | 517 | 622 | | -4 | -5 | 0 | 0 | | 5 | 5 | 0 | 0 | |
| 16/12 | 56 | 156 | 328 | 501 | 593 | | -2 | -5 | 0 | -4 | | 5 | 5 | 0 | 5 | |
| 16/18 | 46 | 244 | 366 | 552 | | | -2 | 0 | 0 | | | 5 | 0 | 5 | | |
| 17/00 | 44 | 356 | 379 | 473 | | | 0 | 0 | 0 | | | 0 | 0 | 5 | | |
| 17/06 | 63 | 396 | 431 | 448 | | | 0 | 0 | -5 | | | 0 | 0 | 5 | | |
| 17/12 | 21 | 182 | 245 | 238 | | | 0 | 0 | -4 | | | 0 | 0 | 5 | | |
| 17/18 | 49 | 132 | 235 | | | | 0 | 0 | | | | 0 | 5 | | | |
| 18/00 | 24 | 126 | 256 | | | | 0 | 0 | | | | 0 | 5 | | | |
| 18/06 | 49 | 74 | 85 | | | | 0 | -5 | | | | 0 | 5 | | | |
| 18/12 | 15 | 93 | 101 | | | | 0 | -9 | | | | 0 | 10 | | | |
| 18/18 | 35 | 78 | | | | | 0 | | | | | 5 | | | | |
| 19/00 | 15 | 67 | | | | | 0 | | | | | 5 | | | | |
| 19/06 | 22 | 59 | | | | | 0 | | | | | 0 | | | | |
| 19/12 | 29 | 91 | | | | | -4 | | | | | 5 | | | | |
| 19/18 | 24 | | | | | | | | | | | | | | | |
| 20/00 | 9 | | | | | | | | | | | | | | | |
| 20/06 | 0 | | | | | | | | | | | | | | | |
| 20/12 | 22 | | | | | | | | | | | | | | | |
| mean | 34 | 150 | 288 | 455 | 608 | -- | -1 | -2 | -1 | -2 | -- | 2 | 4 | 3 | 3 | -- |
| sample | 18 | 14 | 10 | 6 | 2 | 0 | 14 | 10 | 6 | 2 | 0 | 14 | 10 | 6 | 2 | 0 |

| Date/Time | | Center Position (km) | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TS Nari (1906)** | | | | | | | | | | | | | | | | |
| Jul. 25/18 | 51 | 122 | | | | | 4 | | | | | 0 | | | | |
| 26/00 | 11 | 144 | | | | | 4 | | | | | 0 | | | | |
| 26/06 | 0 | | | | | | | | | | | | | | | |
| 26/12 | 15 | | | | | | | | | | | | | | | |
| 26/18 | 0 | | | | | | | | | | | | | | | |
| 27/00 | 0 | | | | | | | | | | | | | | | |
| mean | 13 | 133 | -- | -- | -- | -- | 4 | -- | -- | -- | -- | 0 | -- | -- | -- | -- |
| sample | 6 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TS Wipha (1907)** | | | | | | | | | | | | | | | | |
| Jul. 30/18 | 57 | 33 | | | | | 2 | | | | | -5 | | | | |
| 31/00 | 46 | 35 | 38 | 59 | | | 0 | -5 | -2 | | | 0 | 5 | 5 | | |
| 31/06 | 10 | 15 | 33 | 24 | | | 0 | 0 | -2 | | | 0 | 0 | 5 | | |
| 31/12 | 0 | 64 | 57 | | | | 0 | 0 | | | | 0 | 0 | | | |
| 31/18 | 15 | 0 | 22 | | | | 0 | 2 | | | | 0 | 0 | | | |
| Aug. 01/00 | 46 | 53 | 61 | | | | 0 | 2 | | | | 0 | 0 | | | |
| 01/06 | 0 | 62 | 57 | | | | 5 | 2 | | | | -5 | 0 | | | |
| 01/12 | 11 | 25 | | | | | 0 | | | | | 0 | | | | |
| 01/18 | 15 | 53 | | | | | -2 | | | | | 5 | | | | |
| 02/00 | 31 | 94 | | | | | -7 | | | | | 10 | | | | |
| 02/06 | 30 | 80 | | | | | -2 | | | | | 5 | | | | |
| 02/12 | 44 | | | | | | | | | | | | | | | |
| 02/18 | 81 | | | | | | | | | | | | | | | |
| 03/00 | 30 | | | | | | | | | | | | | | | |
| 03/06 | 22 | | | | | | | | | | | | | | | |
| mean | 29 | 47 | 45 | 41 | -- | -- | 0 | 0 | -2 | -- | -- | 1 | 1 | 5 | -- | -- |
| sample | 15 | 11 | 6 | 2 | 0 | 0 | 11 | 6 | 2 | 0 | 0 | 11 | 6 | 2 | 0 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Francisco (1908)** | | | | | | | | | | | | | | | | |
| Aug. 02/12 | 44 | 61 | 132 | 65 | 292 | | -6 | -5 | 5 | -20 | | 10 | 5 | -5 | 25 | |
| 02/18 | 63 | 46 | 140 | 88 | 332 | | -2 | 0 | 5 | -15 | | 5 | 0 | -5 | 20 | |
| 03/00 | 35 | 111 | 87 | 114 | | | -5 | -5 | -12 | | | 5 | 5 | 15 | | |
| 03/06 | 24 | 92 | 114 | 131 | | | 0 | 0 | -8 | | | 0 | 0 | 15 | | |
| 03/12 | 46 | 29 | 61 | 136 | | | 5 | 10 | -10 | | | -5 | -10 | 15 | | |
| 03/18 | 20 | 56 | 24 | 210 | | | 10 | 15 | -4 | | | -10 | -15 | 5 | | |
| 04/00 | 46 | 44 | 45 | | | | 5 | -2 | | | | -5 | 5 | | | |
| 04/06 | 20 | 56 | 51 | | | | 5 | -8 | | | | -5 | 15 | | | |
| 04/12 | 0 | 15 | 85 | | | | 15 | -4 | | | | -10 | 5 | | | |
| 04/18 | 15 | 29 | 132 | | | | 10 | -4 | | | | -10 | 5 | | | |
| 05/00 | 11 | 50 | | | | | 4 | | | | | -5 | | | | |
| 05/06 | 10 | 64 | | | | | -6 | | | | | 10 | | | | |
| 05/12 | 10 | 99 | | | | | -8 | | | | | 10 | | | | |
| 05/18 | 0 | 76 | | | | | -4 | | | | | 5 | | | | |
| 06/00 | 11 | | | | | | | | | | | | | | | |
| 06/06 | 11 | | | | | | | | | | | | | | | |
| 06/12 | 0 | | | | | | | | | | | | | | | |
| 06/18 | 14 | | | | | | | | | | | | | | | |
| mean | 21 | 59 | 87 | 124 | 312 | -- | 2 | 0 | -4 | -17 | -- | 0 | 2 | 7 | 23 | -- |
| sample | 18 | 14 | 10 | 6 | 2 | 0 | 14 | 10 | 6 | 2 | 0 | 14 | 10 | 6 | 2 | 0 |

| Date/Time | | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| | | | | | | | | **TY Lekima (1909)** | | | | | | | | | |
| Aug. | 04/06 | 149 | 191 | 223 | 114 | 88 | 214 | 0 | -5 | 15 | 20 | 10 | 0 | 5 | -10 | -20 | -10 |
| | 04/12 | 64 | 111 | 168 | 113 | 69 | 185 | -5 | 0 | 25 | 25 | 10 | 5 | -5 | -20 | -25 | -10 |
| | 04/18 | 48 | 24 | 54 | 38 | 93 | 172 | 0 | 5 | 20 | 20 | 20 | 5 | -5 | -15 | -15 | -15 |
| | 05/00 | 68 | 64 | 69 | 24 | 185 | 212 | 0 | 10 | 15 | 40 | 22 | 5 | -5 | -10 | -30 | -15 |
| | 05/06 | 116 | 43 | 54 | 60 | 148 | 209 | 0 | 15 | 20 | 35 | 17 | 0 | -5 | -15 | -25 | -5 |
| | 05/12 | 103 | 46 | 54 | 178 | 267 | 294 | 5 | 35 | 40 | 40 | 20 | -10 | -25 | -30 | -30 | -20 |
| | 05/18 | 39 | 56 | 89 | 276 | 288 | 299 | 5 | 35 | 30 | 35 | 18 | -15 | -30 | -25 | -35 | -20 |
| | 06/00 | 11 | 62 | 160 | 270 | 252 | 324 | 15 | 30 | 40 | 24 | 18 | -20 | -25 | -35 | -20 | -20 |
| | 06/06 | 10 | 61 | 143 | 230 | 278 | 485 | 20 | 35 | 40 | 19 | 18 | -20 | -30 | -35 | -10 | -20 |
| | 06/12 | 54 | 89 | 153 | 246 | 351 | 634 | 10 | 10 | 30 | 0 | 5 | -15 | -20 | -30 | 5 | 0 |
| | 06/18 | 47 | 108 | 202 | 234 | 466 | 671 | 5 | 0 | 20 | -5 | 5 | -15 | -10 | -25 | 10 | 5 |
| | 07/00 | 25 | 91 | 198 | 212 | 467 | 583 | 0 | 0 | 0 | 0 | 0 | -10 | -10 | 0 | 5 | 10 |
| | 07/06 | 10 | 78 | 189 | 243 | 486 | 440 | 5 | 0 | -5 | 0 | 5 | -15 | -10 | 10 | 5 | 5 |
| | 07/12 | 0 | 90 | 195 | 275 | 464 | 199 | 10 | 0 | -25 | -10 | -10 | -20 | -10 | 25 | 15 | 15 |
| | 07/18 | 10 | 67 | 190 | 308 | 408 | | -10 | -10 | -20 | -5 | | -5 | -5 | 20 | 15 | |
| | 08/00 | 10 | 98 | 209 | 394 | 267 | | -5 | -5 | 0 | 5 | | 5 | 15 | 15 | 15 | |
| | 08/06 | 15 | 126 | 233 | 434 | 312 | | 0 | -15 | -5 | 0 | | 5 | 20 | 5 | 0 | |
| | 08/12 | 10 | 80 | 251 | 320 | 266 | | 10 | -15 | 0 | -5 | | 0 | 20 | 0 | 0 | |
| | 08/18 | 0 | 30 | 206 | 167 | | | 15 | -5 | 0 | | | -10 | 5 | 0 | | |
| | 09/00 | 0 | 68 | 174 | 106 | | | 0 | 0 | 0 | | | 5 | 0 | 5 | | |
| | 09/06 | 0 | 29 | 113 | 49 | | | 0 | 10 | 5 | | | 0 | -10 | 0 | | |
| | 09/12 | 0 | 29 | 43 | 58 | | | -5 | 0 | 0 | | | 5 | 0 | 5 | | |
| | 09/18 | 24 | 72 | 35 | | | | -5 | 0 | | | | 5 | 5 | | | |
| | 10/00 | 22 | 73 | 28 | | | | 5 | 0 | | | | 0 | 10 | | | |
| | 10/06 | 22 | 59 | 45 | | | | 5 | 5 | | | | 0 | 5 | | | |
| | 10/12 | 15 | 52 | 127 | | | | 10 | 4 | | | | -5 | 0 | | | |
| | 10/18 | 97 | 38 | | | | | 10 | | | | | 0 | | | | |
| | 11/00 | 0 | 28 | | | | | 9 | | | | | 0 | | | | |
| | 11/06 | 9 | 28 | | | | | 9 | | | | | 0 | | | | |
| | 11/12 | 29 | 58 | | | | | 4 | | | | | 0 | | | | |
| | 11/18 | 0 | | | | | | | | | | | | | | | |
| | 12/00 | 0 | | | | | | | | | | | | | | | |
| | 12/06 | 0 | | | | | | | | | | | | | | | |
| | 12/12 | 0 | | | | | | | | | | | | | | | |
| | mean | 30 | 68 | 139 | 198 | 286 | 351 | 4 | 5 | 11 | 13 | 11 | -4 | -5 | -7 | -8 | -7 |
| | sample | 34 | 30 | 26 | 22 | 18 | 14 | 30 | 26 | 22 | 18 | 14 | 30 | 26 | 22 | 18 | 14 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Krosa (1910)** | | | | | | | | | | | | | | | | |
| Aug. 06/06 | 0 | 88 | 103 | 196 | 244 | 468 | 0 | 5 | -10 | -10 | -10 | 0 | -5 | 5 | 15 | 15 |
| 06/12 | 0 | 69 | 117 | 191 | 366 | 569 | 5 | 0 | -15 | -15 | -15 | -5 | 0 | 10 | 20 | 25 |
| 06/18 | 38 | 62 | 80 | 172 | 407 | 611 | -5 | -15 | -20 | -20 | -15 | 0 | 5 | 15 | 20 | 20 |
| 07/00 | 0 | 23 | 134 | 153 | 355 | 538 | 0 | -15 | -20 | -20 | -15 | -5 | 5 | 15 | 20 | 20 |
| 07/06 | 0 | 53 | 145 | 159 | 341 | 506 | 0 | -20 | -30 | -20 | -20 | -5 | 10 | 25 | 20 | 30 |
| 07/12 | 0 | 78 | 156 | 278 | 393 | 431 | -5 | -20 | -30 | -20 | -20 | 0 | 10 | 25 | 25 | 30 |
| 07/18 | 0 | 113 | 157 | 317 | 419 | 396 | -5 | -20 | -30 | -20 | -20 | 0 | 15 | 25 | 25 | 30 |
| 08/00 | 0 | 113 | 166 | 346 | 453 | 491 | -5 | -20 | -30 | -20 | -20 | 5 | 20 | 20 | 20 | 25 |
| 08/06 | 0 | 101 | 147 | 296 | 401 | 344 | -25 | -25 | -15 | -15 | -15 | 15 | 25 | 20 | 30 | 30 |
| 08/12 | 0 | 90 | 200 | 272 | 335 | 232 | -25 | -25 | -15 | -15 | -15 | 15 | 25 | 25 | 30 | 30 |
| 08/18 | 22 | 101 | 233 | 270 | 245 | 287 | -25 | -25 | -10 | -5 | 0 | 20 | 25 | 20 | 25 | 20 |
| 09/00 | 11 | 46 | 168 | 196 | 92 | 171 | -25 | -15 | 0 | 0 | 5 | 20 | 20 | 15 | 20 | 15 |
| 09/06 | 0 | 15 | 78 | 176 | 92 | 118 | -10 | -10 | 0 | 0 | 10 | 15 | 15 | 20 | 20 | 10 |
| 09/12 | 0 | 78 | 57 | 169 | 85 | 38 | 5 | 10 | 0 | -15 | -10 | 5 | 5 | 20 | 25 | 25 |
| 09/18 | 0 | 100 | 98 | 189 | 74 | 30 | 15 | 10 | 0 | 0 | -15 | -5 | 5 | 20 | 20 | 25 |
| 10/00 | 0 | 75 | 101 | 121 | 106 | 96 | 0 | -5 | -15 | -25 | -5 | 0 | 5 | 20 | 25 | 10 |
| 10/06 | 0 | 62 | 165 | 130 | 69 | 35 | 0 | -15 | -20 | -25 | -3 | 0 | 20 | 25 | 25 | 10 |
| 10/12 | 0 | 70 | 193 | 145 | 101 | 134 | 0 | -15 | -20 | -15 | -5 | 5 | 20 | 25 | 20 | 10 |
| 10/18 | 0 | 63 | 186 | 60 | 53 | 191 | 0 | -20 | -15 | -15 | -5 | 10 | 25 | 20 | 15 | 10 |
| 11/00 | 0 | 45 | 118 | 45 | 62 | 230 | 0 | -15 | -10 | -15 | -5 | 5 | 20 | 15 | 15 | 10 |
| 11/06 | 0 | 69 | 59 | 67 | 69 | 82 | -15 | -15 | -10 | -8 | 0 | 20 | 20 | 15 | 15 | 5 |
| 11/12 | 0 | 61 | 63 | 57 | 96 | | -15 | -20 | -15 | -5 | | 20 | 25 | 20 | 10 | |
| 11/18 | 0 | 60 | 15 | 74 | 188 | | -10 | -15 | -15 | -5 | | 15 | 20 | 15 | 10 | |
| 12/00 | 0 | 37 | 44 | 37 | 253 | | -10 | -15 | -15 | -5 | | 15 | 20 | 15 | 10 | |
| 12/06 | 0 | 39 | 37 | 78 | 79 | | -10 | -15 | -18 | 0 | | 15 | 20 | 20 | 5 | |
| 12/12 | 0 | 22 | 24 | 67 | | | -10 | -10 | -5 | | | 15 | 15 | 10 | | |
| 12/18 | 0 | 49 | 53 | 72 | | | -10 | -15 | -5 | | | 15 | 15 | 10 | | |
| 13/00 | 0 | 56 | 11 | 93 | | | -10 | -15 | 0 | | | 15 | 15 | 5 | | |
| 13/06 | 0 | 33 | 24 | 50 | | | 0 | -8 | -5 | | | 10 | 5 | 0 | | |
| 13/12 | 0 | 19 | 72 | | | | 0 | -10 | | | | 10 | 5 | | | |
| 13/18 | 0 | 50 | 89 | | | | -5 | -10 | | | | 5 | 0 | | | |
| 14/00 | 0 | 15 | 44 | | | | -10 | -10 | | | | 5 | 0 | | | |
| 14/06 | 15 | 14 | 34 | | | | -8 | -5 | | | | 5 | 0 | | | |
| 14/12 | 0 | 27 | | | | | -10 | | | | | 5 | | | | |
| 14/18 | 19 | 34 | | | | | -5 | | | | | 5 | | | | |
| 15/00 | 0 | 54 | | | | | 0 | | | | | 0 | | | | |
| 15/06 | 0 | 55 | | | | | 0 | | | | | 0 | | | | |
| 15/12 | 0 | | | | | | | | | | | | | | | |
| 15/18 | 0 | | | | | | | | | | | | | | | |
| 16/00 | 0 | | | | | | | | | | | | | | | |
| 16/06 | 0 | | | | | | | | | | | | | | | |
| mean | 3 | 58 | 102 | 154 | 215 | 286 | -6 | -13 | -14 | -13 | -9 | 7 | 13 | 17 | 19 | 19 |
| sample | 41 | 37 | 33 | 29 | 25 | 21 | 37 | 33 | 29 | 25 | 21 | 37 | 33 | 29 | 25 | 21 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **STS Bailu (1911)** | | | | | | | | | | | | | | | | |
| Aug. 21/06 | 163 | 175 | 139 | 152 | 148 | | -2 | 5 | 5 | 4 | | 5 | 0 | 0 | -5 | |
| 21/12 | 116 | 210 | 140 | 201 | 280 | | 0 | -10 | -5 | 0 | | 0 | 10 | 0 | 0 | |
| 21/18 | 116 | 148 | 100 | 151 | | | 5 | -10 | -9 | | | -5 | 10 | 10 | | |
| 22/00 | 105 | 135 | 136 | 168 | | | 0 | -10 | -9 | | | 0 | 10 | 10 | | |
| 22/06 | 99 | 91 | 108 | 82 | | | -5 | -10 | 2 | | | 5 | 10 | -5 | | |
| 22/12 | 15 | 98 | 113 | 127 | | | -10 | -5 | 0 | | | 10 | 0 | 0 | | |
| 22/18 | 0 | 46 | 124 | | | | -10 | -9 | | | | 10 | 10 | | | |
| 23/00 | 31 | 38 | 39 | | | | -5 | -4 | | | | 10 | 10 | | | |
| 23/06 | 15 | 53 | 55 | | | | -5 | 0 | | | | 10 | -5 | | | |
| 23/12 | 15 | 59 | 105 | | | | 0 | 2 | | | | 0 | 0 | | | |
| 23/18 | 10 | 67 | | | | | -2 | | | | | 5 | | | | |
| 24/00 | 10 | 51 | | | | | 0 | | | | | 0 | | | | |
| 24/06 | 0 | 70 | | | | | 2 | | | | | -5 | | | | |
| 24/12 | 102 | 0 | | | | | 0 | | | | | 0 | | | | |
| 24/18 | 35 | | | | | | | | | | | | | | | |
| 25/00 | 35 | | | | | | | | | | | | | | | |
| 25/06 | 32 | | | | | | | | | | | | | | | |
| 25/12 | 15 | | | | | | | | | | | | | | | |
| mean | 51 | 89 | 106 | 147 | 214 | -- | -2 | -5 | -3 | 2 | -- | 3 | 6 | 3 | -2 | -- |
| sample | 18 | 14 | 10 | 6 | 2 | 0 | 14 | 10 | 6 | 2 | 0 | 14 | 10 | 6 | 2 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TS Podul (1912)** | | | | | | | | | | | | | | | | |
| Aug. 28/00 | 90 | 150 | | | | | -2 | | | | | 5 | | | | |
| 28/06 | 62 | 192 | | | | | -2 | | | | | 10 | | | | |
| 28/12 | 21 | 91 | | | | | -2 | | | | | 10 | | | | |
| 28/18 | 40 | 115 | | | | | -4 | | | | | 15 | | | | |
| 29/00 | 64 | | | | | | | | | | | | | | | |
| 29/06 | 117 | | | | | | | | | | | | | | | |
| 29/12 | 55 | | | | | | | | | | | | | | | |
| 29/18 | 24 | | | | | | | | | | | | | | | |
| mean | 59 | 137 | -- | -- | -- | -- | -2 | -- | -- | -- | -- | 10 | -- | -- | -- | -- |
| sample | 8 | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Lingling (1913)** | | | | | | | | | | | | | | | | |
| Sep. 02/00 | 11 | 22 | 43 | 81 | 112 | 501 | 0 | 15 | 25 | 25 | 10 | -5 | -20 | -20 | -20 | -5 |
| 02/06 | 15 | 33 | 144 | 185 | 156 | 106 | 2 | 15 | 35 | 20 | 10 | -10 | -20 | -30 | -15 | -10 |
| 02/12 | 11 | 47 | 142 | 146 | 62 | 210 | 7 | 20 | 35 | 15 | 11 | -15 | -25 | -30 | -10 | -10 |
| 02/18 | 0 | 108 | 156 | 156 | 83 | 222 | 10 | 25 | 30 | 15 | 11 | -15 | -25 | -25 | -15 | -10 |
| 03/00 | 15 | 76 | 73 | 134 | 73 | | 10 | 30 | 25 | 15 | | -15 | -25 | -20 | -15 | |
| 03/06 | 0 | 35 | 24 | 15 | 104 | | 5 | 25 | 15 | 5 | | -10 | -20 | -10 | -5 | |
| 03/12 | 15 | 20 | 35 | 169 | 416 | | 5 | 20 | 0 | -5 | | -10 | -20 | 0 | 5 | |
| 03/18 | 68 | 33 | 112 | 284 | 564 | | 10 | 10 | -10 | 0 | | -10 | -10 | 10 | -5 | |
| 04/00 | 59 | 45 | 91 | 229 | | | 15 | 5 | -15 | | | -10 | -5 | 15 | | |
| 04/06 | 0 | 20 | 44 | 130 | | | 15 | 0 | -5 | | | -15 | 0 | 5 | | |
| 04/12 | 10 | 23 | 87 | 256 | | | 15 | -5 | -10 | | | -15 | 5 | 5 | | |
| 04/18 | 10 | 11 | 134 | 368 | | | 5 | -10 | -5 | | | -5 | 10 | -10 | | |
| 05/00 | 0 | 24 | 158 | | | | 0 | -5 | | | | 0 | 10 | | | |
| 05/06 | 0 | 77 | 162 | | | | -15 | -5 | | | | 10 | 10 | | | |
| 05/12 | 0 | 97 | 239 | | | | -15 | -20 | | | | 10 | 10 | | | |
| 05/18 | 0 | 100 | 276 | | | | -15 | -5 | | | | 10 | 0 | | | |
| 06/00 | 0 | 78 | | | | | -10 | | | | | 10 | | | | |
| 06/06 | 0 | 42 | | | | | -10 | | | | | 10 | | | | |
| 06/12 | 0 | 98 | | | | | -15 | | | | | 15 | | | | |
| 06/18 | 0 | 123 | | | | | 0 | | | | | 5 | | | | |
| 07/00 | 0 | | | | | | | | | | | | | | | |
| 07/06 | 9 | | | | | | | | | | | | | | | |
| 07/12 | 42 | | | | | | | | | | | | | | | |
| 07/18 | 60 | | | | | | | | | | | | | | | |
| mean | 14 | 56 | 120 | 179 | 196 | 260 | 1 | 7 | 10 | 11 | 11 | -3 | -8 | -9 | -10 | -9 |
| sample | 24 | 20 | 16 | 12 | 8 | 4 | 20 | 16 | 12 | 8 | 4 | 20 | 16 | 12 | 8 | 4 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TS Kajiki (1914)** | | | | | | | | | | | | | | | | |
| Sep. 02/12 | 21 | | | | | | | | | | | | | | | |
| 02/18 | 31 | | | | | | | | | | | | | | | |
| 03/00 | 31 | | | | | | | | | | | | | | | |
| 03/06 | 140 | | | | | | | | | | | | | | | |
| mean | 56 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| sample | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Faxai (1915)** | | | | | | | | | | | | | | | | |
| Sep. 04/18 | 35 | 135 | | | | | 6 | | | | | -5 | | | | |
| 05/00 | 15 | 133 | 167 | | | | 8 | 17 | | | | -10 | -15 | | | |
| 05/06 | 15 | 145 | 146 | 103 | 337 | | 4 | 20 | 30 | 22 | | -5 | -15 | -25 | -40 | |
| 05/12 | 0 | 135 | 158 | 181 | 286 | | 7 | 20 | 25 | 13 | | -5 | -15 | -20 | -20 | |
| 05/18 | 0 | 88 | 103 | 149 | 177 | | 10 | 25 | 30 | 8 | | -5 | -20 | -25 | -15 | |
| 06/00 | 10 | 104 | 87 | 91 | | | 10 | 20 | 26 | | | -10 | -20 | -35 | | |
| 06/06 | 23 | 89 | 87 | 146 | | | 10 | 20 | 16 | | | -10 | -20 | -25 | | |
| 06/12 | 0 | 37 | 35 | 118 | | | 15 | 15 | 5 | | | -15 | -15 | -10 | | |
| 06/18 | 35 | 22 | 48 | 45 | | | 15 | 10 | 0 | | | -15 | -10 | -5 | | |
| 07/00 | 0 | 22 | 24 | | | | 0 | 0 | | | | -5 | -5 | | | |
| 07/06 | 0 | 24 | 34 | | | | 0 | 0 | | | | -5 | -5 | | | |
| 07/12 | 0 | 0 | 41 | | | | 5 | 5 | | | | -5 | -5 | | | |
| 07/18 | 10 | 38 | 69 | | | | 10 | 4 | | | | -5 | -10 | | | |
| 08/00 | 15 | 62 | | | | | 10 | | | | | -10 | | | | |
| 08/06 | 0 | 43 | | | | | 10 | | | | | -10 | | | | |
| 08/12 | 9 | 28 | | | | | 5 | | | | | -5 | | | | |
| 08/18 | 0 | 14 | | | | | 2 | | | | | -5 | | | | |
| 09/00 | 9 | | | | | | | | | | | | | | | |
| 09/06 | 0 | | | | | | | | | | | | | | | |
| 09/12 | 0 | | | | | | | | | | | | | | | |
| 09/18 | 14 | | | | | | | | | | | | | | | |
| mean | 9 | 66 | 83 | 119 | 267 | -- | 7 | 13 | 19 | 14 | -- | -8 | -13 | -21 | -25 | -- |
| sample | 21 | 17 | 12 | 7 | 3 | 0 | 17 | 12 | 7 | 3 | 0 | 17 | 12 | 7 | 3 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TS Peipah (1916)** | | | | | | | | | | | | | | | | |
| Sep. 15/06 | | | | | | | | | | | | | | | | |
| 15/12 | 0 | | | | | | | | | | | | | | | |
| 15/18 | 11 | | | | | | | | | | | | | | | |
| 16/00 | 0 | | | | | | | | | | | | | | | |
| 16/06 | 61 | | | | | | | | | | | | | | | |
| mean | 18 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| sample | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Tapah (1917)** | | | | | | | | | | | | | | | | |
| Sep. 19/00 | 0 | 15 | 45 | | | | 9 | 15 | | | | -10 | -15 | | | |
| 19/06 | 0 | 39 | 60 | 45 | | | 5 | 10 | 0 | | | -5 | -10 | 0 | | |
| 19/12 | 11 | 61 | 24 | 91 | | | 5 | 10 | 0 | | | -5 | -10 | 0 | | |
| 19/18 | 20 | 81 | 62 | 156 | | | 10 | 5 | -10 | | | -15 | -5 | 10 | | |
| 20/00 | 39 | 15 | 119 | | | | 10 | 0 | | | | -10 | 0 | | | |
| 20/06 | 30 | 81 | 108 | | | | 5 | 0 | | | | -5 | 0 | | | |
| 20/12 | 33 | 45 | 86 | | | | 0 | -10 | | | | -5 | 5 | | | |
| 20/18 | 10 | 58 | 158 | | | | 5 | -10 | | | | -5 | 10 | | | |
| 21/00 | 10 | 86 | | | | | 0 | | | | | 0 | | | | |
| 21/06 | 0 | 76 | | | | | 0 | | | | | 0 | | | | |
| 21/12 | 20 | 39 | | | | | -5 | | | | | 5 | | | | |
| 21/18 | 0 | 62 | | | | | -10 | | | | | 10 | | | | |
| 22/00 | 10 | | | | | | | | | | | | | | | |
| 22/06 | 15 | | | | | | | | | | | | | | | |
| 22/12 | 35 | | | | | | | | | | | | | | | |
| 22/18 | 11 | | | | | | | | | | | | | | | |
| mean | 15 | 55 | 83 | 97 | -- | -- | 3 | 3 | -3 | -- | -- | -4 | -3 | 3 | -- | -- |
| sample | 16 | 12 | 8 | 3 | 0 | 0 | 12 | 8 | 3 | 0 | 0 | 12 | 8 | 3 | 0 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Mitag (1918)** | | | | | | | | | | | | | | | | |
| Sep. 28/00 | 82 | 85 | 106 | 198 | 315 | 230 | 2 | 5 | -5 | -20 | -7 | 0 | 5 | 5 | 20 | 15 |
| 28/06 | 22 | 54 | 112 | 228 | 307 | | 0 | 0 | -25 | -20 | | 5 | 5 | 20 | 20 | |
| 28/12 | 22 | 39 | 67 | 200 | 270 | | -5 | 0 | -10 | -10 | | 5 | 0 | 10 | 15 | |
| 28/18 | 0 | 53 | 44 | 188 | 143 | | -5 | 0 | -10 | -9 | | 10 | 0 | 10 | 15 | |
| 29/00 | 25 | 63 | 20 | 181 | 63 | | 0 | -5 | -10 | -2 | | 5 | 5 | 10 | 10 | |
| 29/06 | 0 | 57 | 20 | 11 | | | -10 | -10 | -5 | | | 10 | 10 | 5 | | |
| 29/12 | 11 | 51 | 78 | 133 | | | -10 | -10 | -5 | | | 5 | 10 | 10 | | |
| 29/18 | 10 | 75 | 44 | 239 | | | -10 | -10 | -4 | | | 5 | 10 | 10 | | |
| 30/00 | 0 | 89 | 111 | 340 | | | 0 | -10 | -2 | | | 0 | 10 | 10 | | |
| 30/06 | 0 | 63 | 131 | | | | -10 | -10 | | | | 10 | 10 | | | |
| 30/12 | 0 | 91 | 120 | | | | -5 | -5 | | | | 5 | 10 | | | |
| 30/18 | 15 | 40 | 92 | | | | -10 | -9 | | | | 10 | 15 | | | |
| Oct. 01/00 | 15 | 39 | 137 | | | | -5 | -2 | | | | 5 | 5 | | | |
| 01/06 | 0 | 33 | | | | | 0 | | | | | 0 | | | | |
| 01/12 | 11 | 57 | | | | | 0 | | | | | 5 | | | | |
| 01/18 | 10 | 93 | | | | | -4 | | | | | 10 | | | | |
| 02/00 | 9 | 83 | | | | | -2 | | | | | 5 | | | | |
| 02/06 | 0 | | | | | | | | | | | | | | | |
| 02/12 | 14 | | | | | | | | | | | | | | | |
| 02/18 | 0 | | | | | | | | | | | | | | | |
| 03/00 | 37 | | | | | | | | | | | | | | | |
| mean | 14 | 63 | 83 | 191 | 220 | 230 | -4 | -5 | -8 | -12 | -7 | 6 | 7 | 10 | 16 | 15 |
| sample | 21 | 17 | 13 | 9 | 5 | 1 | 17 | 13 | 9 | 5 | 1 | 17 | 13 | 9 | 5 | 1 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Hagibis (1919)** | | | | | | | | | | | | | | | | |
| Oct. 05/18 | 86 | 119 | 79 | 81 | 285 | 568 | 35 | 40 | 15 | 0 | -10 | -30 | -25 | -10 | 0 | 10 |
| 06/00 | 93 | 89 | 46 | 128 | 383 | 565 | 35 | 25 | 0 | 0 | -20 | -25 | -15 | 0 | 0 | 15 |
| 06/06 | 49 | 44 | 25 | 137 | 400 | 568 | 45 | 20 | 0 | 0 | -20 | -30 | -10 | 0 | 0 | 15 |
| 06/12 | 31 | 39 | 0 | 91 | 377 | 547 | 40 | 10 | 0 | -5 | -30 | -25 | -5 | 0 | 5 | 20 |
| 06/18 | 0 | 78 | 56 | 161 | 396 | 498 | 20 | 0 | 0 | -10 | -20 | -10 | 0 | 0 | 10 | 15 |
| 07/00 | 0 | 54 | 79 | 265 | 401 | 471 | 10 | 0 | 0 | -10 | -15 | -5 | 0 | 0 | 10 | 15 |
| 07/06 | 0 | 42 | 44 | 250 | 347 | 372 | -15 | 0 | 10 | 5 | 0 | 10 | 0 | -5 | 0 | 5 |
| 07/12 | 0 | 11 | 35 | 203 | 235 | 305 | -15 | 0 | 5 | -5 | -15 | 10 | 0 | 0 | 5 | 15 |
| 07/18 | 0 | 25 | 85 | 241 | 255 | 374 | -10 | 0 | 0 | -5 | -20 | 5 | 0 | 5 | 5 | 20 |
| 08/00 | 0 | 42 | 160 | 210 | 149 | 366 | 0 | 0 | -10 | -10 | 5 | 0 | 0 | 10 | 10 | 0 |
| 08/06 | 0 | 62 | 180 | 213 | 229 | | 0 | 0 | -10 | -10 | | 0 | 0 | 10 | 10 | |
| 08/12 | 0 | 24 | 129 | 102 | 152 | | 0 | 5 | -5 | -10 | | 0 | 0 | 5 | 10 | |
| 08/18 | 0 | 70 | 140 | 80 | 202 | | 0 | 0 | -5 | -10 | | 0 | 5 | 5 | 10 | |
| 09/00 | 0 | 133 | 161 | 75 | 79 | | 0 | 0 | 0 | -5 | | 0 | 5 | 5 | 5 | |
| 09/06 | 0 | 107 | 118 | 57 | | | 0 | -10 | 0 | | | 0 | 10 | 5 | | |
| 09/12 | 0 | 83 | 106 | 100 | | | -5 | -10 | -15 | | | 5 | 10 | 15 | | |
| 09/18 | 0 | 87 | 89 | 194 | | | -10 | -10 | -10 | | | 10 | 10 | 15 | | |
| 10/00 | 0 | 59 | 104 | 216 | | | -10 | -10 | -5 | | | 10 | 10 | 10 | | |
| 10/06 | 10 | 70 | 114 | | | | -10 | -10 | | | | 10 | 10 | | | |
| 10/12 | 0 | 59 | 169 | | | | -20 | -20 | | | | 10 | 15 | | | |
| 10/18 | 0 | 44 | 216 | | | | -15 | 0 | | | | 5 | 0 | | | |
| 11/00 | 0 | 38 | 164 | | | | -5 | 0 | | | | 5 | 0 | | | |
| 11/06 | 0 | 67 | | | | | -5 | | | | | 5 | | | | |
| 11/12 | 0 | 42 | | | | | -20 | | | | | 15 | | | | |
| 11/18 | 0 | 106 | | | | | -5 | | | | | 5 | | | | |
| 12/00 | 0 | 58 | | | | | -5 | | | | | 5 | | | | |
| 12/06 | 0 | | | | | | | | | | | | | | | |
| 12/12 | 0 | | | | | | | | | | | | | | | |
| 12/18 | 0 | | | | | | | | | | | | | | | |
| 13/00 | 0 | | | | | | | | | | | | | | | |
| mean | 9 | 64 | 105 | 156 | 278 | 463 | 1 | 1 | -2 | -5 | -14 | -1 | 1 | 4 | 6 | 13 |
| sample | 30 | 26 | 22 | 18 | 14 | 10 | 26 | 22 | 18 | 14 | 10 | 26 | 22 | 18 | 14 | 10 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Neoguri (1920)** | | | | | | | | | | | | | | | | |
| Oct. 17/00 | | | | | | | | | | | | | | | | |
| 17/06 | 76 | 370 | | | | | 6 | | | | | -10 | | | | |
| 17/12 | 81 | 209 | 297 | | | | 6 | 29 | | | | -10 | -35 | | | |
| 17/18 | 64 | 137 | 256 | 850 | | | 10 | 34 | 21 | | | -10 | -40 | -35 | | |
| 18/00 | 52 | 91 | 298 | 1077 | | | 12 | 34 | 21 | | | -15 | -40 | -35 | | |
| 18/06 | 42 | 126 | 373 | 999 | | | 9 | 19 | 10 | | | -15 | -25 | -20 | | |
| 18/12 | 11 | 68 | 413 | | | | 21 | 18 | | | | -20 | -20 | | | |
| 18/18 | 11 | 61 | 477 | | | | 20 | 9 | | | | -20 | -15 | | | |
| 19/00 | 15 | 60 | 465 | | | | 15 | 9 | | | | -15 | -15 | | | |
| 19/06 | 0 | 145 | 521 | | | | 10 | 4 | | | | -10 | -10 | | | |
| 19/12 | 10 | 285 | | | | | 0 | | | | | 0 | | | | |
| 19/18 | 11 | 402 | | | | | -15 | | | | | 15 | | | | |
| 20/00 | 0 | 354 | | | | | -5 | | | | | 5 | | | | |
| 20/06 | 42 | 234 | | | | | 0 | | | | | 0 | | | | |
| 20/12 | 0 | | | | | | | | | | | | | | | |
| 20/18 | 15 | | | | | | | | | | | | | | | |
| 21/00 | 0 | | | | | | | | | | | | | | | |
| 21/06 | 67 | | | | | | | | | | | | | | | |
| mean | 29 | 196 | 388 | 976 | -- | -- | 7 | 20 | 17 | -- | -- | -8 | -25 | -30 | -- | -- |
| sample | 17 | 13 | 8 | 3 | 0 | 0 | 13 | 8 | 3 | 0 | 0 | 13 | 8 | 3 | 0 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Bualoi (1921)** | | | | | | | | | | | | | | | | |
| Oct. 19/06 | 22 | 47 | | | | | 15 | | | | | -20 | | | | |
| 19/12 | 22 | 24 | 46 | 129 | 247 | 387 | 15 | 20 | 20 | 0 | -20 | -10 | -15 | -20 | -5 | 10 |
| 19/18 | 0 | 64 | 64 | 156 | 342 | 453 | 15 | 15 | 15 | -15 | -25 | -10 | -10 | -15 | 5 | 15 |
| 20/00 | 16 | 70 | 85 | 200 | 307 | 289 | 10 | 5 | 0 | -20 | -30 | -10 | -10 | -5 | 10 | 20 |
| 20/06 | 22 | 15 | 67 | 188 | 271 | 281 | 0 | 5 | 0 | -30 | -30 | -5 | -10 | -5 | 15 | 20 |
| 20/12 | 16 | 11 | 90 | 230 | 330 | | -5 | 0 | -15 | -20 | | 0 | -5 | 5 | 10 | |
| 20/18 | 49 | 22 | 137 | 254 | 357 | | -15 | 0 | -20 | -20 | | 5 | -5 | 10 | 10 | |
| 21/00 | 11 | 21 | 172 | 282 | 416 | | -15 | -15 | -20 | -15 | | 5 | 5 | 10 | 10 | |
| 21/06 | 0 | 46 | 150 | 252 | 358 | | 0 | -5 | -20 | -15 | | -5 | 0 | 10 | 10 | |
| 21/12 | 0 | 67 | 157 | 239 | | | 5 | -10 | -15 | | | -5 | 5 | 10 | | |
| 21/18 | 0 | 70 | 171 | 277 | | | 5 | -15 | -15 | | | -5 | 10 | 10 | | |
| 22/00 | 0 | 90 | 146 | 192 | | | -15 | -10 | -10 | | | 10 | 10 | 10 | | |
| 22/06 | 0 | 84 | 160 | 267 | | | -5 | -15 | -25 | | | 5 | 10 | 20 | | |
| 22/12 | 0 | 68 | 154 | | | | -15 | -15 | | | | 10 | 10 | | | |
| 22/18 | 0 | 78 | 125 | | | | -15 | -15 | | | | 10 | 10 | | | |
| 23/00 | 0 | 37 | 113 | | | | -10 | -10 | | | | 10 | 10 | | | |
| 23/06 | 10 | 59 | 147 | | | | -15 | -10 | | | | 10 | 10 | | | |
| 23/12 | 11 | 22 | | | | | -10 | | | | | 5 | | | | |
| 23/18 | 10 | 58 | | | | | -15 | | | | | 10 | | | | |
| 24/00 | 11 | 69 | | | | | -20 | | | | | 15 | | | | |
| 24/06 | 0 | 142 | | | | | -10 | | | | | 10 | | | | |
| 24/12 | 0 | | | | | | | | | | | | | | | |
| 24/18 | 0 | | | | | | | | | | | | | | | |
| 25/00 | 0 | | | | | | | | | | | | | | | |
| 25/06 | 0 | | | | | | | | | | | | | | | |
| mean | 8 | 55 | 124 | 222 | 328 | 352 | -5 | -5 | -9 | -17 | -26 | 2 | 2 | 3 | 8 | 16 |
| sample | 25 | 21 | 16 | 12 | 8 | 4 | 21 | 16 | 12 | 8 | 4 | 21 | 16 | 12 | 8 | 4 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **STS Matmo (1922)** | | | | | | | | | | | | | | | | |
| Oct. 29/18 | 39 | 90 | | | | | 6 | | | | | -15 | | | | |
| 30/00 | 0 | 40 | | | | | 2 | | | | | -10 | | | | |
| 30/06 | 0 | | | | | | | | | | | | | | | |
| 30/12 | 0 | | | | | | | | | | | | | | | |
| 30/18 | 31 | | | | | | | | | | | | | | | |
| 31/00 | 31 | | | | | | | | | | | | | | | |
| mean | 17 | 65 | -- | -- | -- | -- | 4 | -- | -- | -- | -- | -12 | -- | -- | -- | -- |
| sample | 6 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Halong (1923)** | | | | | | | | | | | | | | | | |
| Nov. 02/12 | 22 | 128 | 113 | | | | -2 | -5 | | | | 5 | 5 | | | |
| 02/18 | 46 | 44 | 49 | 274 | 736 | 1154 | -7 | 0 | 50 | 35 | 17 | 10 | 0 | -30 | -25 | -20 |
| 03/00 | 39 | 57 | 102 | 318 | 1004 | 1450 | -5 | 10 | 50 | 25 | 14 | 5 | -10 | -30 | -20 | -20 |
| 03/06 | 24 | 53 | 33 | 227 | 802 | 935 | 0 | 25 | 50 | 20 | 4 | 0 | -20 | -30 | -15 | -10 |
| 03/12 | 21 | 22 | 62 | 268 | 606 | 326 | -5 | 50 | 35 | 10 | -2 | 0 | -35 | -25 | -15 | 0 |
| 03/18 | 21 | 11 | 46 | 274 | 490 | 281 | 10 | 50 | 15 | 5 | -10 | -10 | -35 | -15 | -10 | 15 |
| 04/00 | 11 | 11 | 94 | 280 | 288 | | 5 | 45 | 0 | 0 | | -10 | -30 | -5 | -5 | |
| 04/06 | 39 | 43 | 127 | 326 | 186 | | 20 | 45 | -5 | -10 | | -20 | -30 | 0 | 5 | |
| 04/12 | 15 | 67 | 103 | 207 | 95 | | 45 | 20 | -5 | -9 | | -30 | -15 | 0 | 10 | |
| 04/18 | 0 | 39 | 15 | 11 | 73 | | 35 | 0 | -10 | -15 | | -25 | -5 | 5 | 20 | |
| 05/00 | 0 | 35 | 35 | 64 | | | 20 | -5 | -5 | | | -15 | 0 | 0 | | |
| 05/06 | 15 | 33 | 38 | 127 | | | 15 | -10 | -15 | | | -10 | 5 | 10 | | |
| 05/12 | 0 | 49 | 83 | 78 | | | 0 | -20 | -19 | | | 0 | 10 | 20 | | |
| 05/18 | 0 | 10 | 37 | 139 | | | -20 | -20 | -20 | | | 10 | 10 | 25 | | |
| 06/00 | 0 | 23 | 67 | | | | -20 | -10 | | | | 15 | 5 | | | |
| 06/06 | 0 | 46 | 339 | | | | -5 | -5 | | | | 5 | 5 | | | |
| 06/12 | 15 | 105 | 393 | | | | -10 | -9 | | | | 5 | 15 | | | |
| 06/18 | 11 | 125 | 366 | | | | -5 | -10 | | | | 5 | 20 | | | |
| 07/00 | 11 | 268 | | | | | -5 | | | | | 5 | | | | |
| 07/06 | 38 | 375 | | | | | -10 | | | | | 10 | | | | |
| 07/12 | 82 | 527 | | | | | 0 | | | | | 0 | | | | |
| 07/18 | 87 | 349 | | | | | -2 | | | | | 5 | | | | |
| 08/00 | 149 | | | | | | | | | | | | | | | |
| 08/06 | 118 | | | | | | | | | | | | | | | |
| 08/12 | 39 | | | | | | | | | | | | | | | |
| 08/18 | 44 | | | | | | | | | | | | | | | |
| mean | 33 | 110 | 117 | 199 | 476 | 829 | 2 | 8 | 9 | 7 | 5 | -2 | -6 | -6 | -6 | -7 |
| sample | 26 | 22 | 18 | 13 | 9 | 5 | 22 | 18 | 13 | 9 | 5 | 22 | 18 | 13 | 9 | 5 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Nakri (1924)** | | | | | | | | | | | | | | | | |
| Nov. 05/18 | 32 | 11 | 64 | 49 | 79 | 86 | -2 | 0 | -10 | -15 | -21 | 5 | 0 | 10 | 15 | 25 |
| 06/00 | 22 | 49 | 152 | 146 | 194 | | 0 | -5 | -10 | -10 | | 0 | 5 | 10 | 10 | |
| 06/06 | 49 | 60 | 67 | 64 | 147 | | 0 | 5 | 0 | 5 | | 0 | -5 | 0 | -5 | |
| 06/12 | 55 | 78 | 44 | 78 | 99 | | 5 | 5 | 0 | -5 | | -5 | -5 | 5 | 5 | |
| 06/18 | 31 | 79 | 79 | 126 | 119 | | 5 | 0 | -5 | -4 | | -5 | 0 | 5 | 5 | |
| 07/00 | 31 | 99 | 103 | 163 | | | 0 | -5 | -10 | | | 0 | 5 | 10 | | |
| 07/06 | 46 | 78 | 74 | 148 | | | 0 | -10 | -15 | | | 0 | 10 | 15 | | |
| 07/12 | 67 | 79 | 109 | 171 | | | 0 | -10 | 8 | | | 0 | 15 | -15 | | |
| 07/18 | 33 | 31 | 70 | 191 | | | -5 | -15 | 4 | | | 5 | 15 | -15 | | |
| 08/00 | 66 | 11 | 71 | | | | -10 | -15 | | | | 10 | 15 | | | |
| 08/06 | 11 | 11 | 57 | | | | -10 | -15 | | | | 10 | 15 | | | |
| 08/12 | 11 | 35 | 67 | | | | -10 | -20 | | | | 15 | 20 | | | |
| 08/18 | 33 | 35 | 68 | | | | -10 | -4 | | | | 10 | 5 | | | |
| 09/00 | 33 | 71 | | | | | -5 | | | | | 5 | | | | |
| 09/06 | 0 | 57 | | | | | -5 | | | | | 5 | | | | |
| 09/12 | 0 | 46 | | | | | -10 | | | | | 10 | | | | |
| 09/18 | 0 | 40 | | | | | -11 | | | | | 15 | | | | |
| 10/00 | 25 | | | | | | | | | | | | | | | |
| 10/06 | 16 | | | | | | | | | | | | | | | |
| 10/12 | 0 | | | | | | | | | | | | | | | |
| 10/18 | 0 | | | | | | | | | | | | | | | |
| mean | 27 | 51 | 79 | 126 | 128 | 86 | -4 | -7 | -4 | -6 | -21 | 5 | 7 | 3 | 6 | 25 |
| sample | 21 | 17 | 13 | 9 | 5 | 1 | 17 | 13 | 9 | 5 | 1 | 17 | 13 | 9 | 5 | 1 |

| Date/Time (UTC) | Center Position (km) T=00 | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt) T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TY Fengshen (1925)** | | | | | | | | | | | | | | | | |
| Nov. 12/00 | 0 | 72 | 231 | | | | 4 | 4 | | | | -5 | 0 | | | |
| 12/06 | 86 | 138 | 247 | 325 | 397 | 369 | 2 | -2 | 5 | 5 | -5 | 0 | 5 | -10 | -10 | 0 |
| 12/12 | 39 | 138 | 284 | 333 | 221 | | 2 | -5 | 5 | 10 | | 0 | 10 | -5 | -10 | |
| 12/18 | 0 | 186 | 255 | 240 | 156 | | 0 | 5 | 10 | 15 | | 5 | 0 | -10 | -15 | |
| 13/00 | 0 | 170 | 233 | 255 | 182 | | 4 | 15 | 5 | 0 | | 0 | -15 | -5 | 0 | |
| 13/06 | 11 | 64 | 199 | 254 | 104 | | 4 | 15 | 10 | -5 | | 0 | -15 | -10 | 5 | |
| 13/12 | 46 | 125 | 162 | 142 | | | 0 | 10 | 10 | | | 5 | -10 | -10 | | |
| 13/18 | 68 | 145 | 151 | 63 | | | 0 | 5 | 10 | | | 5 | -5 | -10 | | |
| 14/00 | 48 | 57 | 67 | 355 | | | 5 | 5 | 0 | | | -5 | -5 | 0 | | |
| 14/06 | 54 | 102 | 264 | 867 | | | 15 | 5 | -10 | | | -15 | -5 | 10 | | |
| 14/12 | 44 | 74 | 256 | | | | 10 | 5 | | | | -10 | -5 | | | |
| 14/18 | 0 | 99 | 372 | | | | 10 | 10 | | | | -10 | -10 | | | |
| 15/00 | 0 | 75 | 392 | | | | -5 | -5 | | | | 5 | 5 | | | |
| 15/06 | 0 | 82 | 543 | | | | 0 | -10 | | | | 0 | 10 | | | |
| 15/12 | 0 | 157 | | | | | 0 | | | | | 0 | | | | |
| 15/18 | 0 | 240 | | | | | -5 | | | | | 5 | | | | |
| 16/00 | 0 | 341 | | | | | 0 | | | | | 0 | | | | |
| 16/06 | 15 | 347 | | | | | 0 | | | | | 0 | | | | |
| 16/12 | 0 | | | | | | | | | | | | | | | |
| 16/18 | 0 | | | | | | | | | | | | | | | |
| 17/00 | 39 | | | | | | | | | | | | | | | |
| 17/06 | 0 | | | | | | | | | | | | | | | |
| mean | 20 | 145 | 261 | 315 | 212 | 369 | 3 | 4 | 5 | 5 | -5 | -1 | -3 | -6 | -6 | 0 |
| sample | 22 | 18 | 14 | 9 | 5 | 1 | 18 | 14 | 9 | 5 | 1 | 18 | 14 | 9 | 5 | 1 |

| Date/Time (UTC) | Center Position (km) T=00 | =24 | =48 | =72 | =96 | =120 | Central Pressure (hPa) T=24 | =48 | =72 | =96 | =120 | Max. Wind (kt) T=24 | =48 | =72 | =96 | =120 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TY Kalmaegi (1926)** | | | | | | | | | | | | | | | | |
| Nov. 14/12 | 97 | 173 | 204 | 188 | 275 | 476 | -10 | -25 | -26 | 10 | 23 | 15 | 30 | 25 | -15 | -35 |
| 14/18 | 48 | 160 | 220 | 199 | 271 | 556 | -10 | -25 | -26 | 17 | -2 | 15 | 30 | 25 | -25 | -10 |
| 15/00 | 68 | 173 | 200 | 206 | 453 | | -15 | -25 | -12 | 21 | | 20 | 30 | 10 | -30 | |
| 15/06 | 15 | 236 | 221 | 262 | 584 | | -8 | -13 | 5 | 21 | | 10 | 15 | -10 | -30 | |
| 15/12 | 25 | 187 | 105 | 265 | 612 | | -8 | -11 | 10 | 21 | | 10 | 10 | -15 | -30 | |
| 15/18 | 49 | 160 | 131 | 254 | 644 | | -10 | -11 | 17 | -2 | | 15 | 10 | -25 | -10 | |
| 16/00 | 89 | 75 | 85 | 303 | | | -10 | -7 | 21 | | | 15 | 5 | -30 | | |
| 16/06 | 90 | 33 | 57 | 245 | | | -6 | 5 | 23 | | | 10 | -5 | -30 | | |
| 16/12 | 56 | 46 | 53 | 322 | | | -4 | 5 | 21 | | | 0 | -10 | -30 | | |
| 16/18 | 35 | 54 | 70 | 268 | | | -4 | 10 | -4 | | | 0 | -15 | -5 | | |
| 17/00 | 62 | 44 | 100 | | | | 0 | 10 | | | | -5 | -15 | | | |
| 17/06 | 35 | 15 | 155 | | | | 7 | 10 | | | | -15 | -15 | | | |
| 17/12 | 39 | 32 | 100 | | | | 10 | 19 | | | | -10 | -25 | | | |
| 17/18 | 32 | 49 | 274 | | | | 15 | 0 | | | | -15 | -10 | | | |
| 18/00 | 21 | 95 | | | | | 17 | | | | | -20 | | | | |
| 18/06 | 15 | 161 | | | | | 10 | | | | | -10 | | | | |
| 18/12 | 11 | 206 | | | | | 19 | | | | | -25 | | | | |
| 18/18 | 15 | 215 | | | | | 0 | | | | | -10 | | | | |
| 19/00 | 24 | | | | | | | | | | | | | | | |
| 19/06 | 15 | | | | | | | | | | | | | | | |
| 19/12 | 31 | | | | | | | | | | | | | | | |
| 19/18 | 67 | | | | | | | | | | | | | | | |
| mean | 43 | 117 | 141 | 251 | 473 | 516 | 0 | -4 | 3 | 15 | 11 | 0 | 3 | -8 | -23 | -22 |
| sample | 22 | 18 | 14 | 10 | 6 | 2 | 18 | 14 | 10 | 6 | 2 | 18 | 14 | 10 | 6 | 2 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **STS Fung-wong (1927)** | | | | | | | | | | | | | | | | |
| Nov. 20/00 | 0 | 148 | 432 | | | | 0 | -11 | | | | -5 | 10 | | | |
| 20/06 | 0 | 107 | 371 | | | | -5 | -4 | | | | 0 | 0 | | | |
| 20/12 | 0 | 96 | | | | | -4 | | | | | 5 | | | | |
| 20/18 | 46 | 99 | | | | | -4 | | | | | 5 | | | | |
| 21/00 | 0 | 157 | | | | | -2 | | | | | 0 | | | | |
| 21/06 | 0 | 179 | | | | | -6 | | | | | 10 | | | | |
| 21/12 | 0 | | | | | | | | | | | | | | | |
| 21/18 | 0 | | | | | | | | | | | | | | | |
| 22/00 | 0 | | | | | | | | | | | | | | | |
| 22/06 | 0 | | | | | | | | | | | | | | | |
| mean | 5 | 131 | 401 | -- | -- | -- | -3 | -7 | -- | -- | -- | 3 | 5 | -- | -- | -- |
| sample | 10 | 6 | 2 | 0 | 0 | 0 | 6 | 2 | 0 | 0 | 0 | 6 | 2 | 0 | 0 | 0 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Kammuri (1928)** | | | | | | | | | | | | | | | | |
| Nov. 26/00 | 89 | 191 | 183 | 180 | 441 | 627 | 0 | -5 | -25 | -40 | -45 | -5 | 0 | 15 | 25 | 25 |
| 26/06 | 0 | 149 | 210 | 376 | 521 | 607 | 0 | -5 | -5 | -35 | -45 | -5 | 0 | 0 | 20 | 25 |
| 26/12 | 40 | 117 | 188 | 424 | 625 | 693 | 0 | -5 | -10 | -35 | -45 | -5 | 0 | 5 | 20 | 25 |
| 26/18 | 71 | 117 | 121 | 431 | 544 | 646 | -5 | -5 | -20 | -45 | -45 | 0 | 0 | 10 | 25 | 25 |
| 27/00 | 31 | 86 | 205 | 389 | 420 | 594 | 0 | -5 | -25 | -45 | -35 | -5 | 0 | 15 | 25 | 20 |
| 27/06 | 35 | 101 | 274 | 332 | 380 | 548 | 0 | -10 | -20 | -35 | -20 | -5 | 5 | 10 | 20 | 10 |
| 27/12 | 25 | 117 | 316 | 369 | 401 | 563 | 0 | -10 | -30 | -45 | -15 | -5 | 5 | 15 | 25 | 5 |
| 27/18 | 50 | 67 | 283 | 359 | 413 | 501 | 0 | -25 | -45 | -45 | -15 | -5 | 15 | 25 | 25 | 5 |
| 28/00 | 31 | 93 | 203 | 248 | 323 | 339 | -20 | -40 | -45 | -35 | -25 | 10 | 25 | 25 | 20 | 15 |
| 28/06 | 22 | 94 | 148 | 197 | 306 | 373 | -25 | -35 | -45 | -30 | -50 | 15 | 20 | 25 | 15 | 30 |
| 28/12 | 66 | 94 | 118 | 116 | 206 | 240 | -25 | -35 | -45 | -25 | -55 | 15 | 20 | 25 | 10 | 35 |
| 28/18 | 216 | 40 | 103 | 140 | 188 | 194 | -20 | -30 | -45 | -25 | -30 | 10 | 15 | 25 | 10 | 20 |
| 29/00 | 0 | 25 | 40 | 135 | 140 | 129 | -25 | -35 | -35 | -25 | -37 | 15 | 20 | 20 | 15 | 30 |
| 29/06 | 54 | 39 | 46 | 147 | 165 | 159 | -30 | -35 | -30 | -40 | -27 | 15 | 20 | 15 | 25 | 25 |
| 29/12 | 34 | 45 | 35 | 125 | 142 | 144 | -30 | -35 | -25 | -25 | -19 | 15 | 20 | 10 | 15 | 20 |
| 29/18 | 43 | 76 | 34 | 49 | 70 | 123 | -30 | -45 | -25 | -10 | -15 | 15 | 25 | 10 | 5 | 20 |
| 30/00 | 49 | 22 | 81 | 49 | 81 | 156 | -30 | -35 | -10 | -12 | -12 | 15 | 20 | 5 | 10 | 15 |
| 30/06 | 97 | 49 | 90 | 55 | 100 | 168 | -30 | -20 | -10 | -7 | -6 | 15 | 10 | 5 | 5 | 5 |
| 30/12 | 66 | 54 | 68 | 78 | 101 | 124 | -30 | -15 | -10 | -4 | -6 | 15 | 5 | 5 | 5 | 0 |
| 30/18 | 87 | 11 | 46 | 46 | 114 | | -30 | -10 | -10 | -8 | | 15 | 0 | 5 | 10 | |
| Dec. 01/00 | 34 | 70 | 57 | 109 | 92 | | -20 | -5 | -12 | -10 | | 10 | 0 | 10 | 10 | |
| 01/06 | 34 | 95 | 85 | 116 | 124 | | -15 | 0 | -12 | -6 | | 5 | -5 | 10 | 5 | |
| 01/12 | 0 | 119 | 116 | 114 | 141 | | 0 | 0 | -4 | -2 | | -5 | -5 | 5 | 0 | |
| 01/18 | 0 | 79 | 116 | 149 | | | 0 | 0 | -4 | | | -5 | -5 | 5 | | |
| 02/00 | 0 | 25 | 84 | 131 | | | 5 | -7 | -6 | | | -5 | 5 | 5 | | |
| 02/06 | 0 | 32 | 119 | 193 | | | -5 | -12 | -10 | | | 0 | 10 | 10 | | |
| 02/12 | 0 | 69 | 130 | 186 | | | -15 | -19 | -12 | | | 10 | 20 | 10 | | |
| 02/18 | 0 | 83 | 119 | | | | -10 | -15 | | | | 10 | 25 | | | |
| 03/00 | 0 | 85 | 134 | | | | -17 | -10 | | | | 20 | 15 | | | |
| 03/06 | 0 | 84 | 159 | | | | -12 | -10 | | | | 15 | 15 | | | |
| 03/12 | 11 | 90 | 117 | | | | -4 | -10 | | | | 10 | 10 | | | |
| 03/18 | 0 | 68 | | | | | -8 | | | | | 15 | | | | |
| 04/00 | 11 | 86 | | | | | -4 | | | | | 5 | | | | |
| 04/06 | 24 | 114 | | | | | -4 | | | | | 5 | | | | |
| 04/12 | 46 | 124 | | | | | -6 | | | | | 5 | | | | |
| 04/18 | 79 | | | | | | | | | | | | | | | |
| 05/00 | 49 | | | | | | | | | | | | | | | |
| 05/06 | 24 | | | | | | | | | | | | | | | |
| 05/12 | 32 | | | | | | | | | | | | | | | |
| mean | 37 | 80 | 130 | 194 | 263 | 365 | -13 | -17 | -21 | -26 | -29 | 7 | 10 | 12 | 15 | 19 |
| sample | 39 | 35 | 31 | 27 | 23 | 19 | 35 | 31 | 27 | 23 | 19 | 35 | 31 | 27 | 23 | 19 |

| Date/Time | Center Position (km) | | | | | | Central Pressure (hPa) | | | | | Max. Wind (kt) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (UTC) | T=00 | =24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 | T=24 | =48 | =72 | =96 | =120 |
| **TY Phanfone (1929)** | | | | | | | | | | | | | | | | |
| Dec. 22/12 | 172 | 143 | 77 | 109 | 194 | 206 | -4 | 15 | 5 | -5 | -6 | 0 | -20 | -10 | 0 | 5 |
| 22/18 | 89 | 66 | 69 | 47 | 132 | 188 | 2 | 22 | -2 | -5 | -8 | -10 | -30 | 0 | 0 | 10 |
| 23/00 | 40 | 55 | 24 | 39 | 93 | | 9 | 17 | 5 | -7 | | -20 | -25 | -10 | 5 | |
| 23/06 | 0 | 57 | 79 | 100 | 110 | | 5 | 12 | 15 | -6 | | -10 | -20 | -20 | 5 | |
| 23/12 | 25 | 59 | 35 | 49 | 0 | | 10 | 5 | 5 | -4 | | -15 | -10 | -10 | 0 | |
| 23/18 | 22 | 88 | 35 | 11 | 49 | | 20 | -2 | 0 | -4 | | -25 | 0 | -5 | 5 | |
| 24/00 | 0 | 25 | 11 | 39 | | | 10 | 0 | -2 | | | -15 | -5 | 0 | | |
| 24/06 | 0 | 35 | 16 | 70 | | | 5 | 5 | -6 | | | -10 | -10 | 5 | | |
| 24/12 | 0 | 16 | 66 | 85 | | | 0 | 0 | -6 | | | -5 | -5 | 5 | | |
| 24/18 | 25 | 22 | 85 | 127 | | | -12 | -10 | -12 | | | 15 | 10 | 20 | | |
| 25/00 | 0 | 45 | 101 | | | | -10 | -12 | | | | 10 | 15 | | | |
| 25/06 | 0 | 45 | 108 | | | | -10 | -16 | | | | 10 | 20 | | | |
| 25/12 | 0 | 63 | 62 | | | | -20 | -13 | | | | 20 | 20 | | | |
| 25/18 | 0 | 62 | 88 | | | | -25 | -12 | | | | 25 | 25 | | | |
| 26/00 | 0 | 39 | | | | | -17 | | | | | 20 | | | | |
| 26/06 | 0 | 15 | | | | | -6 | | | | | 10 | | | | |
| 26/12 | 0 | 25 | | | | | -6 | | | | | 10 | | | | |
| 26/18 | 25 | 25 | | | | | -4 | | | | | 10 | | | | |
| 27/00 | 60 | | | | | | | | | | | | | | | |
| 27/06 | 25 | | | | | | | | | | | | | | | |
| 27/12 | 46 | | | | | | | | | | | | | | | |
| 27/18 | 11 | | | | | | | | | | | | | | | |
| mean | 24 | 49 | 61 | 67 | 96 | 197 | -3 | 1 | 0 | -5 | -7 | 1 | -2 | -2 | 3 | 8 |
| sample | 22 | 18 | 14 | 10 | 6 | 2 | 18 | 14 | 10 | 6 | 2 | 18 | 14 | 10 | 6 | 2 |

## 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 - 2019

| 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 |
| Normal 1981-2010 | 0.3 | 0.1 | 0.3 | 0.6 | 1.1 | 1.7 | 3.6 | 5.8 | 4.9 | 3.6 | 2.3 | 1.2 | 25.6 |

**Appendix 5**

# Code Forms of RSMC Products

## (1) RSMC Tropical Cyclone Advisory for Three-day Forecasts (WTPQ20-25 RJTD)

WTPQ i i 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 =

**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) |
| $YYGGgg_F$ | : | 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:**

```
WTPQ20 RJTD 150000
RSMC TROPICAL CYCLONE ADVISORY
NAME    STS 0320 NEPARTAK (0320)
ANALYSIS
PSTN    150000UTC 12.6N 117.8E FAIR
MOVE    WNW 13KT
PRES    980HPA
MXWD    055KT
GUST    080KT
50KT    40NM
30KT    240NM NORTHEAST 160NM SOUTHWEST
FORECAST
24HF    160000UTC 14.7N 113.7E 110NM 70%
MOVE    WNW 11KT
PRES    965HPA
MXWD    070KT
GUST    100KT
48HF    170000UTC 16.0N 111.0E 170NM 70%
MOVE    WNW 07KT
PRES    970HPA
MXWD    065KT
GUST    095KT
72HF    180000UTC 19.5N 110.0E 250NM 70%
MOVE    NNW 09KT
PRES    985HPA
MXWD    050KT
GUST    070KT =
```

## (2) 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 and symbols are as per the RSMC Tropical Cyclone Advisory for Three-day Forecasts (WTPQ20-25 RJTD) except:

| | | |
|---|---|---|
| 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) |

**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 =
```

## (3) 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=
```

## (4) 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=
```

## (5) 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. =

## (6) 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=
```

## (7) 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

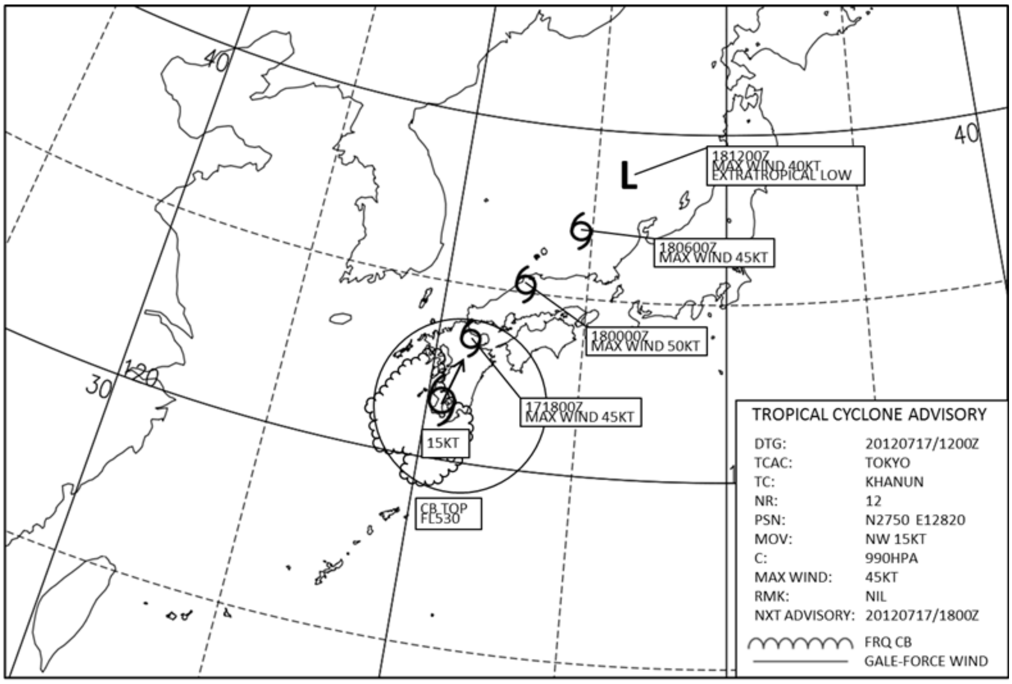
| | | |
|---|---|---|
| i i | : | '30', '31', '32', '33', '34' or '35' |
| YYGGgg | : | Date(YY), hour(GG) and minute(gg) in UTC (Using “Z”) |
| yyyymmdd/time | : | Year(yyyy), month(mm), date(dd), hour and minute (time) in UTC (Using “Z”) |
| name | : | Name assigned to the tropical cyclone by RSMC 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 =
```

## (8) Graphical Tropical Cyclone Advisory for SIGMET

**Example:**




TROPICAL CYCLONE ADVISORY CENTER TOKYO

## Appendix 6

### 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 A6.1.

Table A6.1 Specifications of GSM and GEPS

| NWP Models | GSM (Global Spectral Model), TL959L100 | GEPS (Global Ensemble Prediction System), TL479L100 |
|---|---|---|
| Resolution | 20 km, 100 layers (Top: 0.01hPa) | 40 km, 100 layers (Top: 0.01hPa) |
| Area | Global | Global |
| Method for initial value | Global Data Assimilation System (Hybrid-4DVAR)<br>Outer resolution: TL959L100<br>Inner resolution: TL319L100<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: 27 (26 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) | 132h (00, 06, 18 UTC)<br>264h (12 UTC) | 264 hours (00, 12 UTC)<br>132 hours (06, 18 UTC) |
| Operational as from | 25 May 2017 | 19 January 2017 |

The GSM (TL959L100) has a horizontal resolution of approximately 20 km and 100 vertical layers. Details of the model can be found in JMA (2019) and Yonehara et al. (2018).

GEPS (TL479L100) 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 27 members and a horizontal resolution of approximately 40 km along with 100 vertical layers for the first 11 days of forecasts. Details of the system can be found in JMA (2019) and Tokuhiro (2018). 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. Forecasts from initial times at 06 and 18 UTC are produced when any of the following conditions is satisfied at the initial times:

- A TC of tropical storm (TS) intensity or higher is present in the RSMC Tokyo - Typhoon Center's area of responsibility (0 – 60°N, 100°E – 180°),
- A TC is expected to reach or exceed TS intensity in the area within the next 24 hours.

[Recent upgrades to the Global Data Assimilation System and GEPS]

Global Data Assimilation System:

- All-sky assimilation of microwave imager (AMSR2/GCOM-W, GMI/GPM, SSMIS/DMSP F-17, F-18, WindSat/Coriolis, MWRI/FY-3C) and microwave water-vapor sounder (GMI/GPM, MHS/NOAA-19, Metop-A, -B) data was started (December 2019).
- Assimilation of ASCAT from Metop-C was started (December 2019).
  Hybrid background error covariances estimated with LETKF and outer-loop iteration were introduced in the 4D-Var system (December 2019).

GEPS:

- LETKF-based initial perturbation was updated (March 2019).

[References]

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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.

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**Appendix 7**

# Products on WIS GISC Tokyo Server

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

## NWP products (GSM and GEPS)

| 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 96–192 every 12 hours 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 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 |

| Model | 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° |
| 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 |
| Forecast hours | 0–84 (every 3 hours)<br>90–264 (every 6 hours) are available for 12 UTC initial | 0–84 (every 3 hours)<br>90–264 (every 6 hours) are available for 12 UTC initial |
| Initial times | 00, 06, 12, 18 UTC | 00, 06, 12, 18 UTC |

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 | 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 (VIS, IR, WVx3: every hour), 60S-60N, 90E-170W<br>Clear Sky Radiance (CSR) data (BUFR)<br>Himawari-8 radiances and brightness temperatures 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<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 8

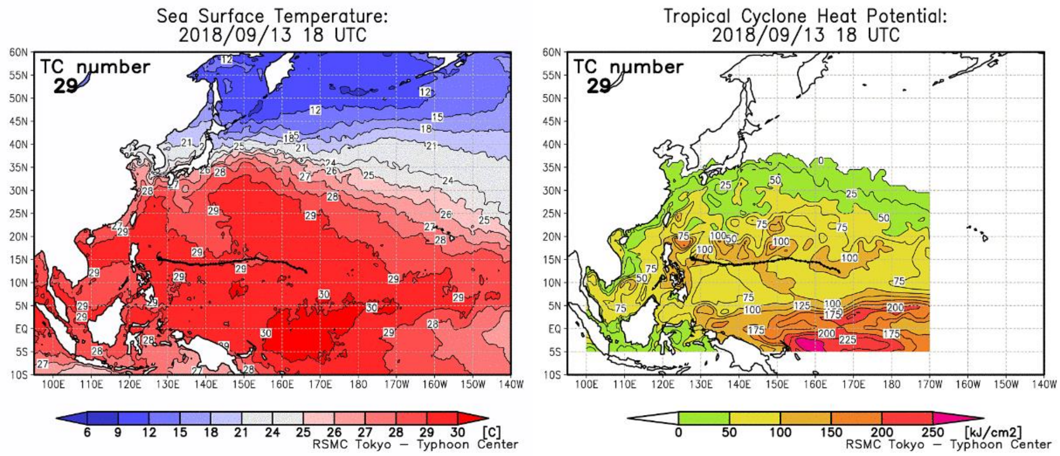
# Products on NTP Website

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

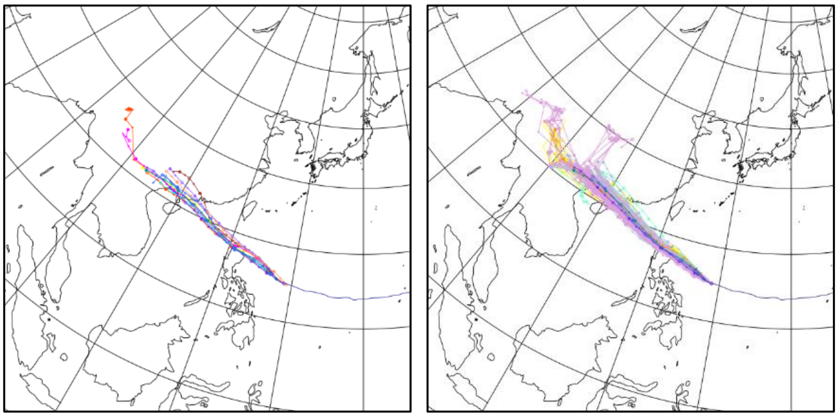
| Products | Frequency | Details |
|---|---|---|
| RSMC Advisories | | |
| RSMC TC Advisory | At least 8 times/day | • The Center's TC analysis and forecasts up to 120 hours ahead (linked to the JMA website at https://www.jma.go.jp/en/typh/) |
| Storm Wind Probability Map | 4 times/day | • Probabilistic 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) |
| Operational Remarks | | • Advance notice on TC status change from the Center |
| Graphical TC Advisory | 4 times/day | • Graphical TC Advisory including RSMC Tokyo - Typhoon 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 | Up to 142 times/day | • Satellite imagery of Himawari-8/9 (linked to the JMA website at https://www.jma.go.jp/en/gms/smallc.html?area=6&element=0&mode=UTC) |
| 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 from 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 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 | Once/day | MJO phase and amplitude diagram and MJO Hovmöller diagram (linked to the Tokyo Climate Center web site) |

| Products | Frequency | Details |
|---|---|---|
| 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 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) and a related consensus<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 |
| Marine Forecast | | |
| Storm Surge Forecasts | 4 times/day | • Distribution maps of storm surge for RSMC Tokyo - Typhoon 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 72 hours)<br>• Time-series storm surge forecast charts for RSMC Tokyo - Typhoon Center's TC track forecast and each of five TC track forecasts selected from GEPS ensemble members (up to 72 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) |

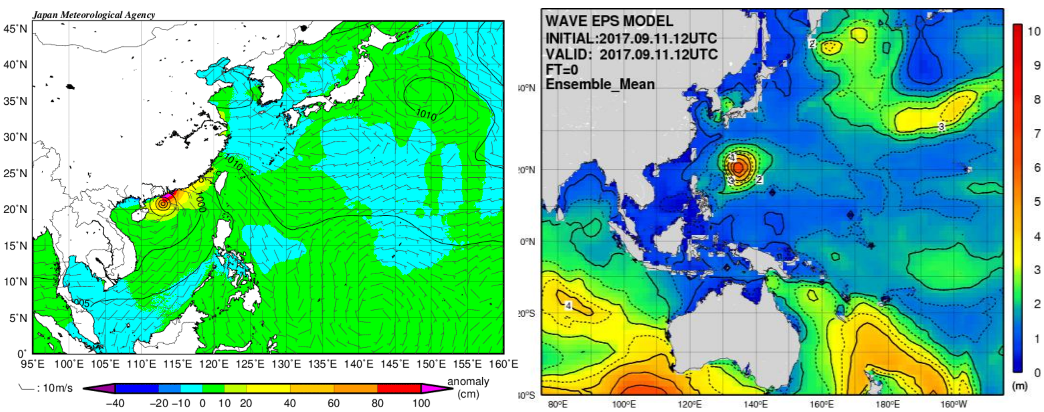
## RSMC Tokyo - Typhoon Center product examples




Left: Sea surface temperature analysis based on buoy, ship and satellite observation data, with values representing potential for TC development and genesis. Right: Tropical cyclone heat potential (total heat content from the sea surface down to the 26°C isotherm), with values representing heat energy measure associated with changes in TC intensity.



Left: Global NWP model deterministic track predictions from BoM, CMA, CMC, DWD, KMA, UKMO, NCEP, ECMWF and JMA. Track predictions from specific NWP models can be displayed. Right: Ensemble Track Predictions from NCEP, UKMO, ECMWF and JMA.

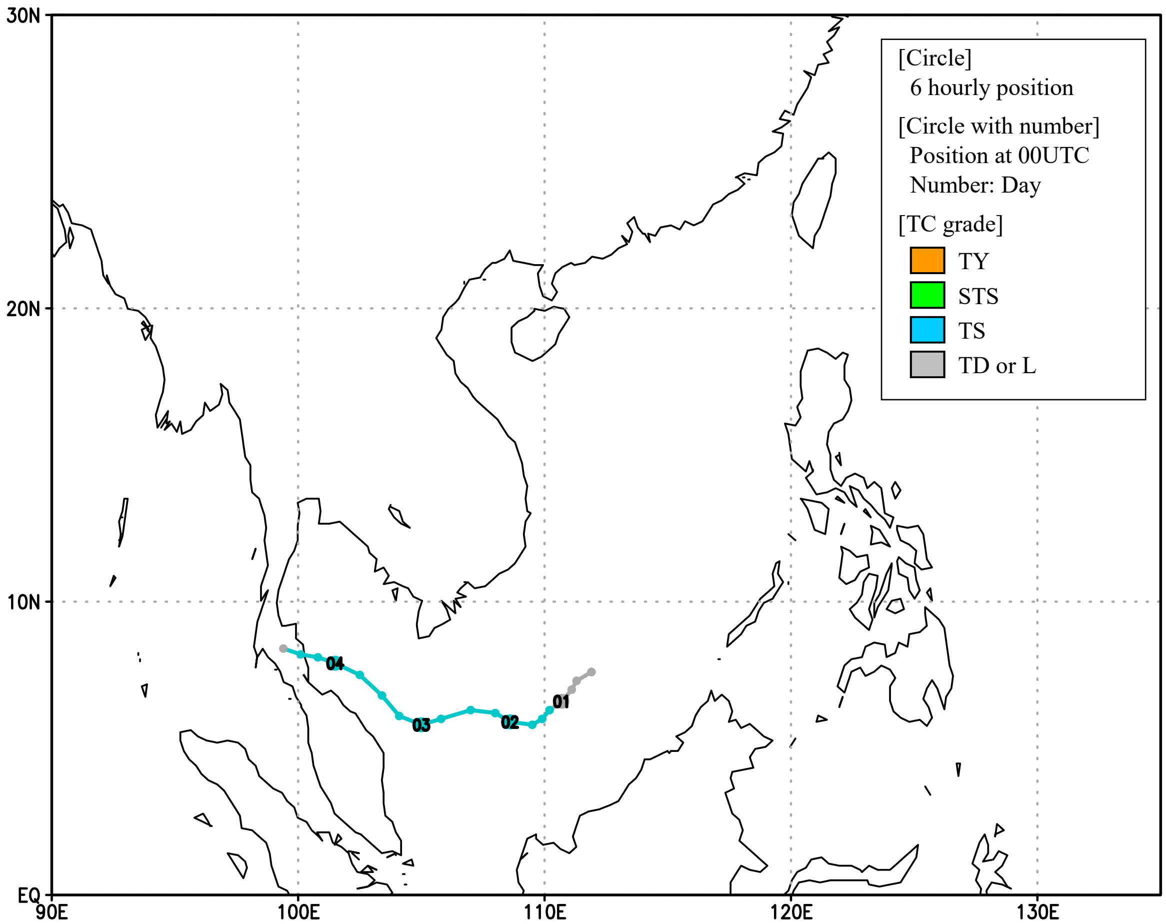



Left: Forecast derived from EPS for TC-related storm surge. The EPS is run for six possible TC tracks (the Center's operational track forecast, the center track with highest estimated possibility, the fastest track, the most rightward-biased track, the slowest track and most leftward-biased track) to cover a major set of TC track scenarios. Right: Ocean wave height data from JMA's wave ensemble system.

# Tropical Cyclones in 2019

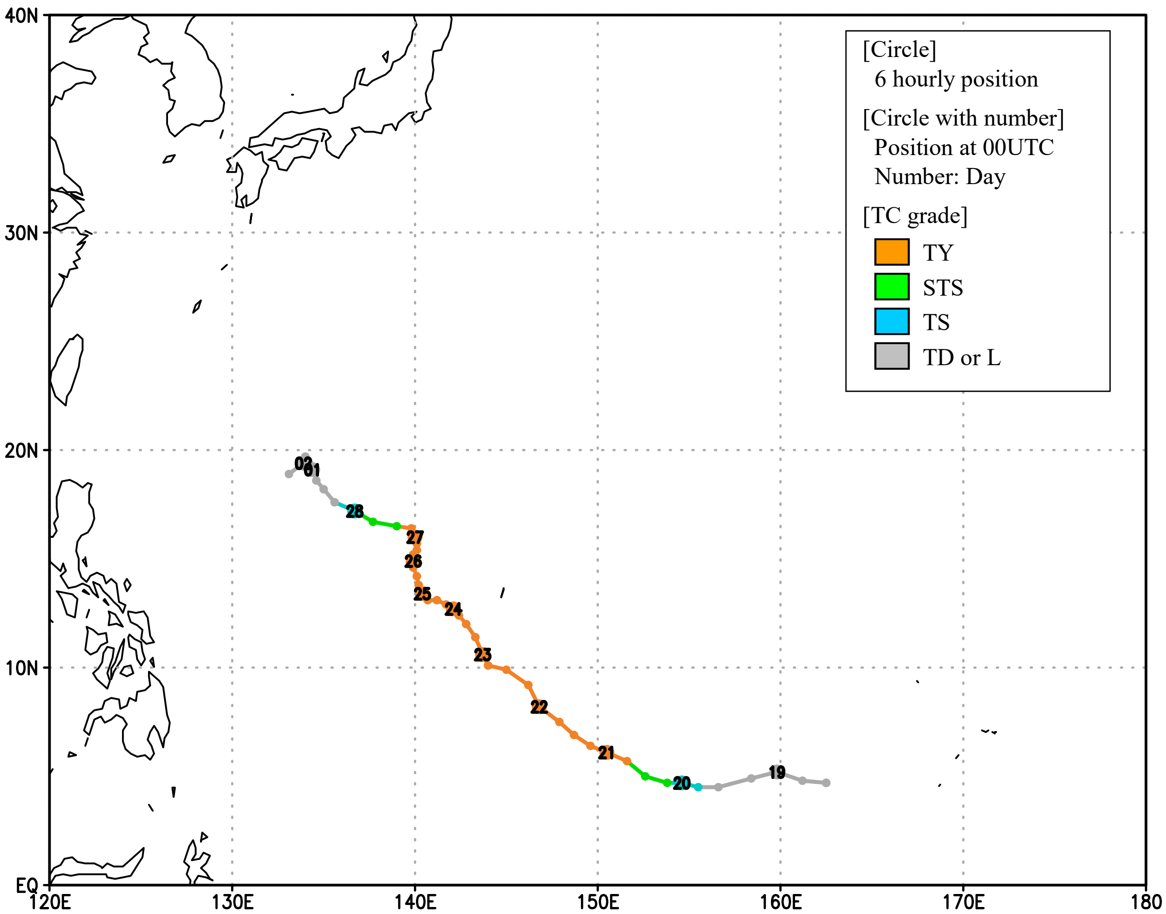
# PABUK (1901)

PABUK formed as a tropical depression (TD) over the South China Sea at 06 UTC on 31 December 2018 and moved west-southwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 06 UTC on 1 January 2019. After moving west-northwestward, PABUK reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 996 hPa over the Gulf of Thailand at 18 UTC on 3 January. After hitting the Malay Peninsula at 12 UTC on 4 January, it crossed longitude 100 degrees east six hours later.



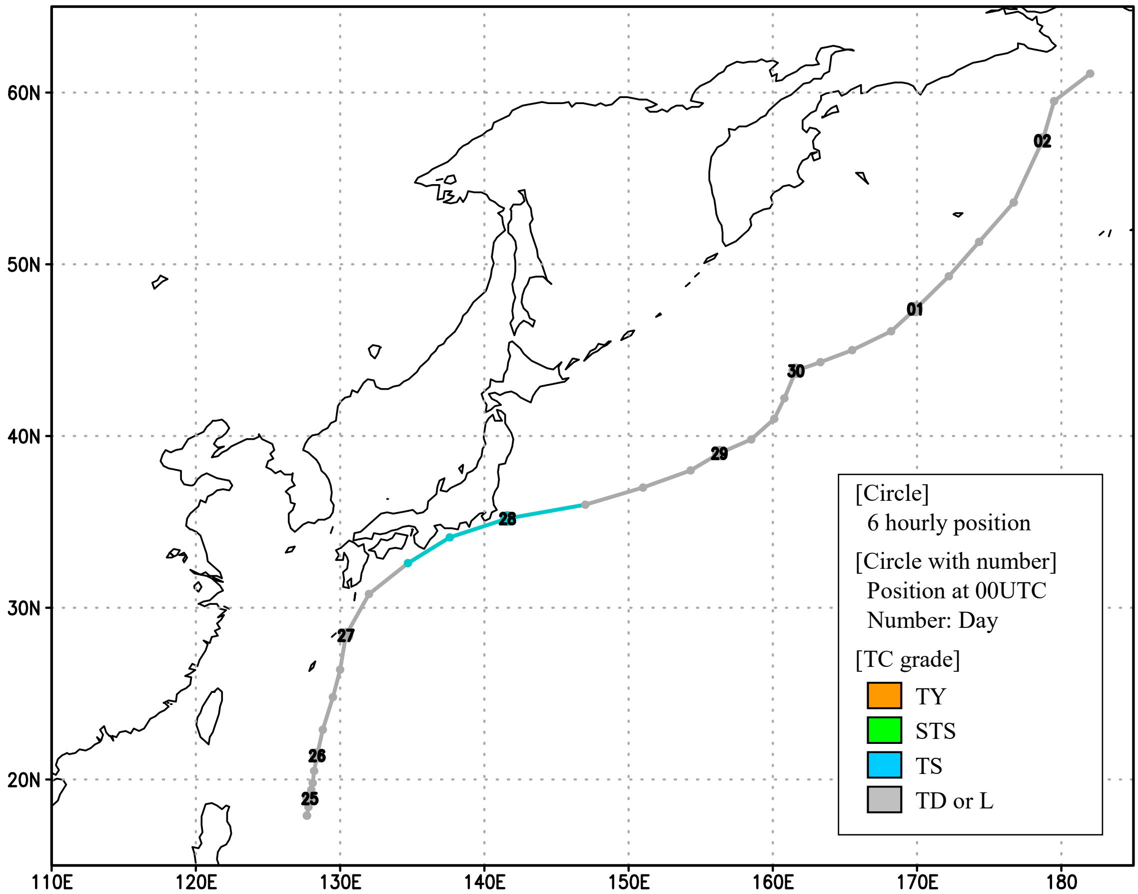
# WUTIP (1902)

WUTIP formed as a tropical depression (TD) around the Marshall Islands at 12 UTC on 18 February 2019 and moved westward. WUTIP was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on 19 February before it turned northwestward. WUTIP was upgraded to typhoon (TY) intensity around the Chuuk Islands at 18 UTC on 20 February. WUTIP reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 920 hPa over the sea southwest of Guam Island at 12 UTC on 23 February. Subsequently it slowed its speed and drifted northward. WUTIP weakened to TD intensity east of the Philippines at 06 UTC on 28 February and dissipated over the same waters at 12 UTC on 2 March.



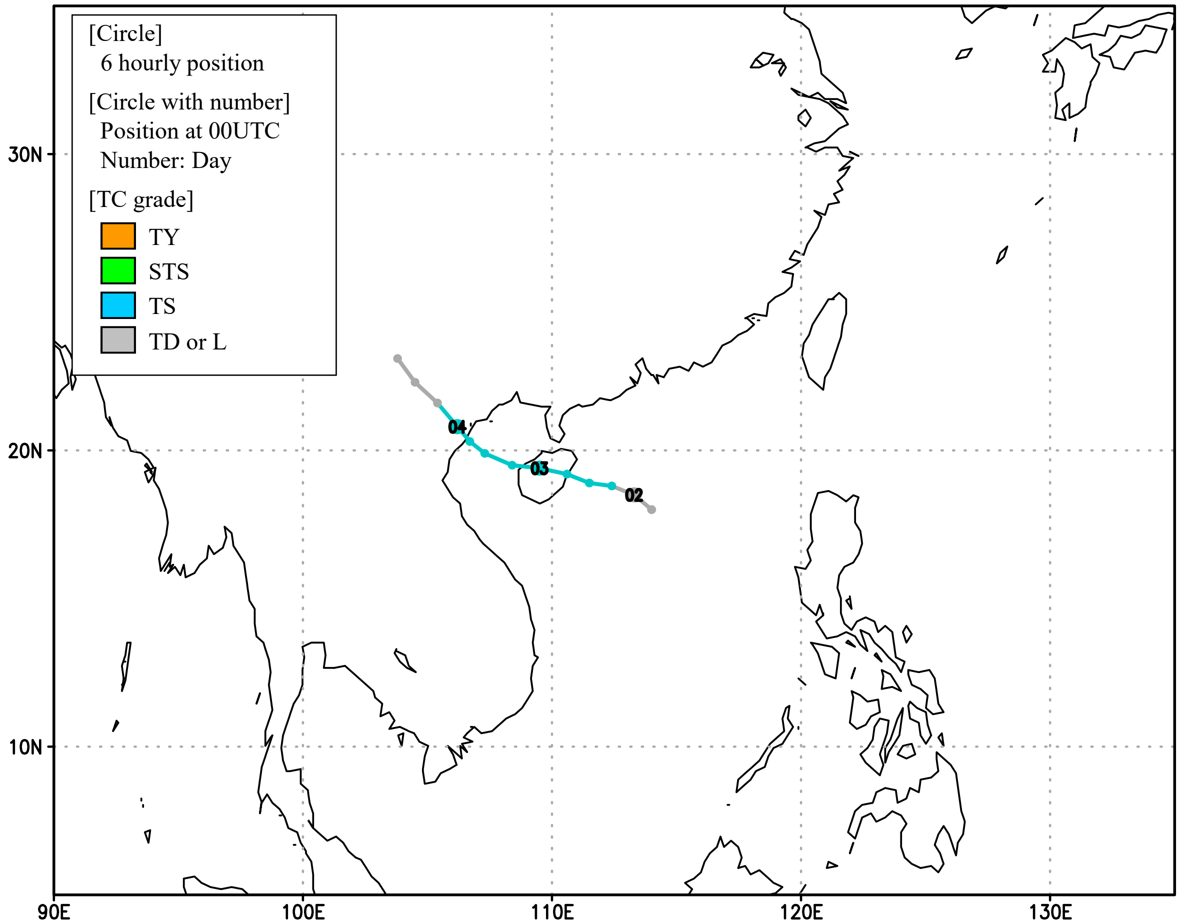
## SEPAT (1903)

SEPAT formed as a tropical depression (TD) east of the Philippines at 12 UTC on 24 June 2019, and moved north-northeastward. After turning east-northeastward, it was upgraded to tropical storm (TS) intensity to the south of Cape Muroto at 12 UTC on 27 June, then reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 996 hPa off the coast of central Japan six hours later. Keeping on its east-northeastward track, SEPAT transformed into an extratropical cyclone east of Japan at 06 UTC on 28 June. After turning north-northeastward, it crossed the longitude 180 degrees eastward over the Bering Sea by 12 UTC on 2 July.



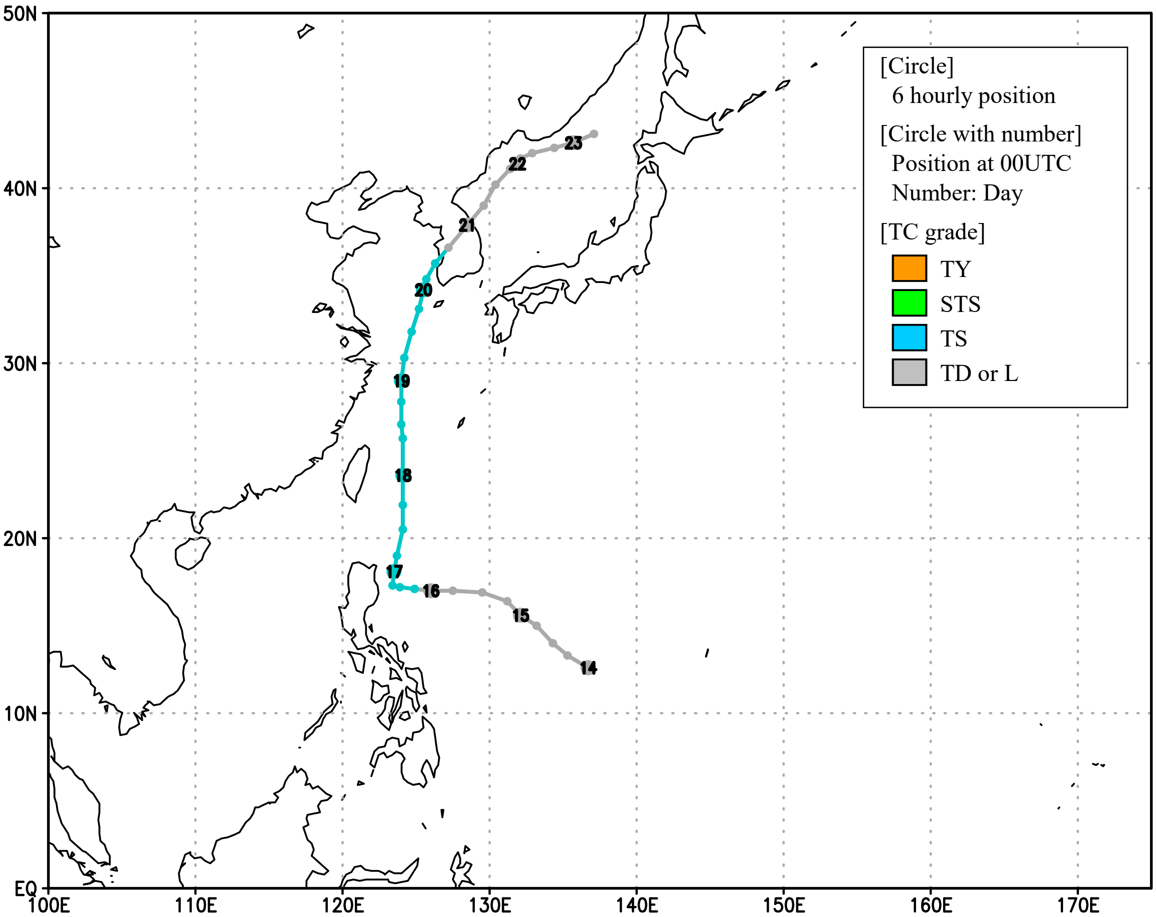
# MUN (1904)

MUN formed as a tropical depression (TD) in the South China Sea at 18 UTC on 1 July 2019 and moved west north-westward. MUN was upgraded to tropical storm (TS) intensity east of Hainan Island at 06 UTC on 2 July and hit the island with TS intensity on 2 July. It reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 992 hPa in Tonkin Bay at 06 UTC on 3 July. MUN turned northwest and hit the coast of northern Viet Nam on 3 July. MUN weakened to TD intensity in inland northern Viet Nam at 06 UTC on 4 July and dissipated at 00UTC next day.



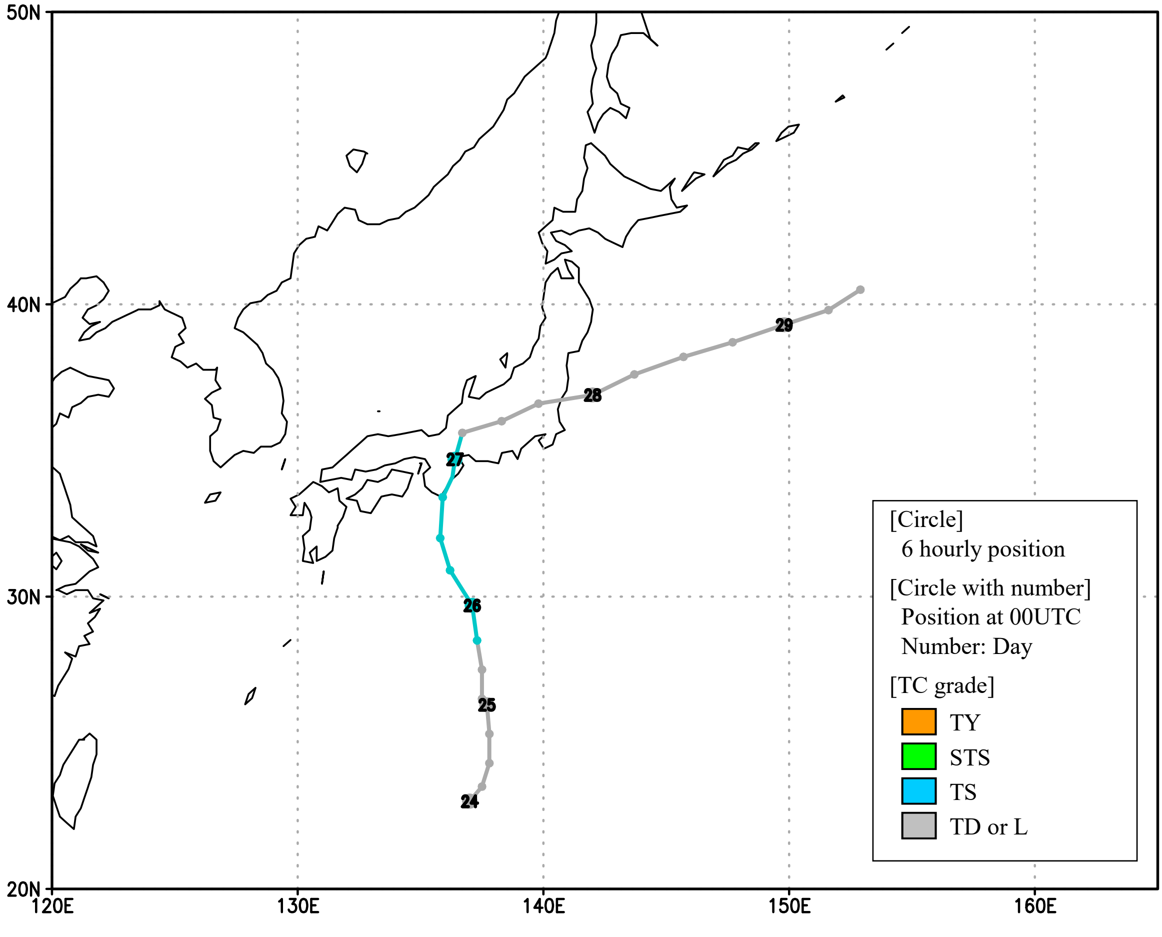
# DANAS (1905)

DANAS formed as a tropical depression (TD) over the sea north of Yap Island at 00 UTC on 14 July 2019. It initially moved northwestward and gradually turned westward before being upgraded to tropical storm (TS) intensity over the sea east of Luzon Island at 06 UTC on 16 July. DANAS took a sudden turn over the same waters and started to head due north. DANAS passed through the narrow strait between the two islands of Iriomotejima and Ishigakijima and entered the East China Sea, where it reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 985 hPa at 18 UTC on 18 July. DANAS continued to move northward and was downgraded to TD intensity at 18 UTC on 20 July just after crossing the western coast of the Korean Peninsula. It transformed into an extratropical cyclone at 12 UTC on 21 July over the Sea of Japan and dissipated at 12 UTC on 23 July over the same waters.



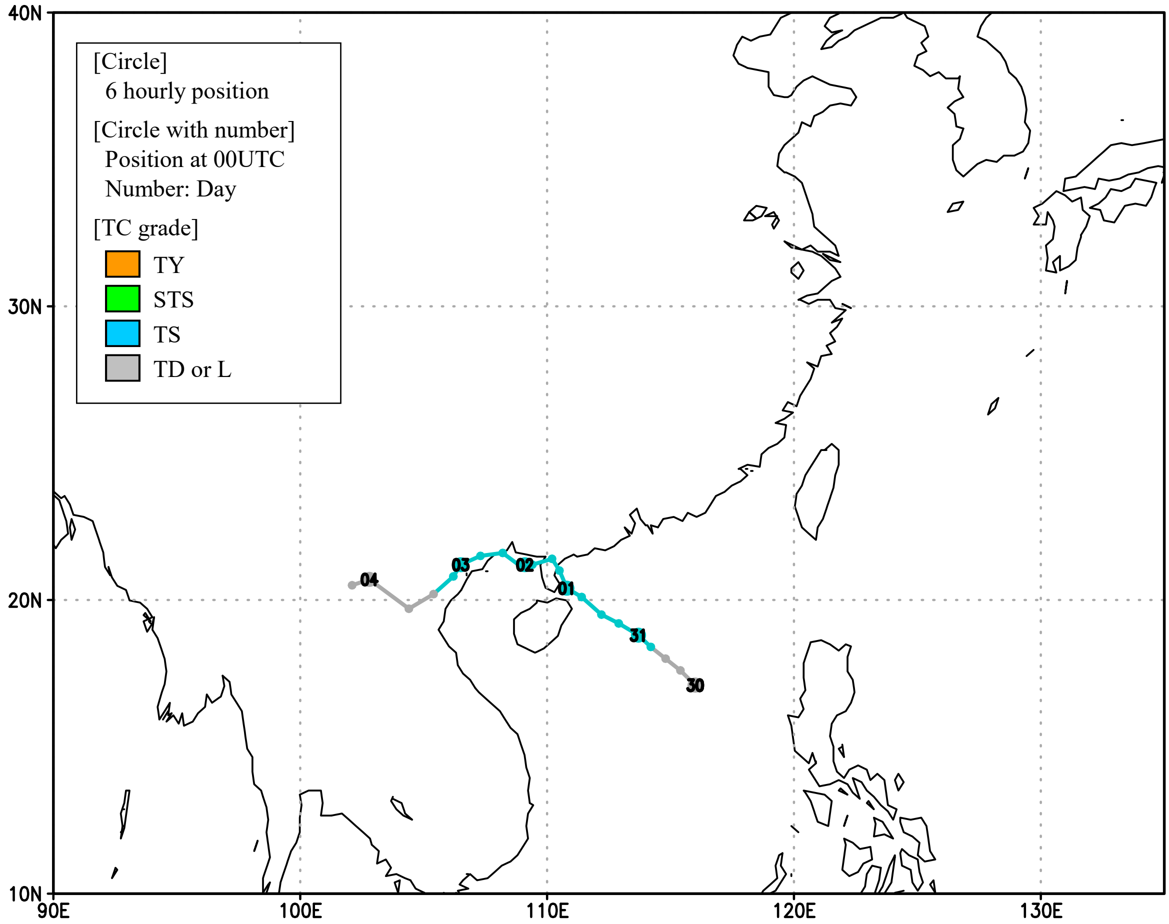
# NARI (1906)

NARI formed as a tropical depression (TD) over the sea north of the Okinotorishima Island at 00 UTC on 24 July 2019. NARI initially moved northeastward and soon turned northward. It was upgraded to tropical storm (TS) intensity over the sea west of the Ogasawara Islands at 18 UTC on the next day with maximum sustained winds of 35 kt. This was NARI's peak intensity. Keeping its northward track NARI maintained its intensity, while its central pressure decreased from 1002 hPa to the lifetime lowest of 998 hPa at 18 UTC on 26 July. It made landfall on the southern part of Mie Prefecture around 22 UTC on 26 July. NARI weakened to TD intensity on the Honshu Island at 06 UTC on 27 July. After turning east-northeastward, it transformed into an extratropical cyclone over the sea east of Japan at 00 UTC on 28 July. Keeping its east-northeastward track, it dissipated over the sea far east of Japan at 18 UTC on the next day.



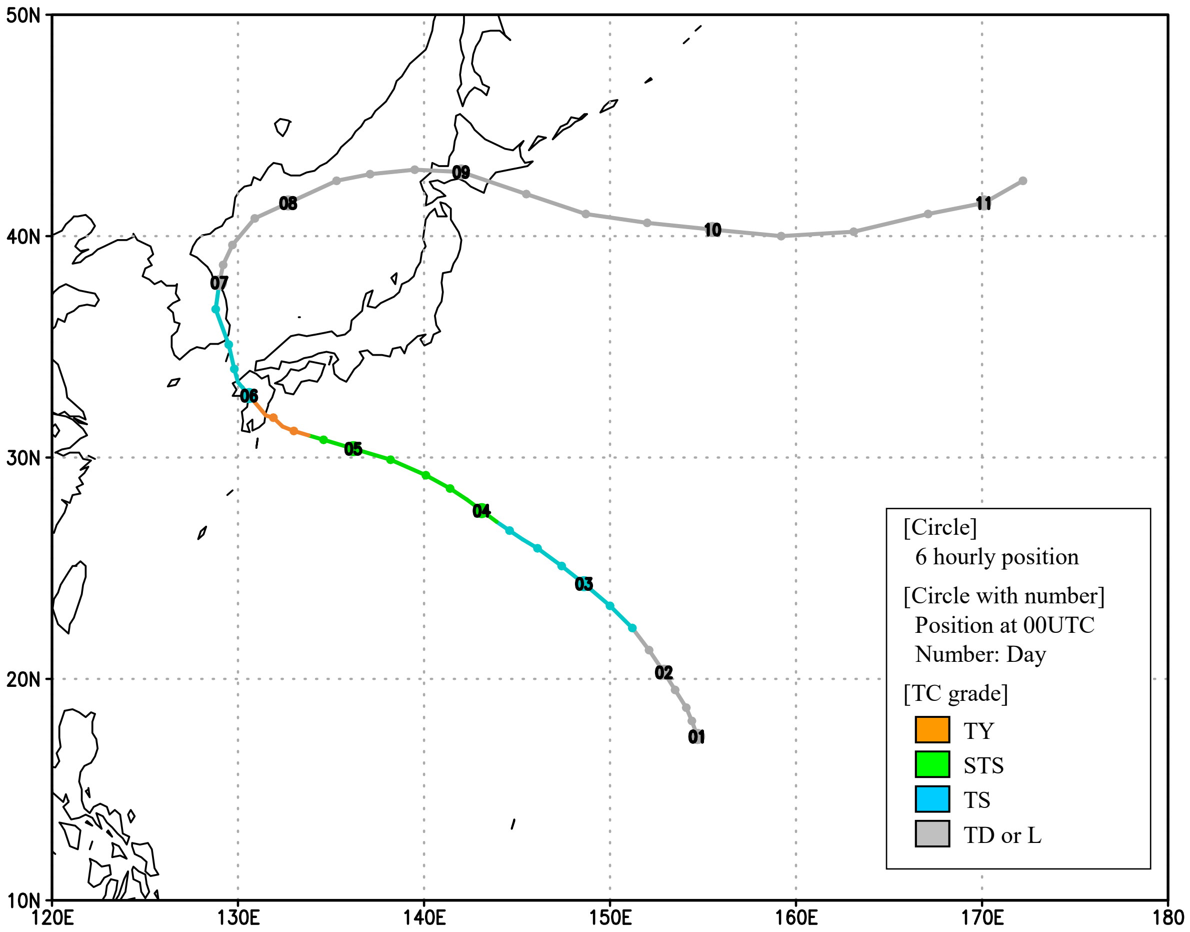
# WIPHA (1907)

WIPHA formed as a tropical depression (TD) over the South China Sea at 00 UTC on 30 July 2019 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters 18 hours later. Keeping its northwestward track, WIPHA crossed the Leizhou Peninsula and entered the Gulf of Tonkin at 18 UTC on 1 August. It reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 985 hPa 12 hours later. After crossing the coast line of southern China late on 2 August, it gradually weakened and turned west-southwestward. WIPHA weakened to TD intensity in northern Viet Nam at 12 UTC on 3 August and dissipated in Laos 24 hours later.



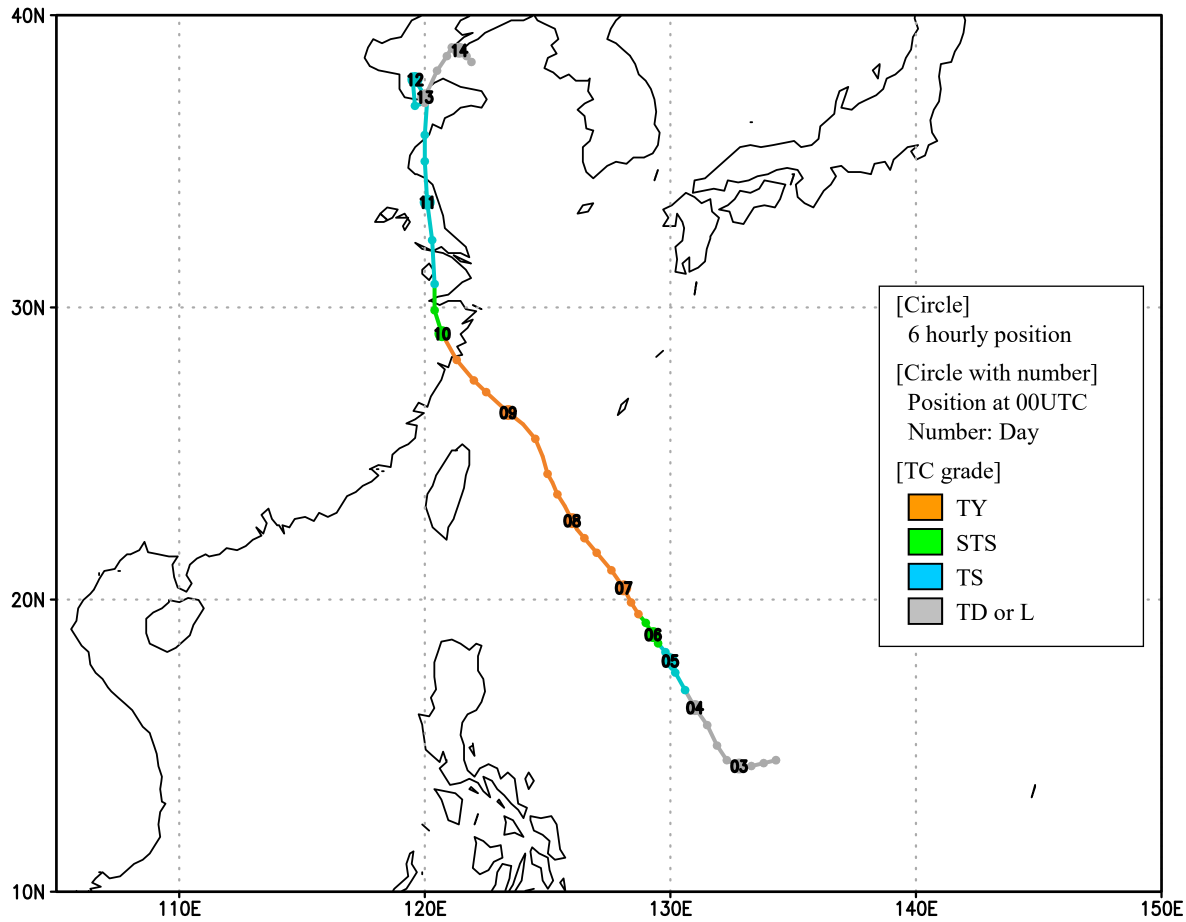
# FRANCISCO (1908)

FRANCISCO formed as a tropical depression (TD) south of Minamitorisima Island at 00 UTC on 1 August 2019 and moved northwestward. It was upgraded to tropical storm (TS) intensity southwest of the same island at 12 UTC the next day. Keeping its northwestward track, FRANCISCO was upgraded to typhoon (TY) intensity south of Shikoku at 09 UTC on 5 August, and it reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 970 hPa over the same waters three hours later. Maintaining TY intensity, FRANCISCO made landfall on Miyazaki City, Miyazaki Prefecture about 20 UTC on 5 August. After turning northward and passing over the Korean Peninsula, it weakened to TD intensity over the Sea of Japan at 00 UTC on 7 August. FRANCISCO started to recurve and accelerated eastward before it transformed into an extratropical cyclone at 18UTC over the same waters on 8 August, and dissipated south of the Aleutian Islands at 12 UTC on 11 August.



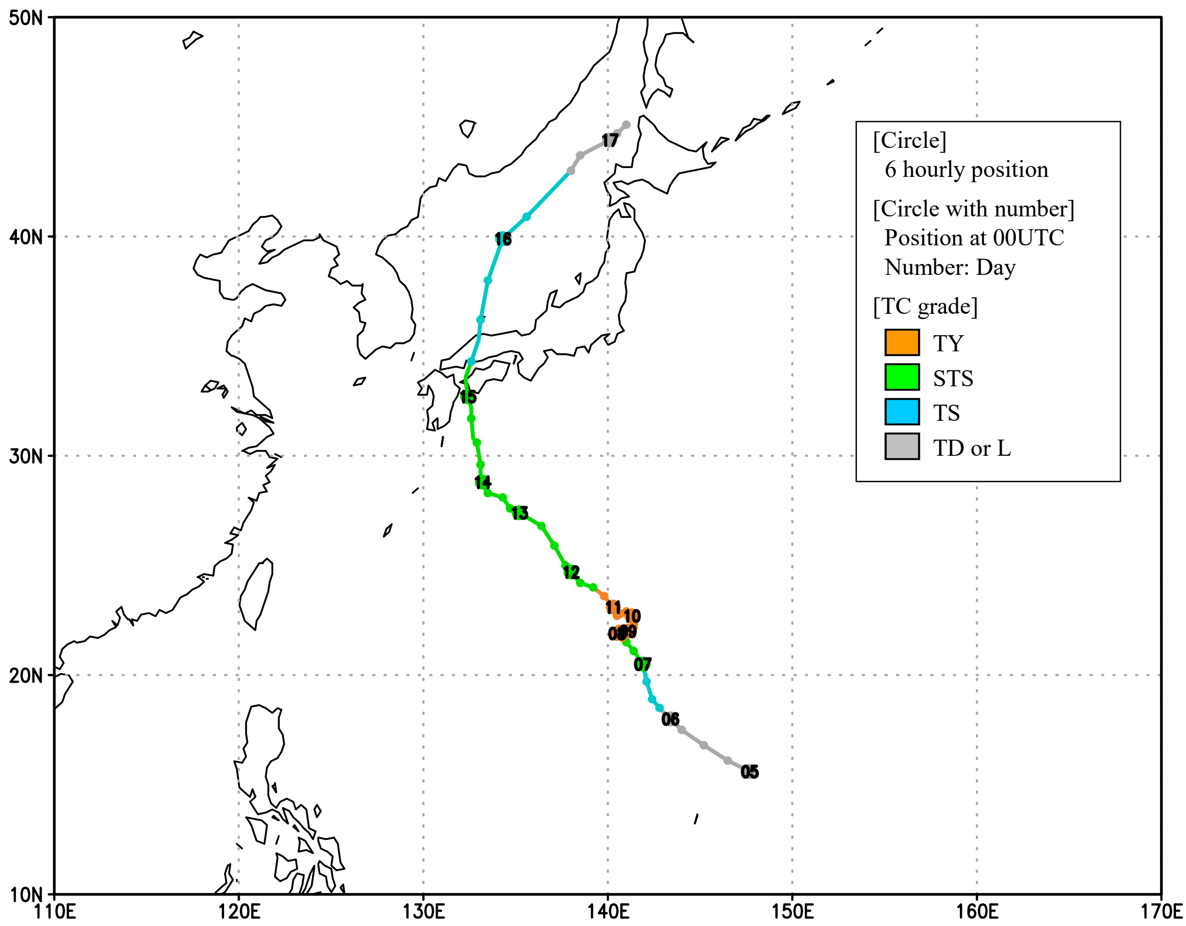
# LEKIMA (1909)

LEKIMA formed as a tropical depression (TD) over the sea east of the Philippines at 06 UTC on 2 August 2019. It moved initially westward and soon turned north-northwestward. LEKIMA was upgraded to tropical storm (TS) intensity over the same waters at 06 UTC on 4 August. From 5 August, LEKIMA developed rapidly and was upgraded to typhoon (TY) intensity over the sea east of Luzon Island at 12 UTC on 6 August. LEKIMA continued to develop and reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 925 hPa around Ishigakijima Island at 12 UTC on 8 August. Keeping its north-northwestward track, LEKIMA weakened slowly in the East China Sea. LEKIMA hit the coast of central China around 18 UTC on 9 August before it turned northward. LEKIMA made a counterclockwise loop over the Shandong Peninsula on 12 August and soon weakened to TD intensity at 18 UTC on the same day. LEKIMA transformed into an extratropical cyclone around the Liaodong Peninsula 00 UTC on 14 August and dissipated in the Yellow Sea at 00 UTC on 15 August.



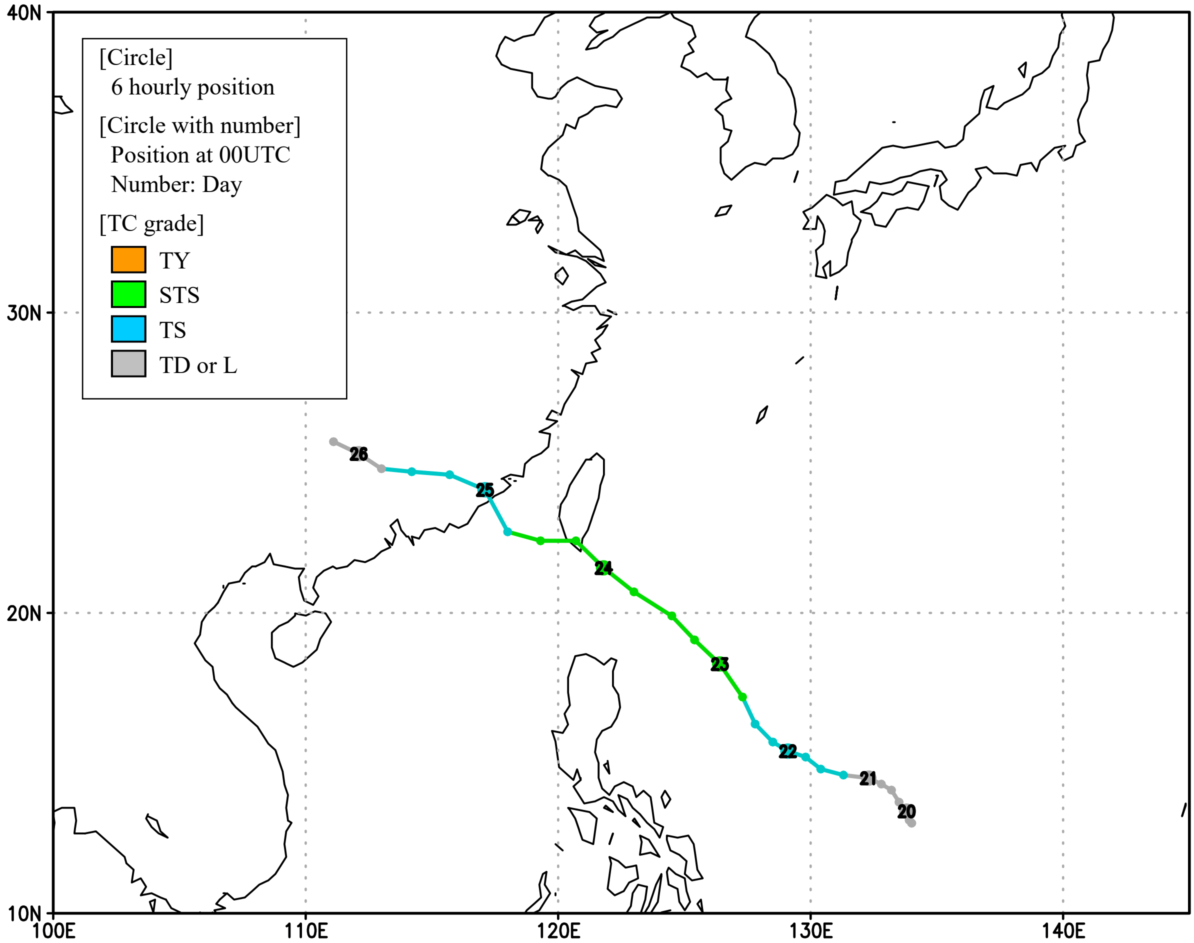
## KROSA (1910)

KROSA formed as a tropical depression (TD) over the sea east of Saipan at 00 UTC on 5 August 2019. It initially moved northwestward and was upgraded to tropical storm (TS) intensity over the eastern part of the Philippines Sea at 06 UTC on 6 August. KROSA reduced its speed before attaining typhoon (TY) intensity and soon reaching its peak intensity with maximum sustained winds of 75 kt and a central pressure of 965 hPa at 06 UTC on 8 August. It made a partial cyclonic loop before getting back on a northwesterly track. Subsequently KROSA turned northward far to the east of the Amami Islands, passed through the narrow strait between Japan’s two main islands of Shikoku and Kyushu and eventually made landfall on Kure City, Hiroshima Prefecture around 06 UTC on 15 August. KROSA entered the Sea of Japan and transformed into an extratropical cyclone at 12 UTC on 16 August. It dissipated at 18 UTC on 17 August off the western coast of northern Hokkaido.



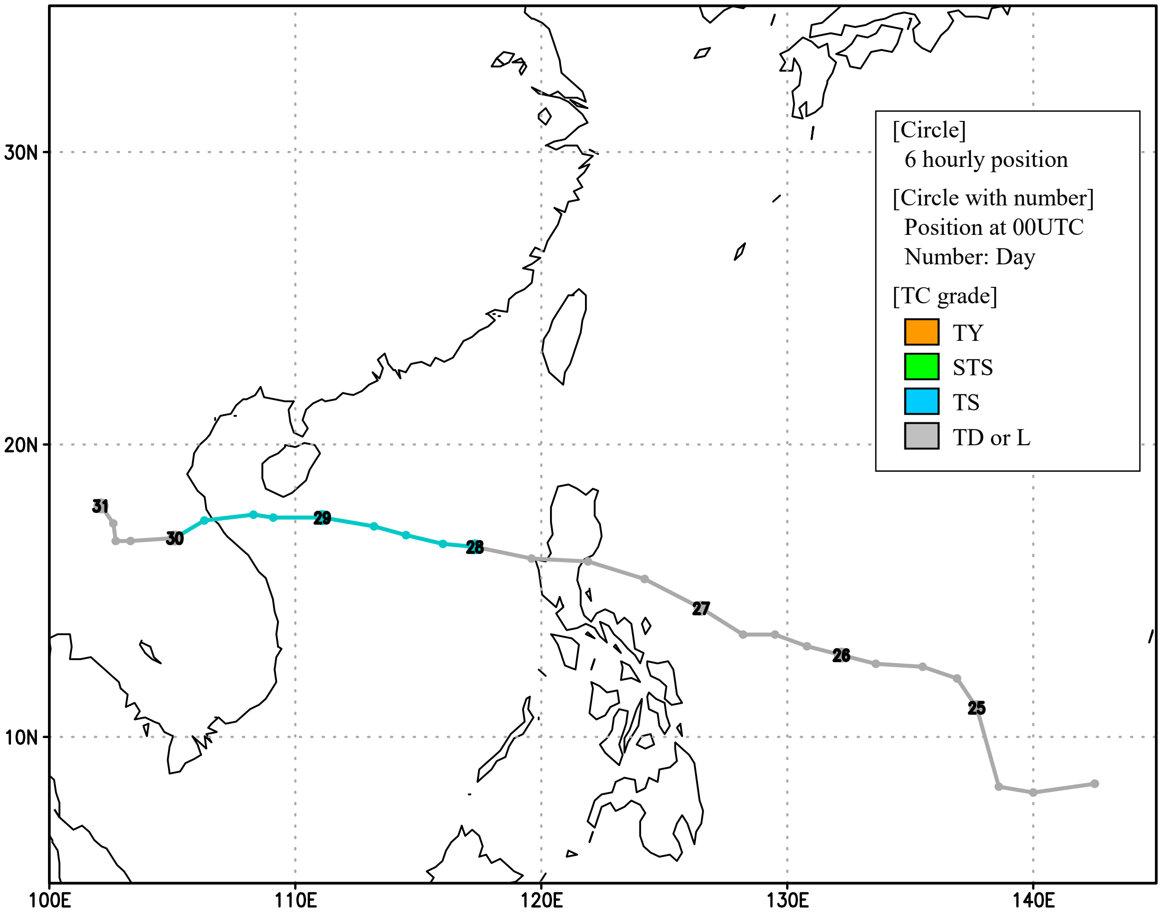
# BAILU (1911)

BAILU formed as a tropical depression (TD) over the sea north of Palau at 12 UTC on 19 August 2019, and moved northwestward slowly. It was upgraded to tropical storm (TS) intensity over the same waters at 06 UTC on 21 August and continued to move northwestward. BAILU was upgraded to severe tropical storm (STS) intensity over the sea east of Luzon Island at 18 UTC next day with maximum sustained winds of 50 kt and a central pressure of 985 hPa. This was its peak intensity. After gradually turning west-northwestward, it crossed Taiwan on 24 August. Keeping its west-northwestward track BAILU hit the coast of southeastern China at around 00 UTC on 25 August and weakened to a TD at 18 UTC on the same day. It dissipated over southern China at 12 UTC next day.



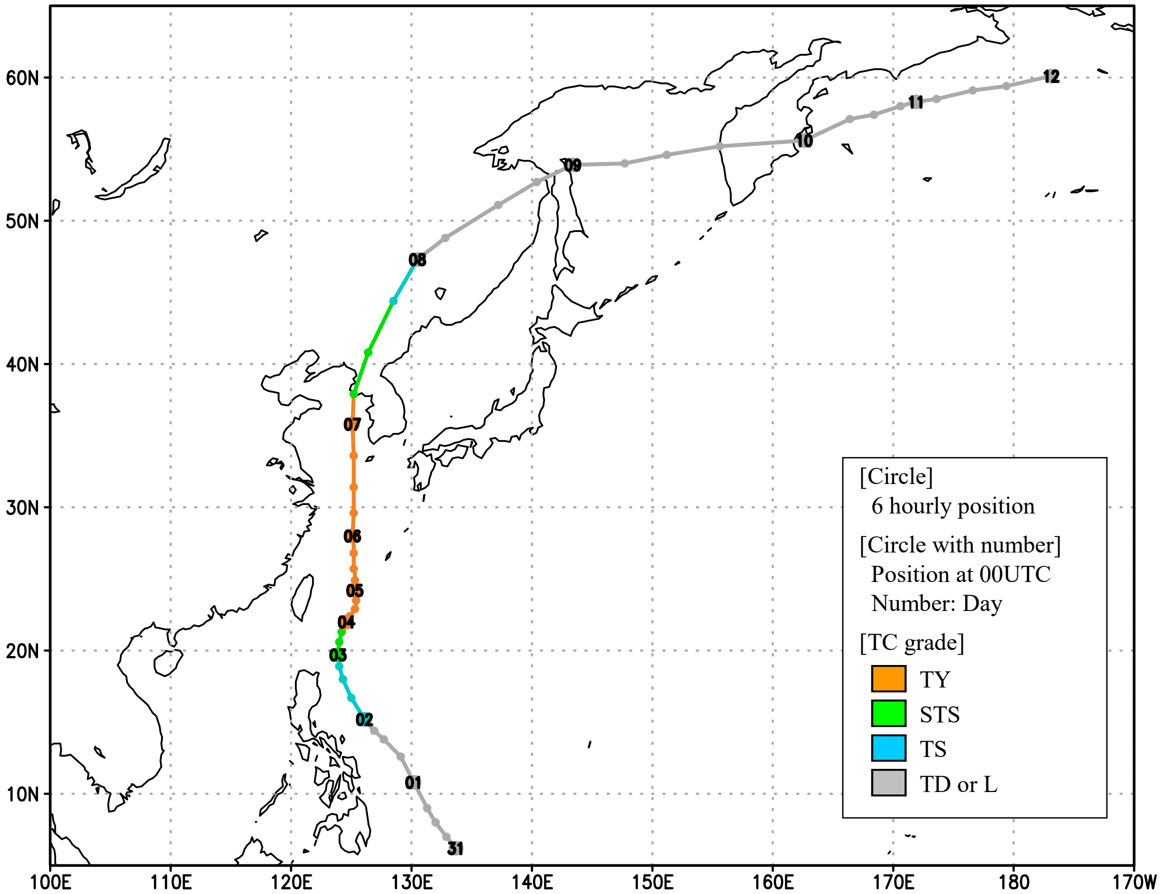
# PODUL (1912)

PODUL formed as a tropical depression (TD) around the Caroline Islands at 06 UTC on 24 August 2019 and moved westward. After crossing the Luzon Island, it was upgraded to tropical storm (TS) intensity over the South China Sea at 00 UTC on 28 August. PODUL reached its peak intensity over the same waters six hours later with maximum sustained winds of 40 kt and a central pressure of 996 hPa. Having maintained its peak intensity for 30 hours until it crossed the coastline of Viet Nam, PODUL weakened to TD intensity in southern Laos at 00 UTC on 30 August and dissipated in northern Thailand 30 hours later.



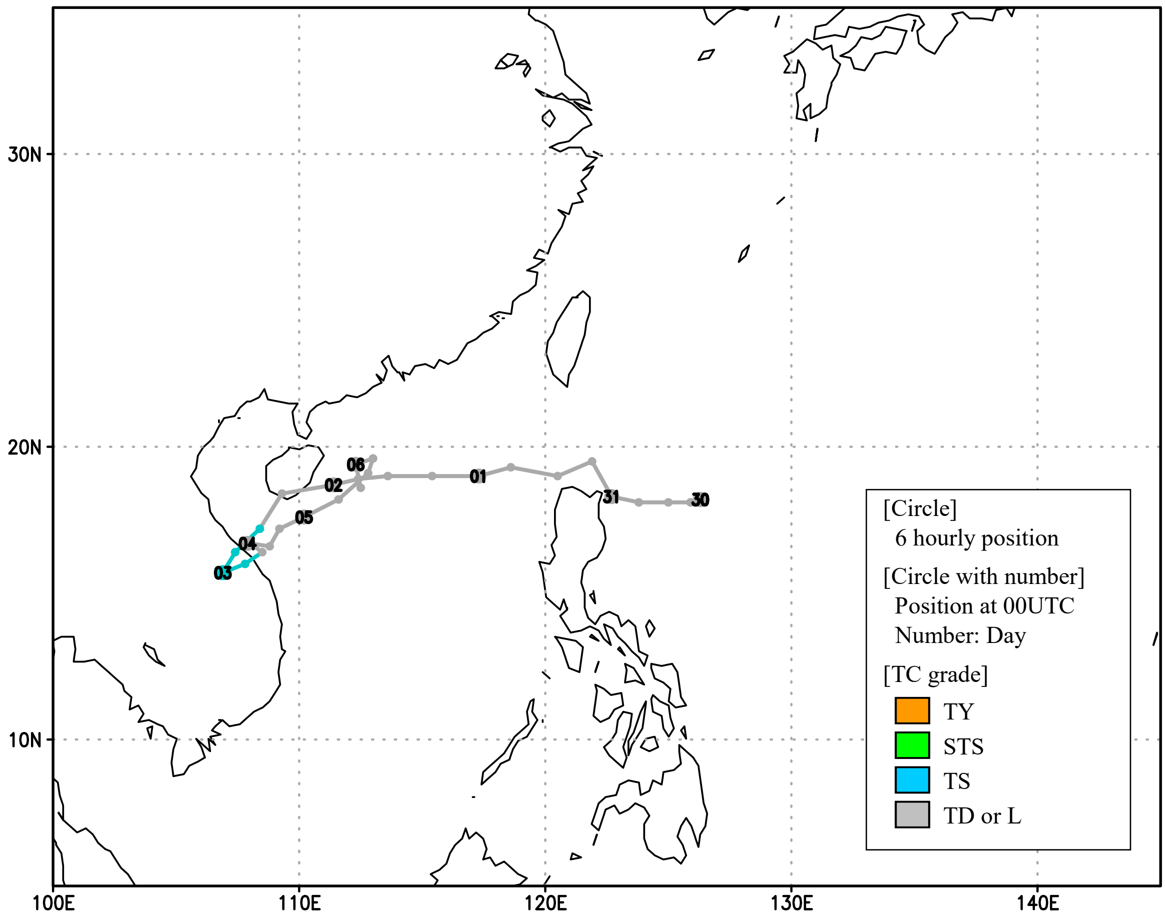
## LINGLING (1913)

LINGLING formed as a tropical depression (TD) around the Caroline Islands at 00 UTC on 31 August 2019. It moved initially northwestward. LINGLING was upgraded to tropical storm (TS) intensity east of the Philippines at 00 UTC on 2 September and it turned northward. LINGLING decelerated over the sea south of the Okinawa Islands and it was upgraded to typhoon (TY) intensity over the same waters at 18 UTC on 3 September. LINGLING reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 940 hPa in the proximity of Miyakojima Island at 06 UTC on 5 September. It accelerated northward in the East China Sea and hit the Korean Peninsula on 7 September. Having transformed into an extratropical cyclone in northeast China at 00 UTC on 8 September, it gradually turned eastward. LINGLING entered the Bering Sea and crossed the longitude of 180 degrees by 00 UTC on 12 September.



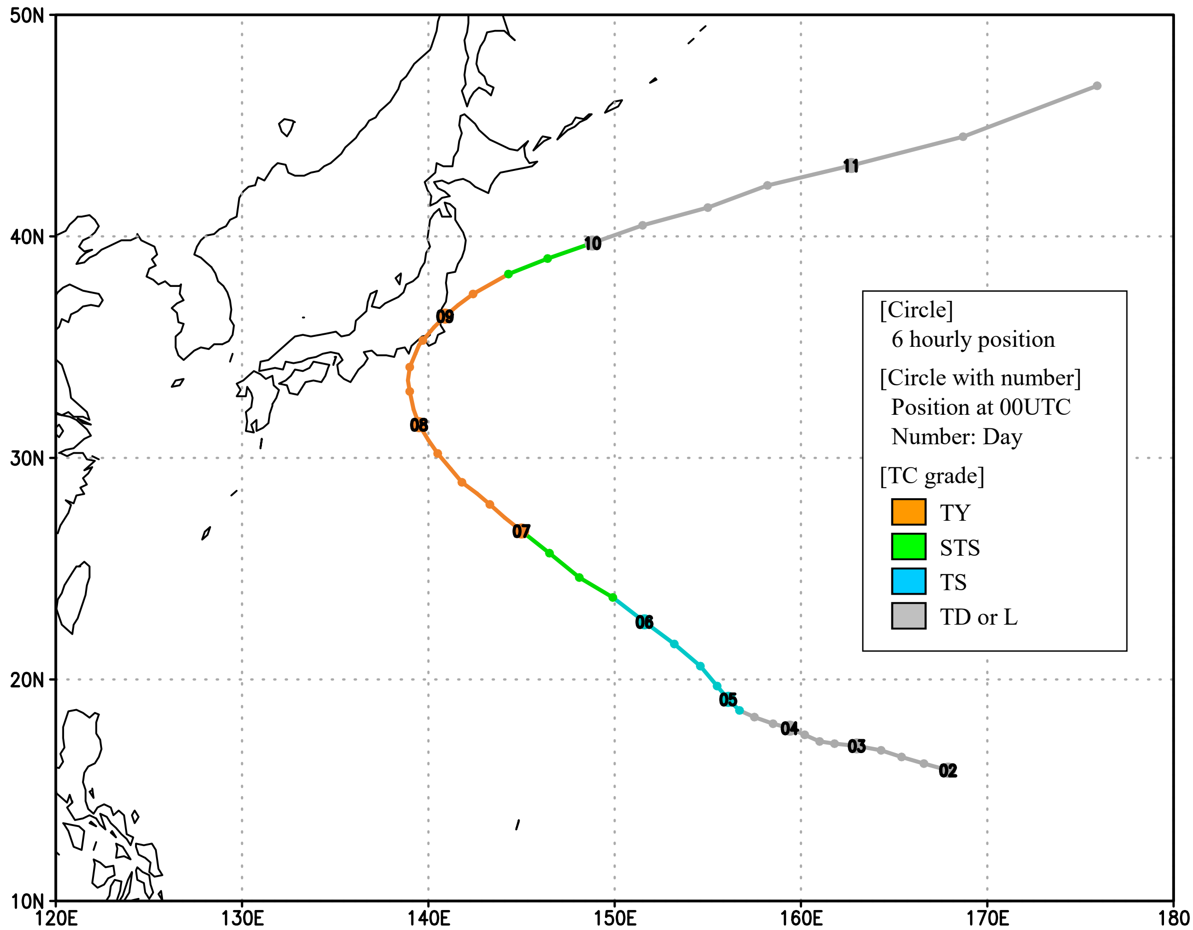
# KAJIKI (1914)

KAJIKI formed as a tropical depression (TD) over the sea east of the Philippines at 00 UTC on 30 August 2019. Moving westward, it was upgraded to tropical storm (TS) intensity off the coast of Viet Nam at 12 UTC on 2 September and hit Viet Nam later on the same day with maximum sustained winds of 35 kt and a central pressure of 996 hPa. This was KAJIKI's peak intensity. It turned sharply backward and entered the South China Sea again. KAJIKI weakened to TD intensity off the coast of Viet Nam at 12 UTC on 3 September. Moving northeastward, it dissipated to the east of Hainan Island at 12 UTC on 6 September.



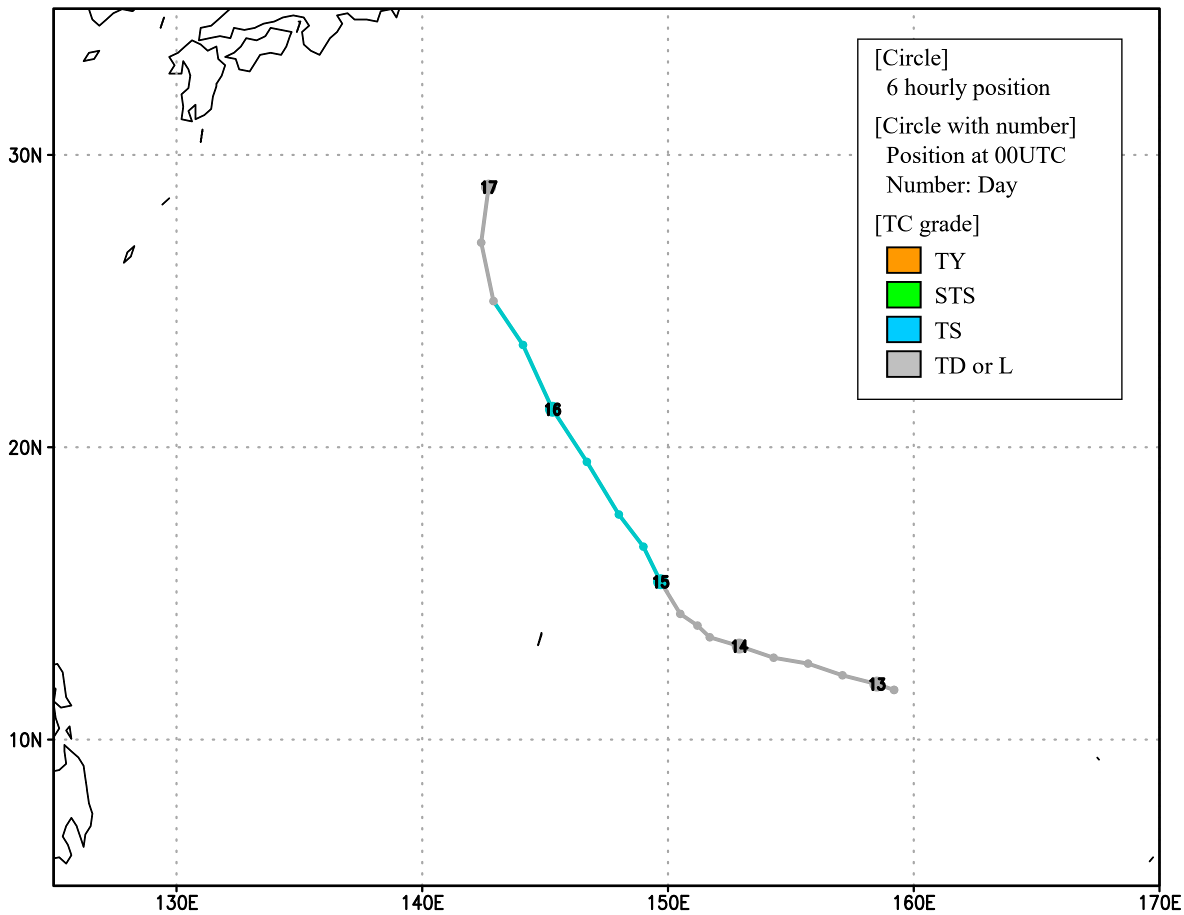
## FAXAI (1915)

FAXAI formed as a tropical depression (TD) over the sea south of Wake Island at 00 UTC on 2 September 2019 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity at 18 UTC on 4 September over the sea southeast of Minamitorishima Island and turned northwestward. Keeping its northwestward track, FAXAI rapidly intensified and was upgraded to typhoon (TY) intensity around the Ogasawara Islands at 00 UTC on 7 September. It reached its peak intensity with maximum sustained winds of 85 kt and a central pressure of 955 hPa south of Hachijojima Island at 18 UTC on the same day and turned north-northwestward. Sustaining TY intensity, FAXAI recurved north-northeastward and passed over Miura Peninsula before 18 UTC on 8 September and made landfall around Chiba City, Chiba Prefecture before 20 UTC on the same day. It moved northeastward over the sea east of eastern Japan and transitioned into an extratropical cyclone by 00 UTC on 10 September. FAXAI accelerated east-northeastward and crossed the longitude of 180 degrees by 18UTC on 11 September.



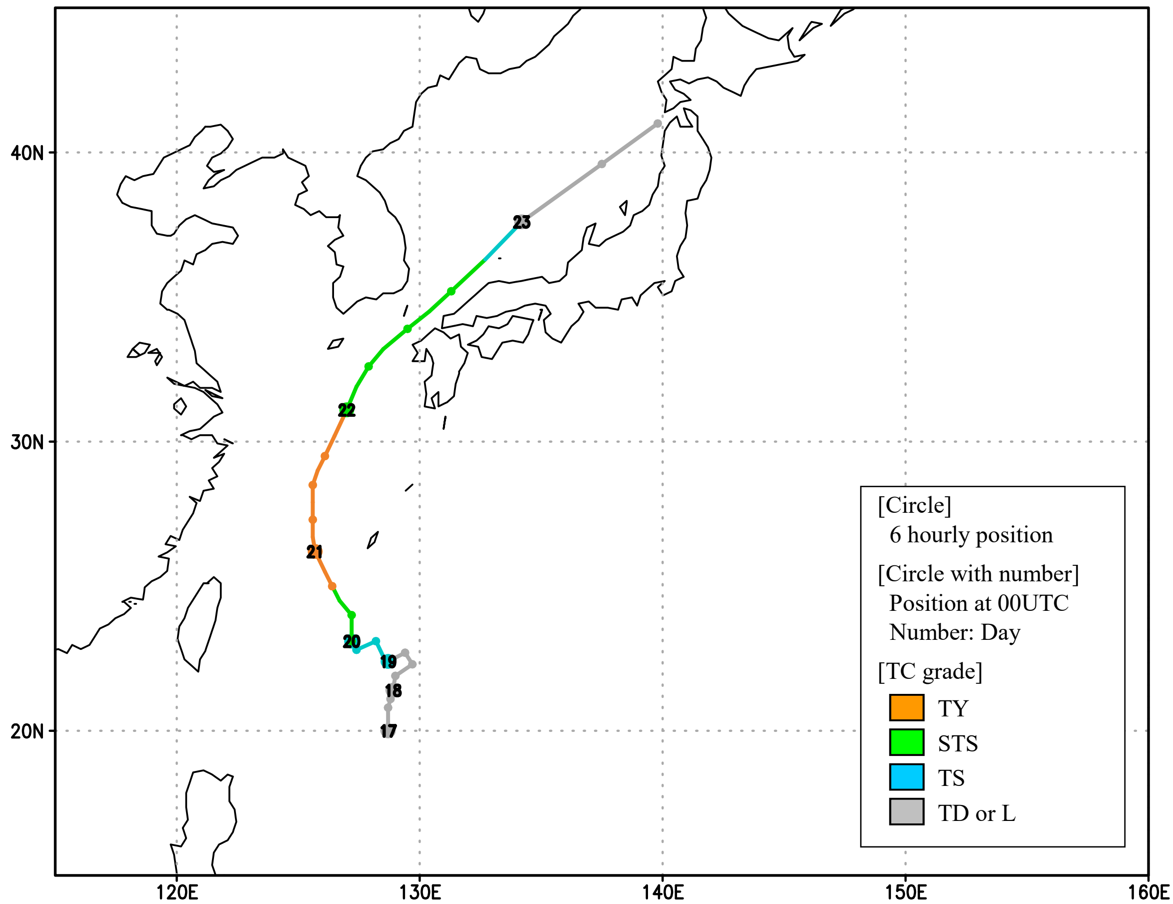
# PEIPAH (1916)

PEIPAH formed as a tropical depression (TD) around the Marshall Islands at 18 UTC on 12 September 2019. It moved initially westward and gradually turned northwestward. PEIPAH was upgraded to tropical storm (TS) intensity over the sea east of the Mariana Islands at 00 UTC on 15 September with maximum sustained winds of 35 kt and central pressure of 1000 hPa. This was its peak intensity. PEIPAH weakened to TD intensity around the Ogasawara Islands at 12 UTC on 16 September. Having turned northward, PEIPAH dissipated around Chichijima Island at 06 UTC on 17 September.



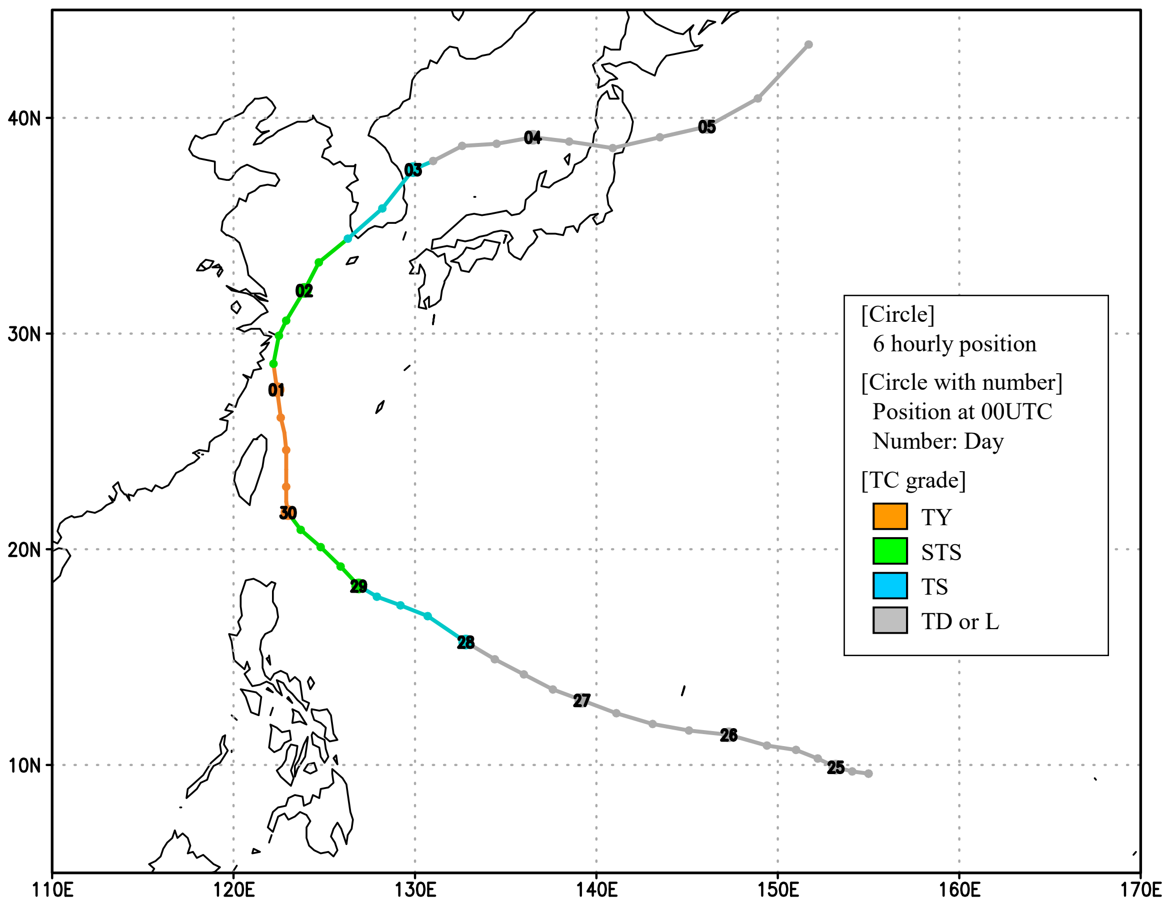
**TAPAH (1917)**

TAPAH formed as a tropical depression (TD) over the sea south of Okinawa Islands 00 UTC on 17 September 2019 and moved slowly northward. It was upgraded to tropical storm (TS) intensity at 00 UTC on 19 September on the same waters and turned northwestward. TAPAH was upgraded to typhoon (TY) intensity with maximum sustained winds of 65 kt and a central pressure of 970 hPa around Miyakojima Island at 18 UTC on 20 September. This was its peak intensity. It maintained its intensity while moving northward over the East China Sea. TAPAH turned northeastward and weakened gradually. It transitioned into an extratropical cyclone over the Sea of Japan by 00 UTC on 23 September and dissipated off the western coast of northern Japan at 18 UTC on the same day.



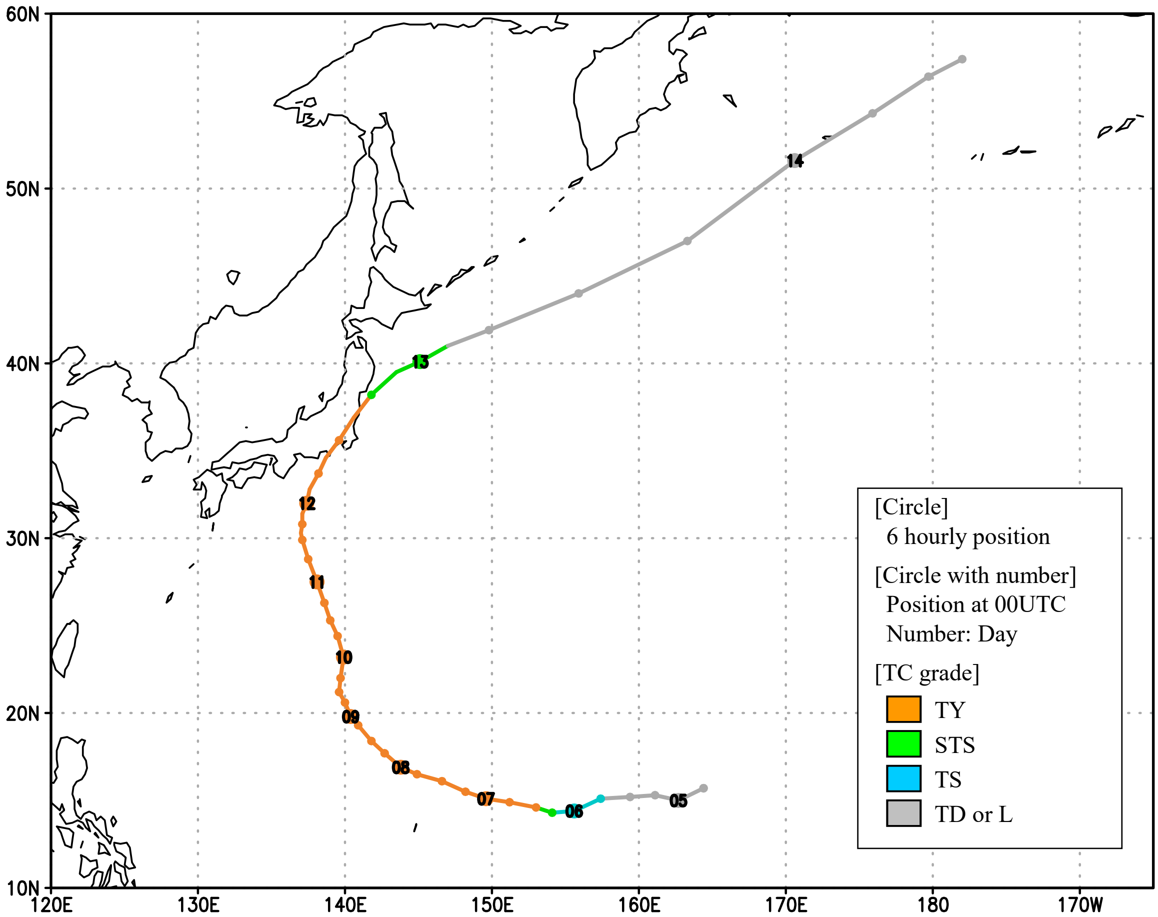
# MITAG (1918)

MITAG formed as a tropical depression (TD) around the Chuuk Islands at 12 UTC on 24 September 2019 and moved initially west-northwestward and later northwestward. MITAG was upgraded to tropical storm (TS) intensity at 00 UTC on 28 September to the east of the Philippines. It turned northward after it attained typhoon (TY) intensity over the Bashi Channel at 00 UTC on 30 September. MITAG reached its peak intensity with maximum sustained winds of 75 kt and a central pressure of 965 hPa to the west of Yonagunijima Island at 12 UTC on 30 September. It turned northeastward and hit the Korean Peninsula after 12UTC on 2 October. MITAG transitioned into an extratropical cyclone over the Sea of Japan by 06 UTC on 3 October and dissipated over the sea east of Japan at 18 UTC on 5 October.



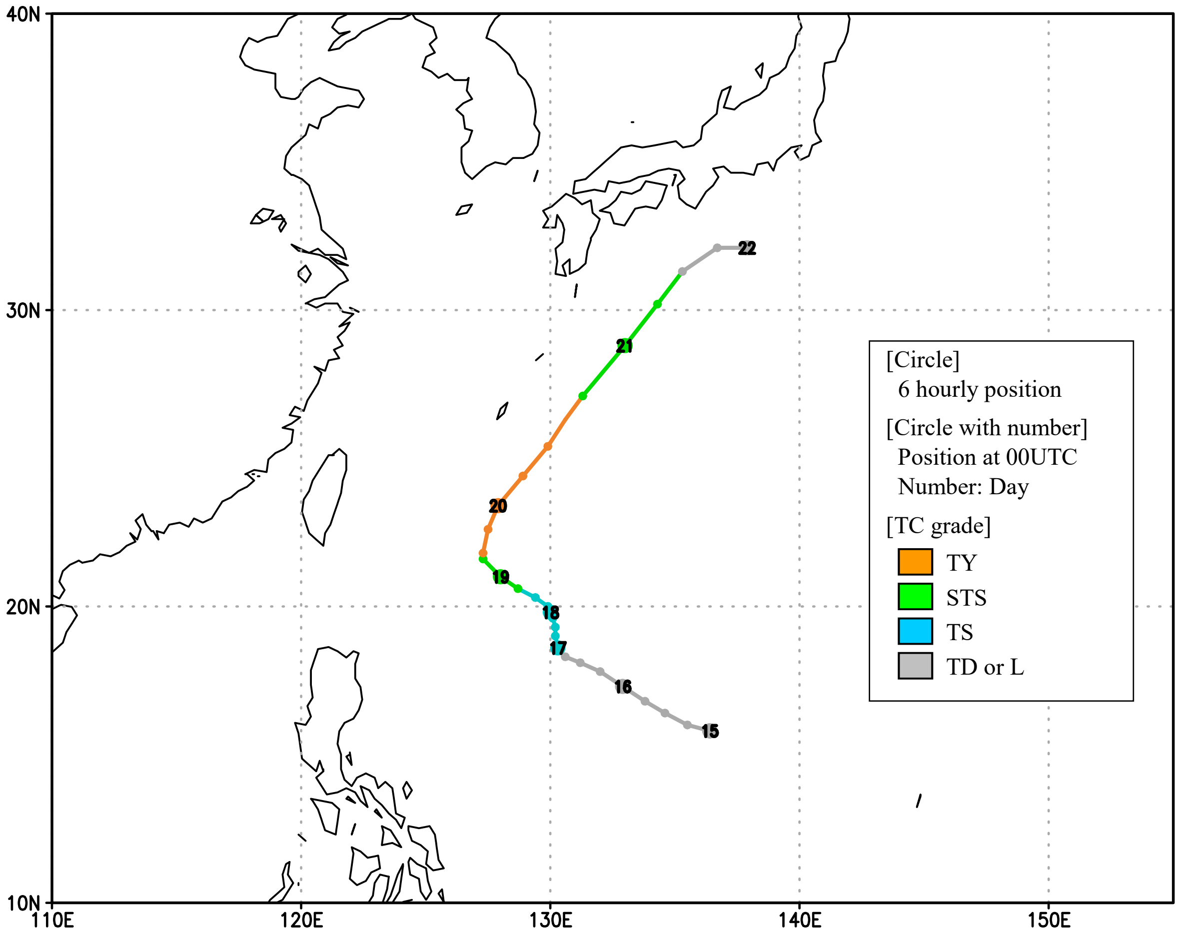
## HAGIBIS (1919)

HAGIBIS formed as a tropical depression (TD) over the sea south of the Wake Island at 18 UTC on 4 October 2019. It initially moved westward and was upgraded to tropical storm (TS) intensity to the south of the Minamitorishima Island 24 hours later. HAGIBIS started to rapidly intensify and attained typhoon (TY) intensity over the same waters at 12 UTC on 6 October. It reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 915 hPa over the waters near the Mariana Islands at 12 UTC the next day. Meanwhile HAGIBIS gradually turned north and continued on a largely northward track before it made landfall on the Izu Peninsula, Shizuoka Prefecture before 10 UTC on 12 October. HAGIBIS passed over the Greater Tokyo Area, went out to the Pacific Ocean and transitioned into an extratropical cyclone to the southeast of Hokkaido by 03 UTC on 13 October. It crossed the date line and entered the Western Hemisphere by 18 UTC on 14 October.



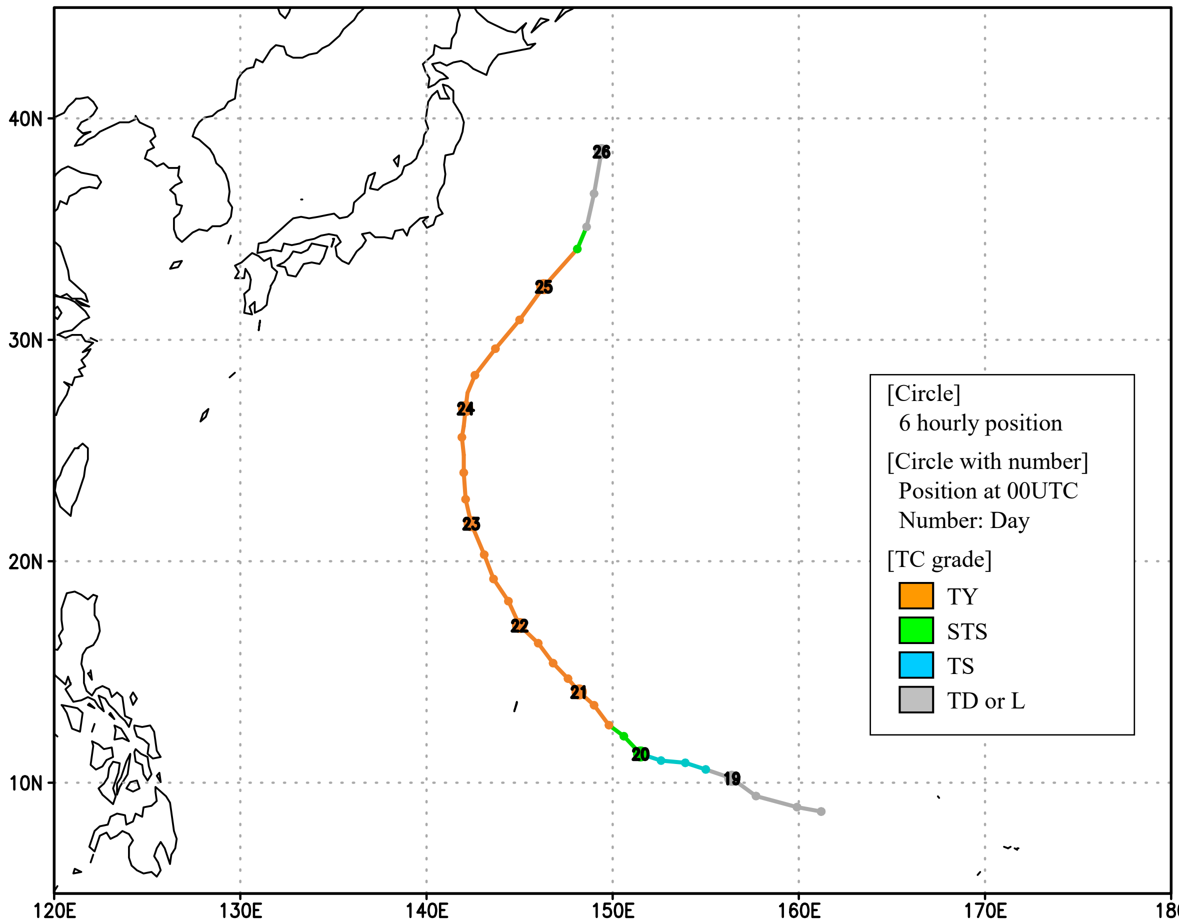
## NEOGURI (1920)

NEOGURI formed as a tropical depression (TD) over the sea south of the Okinotorishima Island at 00 UTC on 15 October 2019. It moved west-northwestward and was upgraded to tropical storm (TS) intensity to the west of the Okinotorishima Island at 00 UTC on 17 October. NEOGURI attained typhoon (TY) intensity to the south of the Okinawa Island at 12 UTC on 19 October. It reached its peak intensity with maximum sustained winds of 75 kt and a central pressure of 970 hPa over the same waters six hours later. NEOGURI gradually turned northeastward and accelerated in that direction. It transitioned into an extratropical cyclone to the south of Honshu by 12 UTC on 21 October and dissipated over the same waters at 06 UTC on the next day.



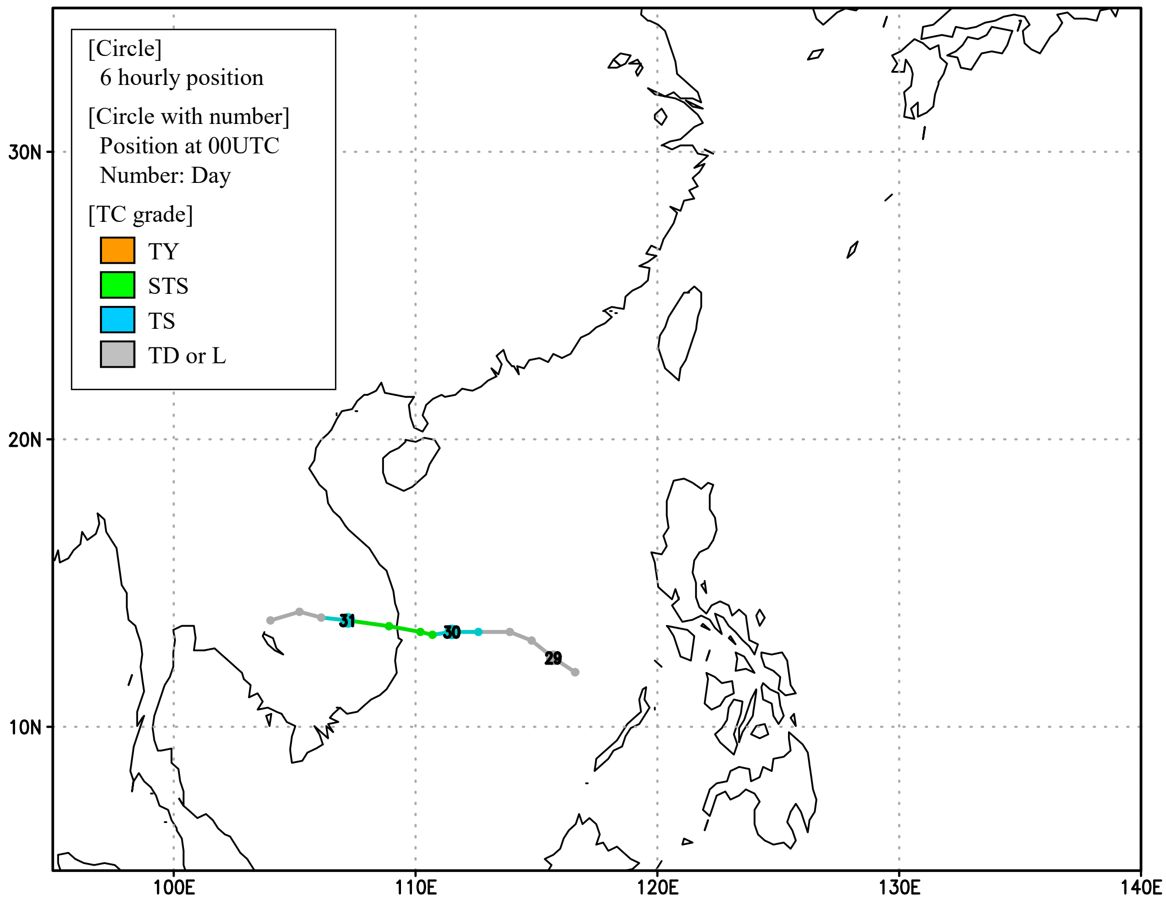
# BUALOI (1921)

BUALOI formed as a tropical depression (TD) around the Marshall Islands at 06 UTC on 18 October 2019 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity over the sea northwest of the Pohnpei Island 24 hours later. Gradually turning northwestward, BUALOI attained typhoon (TY) intensity over the sea east of the Mariana Islands at 12 UTC on 20 October, and reached its peak intensity 42 hours later with maximum sustained winds of 100 kt and a central pressure of 935 hPa. BUALOI maintained TY intensity while it turned northward and passed over the waters off the Chichijima Island around 00 UTC on 24 October. After accelerating northeastward, BUALOI transitioned into an extratropical cyclone over the sea east of Japan by 12 UTC on 25 October and dissipated 18 hours later.



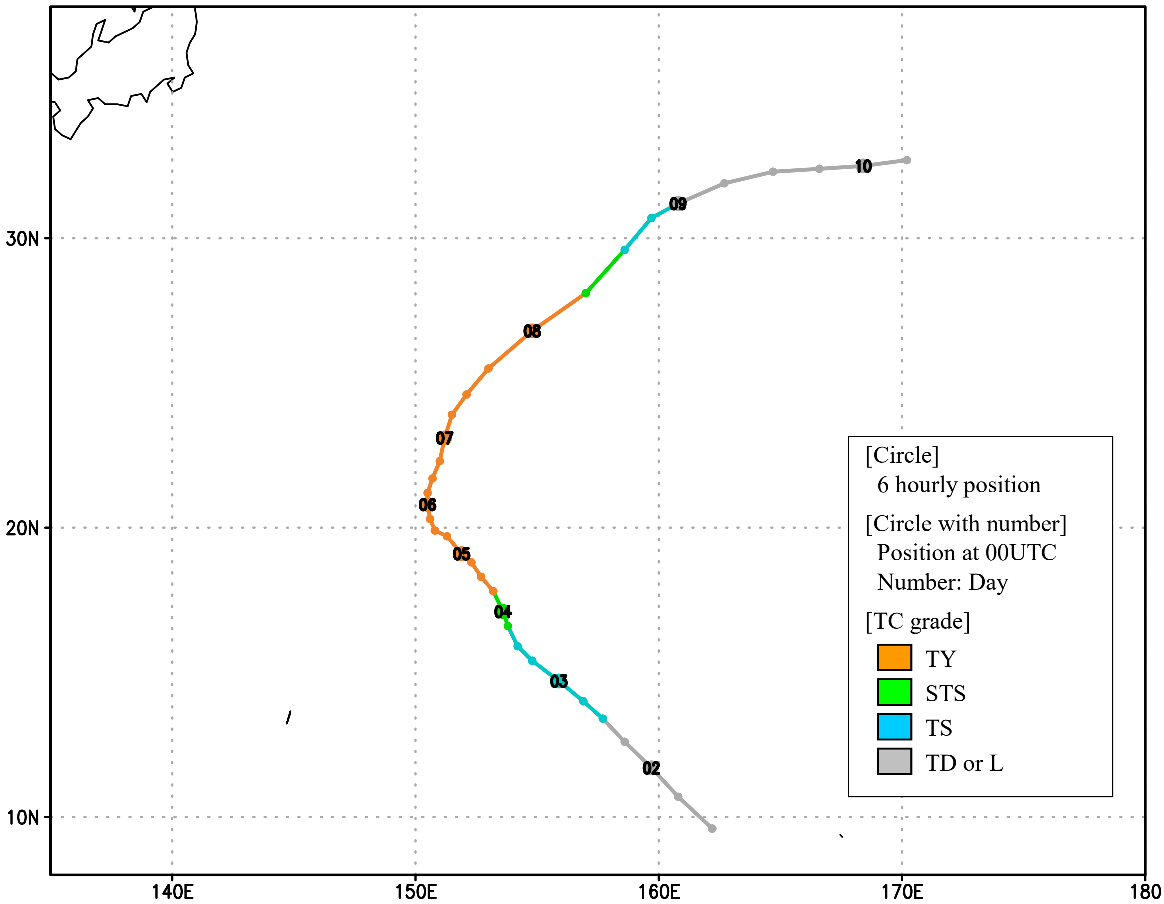
## MATMO (1922)

MATMO formed as a tropical depression (TD) over the sea northwest of Palawan Island at 18 UTC on 28 October 2019. It initially moved west-northwestward and later westward over the South China Sea, and was upgraded to tropical storm (TS) intensity at 18 UTC on 29 October over the same waters. MATMO reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 992 hPa at 06 UTC on 30 October. It crossed the coastline of Viet Nam late on the same day, weakened to TD intensity at 06 UTC on 31 October and dissipated at 00 UTC on 1 November.



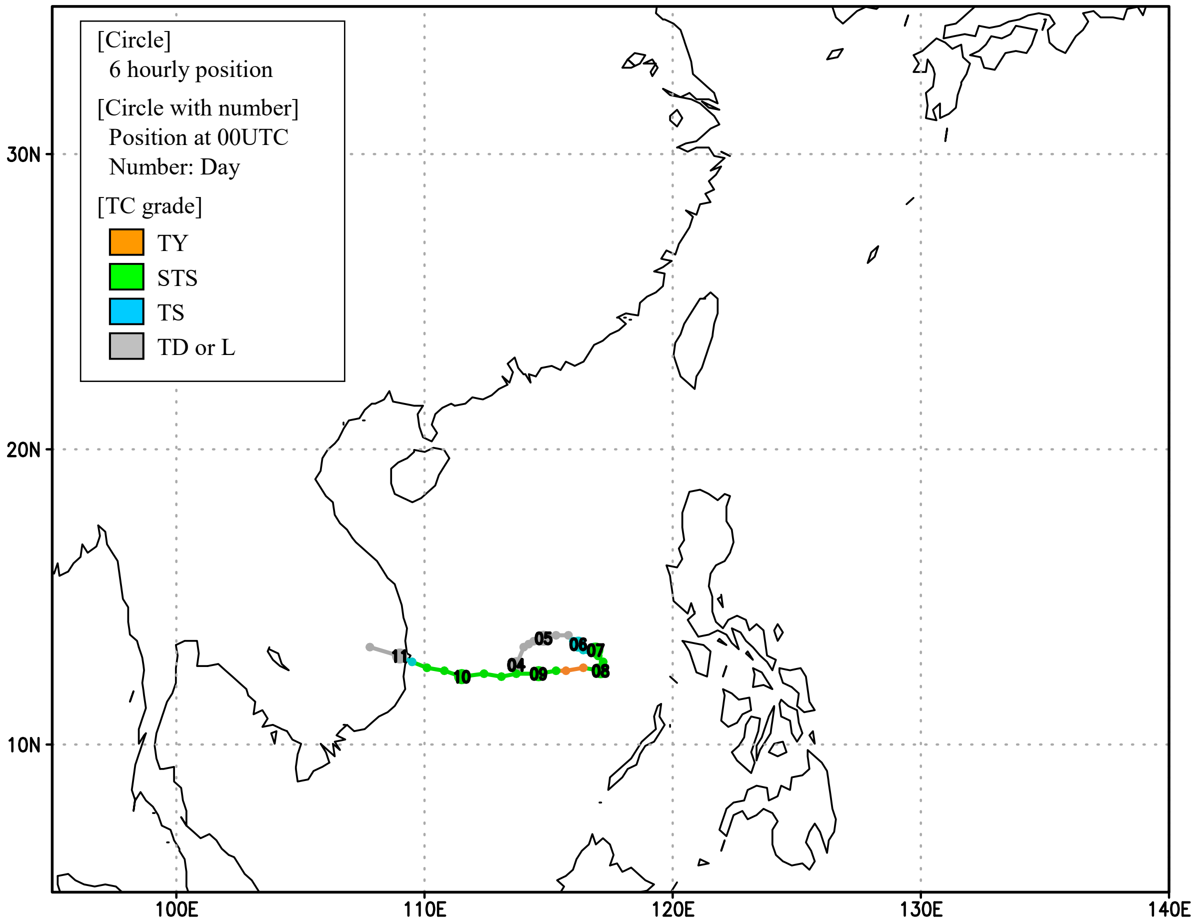
# HALONG (1923)

HALONG formed as a tropical depression (TD) over the sea south of the Marshall Islands at 12 UTC on 1 November 2019. It moved northwestward and was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on the next day. HALONG attained typhoon (TY) intensity to the south of the Minamitorishima Island at 06 UTC on 4 November. 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 on 5 November. HALONG gradually turned northeastward and accelerated in that direction. It transitioned into an extratropical cyclone over the sea far east of Japan by 00 UTC on 9 November and dissipated over the same waters at 12 UTC on the next day.



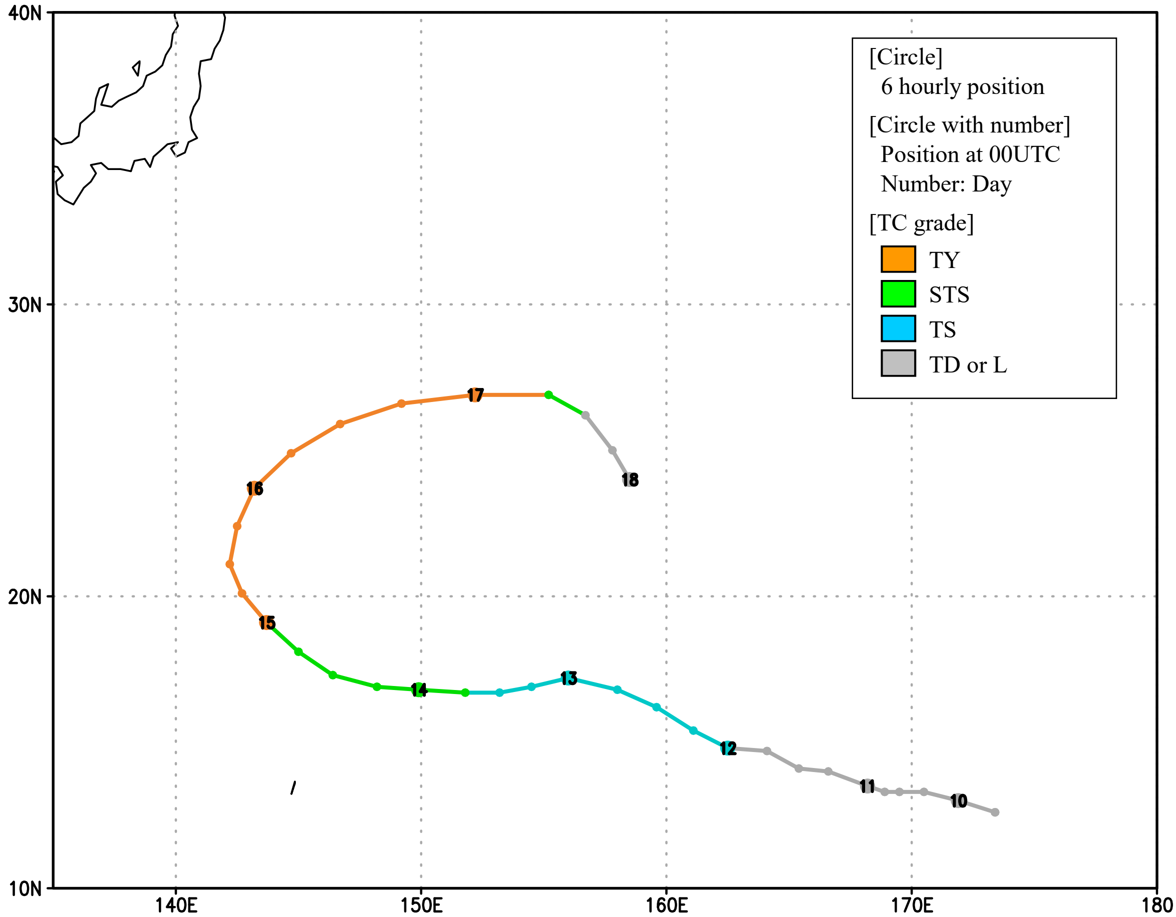
# NAKRI (1924)

NAKRI formed as a tropical depression (TD) over the South China Sea at 00 UTC on 4 November 2019 and moved northeastward. NAKRI was upgraded to tropical storm (TS) intensity at 18 UTC the next day over the same waters and moved slowly eastward. After turning to the west, NAKRI was upgraded to typhoon (TY) intensity with maximum sustained winds of 65 kt and a central pressure of 975 hPa over the same waters at 06 UTC on 8 November. This was its peak intensity. After crossing the coast of Viet Nam, NAKRI weakened to TD intensity at 00 UTC on 11 November and dissipated 12 hours later.



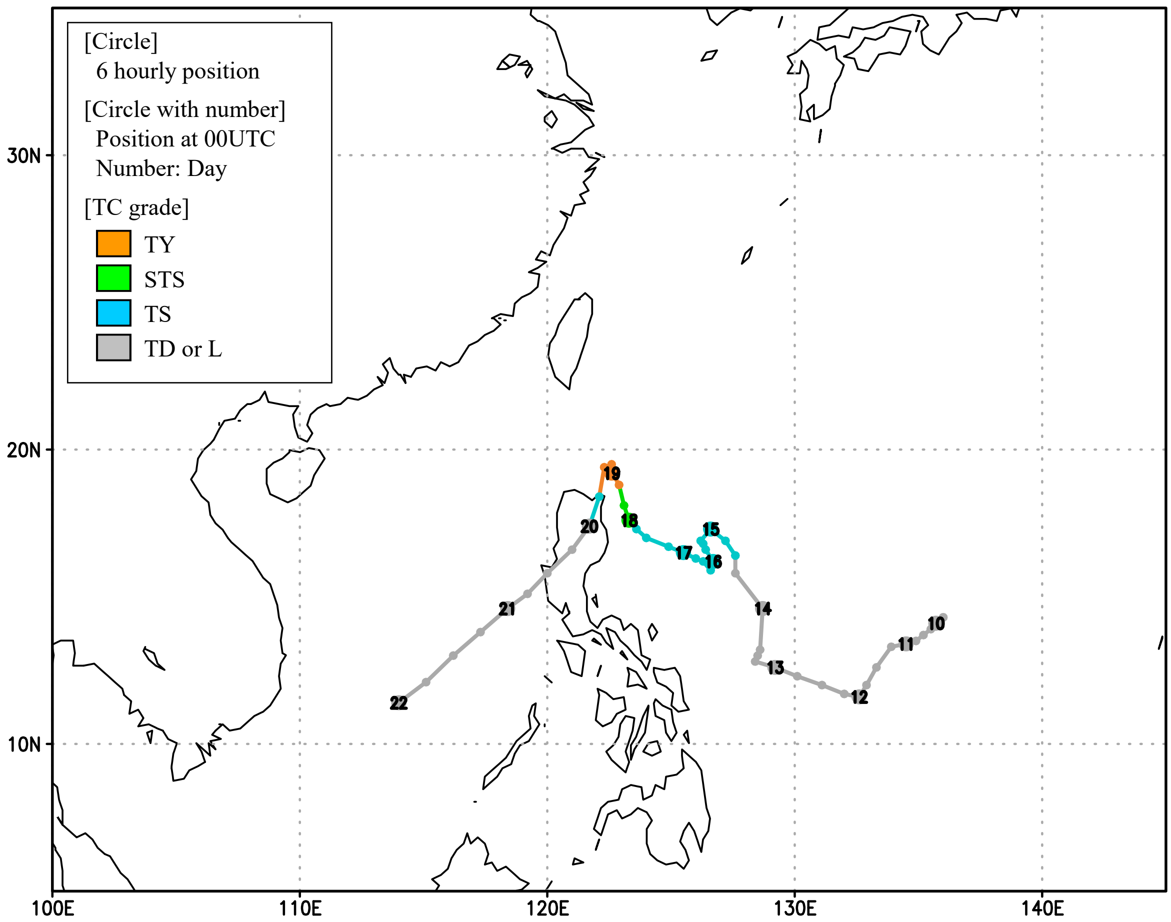
## FENGSHEN (1925)

FENGSHEN formed as a tropical depression (TD) near the Marshall Islands at 18 UTC on 9 November 2019. It moved initially west-northwestward and was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 12 November. Keeping its west-northwestward track, FENGSHEN continued to intensify for around two days. Turning gradually to the north, it started to rapidly intensify and was upgraded to typhoon (TY) intensity near the Mariana Islands at 00UTC on 15 November. It reached its peak intensity with maximum sustained winds of 85 kt and a central pressure of 965 hPa to the south of Chichijima Island at 06 UTC on 15 November. It turned gradually northeastward and kept this peak intensity until 12 UTC on 16 November. Having turned eastward, FENGSHEN weakened and transitioned into an extratropical cyclone over the sea northeast of Minamitorishima Island by 12 UTC on 17 November. It moved southeastward and dissipated to the east of Minamitorishima Island at 06 UTC on 18 November.



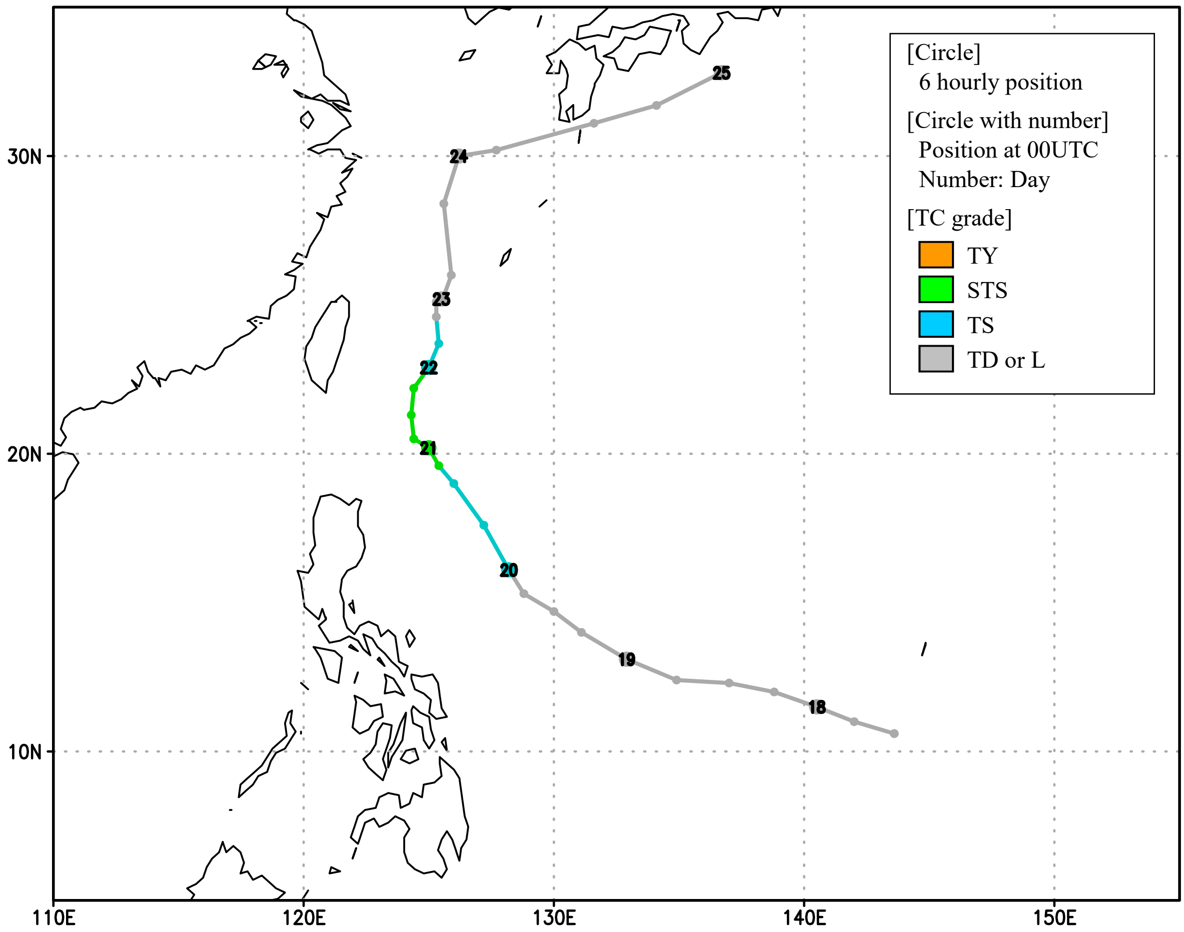
# KALMAEGI (1926)

KALMAEGI formed as a tropical depression (TD) over the sea east of the Philippines at 18 UTC on 9 November 2019. It moved southwestward initially, and turned northwestward on 12 November. KALMAEGI was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on 14 November while drifting northwestward. It was upgraded to typhoon (TY) intensity around the Luzon Strait at 12 UTC on 18 November and reached its peak intensity six hours later with maximum sustained winds of 70 kt and a central pressure of 975 hPa. After maintaining the TY intensity for the subsequent 24 hours, KALMAEGI turned sharply southward and began to weaken rapidly. KALMAEGI hit Luzon Island late on 19 November and weakened to TD intensity at 00 UTC on the next day. It moved southwestward over the South China Sea and dissipated at 06 UTC on 22 November.



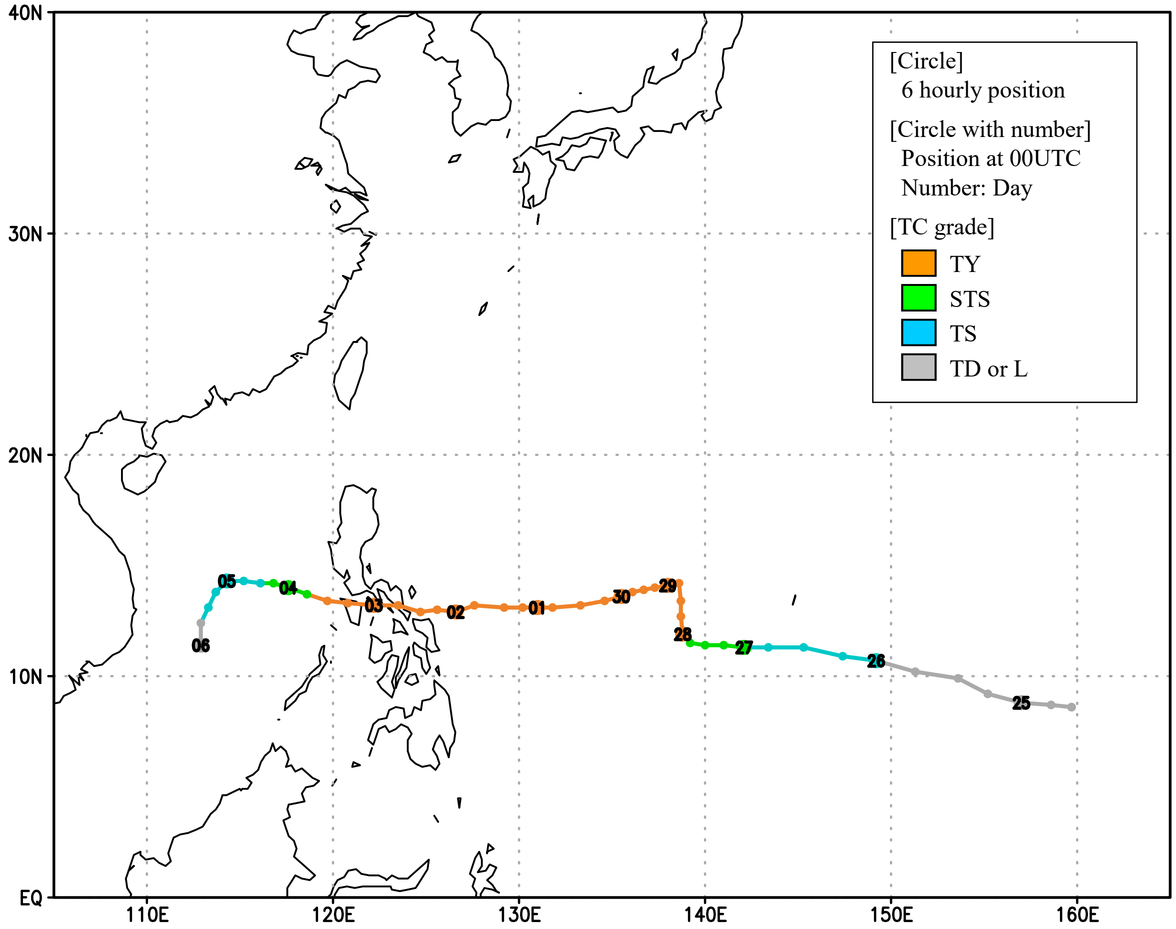
# FUNG-WONG (1927)

FUNG-WONG formed as a tropical depression (TD) around the Mariana Islands at 12 UTC on 17 November 2019. It moved west-northwestward initially. FUNG-WONG was upgraded to tropical storm (TS) intensity over the sea east of the Philippines at 00 UTC on 20 November. FUNG-WONG reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 990 hPa to the south of the Yaeyama Islands at 00 UTC on 21 November. It turned to the north and soon to the north-northeast while beginning to weaken rapidly. FUNG-WONG weakened to TD intensity at 12 UTC on 22 November around Miyakojima Island. FUNG-WONG transitioned into an extra tropical cyclone by 18 UTC 23 November in the East China Sea and it turned to the east-northeast. FUNG-WONG dissipated at 06 UTC on 25 November off the coast of the Kii peninsula.



## KAMMURI (1928)

KAMMURI formed as a tropical depression (TD) around the Caroline Islands at 12 UTC on 24 November 2019. It moved westward and was upgraded to tropical storm (TS) intensity at 00 UTC on 26 November. Continuing on its westward track, KAMMURI reached severe tropical storm (STS) intensity at 00 UTC on 27 November. It developed further and attained Typhoon (TY) intensity 24 hours later when it turned northward over the sea west of the Mariana Islands. KAMMURI continued on the northward track until 18 UTC on 28 November, and started to move westward again. It reached the peak intensity with maximum sustained winds of 90 kt and a central pressure of 950 hPa over the sea east of the Philippines at 12 UTC on 2 December shortly before hitting the Philippines. After crossing the Philippines, KAMMURI was downgraded to STS intensity at 18 UTC on 3 December, and further weakened to TS intensity over the South China Sea at 12 UTC on 4 December. Finally, it weakened to TD intensity at 18 UTC 5 December and dissipated at 06 UTC on 6 December over the same waters.



# PHANFONE (1929)

PHANFONE formed as a tropical depression (TD) around the Chuuk Islands at 12 UTC on 19 December 2019. It moved westward initially. PHANFONE turned to the west-northwest on 21 December and it was upgraded to tropical storm (TS) intensity around Yap Island at 12 UTC on 22 December. PHANFONE was upgraded to typhoon intensity (TY) east of the Philippines at 00UTC on 24 December and it passed over the central part of the Philippines from that day to the next. PHANFONE reached its peak intensity with maximum sustained winds of 80 kt and a central pressure of 970 hPa around Panay Island at 18 UTC on 24 December. Soon after it reached its peak intensity, PHANFONE started to weaken and entered the South China Sea on 25 December. PHANFONE intensified again over the South China Sea until 06 UTC on 26 December. After that it weakened rapidly and turned to the west next day. PHANFONE weakened to TD intensity over the same waters at 00 UTC on 28 December and it dissipated off the coast of Viet Nam at 06 UTC on 29 December.