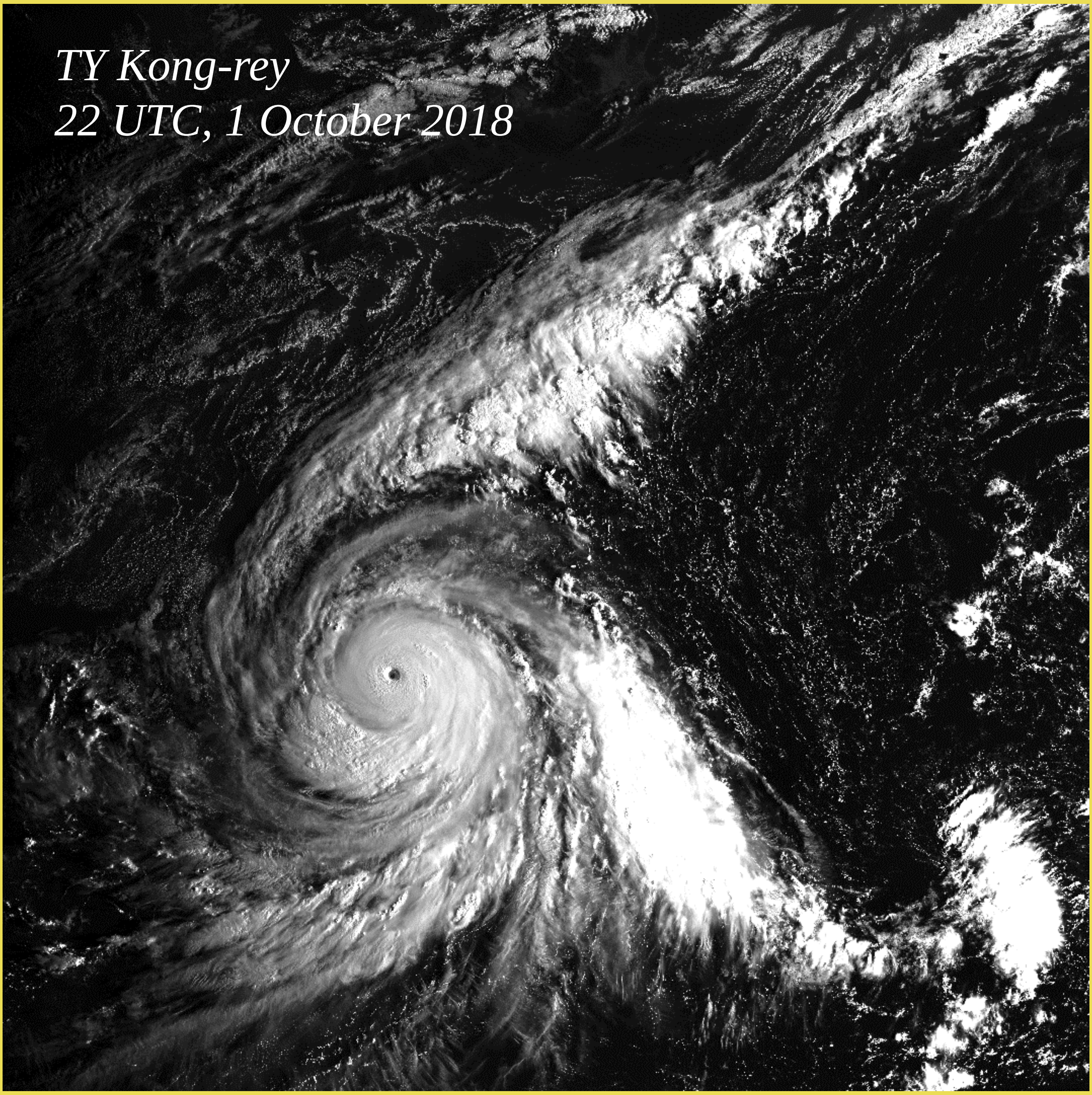
Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2018



Japan Meteorological Agency

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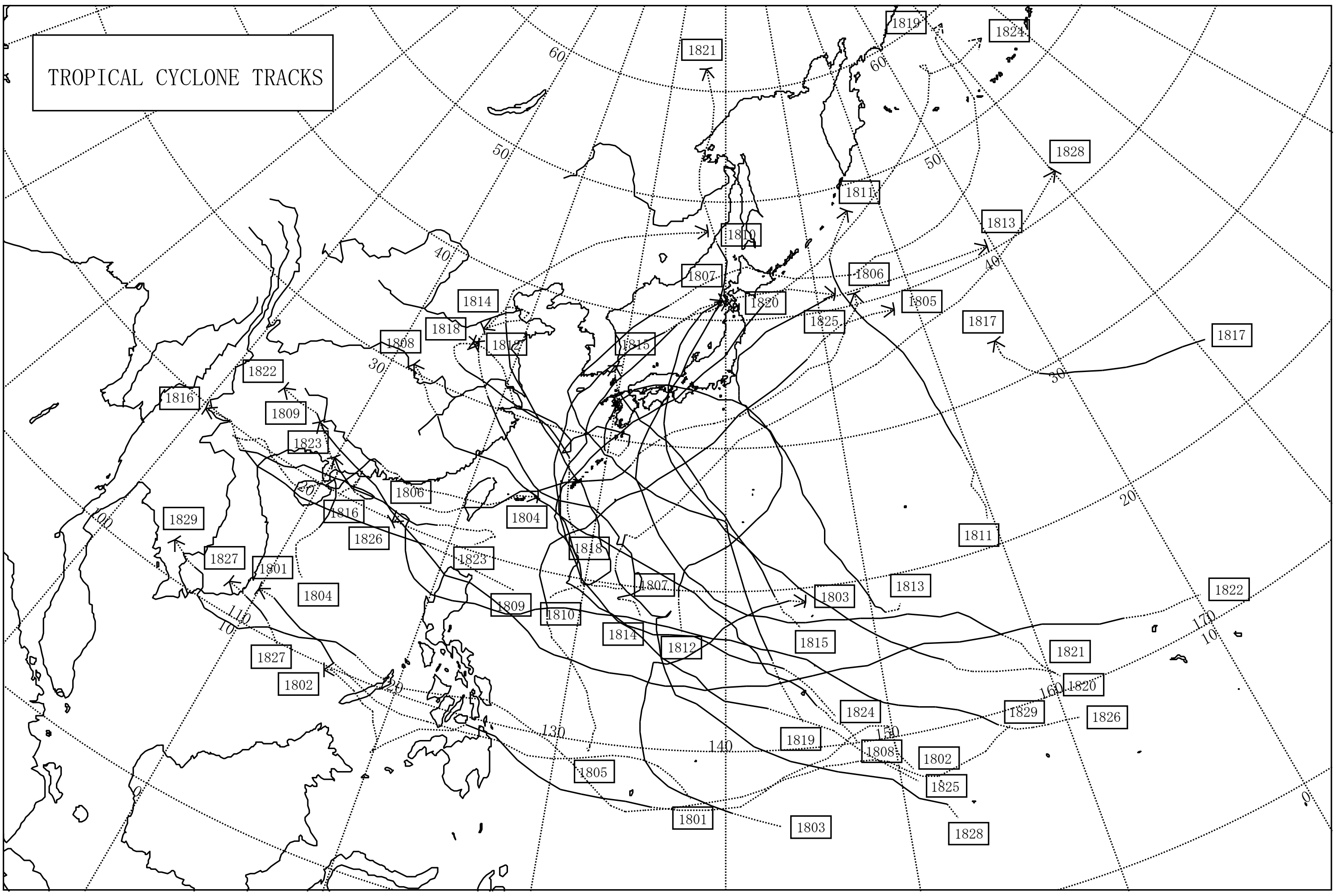

Japan Meteorological Agency

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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 2018, Chapter 1 outlines routine operations performed at the Center and its operational products, while Chapter 2 reports on its major activities in 2018. Chapter 3 describes atmospheric and oceanic conditions in the tropics and notes the highlights of TC activity in 2018. 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 and storm surge prediction. Best track data for 2018 TCs of tropical storm (TS) intensity or higher are shown in table and chart form in the appendices. All relevant text, tables, charts and appendices are included on the DVD provided with this report.

The DVD contains hourly cloud images of all 2018 TCs of TS intensity or higher within the Center's area of responsibility. Also included is the necessary viewer software, which features various functions for analyzing satellite imagery (such as image animations) and facilitates efficient post-analysis of TCs and their environments. A setup program and a user manual for the software are included on the DVD. Appendix 9 gives an outline of the DVD and instructions on using the software.

Chapter 1

Operations at the RSMC Tokyo - Typhoon Center in 2018

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.

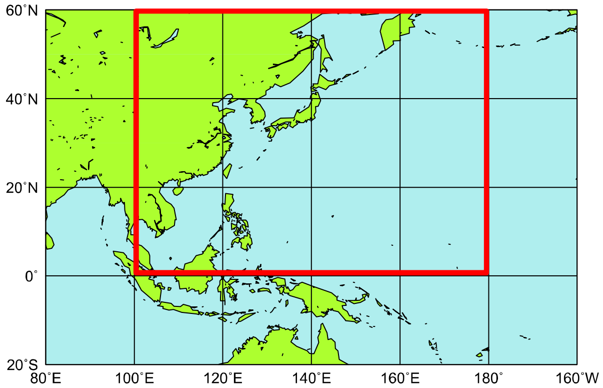


Figure 1.1
Area of responsibility of the RSMC Tokyo - Typhoon Center

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 up to 120 hours ahead and intensity forecasts up to 72 hours ahead. As a primary basis for TC track forecasts, JMA implements NWP using the Global Spectral Model (GSM) and the Global Ensemble Prediction System (GEPS). The GSM (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. In relation to TC intensity, central pressure and maximum sustained wind speeds are forecast mainly using a statistical intensity prediction scheme in an experimental phase in addition to results from NWP models, guidance models based on climatology and persistence, and the Dvorak method. The Center began providing TC intensity forecasts with extended lead times of up to 120 hours in March 2019 using a prediction scheme developed by JMA based on the Statistical Hurricane Intensity Prediction Scheme (SHIPS). The new approach is known as TIFS (Typhoon Intensity Forecasting scheme based on SHIPS).

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 is 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 are 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.)

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 exists in the Center's area of responsibility. Appendix 5 denotes the code forms of the bulletins.

(1) <u>RSMC Tropical Cyclone Advisory</u> (WTPQ20-25 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- and 72-hour forecasts for TCs:

Analysis	Center position Accuracy of center position determination Direction and speed of movement Central pressure Maximum sustained wind speed (10-minute average) Maximum gust wind speed Radii of wind areas over 50 and 30 knots
24-, 48- and 72-hour forecasts	Center position and radius of probability circle Direction and speed of movement Central pressure Maximum sustained wind speed (10-minute average) Maximum gust wind speed

(2) RSMC Tropical Cyclone Advisory for Five-day Track Forecast (WTPQ50-55 RJTD: via GTS)

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

Analysis	Center position Accuracy of center position determination Direction and speed of movement Central pressure Maximum sustained wind speed (10-minute average) Maximum gust wind speed Radii of wind areas over 50 and 30 knots
24-, 48- and 72-hour forecasts	Center position and radius of probability circle Direction and speed of movement Central pressure Maximum sustained wind speed (10-minute average) Maximum gust wind speed
96- and 120-hour forecasts	Center position and radius of probability circle Direction and speed of movement

(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:

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 (https://tynwp-web.kishou.go.jp/Analysis/Satellite/Satellite_analysis/index.html; 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 Direction and speed of movement Central pressure Maximum sustained wind speed (10-minute average)

Forecast	Center position 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 (https://www.data.jma.go.jp/fcd/tca/data/index.html). 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 (https://tynwp-web.kishou.go.jp/) 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 2018

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 2018 are listed in Table 2.1.

Table 2.1 Monthly and annual totals of products issued by the RSMC Tokyo - Typhoon Center in 2018

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
IUCC10	14	24	54	7	0	115	250	375	232	132	114	19	1336
WTPQ20-25	21	27	64	7	0	149	281	400	251	135	141	40	1516
WTPQ30-35	10	13	32	4	0	74	140	197	124	67	68	21	750
WTPQ50-55	0	10	27	1	0	11	56	92	75	53	21	0	346
FXPQ20-25	20	26	64	6	4	144	274	195	120	67	68	20	1008
FXPQ30-35	0	0	0	0	0	0	0	195	120	67	68	20	470
FKPQ30-35	10	13	32	3	0	73	138	195	124	67	68	20	743
AXPQ20	2	1	2	1	0	0	2	4	4	9	1	4	30

Notes:

IUCC10 RJTD	SAREP (BUFR format)
WTPQ20-25 RJTD	RSMC Tropical Cyclone Advisory
WTPQ30-35 RJTD	RSMC Prognostic Reasoning
WTPQ50-55 RJTD	RSMC Tropical Cyclone Advisory for Five-day Track Forecast
FXPQ20-25 RJTD	RSMC Guidance for Forecast by GSM
FXPQ30-35 RJTD	RSMC Guidance for Forecast by GEPS
FKPQ30-35 RJTD	Tropical Cyclone Advisory for SIGMET
AXPQ20 RJTD	RSMC Tropical Cyclone Best Track

2.2 Publications

In March 2018, the 20th issue of the *RSMC Technical Review* was issued with the following areas of focus:

1. Assimilation of Himawari-8 data into JMA's NWP systems
2. Introduction to JMA's new Global Ensemble Prediction System
3. 2016 and 2017 Reviews of Probability-circle Radii in Tropical Cyclone Track Forecasts

In December 2018, the Center published the *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2017*. 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 18th Typhoon Committee Attachment Training course was held at JMA Headquarters from 15 to 26 October 2018.

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 2018 attendees were Mr. Kuok-Hou Ho from Macao, Mr. Mohd Afzainizam Bin Noordin from Malaysia, Mr. Jun Ezra M. Bulquerin from the Philippines, Mr. Saif Al-Maqbali from Oman, and Mr. Sujeewa Kanda Durage from Sri Lanka.

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 (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. 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 2018, was conducted for two TCs:

1. Typhoon (TY) Soulik (1819), from 12UTC 19 August to 12UTC 24 August 2018
2. TY Mangkhut (1822), from 00UTC 12 September to 00UTC 17 September 2018

The results were distributed to all Typhoon Committee Members in February 2019, 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 2018

2.5.1 Services Introduced in 2018

The Center introduced the services detailed below in 2018.

(1) Advance Notice on Tropical Cyclone Status Change

The Center now provides advance notice to registered Committee Members via email and the NTP website when TC status changes are likely. This is unofficial and does not replace official RSMC Tropical Cyclone Advisory information.

(2) Enhanced RSMC Prognostic Reasoning

On 1 January 2018, the Center started providing RSMC Prognostic Reasoning reports at 12 and 18 UTC, in addition to the information provided at 00 and 06 UTC, with the WMO header WTPQ30-35 RJTD. Content was also changed to include detailed information on synoptic situations, models and guidance used to produce forecasts and justification of forecaster decisions.

(3) Extended RSMC Guidance for Forecasting

JMA began the operation of its new supercomputer system on 5 June 2018. The system has an effective peak performance 10 times faster than its predecessor and is capable of processing larger amounts of data with higher efficiency. JMA uses this power for a variety of numerical calculations in monitoring and prediction of weather and climate conditions over periods ranging from the short term to several months ahead, and utilizes the results to support the output of meteorological information for use in disaster prevention, daily life, socio-economic activity and a variety of other areas. JMA plans to utilize the new supercomputer for precise early prediction of TCs and localized torrential rain and for improvements in various types of information, including ensemble prediction on scales ranging from weeks to months.

In the area of TC forecasts, the range of JMA's GSM was extended on 5 June to cover periods up to 132 hours ahead for initial times of 00, 06 and 18 UTC in association with the supercomputer system upgrade (the forecast range for the initial time of 12 UTC remains up to 264 hours). Leveraging this extension, the Center began providing track forecasts from a deterministic GSM with the header FXPQ20-25 RJTD at 00 UTC on 1 August 2018 using the extended forecast range. Track forecasts based on data from JMA's GEPS, which were previously issued with the FXPQ20-25 header, are now provided with the FXPQ30-35 RJTD header.

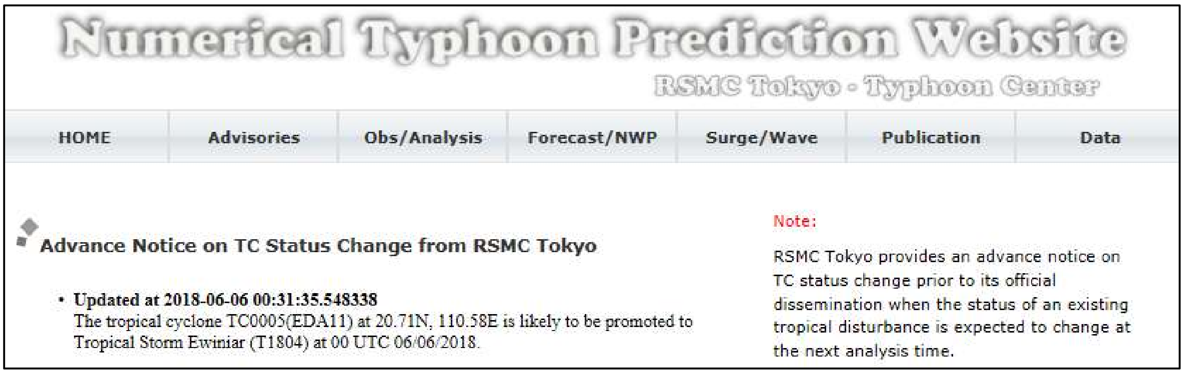


Figure 2.1 Advance Notice on Tropical Cyclone Status Change on the NTP website

2.5.2 Numerical Typhoon Prediction Website Upgrades

The changes outlined below were made to the NTP website in 2018.

(1) Curvature Vorticity and Streamline Maps for the 850 hPa Level (5 June)

Maps of Curvature vorticity and streamline data at 850 hPa are now provided in place of the previous total vorticity and streamline maps, with the contribution of shear vorticity eliminated.

(2) Chart Area Expansion and Color Tone Change (5 June)

Map coverage was changed as follows:

- Tropical cyclone heat potential (TCHP) map: 5-degree expansion to the south and west
- Wave height prediction maps: 5-degree expansion to the west
- Tropospheric circulation analysis maps: 30-degree expansion to the east to support early identification of tropical cyclogenesis precursors, and 10-degree expansion to the north

Color tone has also been improved for some maps to highlight areas requiring increased attention (e.g., from a basic two-color range (blue-red) or a GrADS (Grid Analysis and Display System) rainbow palette to a multi-color range). Coastlines in numerical weather maps have also been changed from black to brown for better visibility.

(3) Bulletins (5 June and 1 August)

The Center started providing RSMC Prognostic Reasoning (5 June) and numerical forecast TC track bulletins (1 August), described in 2.5.1, on the NTP website.

(4) Tropical Cyclone Activity Prediction Upgrades (5 June and 1 October)

In 2016, the Center began providing two- and five-day Tropical Cyclone Activity Prediction maps for its area of responsibility with ensemble prediction results from two centers (ECMWF, UKMO) as well as a related multi-center grand ensemble. The number of EPSs used for the prediction was increased to four in 2018 with the addition of those of NCEP and JMA. The maps display potential TC activity in terms of what percentage of ensemble members represent TC-like vortices within 300 km of certain locations during the relevant forecast time. The products are intended to help forecasters identify and monitor areas in which TCs may form within two- and five-day periods.

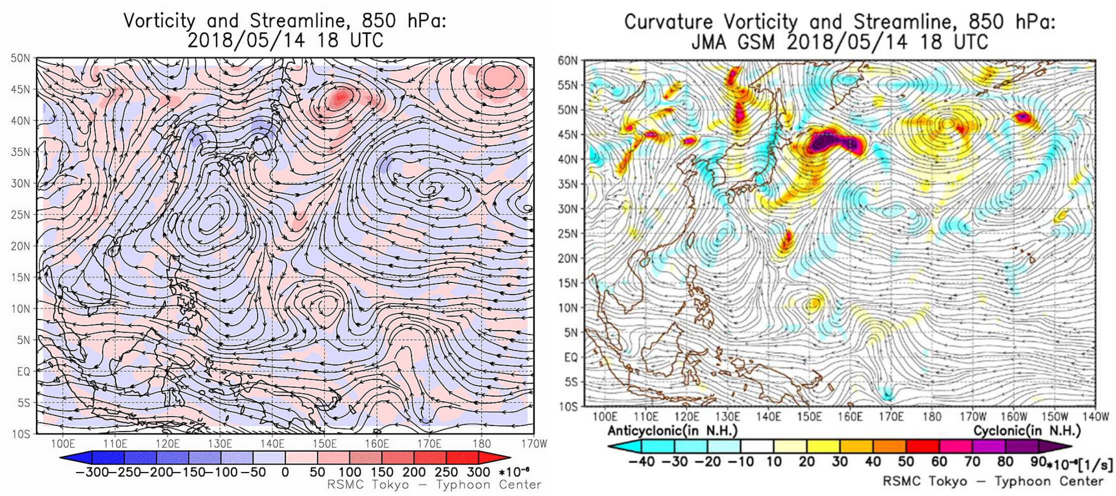


Figure 2.2 Product samples before and after the revision: 850-hPa total vorticity and streamline map (left); 850-hPa curvature vorticity and streamline map (right)

Chapter 3

Summary of the 2018 Typhoon Season

In 2018, 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, 13 reached TY intensity, 5 reached severe tropical storm (STS) intensity and 11 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 2018

Tropical Cyclone			Duration (UTC) (TS or higher)					Minimum Central Pressure (UTC)	lat (N)	long (E)	(hPa)	Max Wind (kt)
TS	Bolaven	(1801)	030000	Jan	-	040000	Jan	030000	10.4	116.0	1002	35
TS	Sanba	(1802)	110600	Feb	-	130600	Feb	110600	6.8	135.8	1000	35
TY	Jelawat	(1803)	250600	Mar	-	010000	Apr	300600	16.2	138.1	915	105
TS	Ewiniar	(1804)	050000	Jun	-	081800	Jun	060600	20.1	110.4	998	40
STS	Maliksi	(1805)	071800	Jun	-	111800	Jun	100000	25.0	130.7	970	60
TS	Gaemi	(1806)	150000	Jun	-	170000	Jun	160600	26.8	128.9	990	45
TY	Prapiroon	(1807)	290000	Jun	-	040600	Jul	021800	30.7	127.8	960	65
TY	Maria	(1808)	041200	Jul	-	111800	Jul	090000	21.8	133.5	915	105
TS	Son-tinh	(1809)	170000	Jul	-	190000	Jul	171200	19.0	113.6	994	40
STS	Ampil	(1810)	181200	Jul	-	231200	Jul	191800	22.3	131.2	985	50
STS	Wukong	(1811)	231200	Jul	-	270000	Jul	250000	32.7	158.2	990	50
TY	Jongdari	(1812)	241200	Jul	-	030000	Aug	270000	25.0	142.4	960	75
TY	Shanshan	(1813)	030000	Aug	-	100600	Aug	041800	22.5	147.7	970	70
TS	Yagi	(1814)	080000	Aug	-	130000	Aug	111200	25.0	126.8	990	40
STS	Leepi	(1815)	111200	Aug	-	150000	Aug	130600	26.5	138.6	994	50
TS	Bebinca	(1816)	130000	Aug	-	170600	Aug	160600	20.1	107.9	985	45
TS	Hector	(1817)	131800	Aug	-	151200	Aug	131800	25.8	178.9	998	40
TS	Rumbia	(1818)	150600	Aug	-	180000	Aug	161200	30.5	122.9	985	45
TY	Soulik	(1819)	160000	Aug	-	241800	Aug	201800	27.0	133.3	950	85
TY	Cimaron	(1820)	181200	Aug	-	241200	Aug	220600	25.5	138.8	950	85
TY	Jebi	(1821)	271800	Aug	-	050000	Sep	310000	17.9	144.2	915	105
TY	Mangkhut	(1822)	071200	Sep	-	170600	Sep	111200	13.7	138.7	905	110
TS	Barijat	(1823)	110000	Sep	-	130600	Sep	110600	20.7	118.0	998	40
TY	Trami	(1824)	210600	Sep	-	010000	Oct	241800	19.6	129.1	915	105
TY	Kong-rey	(1825)	290600	Sep	-	061200	Oct	011200	16.8	134.4	900	115
TY	Yutu	(1826)	220000	Oct	-	020600	Nov	241200	14.7	146.2	900	115
TS	Toraji	(1827)	170600	Nov	-	180000	Nov	170600	10.9	111.3	1004	35
TY	Man-yi	(1828)	201800	Nov	-	270600	Nov	241200	18.7	136.2	960	80
STS	Usagi	(1829)	220000	Nov	-	260000	Nov	240000	9.7	109.5	990	60

3.1 Atmospheric and Oceanographic Conditions in the Tropics

While the La Niña event, which started in autumn 2017, ended in spring 2018, positive sea surface temperature (SST) anomalies were seen in the western equatorial Pacific throughout the year. Positive SST anomalies strengthened in the seas east of the dateline from autumn onward, indicating El Niño conditions. In the South China Sea, relatively negative SST anomalies were seen in April and summer, while positive anomalies prevailed from November onward. Convective activity over the South China Sea was suppressed around spring and autumn.

In the lower troposphere, cyclonic circulation anomalies were seen from the Bay of Bengal to the seas east of the Philippines in winter 2017/2018 in association with enhanced convective activity. In spring and autumn, cyclonic circulation anomalies were seen over the east of the Philippines.

In summer, cyclonic circulation anomalies with enhanced convective activity were seen from the northern part of the South China Sea to the seas east of the Philippines, indicating a stronger-than-normal monsoon trough over Southeast Asia. The subtropical jet stream exhibited significant meandering in the vicinity of Japan, and the expansion of the North Pacific Subtropical High to mainland Japan was stronger than normal. These conditions may have contributed to the large number of TC formations in summer.

Figure 3.1 shows monthly mean streamlines at 850 and 200 hPa, Outgoing Longwave Radiation (OLR*, with lower values corresponding to stronger convective activity) in August 2018, and the tracks of named TCs forming during the month, when convective activity was enhanced from the Philippines to the east along the 10 – 20˚N latitude band in the North Pacific. Seven named TCs formed in the area of 120 – 160˚E, where strong convective activity and lower-level wind convergence were seen.

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 included on the DVD provided with this report.

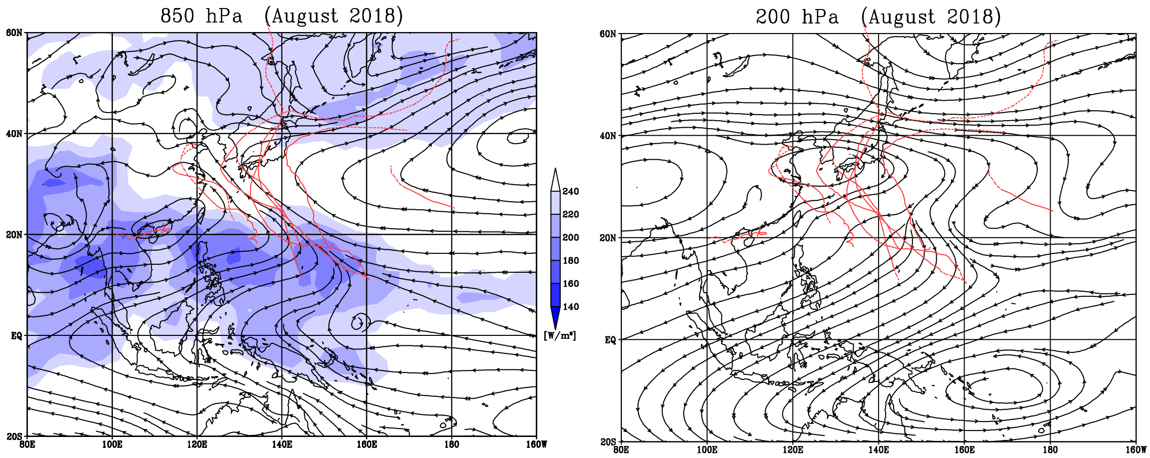


Figure 3.1 Monthly mean streamlines (lines with arrows) at 850 hPa (left) and 200 hPa (right) for August 2018. Shading in the figure on the left indicates OLR*. The tracks of the nine named TCs forming in August are superimposed in red onto both figures.

** 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 2018

A total of 29 named TCs formed over the western North Pacific and the South China Sea in 2018. 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 - 2017).

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

Eighteen named TCs formed in summer (June to August), which ties with 1994 as the most since the Center began keeping TC statistics in 1951. Nine of these formed in August, representing the third highest total after the ten recorded in both 1960 and 1966. During the month, SSTs were above normal in the tropical Pacific east of 150˚E. Enhanced cyclonic vorticity was observed over the seas east of the Philippines, where strong south-westerly winds associated with above-normal monsoon activity and easterly winds on the southern side of the North Pacific Subtropical High converged. Upper cold lows cut off from the meandering subtropical jet stream in the central to eastern North Pacific repeatedly moved southward and westward. These factors are thought to have contributed to the large number of TC formations. The monthly and annual frequencies of named TCs forming since 1951 are detailed in Appendix 4.

There were seven TCs with maximum sustained winds of 105 kt or higher (referred to as violent TYs), representing the largest number since 1977. These moved over areas where ocean and atmospheric conditions were favorable for TC intensification, such as those with high SSTs and weak vertical wind shear.

The mean genesis point of named TCs was 16.3˚N and 137.2˚E, which was almost the same as that of the 30-year average** (16.2˚N and 136.7˚E). The mean genesis point of named TCs forming in summer (June to August) was 19.5˚N and 137.8˚E, with almost no deviation from that of the 30-year summer average** (18.4˚N and 135.9˚E), and that of named TCs forming in autumn (September to November) was 12.3˚N and 138.4˚E, showing a south-southeastward deviation from the 30-year autumn average** (15.9˚N and 137.8˚E). The autumn deviation may be partly attributable to below-normal SSTs around the Philippines, above-normal SSTs in the tropical Pacific east of 150˚E and associated convection anomalies.

The mean duration of TCs sustaining TS intensity or higher was 5.2 days, which was almost the same as that of the 30-year average** (5.3 days). The mean duration of TCs sustaining TS intensity or higher that formed in summer was 5.0 days, which was almost the same as the 30-year average** (5.1 days), and the mean duration of TCs sustaining TS intensity or higher that formed in autumn was 6.4 days, which was longer than the 30-year average** (5.6 days). The longer duration in autumn is consistent with anomalies observed in past El Niño events.

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

Detailed descriptions of each named TC forming in 2018 are included on the DVD provided with this report.

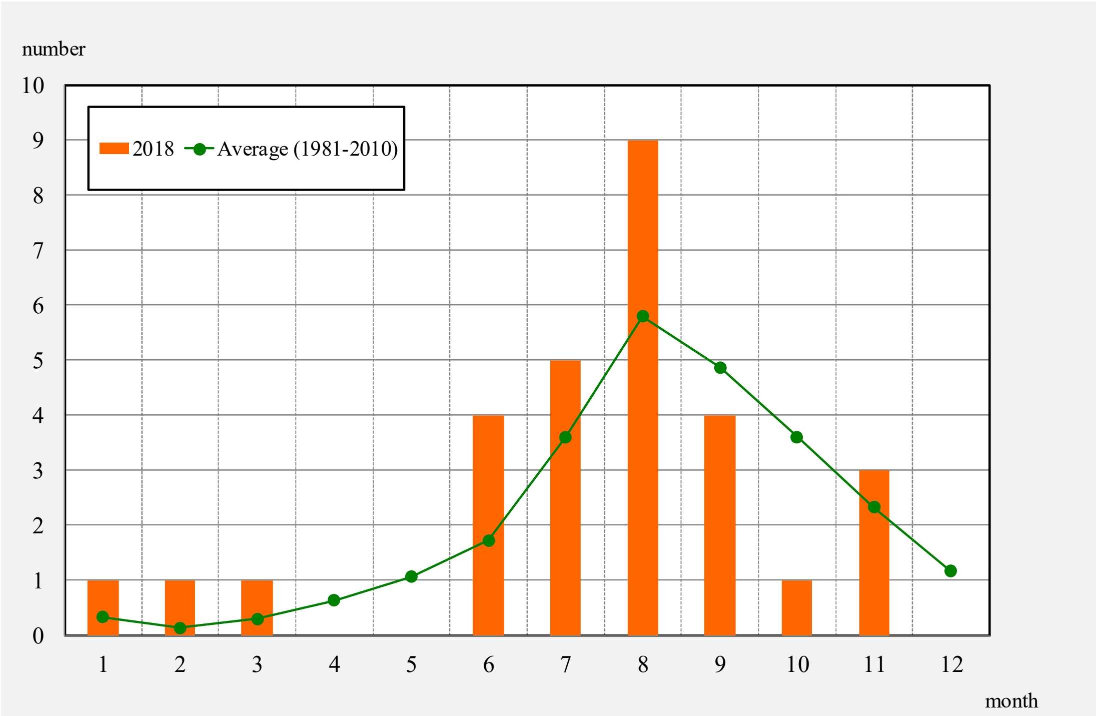


Figure 3.2 Monthly number of named TC formations for 2018 compared to the climatological normal

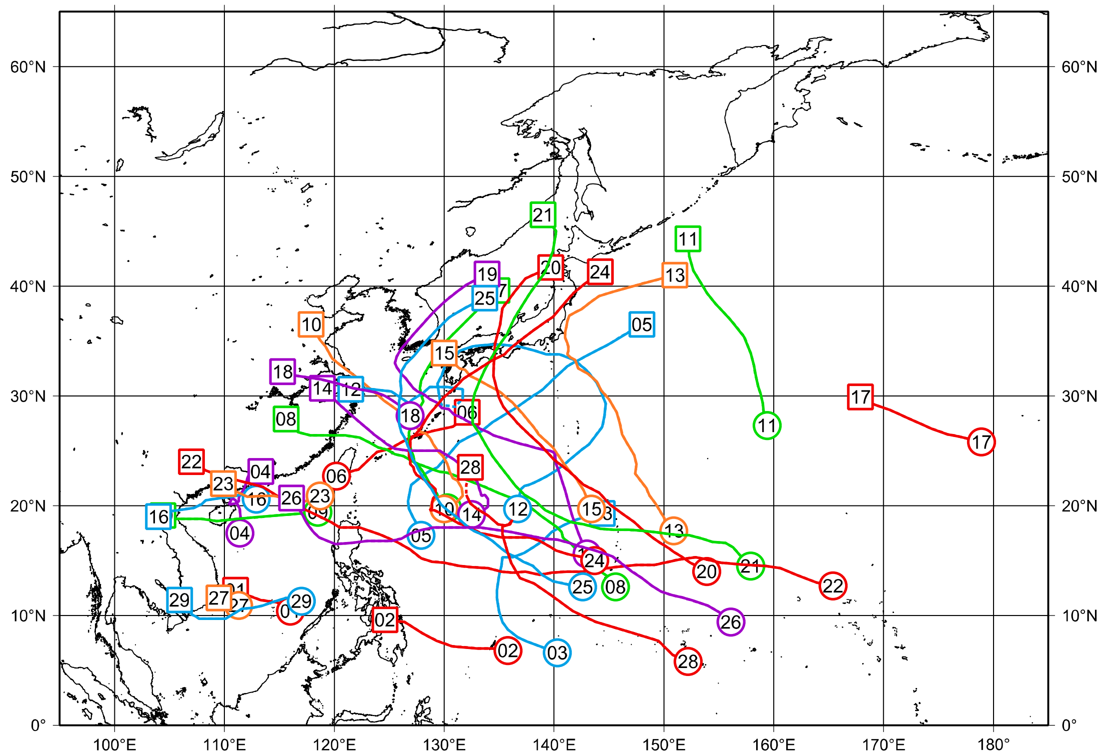


Figure 3.3 Tracks of the 29 named TCs forming in 2018. TC tracks for those with an intensity of TS or higher are shown.

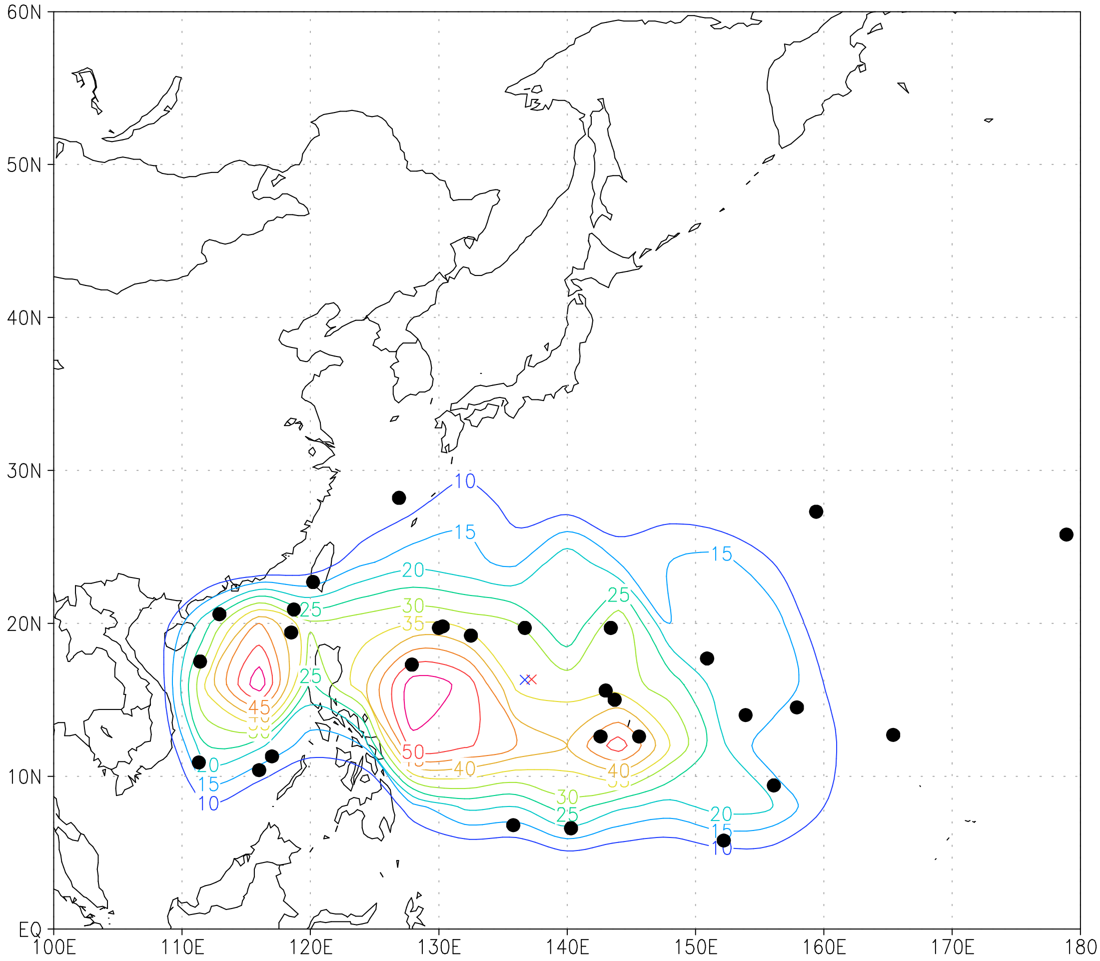


Figure 3.4 Genesis points of the 29 named TCs forming in 2018 (dots) and related frequency distribution for 1951 - 2017 (lines). Red and blue crosses show the mean genesis points of TCs forming in 2018 and the 30-year average period (1981 – 2010), respectively.

Chapter 4

Verification of Forecasts and Other Products in 2018

4.1 Verification of Operational Forecasts

Operational forecasts (i.e., official forecasts) for the 29 TCs of TS intensity or higher that formed in 2018 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 three days ahead). The position and intensity errors of operational forecasts for each named TC forming in 2018 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 for operational forecasts in that year. The errors in 2018 were 66, 112, 179, 277 and 409 km for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively. The errors of 24- and 48-hour forecasts were the lowest on record, and those of 72-, 96- and 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) since 2011 are shown in Figure 4.2 to support evaluation of the net improvement of operational forecasting performance with elimination of the year-to-year fluctuations seen in Figure 4.1. The values are defined as ratios of positional errors in operational forecasts to those of CLIPER predictions and positive/negative values indicate that the operational forecasts were better/worse than the CLIPER predictions. It can be seen that operational forecasts have steadily improved with minimal year-to-year fluctuations. The annual mean improvement ratios for 24-, 48-, 72-, 96- and 120-hour forecasts in 2018 were 68% (65% in 2017), 75% (70%), 74% (69%), 70% (68%) and 67% (65%), respectively. The ratios for all forecast times in 2018 were the highest on record.

The details of errors including improvement ratios to CLIPER for each named TC forming in 2018 are summarized in Table 4.1. Forecasts for Prapiroon (1807), Jongdari (1812) and Yagi (1814) were characterized by large errors. Those for Prapiroon (1807) are attributed to the fact that guidance models did not predict the change in direction of movement from north-westward to north-eastward associated with the weakening of the North Pacific Subtropical High and showed westward errors in the early stage. Those for Jongdari (1812) are attributed to the fact that guidance models did not properly predict changes in movement caused by interaction with upper cold vortices and exhibited large errors, especially for longer forecast times. Those for Yagi (1814) are attributed to the fact that track predictions from guidance models showed large errors. This difficulty observed in prediction may have been contributed to by the positional difference between the TC low-level vortex center and the dense cloud area. Meanwhile, forecasts for Shanshan (1813), Cimaron (1820) and Trami (1824) showed relatively small errors.

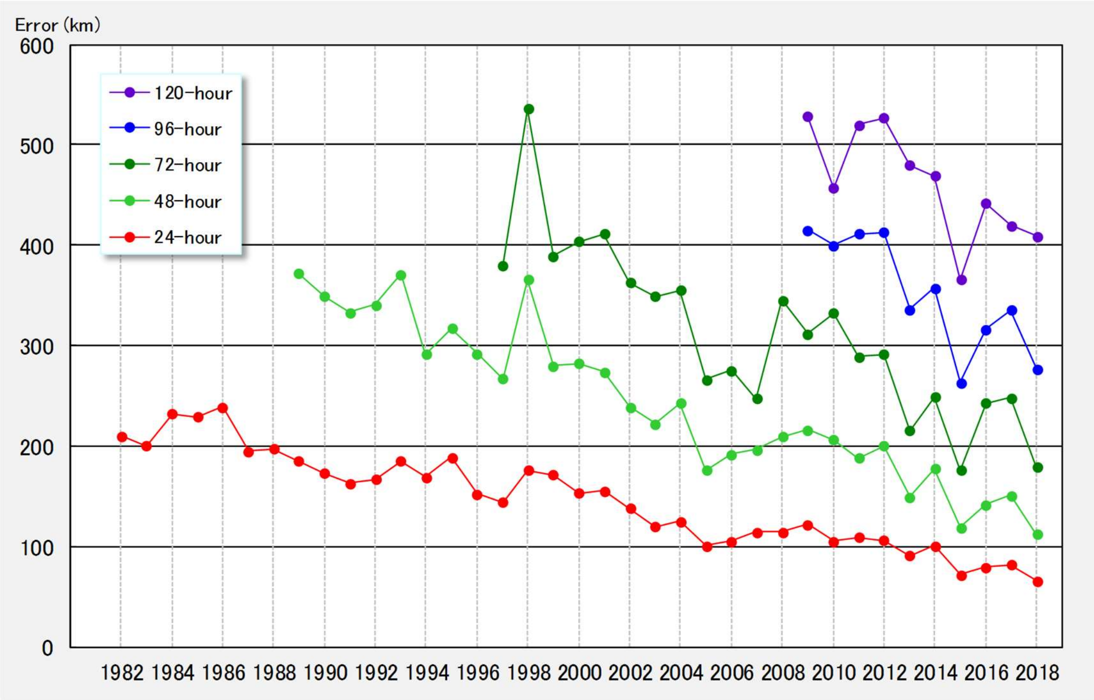


Figure 4.1 Annual mean position errors in 24-, 48-, 72-, 96- and 120-hour operational track forecasts

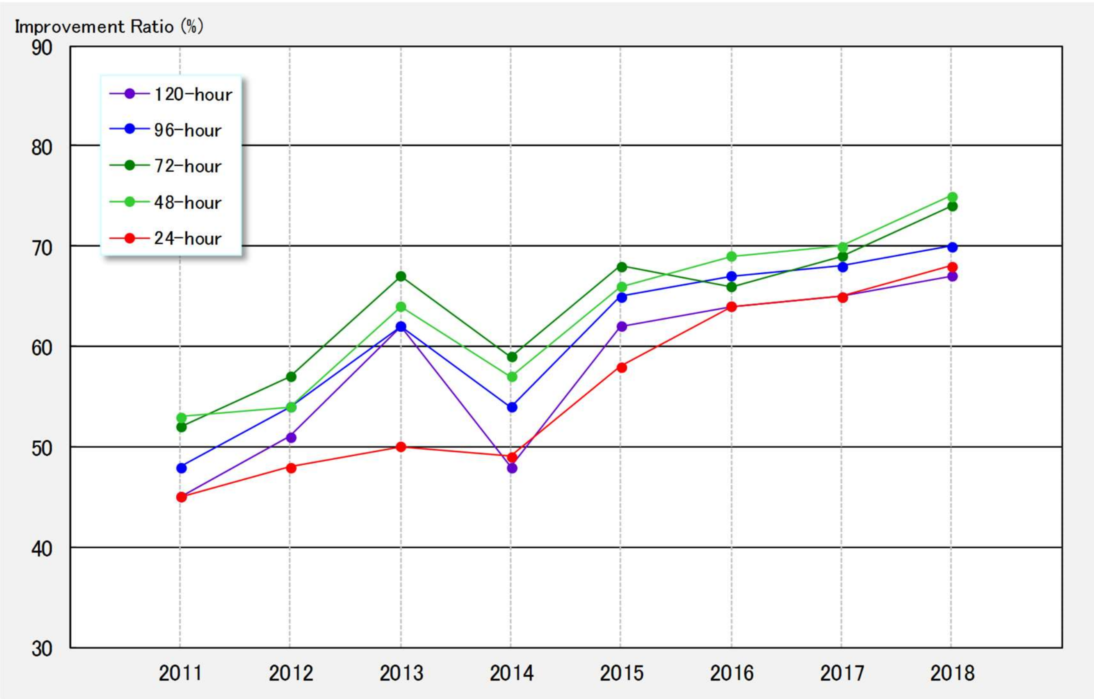


Figure 4.2 Annual mean improvement ratios in 24-, 48-, 72-, 96- and 120-hour operational track forecasts

Figure 4.3 shows a histogram of 24-hour forecast position errors. About 94% (91% in 2017) of 24-hour forecasts, 96% (92%) of 48-hour forecasts, 96% (91%) of 72-hour forecasts, 90% (80%) of 96-hour forecasts and 79% (81%) of 120-hour forecasts had errors of less than 150, 300, 450, 500 and 600 km, respectively.

Table 4.1 Mean position errors of 24-, 48-, 72-, 96- and 120-hour operational forecasts for each named TC forming in 2018. S.D. and Impr. represent the standard deviation of operational forecast position errors and the ratios of position errors in operational forecasts to those in CLIPER predictions, 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	Bolaven	(1801)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Sanba	(1802)	120	51	4	38	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Jelawat	(1803)	90	40	23	62	141	65	19	72	247	89	15	71	339	90	11	69	344	26	7	76
TS	Ewiniar	(1804)	60	31	11	69	122	64	5	65	-	-	0	-	-	-	0	-	-	-	0	-
STS	Maliksi	(1805)	67	51	12	71	92	31	8	86	153	39	4	89	-	-	0	-	-	-	0	-
TS	Gaemi	(1806)	141	73	4	68	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Prapiroon	(1807)	77	35	17	50	248	90	13	8	560	197	9	-13	867	43	4	-1	898	0	1	28
TY	Maria	(1808)	60	31	25	66	107	31	21	76	173	43	17	80	276	52	13	77	418	118	9	72
TS	Son-tinh	(1809)	45	27	4	76	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Ampil	(1810)	82	29	16	67	110	36	12	81	208	48	8	78	344	9	4	74	-	-	0	-
STS	Wukong	(1811)	55	15	10	76	104	28	6	83	160	48	2	84	-	-	0	-	-	-	0	-
TY	Jongdari	(1812)	83	41	30	78	128	101	26	85	243	132	21	77	448	181	15	60	636	183	11	60
TY	Shanshan	(1813)	54	33	25	68	99	44	21	71	117	64	17	75	194	137	13	63	201	106	9	59
TS	Yagi	(1814)	109	39	16	51	235	53	12	46	400	50	7	47	425	67	3	69	-	-	0	-
STS	Leepi	(1815)	178	56	9	4	340	59	5	22	-	-	0	-	-	-	0	-	-	-	0	-
TS	Bebinca	(1816)	110	58	13	32	100	45	9	75	96	26	5	87	120	0	1	87	-	-	0	-
TS	Hector	(1817)	45	23	2	76	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Rumbia	(1818)	39	23	7	87	111	67	3	89	-	-	0	-	-	-	0	-	-	-	0	-
TY	Soulik	(1819)	28	17	31	86	79	54	27	80	174	120	23	74	323	175	19	69	538	227	15	62
TY	Cimaron	(1820)	67	38	20	71	89	47	16	83	109	94	12	86	169	63	8	85	243	81	4	82
TY	Jebi	(1821)	43	21	29	73	86	70	24	72	121	50	20	74	219	151	16	69	388	256	12	58
TY	Mangkhut	(1822)	53	29	35	68	95	43	31	73	151	71	27	76	226	104	23	76	311	163	19	76
TS	Barijat	(1823)	51	32	5	70	103	0	1	-45	-	-	0	-	-	-	0	-	-	-	0	-
TY	Trami	(1824)	48	32	35	69	58	26	30	84	95	35	26	82	184	100	22	67	426	244	18	29
TY	Kong-rey	(1825)	50	28	25	62	107	55	21	65	202	121	17	55	336	196	13	43	556	252	9	27
TY	Yutu	(1826)	44	38	41	69	71	47	37	81	136	80	33	81	236	125	29	80	343	179	25	82
TS	Toraji	(1827)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Man-yi	(1828)	119	57	19	68	185	68	15	72	209	75	11	70	213	96	7	66	467	108	3	58
STS	Usagi	(1829)	64	31	12	67	77	34	7	78	91	11	2	82	-	-	0	-	-	-	0	-
Annual Mean (Total)			66	46	480	68	112	77	369	75	179	128	276	74	277	172	201	70	409	226	142	67

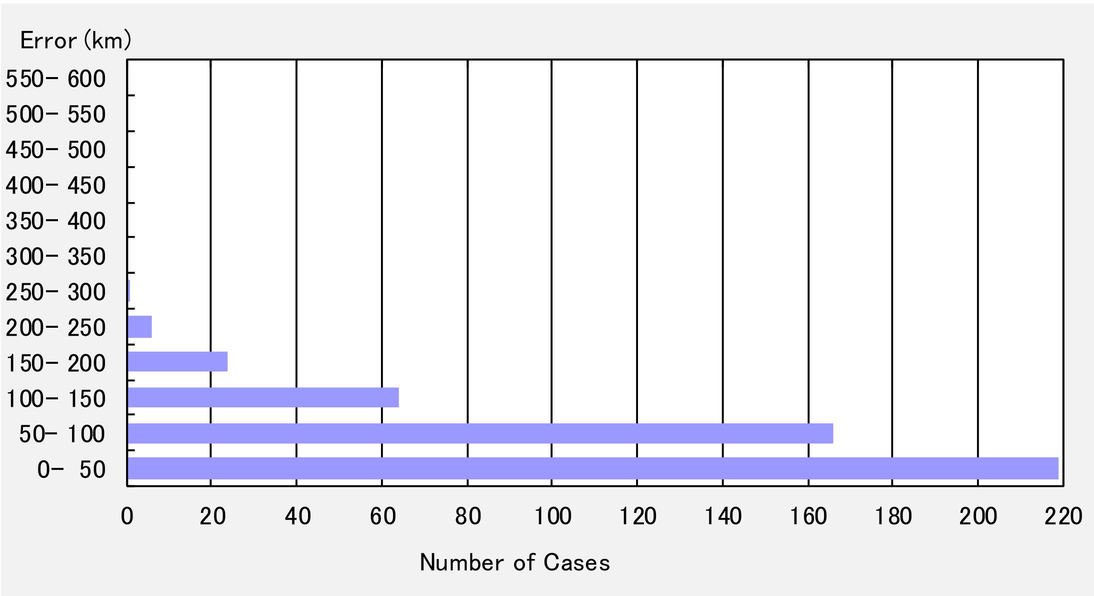


Figure 4.3 Histogram of 24-hour forecast position errors in 2018
(Histograms for 48-, 72-, 96- and 120-hour forecasts are included on the DVD provided with this report).

Table 4.2 presents the mean hitting ratios and radii of 70% probability circles* provided in operational forecasts for each named TC forming in 2018. 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 110 km (112 km in 2017), and their hitting ratio was 82% (78%). The corresponding values for 48-hour forecasts were 203 km (206 km in 2017) and 89% (79%), those for 72-hour forecasts were 279 km (299 km in 2017) and 82% (75%), those for 96-hour forecasts were 419 km (418 km in 2017) and 82% (68%), and those for 120-hour forecasts were 610 km (552 km in 2017) and 78% (75%).

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

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 2018

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	Bolaven	(1801)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TS	Sanba	(1802)	25	4	111	-	0	-	-	0	-	-	0	-	-	0	-
TY	Jelawat	(1803)	61	23	106	79	19	198	73	15	310	100	11	450	100	7	601
TS	Ewiniar	(1804)	91	11	145	100	5	263	-	0	-	-	0	-	-	0	-
STS	Maliksi	(1805)	83	12	136	100	8	269	100	4	407	-	0	-	-	0	-
TS	Gaemi	(1806)	50	4	148	-	0	-	-	0	-	-	0	-	-	0	-
TY	Prapiroon	(1807)	82	17	127	46	13	244	33	9	391	0	4	556	0	1	787
TY	Maria	(1808)	96	25	101	100	21	192	100	17	254	100	13	370	78	9	537
TS	Son-tinh	(1809)	100	4	106	-	0	-	-	0	-	-	0	-	-	0	-
STS	Ampil	(1810)	75	16	109	100	12	201	88	8	259	100	4	370	-	0	-
STS	Wukong	(1811)	100	10	111	100	6	204	100	2	259	-	0	-	-	0	-
TY	Jongdari	(1812)	83	30	120	81	26	217	71	21	325	40	15	456	55	11	643
TY	Shanshan	(1813)	84	25	101	95	21	188	94	17	282	92	13	501	100	9	787
TS	Yagi	(1814)	50	16	112	25	12	204	0	7	254	33	3	370	-	0	-
STS	Leepi	(1815)	11	9	111	0	5	204	-	0	-	-	0	-	-	0	-
TS	Bebinca	(1816)	38	13	98	100	9	176	100	5	274	100	1	389	-	0	-
TS	Hector	(1817)	100	2	111	-	0	-	-	0	-	-	0	-	-	0	-
TS	Rumbia	(1818)	100	7	103	67	3	185	-	0	-	-	0	-	-	0	-
TY	Soulik	(1819)	100	31	107	100	27	198	83	23	278	74	19	443	60	15	673
TY	Cimaron	(1820)	80	20	114	100	16	213	83	12	272	100	8	444	100	4	695
TY	Jebi	(1821)	100	29	116	96	24	208	100	20	282	88	16	391	83	12	546
TY	Mangkhut	(1822)	97	35	111	100	31	203	85	27	259	87	23	370	79	19	537
TS	Barijat	(1823)	80	5	100	100	1	176	-	0	-	-	0	-	-	0	-
TY	Trami	(1824)	94	35	111	100	30	204	100	26	276	91	22	411	72	18	578
TY	Kong-rey	(1825)	92	25	104	90	21	193	59	17	254	62	13	385	56	9	537
TY	Yutu	(1826)	90	41	99	100	37	187	88	33	253	90	29	398	92	25	618
TS	Toraji	(1827)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TY	Man-yi	(1828)	42	19	101	53	15	187	64	11	263	100	7	508	100	3	756
STS	Usagi	(1829)	75	12	113	100	7	201	100	2	241	-	0	-	-	0	-
Annual Mean (Total)			82	480	110	89	369	203	82	276	279	82	201	419	78	142	610

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) and 72 hours (since 2003). The values for maximum wind speed forecasts are included on the DVD provided with this report. 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 lower accuracy observed in 2018 compared to 2017, mainly due to differences in TC characteristics. This improvement is partially attributed to the experimental use of TIFS. The annual mean RMSEs of central pressure and maximum wind speed for 24-hour forecasts were 13.8 hPa (10.1 hPa in 2017) and 5.4 m/s (5.0 m/s). For 48-hour forecasts, the corresponding values were 18.7 hPa (14.9 hPa in 2017) and 6.9 m/s (6.8 m/s), while those for 72-hour forecasts were 20.4 hPa (16.9 hPa in 2017) and 7.3 m/s (7.8 m/s).

Figure 4.5 shows annual mean improvement ratios for a guidance model based on climatology and persistence (SHIFOR) to highlight the net improvement of operational central pressure forecast performance with elimination of the year-to-year fluctuations seen in Figure 4.4. The values are defined as ratios of the RMSEs of operational central pressure forecasts to those of SHIFOR predictions, with positive/negative values indicating better/worse operational forecasts than SHIFOR predictions. The values for maximum wind speed forecasts are included on the DVD provided with this report. 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 and maximum wind speed for 24-hour forecasts were 16% (16% in 2017) and 12% (19%). For 48-hour forecasts, the corresponding values were 9% (9% in 2017) and 18% (21%), while those for 72-hour forecasts were 3% (16% in 2017) and 23% m/s (26%).

The details of errors in operational central pressure forecasts, including improvement ratios to SHIFOR for each named TC forming in 2018, are summarized in Table 4.3. The data for maximum wind speed forecasts are included on the DVD provided with this report. Forecasts for Jelawat (1803), Kong-rey (1825) and Yutu (1826) were characterized by large errors. For Jerawat (1803), the errors are 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 approaching upper-level trough and rapid weakening due to increased vertical wind shear and intrusion of dry air. For Kong-rey (1825), the errors are attributed to the fact that guidance models did not predict rapid intensification in the early stage and rapid weakening in the end stage, and did not support appropriate estimation of reduced sea surface temperatures associated with the previous TY Trami (1824). The errors for Yutu (1826) are attributed to the fact that guidance models did not appropriately represent the repeated developments and weakenings observed, and especially the rapid weakening caused by dry air intrusion in the middle stage.

Figure 4.6 shows a histogram of maximum wind speed errors for 24-hour forecasts. Approximately 64% (56% in 2017) of 24-hour forecasts had errors of less than ±3.75 m/s, with figures of ±6.25 m/s for 76% (68%) of 48-hour forecasts and ±6.25 m/s for 68% (60%) of 72-hour forecasts.

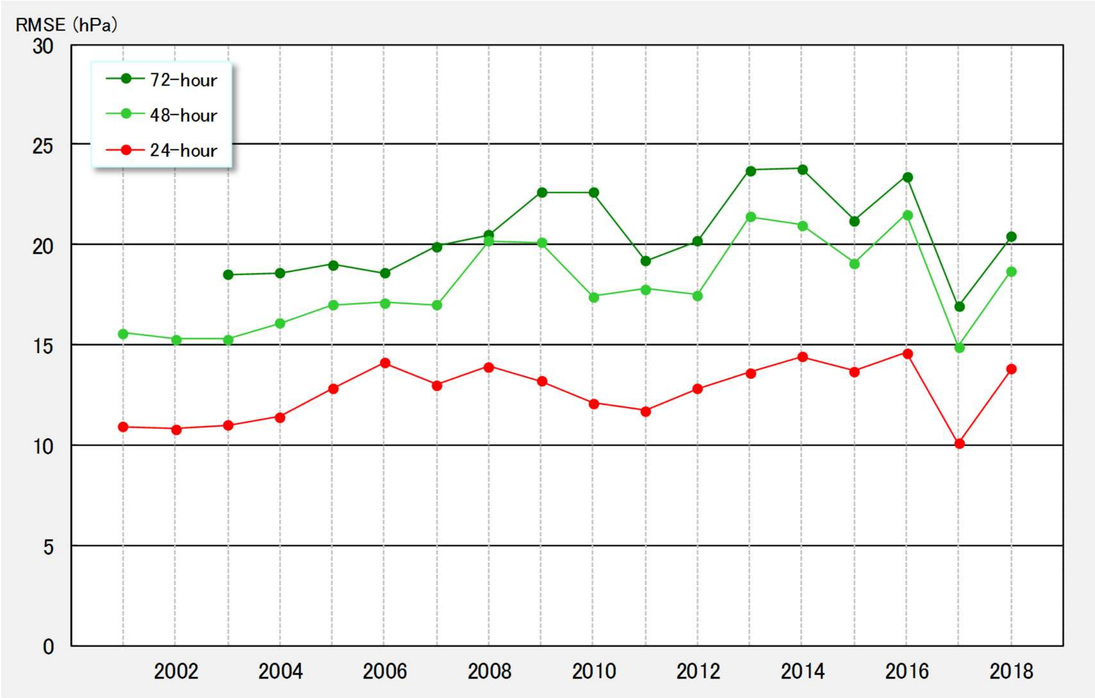


Figure 4.4　Annual RMSEs in 24-, 48- and 72-hour operational central pressure forecasts

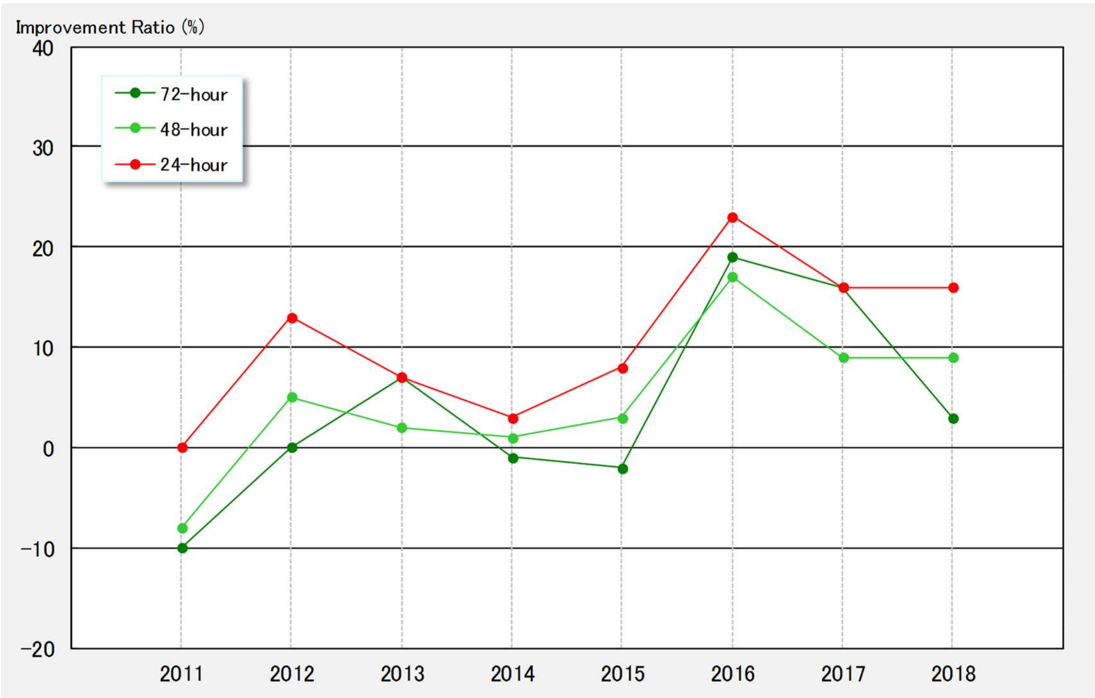


Figure 4.5　Annual mean improvement ratios in 24-, 48- and 72-hour operational central pressure forecasts

Table 4.3 Mean intensity errors of 24-, 48- and 72-hour operational central pressure forecasts for each named TC forming in 2018. Impr. represents the ratios of RMSEs of operational forecasts to those of SHIFOR predictions.

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast			
			Error (hPa)	RMSE (hPa)	Num.	Impr. (%)	Error (hPa)	RMSE (hPa)	Num.	Impr. (%)	Error (hPa)	RMSE (hPa)	Num.	Impr. (%)
TS	Bolaven	(1801)	-	-	0	-	-	-	0	-	-	-	0	-
TS	Sanba	(1802)	-2.5	2.6	4	53	-	-	0	-	-	-	0	-
TY	Jelawat	(1803)	14.4	27.5	23	16	20.7	33.0	19	-8	24.5	36.3	15	-28
TS	Ewiniar	(1804)	1.8	2.1	11	65	2.0	2.0	5	87	-	-	0	-
STS	Maliksi	(1805)	0.3	3.3	12	65	2.5	5.0	8	4	-2.5	3.5	4	68
TS	Gaemi	(1806)	0.0	1.4	4	56	-	-	0	-	-	-	0	-
TY	Prapiroon	(1807)	7.0	9.7	17	9	13.2	16.5	13	-45	24.7	26.1	9	-390
TY	Maria	(1808)	1.2	20.3	25	0	-1.0	21.5	21	-15	-4.5	17.0	17	13
TS	Son-tinh	(1809)	-0.5	1.0	4	89	-	-	0	-	-	-	0	-
STS	Ampil	(1810)	-2.0	6.0	16	-22	-5.8	7.4	12	35	-1.1	7.2	8	59
STS	Wukong	(1811)	-1.8	2.6	10	57	-1.0	3.9	6	73	-4.0	4.0	2	85
TY	Jongdari	(1812)	-1.4	7.0	30	2	2.2	9.1	26	27	4.4	9.6	21	42
TY	Shanshan	(1813)	-4.4	10.4	25	-130	-4.6	10.3	21	-49	-4.2	5.8	17	37
TS	Yagi	(1814)	-1.3	2.3	16	69	-1.1	3.0	12	82	1.4	2.3	7	90
STS	Leepi	(1815)	4.2	4.9	9	11	10.4	11.0	5	44	-	-	0	-
TS	Bebinca	(1816)	-1.2	4.1	13	25	2.7	3.6	9	69	3.6	4.6	5	65
TS	Hector	(1817)	-4.0	4.0	2	65	-	-	0	-	-	-	0	-
TS	Rumbia	(1818)	7.7	8.2	7	-2	7.0	7.1	3	-29	-	-	0	-
TY	Soulik	(1819)	0.3	7.9	31	13	1.5	9.5	27	8	4.7	8.7	23	29
TY	Cimaron	(1820)	3.2	6.9	20	46	8.7	12.3	16	31	10.5	17.7	12	0
TY	Jebi	(1821)	1.6	11.6	29	16	4.2	21.7	24	-6	5.8	23.7	20	-12
TY	Mangkhut	(1822)	1.7	10.5	35	40	0.1	12.6	31	50	-1.2	16.3	27	48
TS	Barijat	(1823)	-5.2	5.9	5	45	-10.0	10.0	1	57	-	-	0	-
TY	Trami	(1824)	-7.4	14.5	35	-1	-12.3	20.0	30	6	-12.1	22.0	26	-2
TY	Kong-rey	(1825)	0.2	27.1	25	7	-2.1	38.0	21	-11	-13.8	35.2	17	-40
TY	Yutu	(1826)	-3.3	18.6	41	22	-5.1	23.1	37	14	-15.1	24.6	33	-14
TS	Toraji	(1827)	-	-	0	-	-	-	0	-	-	-	0	-
TY	Man-yi	(1828)	-4.4	14.8	19	22	-0.7	18.0	15	7	-2.3	16.4	11	29
STS	Usagi	(1829)	-6.7	9.4	12	50	-0.9	1.3	7	95	1.0	1.4	2	95
Annual Mean (Total)			-0.1	13.8	480	16	0.5	18.7	369	9	-0.8	20.4	276	3

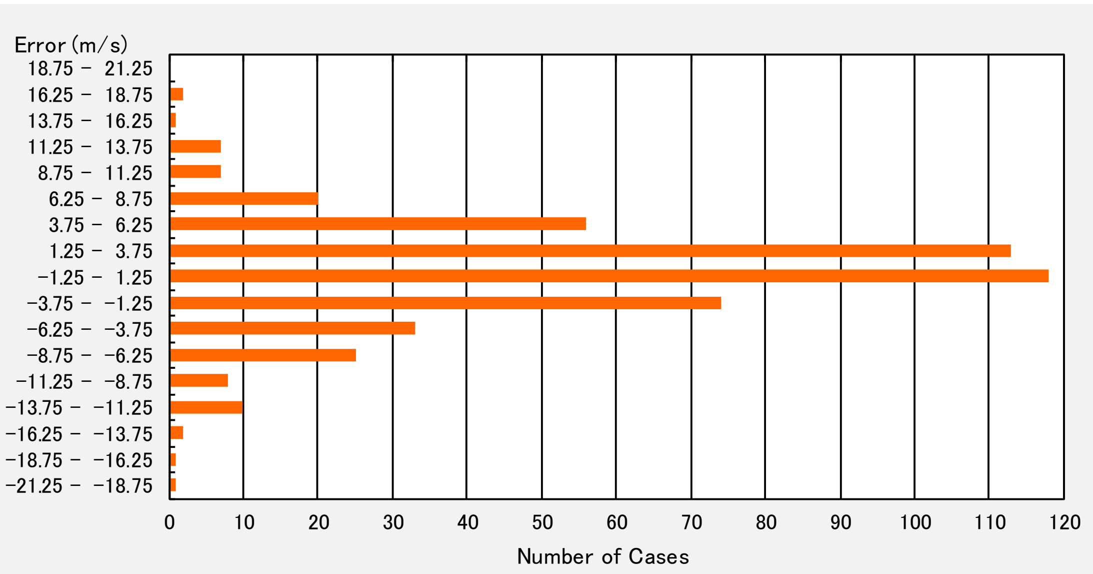


Figure 4.6 Histogram of 24-hour forecast maximum wind speed errors in 2018
(Histograms for 48- and 72-hour forecasts are included on the DVD provided with this report).

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 2018, the annual mean errors for 30-, 54- and 78-hour* predictions were 89 km (106 km in 2017), 145 km (182 km) and 237 km (300 km), respectively. The mean position errors of 18-, 30-, 42-, 54-, 66- and 78-hour predictions for each named TC are given in Table 4.4.

* *30-, 54- and 78-hour GSM predictions are used as primary information by forecasters creating 24-, 48- and 72-hour operational forecasts, respectively.*

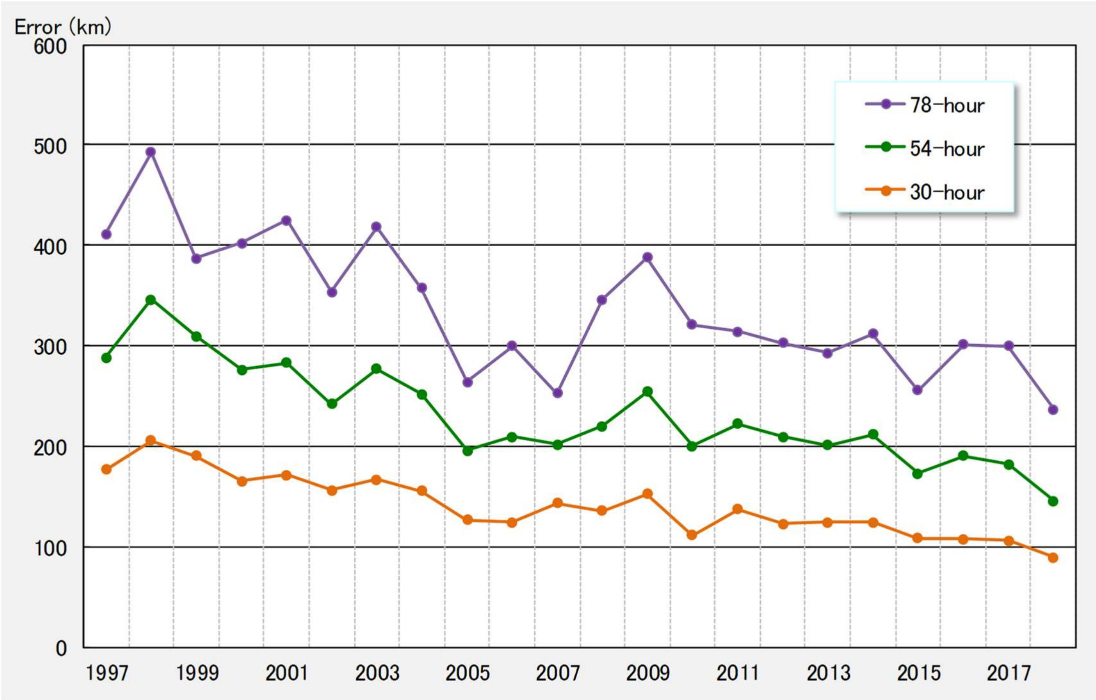


Figure 4.7 GSM annual mean position errors since 1997

Table 4.4 GSM mean position errors (km) for each named TC forming in 2018. The number of samples is given in parentheses.

Tropical Cyclone			T=18		T=30		T=42		T=54		T=66		T=78	
TS	BOLAVEN	(1801)	170.1	(5)	254.3	(3)	274.0	(1)	-	(-)	-	(-)	-	(-)
TS	SANBA	(1802)	126.1	(10)	165.6	(8)	189.1	(6)	167.2	(4)	184.4	(1)	-	(-)
TY	JELAWAT	(1803)	72.2	(28)	85.4	(26)	95.6	(24)	142.0	(22)	204.9	(20)	266.2	(18)
TS	EWINIAR	(1804)	76.8	(22)	87.0	(19)	96.4	(17)	110.7	(16)	142.0	(14)	136.6	(12)
STS	MALIKSI	(1805)	71.8	(19)	85.3	(17)	110.6	(15)	140.5	(13)	152.8	(11)	177.9	(9)
TS	GAEMI	(1806)	107.3	(8)	162.6	(5)	264.0	(4)	186.3	(2)	162.9	(1)	-	(-)
TY	PRAPIROON	(1807)	71.9	(20)	115.5	(18)	196.1	(16)	320.5	(14)	470.6	(12)	606.1	(10)
TY	MARIA	(1808)	51.3	(31)	63.7	(29)	102.9	(27)	135.0	(25)	161.5	(23)	183.5	(21)
TS	SON-TINH	(1809)	103.6	(8)	90.5	(6)	75.7	(4)	109.7	(1)	-	(-)	-	(-)
STS	AMPIL	(1810)	57.1	(22)	57.3	(20)	69.5	(18)	85.6	(16)	113.1	(14)	156.9	(12)
STS	WUKONG	(1811)	48.8	(14)	82.1	(12)	115.0	(10)	151.3	(8)	216.3	(6)	253.4	(4)
TY	JONGDARI	(1812)	65.8	(39)	97.0	(37)	142.1	(35)	181.9	(33)	218.8	(31)	263.5	(29)
TY	SHANSHAN	(1813)	54.1	(28)	82.4	(26)	103.0	(24)	130.7	(22)	173.1	(20)	232.6	(18)
TS	YAGI	(1814)	78.4	(23)	106.8	(21)	144.3	(19)	163.0	(17)	209.6	(15)	297.7	(13)
STS	LEEPI	(1815)	156.2	(11)	296.6	(4)	-	(-)	-	(-)	-	(-)	-	(-)
TS	BEBINCA	(1816)	115.1	(16)	187.8	(14)	247.4	(12)	254.9	(10)	256.7	(8)	257.6	(6)
TS	HECTOR	(1817)	34.2	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	RUMBIA	(1818)	35.0	(9)	50.6	(7)	77.4	(5)	129.7	(3)	187.5	(1)	-	(-)
TY	SOULIK	(1819)	41.0	(34)	52.1	(32)	70.6	(30)	110.3	(28)	184.8	(26)	276.2	(24)
TY	CIMARON	(1820)	74.5	(22)	100.4	(20)	133.8	(18)	187.6	(16)	255.2	(14)	323.6	(12)
TY	JEBI	(1821)	41.4	(31)	47.3	(29)	70.9	(27)	113.6	(25)	162.7	(23)	222.6	(21)
TY	MANGKHUT	(1822)	40.0	(37)	62.7	(35)	91.7	(33)	119.2	(31)	158.2	(29)	207.6	(27)
TS	BARIJAT	(1823)	60.5	(10)	65.2	(8)	75.6	(6)	121.3	(4)	196.1	(2)	-	(-)
TY	TRAMI	(1824)	39.4	(39)	58.1	(37)	71.7	(35)	97.8	(33)	135.3	(31)	199.3	(29)
TY	KONG-REY	(1825)	56.9	(31)	82.3	(29)	117.0	(27)	156.3	(25)	204.9	(23)	275.7	(21)
TY	YUTU	(1826)	55.3	(45)	66.9	(43)	87.7	(41)	109.1	(39)	142.8	(37)	183.3	(35)
TS	TORAJI	(1827)	188.9	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	MAN-YI	(1828)	178.3	(21)	229.4	(19)	269.6	(17)	325.2	(15)	358.1	(13)	372.7	(11)
STS	USAGI	(1829)	76.7	(30)	101.1	(28)	101.5	(26)	104.9	(24)	111.5	(22)	119.7	(20)
Annual Mean (Total)			68.5	(617)	89.4	(552)	113.9	(497)	145.3	(446)	187.4	(397)	236.8	(352)

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 59% (58% in 2017), 70% (67%), 76% (72%) and 75% (70%) for 18-, 30-, 54- and 78-hour predictions, respectively.

About 85% (80% in 2017) of 30-hour predictions had errors of less than 150 km, while 93% (88%) of 54-hour predictions had errors of less than 300 km, and 91% (82%) of 78-hour predictions had errors of less than 450 km. Histograms showing the position errors of 30-, 54- and 78-hour predictions are included on the DVD provided with this report.

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

Table 4.5 Mean position errors (km) of GSM and PER method predictions for the 29 named TCs forming in 2018 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	71.1 (354)	65.4 (152)	64.5 (111)	68.5 (617)
	PER	158.9 (354)	146.7 (152)	221.2 (111)	167.1 (617)
	IMPROV	55.3 %	55.4 %	70.8 %	59.0 %
T=30	GSM	90.5 (310)	91.8 (140)	82.6 (102)	89.4 (552)
	PER	273.9 (310)	265.1 (140)	416.3 (102)	298.0 (552)
	IMPROV	67.0 %	65.4 %	80.2 %	70.0 %
T=42	GSM	114.1 (278)	113.7 (125)	113.9 (94)	113.9 (497)
	PER	407.1 (278)	384.4 (125)	613.0 (94)	440.3 (497)
	IMPROV	72.0 %	70.4 %	81.4 %	74.1 %
T=54	GSM	135.4 (247)	160.6 (112)	153.6 (87)	145.3 (446)
	PER	551.6 (247)	506.2 (112)	831.3 (87)	594.8 (446)
	IMPROV	75.5 %	68.3 %	81.5 %	75.6 %
T=66	GSM	159.5 (219)	209.4 (95)	235.5 (83)	187.4 (397)
	PER	742.4 (219)	621.7 (95)	975.3 (83)	762.2 (397)
	IMPROV	78.5 %	66.3 %	75.9 %	75.4 %
T=78	GSM	190.4 (197)	256.4 (77)	334.5 (78)	236.8 (352)
	PER	926.4 (197)	757.2 (77)	1108.4 (78)	929.7 (352)
	IMPROV	79.4 %	66.1 %	69.8 %	74.5 %

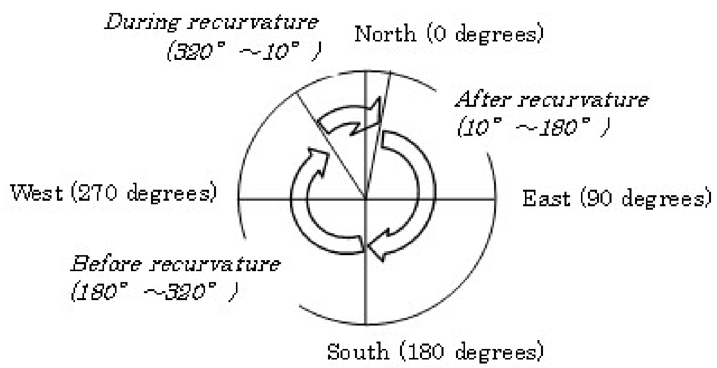


Figure 4.8 Definition of the stages before, during and after recurvature based on the direction of TC movement.

2) Central Pressure and Maximum Wind Speed

The mean errors of 30-, 54- and 78-hour GSM central pressure predictions in 2018 were +11.4 hPa (+5.1 hPa in 2017), +12.6 hPa (+5.0 hPa) and +12.9 hPa (+3.4 hPa), respectively. Their RMSEs were 21.0 hPa (12.8 hPa in 2017) for 30-hour predictions, 24.4 hPa (16.4 hPa) for 54-hour predictions and 27.6 hPa (19.1 hPa) for 78-hour predictions. The biases for 30-, 54- and 78-hour maximum wind speed predictions were -8.3 m/s (-5.5 m/s in 2017) with a RMSE of 11.1 m/s (8.5 m/s), -8.8 m/s (-5.8 m/s) with a RMSE of 12.9 m/s (10.4 m/s) and -8.8 m/s (-5.3 m/s) with a RMSE of 13.9 m/s (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.

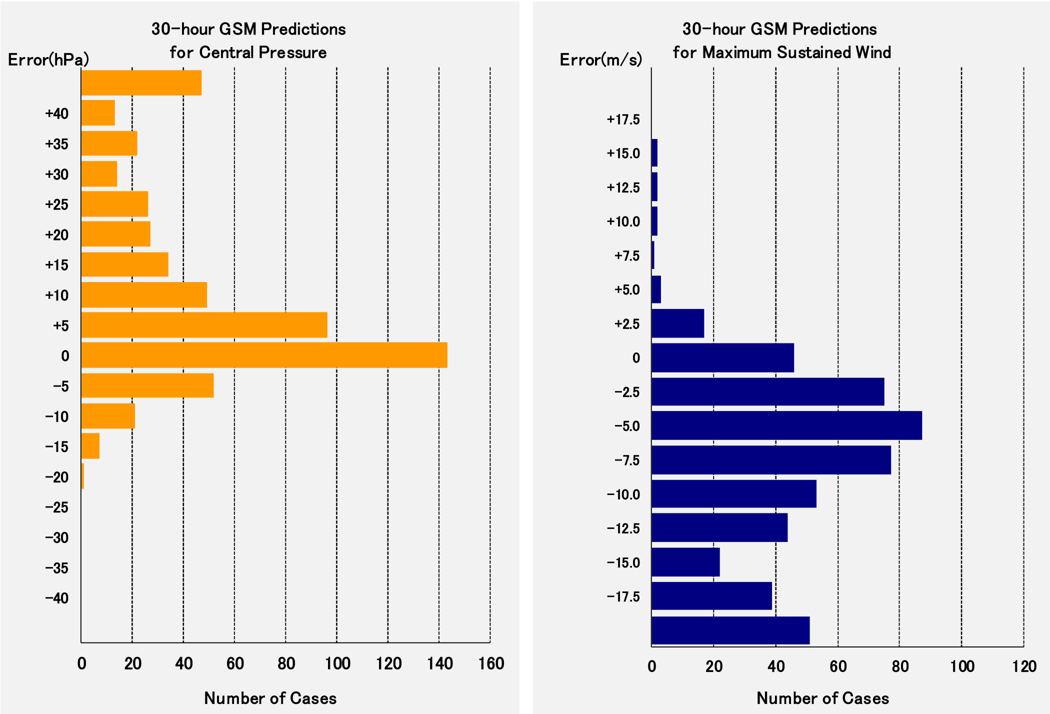


Figure 4.9 Error distribution of GSM 30-hour intensity predictions in 2018.
The figure on the left shows error distribution for central pressure, while the one on the right shows that for maximum wind speed (the error distributions of 54- and 78-hour predictions are included on the DVD provided with this report).

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 2018, 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 95 km (89 km with the GSM), 154 km (145 km), 241 km (237 km), 332 km and 462 km, respectively.

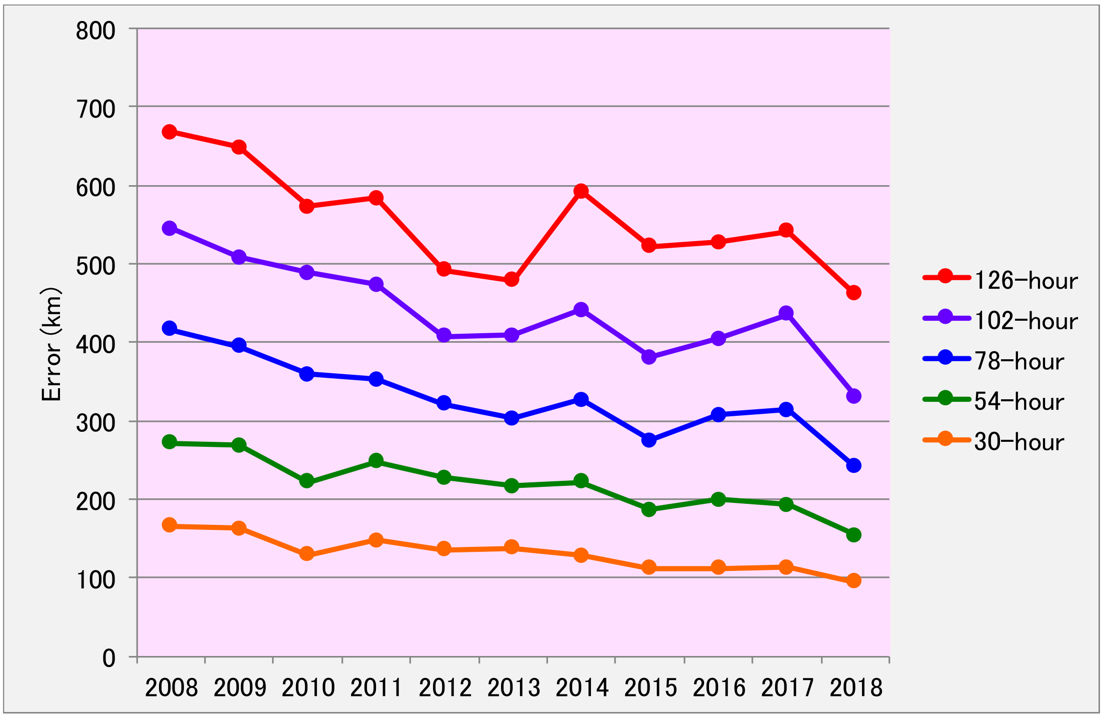


Figure 4.10 GEPS and TEPS annual mean position errors since 2008

Table 4.6 Mean position errors (km) of GEPS ensemble mean forecasts for each named TC forming in 2018. The number of samples is given in parentheses.

Tropical Cyclone			T=30		T=54		T=78		T=102		T=126	
TS	BOLAVEN	(1801)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	SANBA	(1802)	150.8	(8)	198.4	(4)	-	(-)	-	(-)	-	(-)
TY	JELAWAT	(1803)	125.0	(25)	183.0	(21)	285.3	(17)	388.5	(13)	498.5	(9)
TS	EWINIAR	(1804)	86.3	(18)	102.7	(16)	88.2	(10)	128.1	(6)	328.9	(4)
STS	MALIKSI	(1805)	88.2	(17)	110.4	(13)	139.7	(9)	235.2	(5)	449.5	(1)
TS	GAEMI	(1806)	170.3	(8)	190.9	(4)	-	(-)	-	(-)	-	(-)
TY	PRAPIROON	(1807)	120.0	(18)	304.4	(14)	572.9	(10)	439.7	(1)	-	(-)
TY	MARIA	(1808)	51.5	(29)	111.8	(25)	162.4	(21)	236.6	(17)	337.9	(13)
TS	SON-TINH	(1809)	115.3	(5)	-	(-)	-	(-)	-	(-)	-	(-)
STS	AMPIL	(1810)	65.7	(20)	115.2	(16)	188.2	(12)	242.2	(8)	389.7	(3)
STS	WUKONG	(1811)	94.7	(12)	202.1	(8)	266.9	(4)	-	(-)	-	(-)
TY	JONGDARI	(1812)	118.0	(37)	209.5	(33)	298.2	(29)	460.6	(25)	624.1	(16)
TY	SHANSHAN	(1813)	72.5	(26)	115.5	(22)	245.6	(18)	352.0	(14)	578.1	(10)
TS	YAGI	(1814)	99.7	(21)	168.0	(17)	281.7	(13)	436.5	(9)	568.1	(5)
STS	LEEPI	(1815)	332.1	(2)	-	(-)	-	(-)	-	(-)	-	(-)
TS	BEBINCA	(1816)	186.7	(14)	257.3	(10)	335.8	(6)	-	(-)	-	(-)
TS	HECTOR	(1817)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	RUMBIA	(1818)	52.2	(7)	145.3	(3)	-	(-)	-	(-)	-	(-)
TY	SOULIK	(1819)	62.4	(32)	130.0	(28)	242.3	(24)	324.3	(20)	384.7	(16)
TY	CIMARON	(1820)	101.4	(20)	186.4	(15)	377.5	(12)	516.0	(8)	730.4	(4)
TY	JEBI	(1821)	45.2	(29)	100.8	(25)	196.0	(21)	301.1	(17)	419.4	(13)
TY	MANGKHUT	(1822)	70.9	(34)	140.0	(30)	229.3	(26)	334.4	(22)	443.6	(18)
TS	BARIJAT	(1823)	57.3	(8)	122.9	(4)	-	(-)	-	(-)	-	(-)
TY	TRAMI	(1824)	54.2	(37)	96.6	(33)	194.6	(29)	367.0	(25)	631.8	(21)
TY	KONG-REY	(1825)	91.3	(28)	157.7	(24)	263.2	(20)	392.1	(16)	565.7	(12)
TY	YUTU	(1826)	75.8	(43)	117.5	(39)	193.0	(35)	270.4	(31)	340.9	(27)
TS	TORAJI	(1827)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	MAN-YI	(1828)	286.2	(19)	388.0	(15)	390.7	(11)	288.8	(7)	398.8	(3)
STS	USAGI	(1829)	106.3	(28)	115.9	(24)	155.4	(20)	212.3	(15)	231.3	(11)
All Mean (Total)			95.1	(545)	153.8	(443)	241.2	(347)	331.6	(259)	462.0	(186)

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 2018 only when GEPS predicted large spreads.

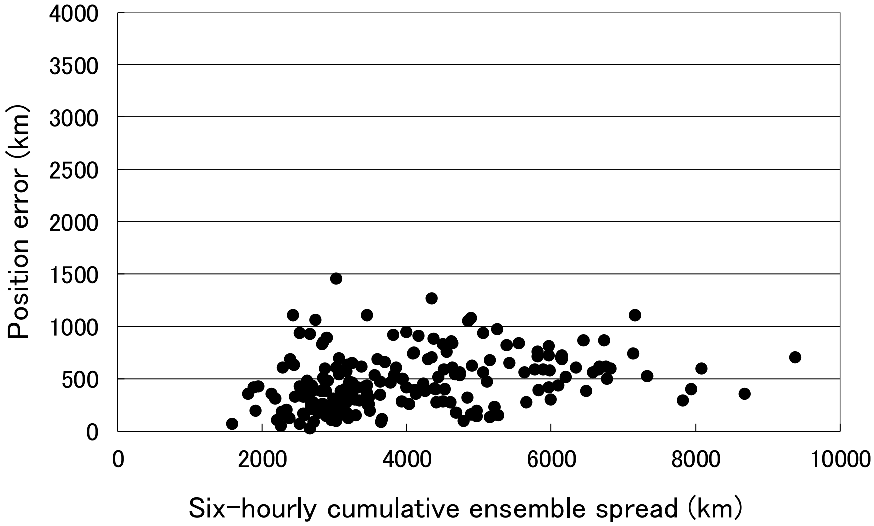


Figure 4.11 Relationship between six-hourly cumulative ensemble spread in TC position forecasts (km) and ensemble mean forecast position errors (km) in 126-hour predictions in 2018.

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 2018 TC track forecasts except for 54-hour predictions.

Table 4.7 Ensemble mean forecast position errors (km) in 2018 classified with six-hourly cumulative ensemble spread at each forecast time. The number of samples is given in parentheses.

	Reliability Index					
Time	A		B		C	
T=30	64.8	(224)	98.4	(187)	142.6	(183)
T=54	140.7	(186)	139.5	(186)	225.7	(117)
T=78	208.0	(161)	250.9	(158)	318.7	(72)
T=102	286.3	(144)	346.7	(104)	457.1	(44)
T=126	376.6	(118)	547.4	(59)	592.5	(33)

4.3 Verification for Other Guidance Models

The Center utilizes other guidance models in addition to JMA's NWP models for operational TC track and intensity forecasts, including global deterministic NWP models from eight other centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP and UKMO), global EPSs from three other centers (ECMWF, NCEP and UKMO) as provided via the NTP website, a regional deterministic model (HWRF) and various JMA intensity guidance models. Related predictions for center position (up to five days ahead), central pressure and maximum wind speed (up to three days ahead) were verified in consideration of availability time for RSMC TC best track data. Spread-skill relationships of EPS predictions were also verified.

4.3.1 Center Position

Table 4.8 shows mean center position errors of RSMC operational forecasts, nine global deterministic model predictions, one regional deterministic model prediction, ensemble mean predictions from four global EPSs and the climatology and persistence model prediction. Examples from the consensus method are also shown, as the Center today mainly employs such a method involving the use of the mean of predicted TC positions from multiple global deterministic models. The effectiveness of this approach is seen in the tendency of related errors to be smaller than those of deterministic models, and errors in RSMC official forecasts based on the method were smaller than those of deterministic models for most forecast times. It can also be seen that the regional deterministic model produces larger errors than global models for most forecast times. Ensemble mean predictions from global EPSs exhibit errors slightly larger than the same centers' deterministic models for most forecast times.

Table 4.8 Mean position errors of various guidance models in 2018
As examples of the consensus method with global deterministic models, EU (ECMWF and UKMO), JENU (JMA, ECMWF, NCEP and UKMO) and All (all nine models) are shown.

Prediction		24-hour		48-hour		72-hour		96-hour		120-hour	
		Mean (km)	Num.	Mean (km)	Num.	Mean (km)	Num.	Mean (km)	Num.	Mean (km)	Num.
RSMC Operational		67	480	113	369	181	277	277	202	408	143
Global deterministic model	JMA (GSM)	85	471	146	368	244	284	372	208	522	147
	BoM	140	454	218	359	297	276	390	203	522	131
	CMA	158	454	269	356	377	266	352	13	-	0
	CMC	139	454	223	356	325	273	454	204	675	137
	DWD	96	460	163	363	241	144	-	0	-	0
	ECMWF	142	464	146	363	196	276	274	201	393	141
	KMA	98	442	153	346	230	265	-	0	-	0
	NCEP	80	476	141	372	236	281	356	207	477	37
	UKMO	106	463	136	361	195	276	294	202	-	0
Consensus method with global deterministic models	EU	80	385	114	293	169	222	239	154	-	0
	JENU	73	477	116	371	179	284	286	211	406	117
	All	83	477	136	371	202	284	292	211	420	142
Regional deterministic model	HWRF	93	476	156	370	238	282	337	211	518	148
Ensemble mean of global EPS	JMA (GEPS)	96	479	160	372	257	285	361	211	493	149
	ECMWF	92	411	142	311	199	234	286	168	406	110
	NCEP	91	462	160	364	258	280	377	208	558	144
	UKMO	94	411	143	314	203	238	298	175	415	116
climatology and persistence model	CLIPER	205	474	445	369	690	282	922	209	1224	148

4.3.2 Spread-Skill Relationship

Although ensemble mean predictions from EPSs exhibit errors slightly larger than those of the same centers' deterministic models, EPSs (including multi- and single-EPS types) provide useful information on the reliability of TC track forecasts with the related ensemble spread. Figure 4.12 shows relationships between the RMSE of the ensemble mean prediction and the spread for forecast times from each single-EPS and certain combinations of multi-EPSs. It can be seen that the spread for all single EPSs is smaller than the RMSE, especially for longer forecast times, although the extent of the spread should be the same as the RMSE value. Meanwhile, the multi-EPS RMSE is smaller than the single-EPS value, and the multi-EPS spread is closer to the RMSE value than that of single EPSs.

Figure 4.13 shows scatter diagrams illustrating the relationships between ensemble mean prediction errors and six-hourly cumulative ensemble spreads for 72-hour forecasts. Although all single EPSs and multi-EPS combinations exhibit a correlation between prediction errors and cumulative ensemble spreads, the correlation coefficients in multi-EPSs tend to be larger than those in the single ones. This indicates that multi-EPSs provide more effective information on track forecast reliability.

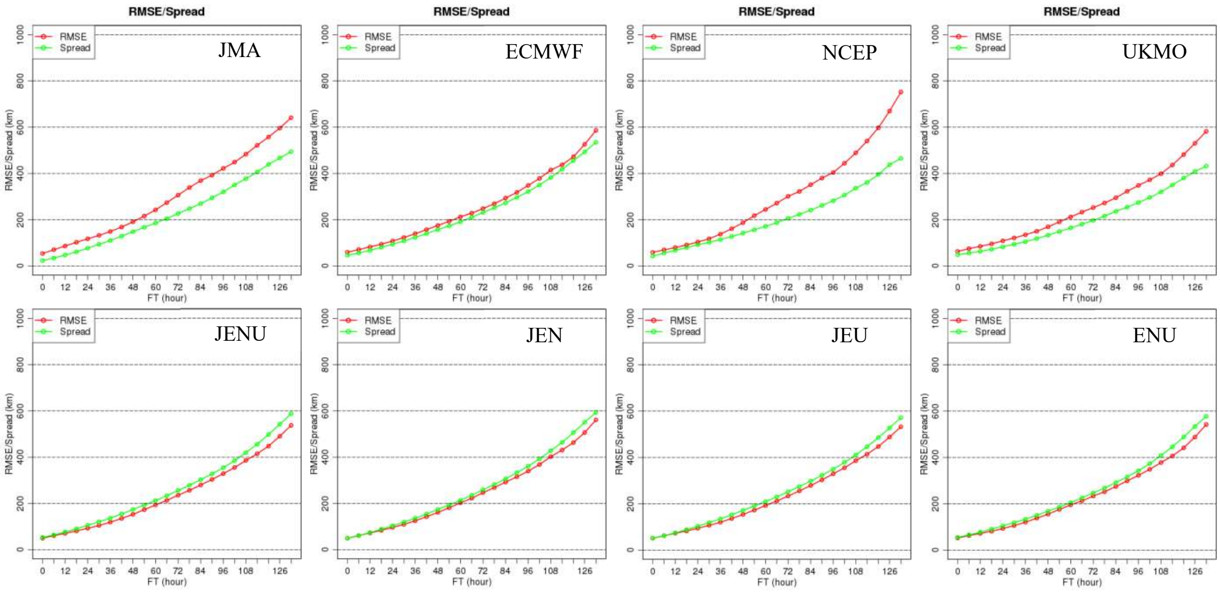


Figure 4.12 Relationships between the RMSE (km) of ensemble mean prediction and spread (km) for forecast times for each single-EPS (top) and four combinations of multi-EPSs (bottom) in 2018. The combinations are represented by the initials of the component models (e.g., JENU represents a multi-EPS incorporating JMA, ECMWF, NCEP and UKMO).

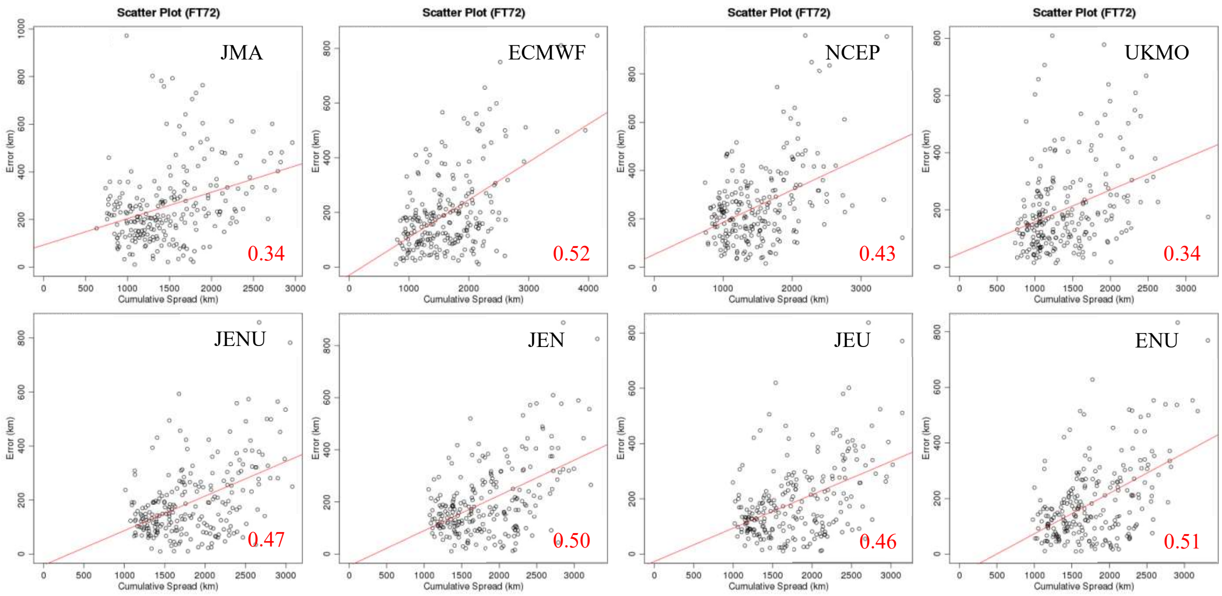


Figure 4.13 Relationships between prediction errors and cumulative ensemble spreads for 72-hour forecasts with each single-EPS (top) and four multi-EPS combinations (bottom) for 2018. Regression lines and correlation coefficients are shown in red.

4.3.3 Central Pressure and Maximum Wind Speed

Table 4.9 shows mean central pressure errors in intensity guidance models; TIFS, LGEM (the Logistic Growth Equation Model), SHIFOR and examples from the consensus method with intensity guidance models, in addition to all predictions except for CLIPER shown for TC track forecasts in Table 4.8. Values for maximum wind speed forecasts are included on the DVD provided with this report. The data show a need for resolution improvement in global deterministic models, the consensus method with global deterministic models and global EPSs for direct application in TC intensity forecasting. Meanwhile, the regional deterministic model with higher resolution, intensity guidance model TIFS, RSMC operational forecasts based on TIFS data and the consensus method with intensity guidance models exhibit smaller errors and superior levels of skill than SHIFOR, which is used as the base for verification.

Table 4.9 Mean central pressure errors of various guidance models in 2018
Examples of the consensus method with intensity guidance models are represented by the initials of the components (TIFS, LGEM, HWRF).

Prediction		24-hour			48-hour			72-hour		
		Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.
RSMC Operational		0.2	13.8	480	1.0	18.8	369	-0.4	20.4	277
Global deterministic model	JMA (GSM)	13.1	22.7	471	13.4	25.1	368	12.0	26.9	284
	BoM	25.6	35.4	454	28.5	38.4	359	27.9	37.7	276
	CMA	11.7	23.3	454	12.8	28.9	356	11.5	29.5	266
	CMC	22.8	32.0	454	25.5	34.4	356	25.4	34.1	273
	DWD	14.9	25.2	460	15.5	27.6	363	14.0	27.3	144
	ECMWF	6.4	19.2	393	5.4	20.2	300	2.9	18.7	226
	KMA	-1.2	22.3	442	-1.9	27.0	346	-5.3	28.0	265
	NCEP	-2.6	15.8	476	-5.9	22.1	372	-12.2	27.2	281
	UKMO	8.0	20.5	463	6.7	22.5	361	2.9	22.6	276
Consensus method with global deterministic models	EU	7.5	19.3	385	5.2	19.9	293	1.2	18.4	222
	JENU	6.1	16.5	477	5.3	19.6	371	2.1	20.4	284
	All	10.7	20.2	477	11.4	23.5	371	9.3	23.3	284
Regional deterministic model	HWRF	-4.3	15.0	476	-3.7	18.5	370	-2.7	19.9	282
Ensemble mean of global EPS	JMA (GEPS)	20.2	29.8	479	23.2	33.6	372	23.0	34.0	285
	ECMWF	10.0	21.9	411	10.7	24.6	311	9.0	24.3	234
	NCEP	22.0	31.3	462	23.7	33.9	364	22.5	33.1	280
	UKMO	11.4	23.3	411	10.9	24.0	314	8.1	21.7	238
Intensity guidance model	TIFS	0.4	13.6	471	0.0	15.7	368	-1.2	17.3	284
	LGEM	1.0	14.3	449	-0.5	17.0	353	-2.4	17.2	277
	SHIFOR	-0.4	16.3	474	1.1	20.2	369	1.4	20.7	282
Consensus method with intensity guidance models	TL	0.8	13.8	449	-0.1	16.1	353	-1.7	16.9	277
	TH	-1.9	12.7	466	-1.9	15.1	365	-1.9	16.2	281
	LH	-1.6	13.0	447	-2.2	16.2	353	-2.6	16.4	277
	TLH	-1.0	12.7	468	-1.4	15.1	365	-2.1	15.8	281

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

JMA produces AMVs using serial imagery from the Himawari-8 geostationary satellite. These 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 AMV-based Sea-surface Winds (ASWinds) product based on low-level AMVs (assigned below 700 hPa level) to estimate such winds in the vicinity of TCs. The ASWinds product derived at intervals of 10 – 30 minutes with frequent and wide-ranging wind distribution information is intended to support real-time sea surface wind estimation in the vicinity of TCs together with surface wind observations conducted using satellite microwave scatterometers such as the ASCAT units on board MetOp polar-orbiting satellites (referred to here as "ASCAT winds").

JMA launched its ASWind monitoring web resource (https://www.data.jma.go.jp/mscweb/en/product/product/aswind/index.html) in July 2019, and provides National Meteorological and Hydrological Services (NMHSs) with ASWinds information via the JMA Data Dissemination System (JDDS; http://www.jma.go.jp/jma/jma-eng/satellite/jdds.html).

ASWinds (Figure 4.14) data for the vicinity of TS Yagi (1814) during the development phase clearly show a low-level vortex indicating the TC center, thereby highlighting the product's usefulness in TC center identification. The wide-area coverage and high temporal resolution of ASWinds data also support real-time determination of 30-kt wind radii for areas where low-level clouds appear in Himawari-8 imagery.

To verify the quality of ASWinds data, JMA examined related RMSEs and biases with reference to ASCAT wind data in the vicinity of named 29 TCs occurring in 2018 (Table 4.10). Values from full-disk and Region 3 observations were small at 1.3 to 2.3 m/s and -0.7 to 0.3 m/s, respectively. The RMSE of ASWinds (Visible, B03: 0.64 µm) was smaller than those for Short-wave Infrared (B07: 3.9 µm) and Infrared (B13: 10.4 µm) imagery, indicating its superior accuracy for low-level cloud detection. The biases of ASWinds from Region 3 observations were smaller than those from full-disk observations, highlighting an advantage from the high temporal resolution of the former in wind observation.

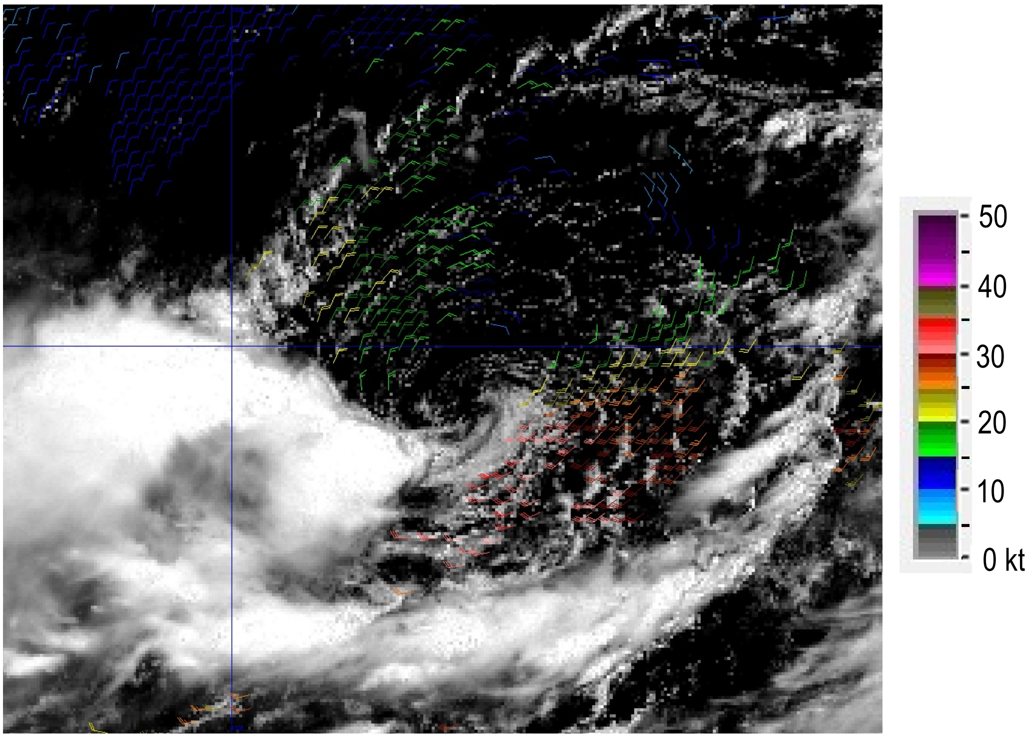


Figure 4.14 ASWinds derived from a series of full-disk Himawari-8 visible images (B03) taken every 10 minutes for TS Yagi (1814) at 0346 UTC on 8 August 2018

Table 4.10 ASWinds RMSEs and biases with reference to ASCAT winds within a radius of 1,000 km from the TC center for named 29 TCs in 2018

ASWinds (Full Disk)

	Number of collocations	RMSE [m/s]	Bias [m/s]
B03 (VIS)	57,423	1.33	-0.41
B07 (SWIR)	47,281	1.6	-0.67
B13 (IR)	39,883	1.61	-0.69

ASWinds (Region 3)

	Number of collocations	RMSE [m/s]	Bias [m/s]
B03 (VIS)	755,595	2.03	0.24
B07 (SWIR)	728,146	2.21	-0.27
B13 (IR)	473,939	2.31	-0.35

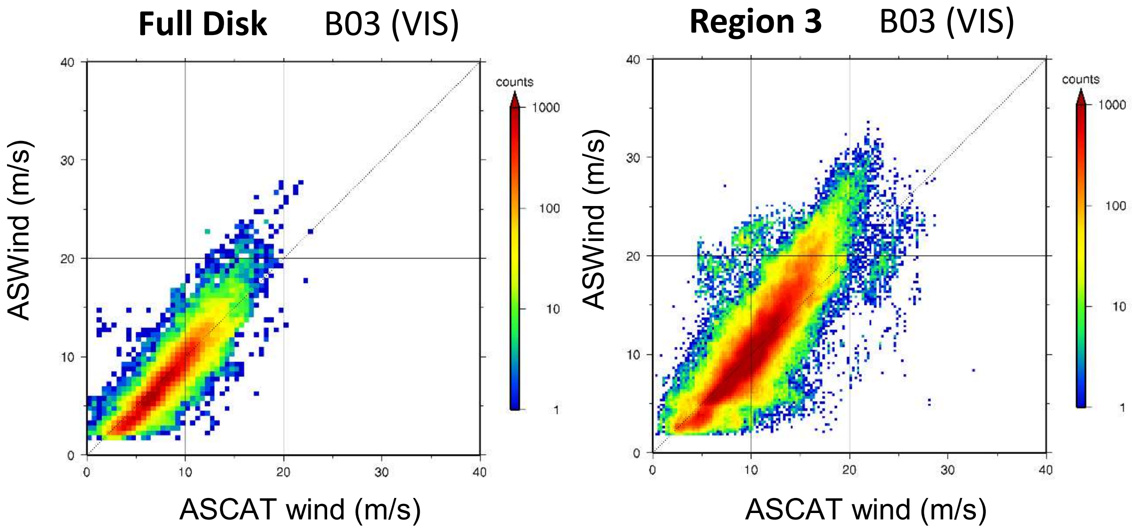


Figure 4.15 Scatter plots of wind speeds between ASCAT winds and ASWinds (B03) in the vicinity of 29 named TCs (radius from TC center: < 1,000 km) in 2018. The color scale indicates the number of collocations.

Figure 4.15 shows scatter plots of wind speeds between ASCAT winds and ASWinds in the vicinity of 29 named TCs occurring in 2018. Both sets of data correspond closely for full-disk and Region 3 observations. The maximum wind speed in ASWinds for Region 3 observations is notably higher than that for full-disk observations, implying that the high temporal resolution of Region 3 observations helps to highlight low-level winds in the vicinity of TCs where wind speed and direction abruptly change.

Statistical verification also reveals that the wind speed bias of ASWinds depends on the height of the AMV data used for derivation. ASWinds derived using AMVs for levels between 700 and 850 hPa tend to have a positive wind speed bias in comparison to ASCAT winds. To improve the ASWinds quality, JMA will continue to verify related data in consideration of AMV height, latitude and other variables.

4.5 Verification of Storm Surge Prediction

Storm surge predictions have been provided since 2011 via the NTP 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 RSMC Tokyo - Typhoon Center 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 2018. 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 Hong Kong for TY Mangkhut (1822).

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

4.5.1 Deterministic Prediction

Storm surges on a scale exceeding 2 meters were observed in Quarry Bay (Hong Kong) in 2018 (Table 4.12). Figure 4.16 shows a scatter diagram of model storm surges (hindcast and forecast) against observation data. The RMSEs (unit: m) were 0.09 (hindcast) and 0.09 (forecast), and the correlations were 0.35 and 0.33, respectively. Verification results in past Annual Reports indicate a tendency of the model to overestimate storm surges, and the underestimation observed with TY Mangkhut in Hong Kong for large storm surges is attributed to errors in the typhoon track forecast and in the model scheme.

Table 4.12 Maximum storm surges observed at the eight stations for each named TC forming in 2018 (unit: m). Slashes indicate missing observation data.

	T1801	T1802	T1803	T1804	T1805	T1806	T1807	T1808	T1809	T1810
QB	0.05	0.21	0.05	0.37	0.37	0.46	0.07	0.19	0.48	0.38
LK	0.06	0.01		0.08	0.16	0.13	0.02	0.14	0.15	0.20
LG	0.10	0.05	0.12	0.13	0.13	0.06	0.13	0.11	0.12	0.25
ML	0.02	0.06	0.06	0.04	0.23	0.10	0.03	0.10	0.16	0.28
SB	−0.02	0.03	0.09	0.09	0.10	0.14	0.07	0.14	0.17	0.17
AP	0.16	0.17	0.20	0.09	0.08	0.07	0.06	0.10	0.05	0.10
QN	0.02	0.03	0.10	0.20	0.15	0.03	0.04	0.18	0.21	0.22
VT	0.16	0.17	0.25	0.09	0.10	0.05	0.15	0.10	0.21	0.24

	T1811	T1812	T1813	T1814	T1815	T1816	T1817	T1818	T1819	T1820
QB	0.15	0.14	0.18	0.25	0.28	0.28	0.28	0.21	0.13	0.11
LK	0.09	0.16	0.21	0.27	0.27	0.22	0.22	0.22	0.24	0.24
LG	0.17	0.17	0.11	0.12	0.11	0.11	0.11	0.15	0.15	0.10
ML	0.07	0.07	0.20	0.31	0.28	0.22	0.22	0.17	0.17	0.16
SB	0.13	0.13	0.19	0.18	0.19	0.19	0.19	0.10	0.13	0.13
AP	0.05	0.05	0.04	0.02	0.09	0.14	0.09	0.14	0.12	0.12
QN	0.13	0.14	0.21	0.21	0.09	0.03	0.03	0.00	0.08	0.08
VT	0.16	0.17	0.16	0.14	0.14	0.14	0.14	0.03	0.11	0.11

	T1821	T1822	T1823	T1824	T1825	T1826	T1827	T1828	T1829
QB	0.00	2.18	0.28	0.34	0.34	0.46	0.10	0.13	0.13
LK	0.17	0.08	0.08	0.06	0.03	0.09	0.15	0.34	0.24
LG	0.02	0.11	0.05	0.03	0.06	0.17	−0.01	0.11	−0.02
ML	0.05	0.46	0.01	0.06	0.02	0.20	0.03	0.05	0.05
SB	0.08	0.15	−0.02	0.01	0.00	0.06	−0.04	−0.02	−0.02
AP	0.10	0.27	0.05	0.04	0.00	0.09	−0.08	0.03	0.03
QN	−0.04	0.16	0.13	0.15	0.20	0.05	−0.02	0.10	0.05
VT	0.04	0.21	0.09	0.16	0.33	0.21	−0.04	0.10	0.10

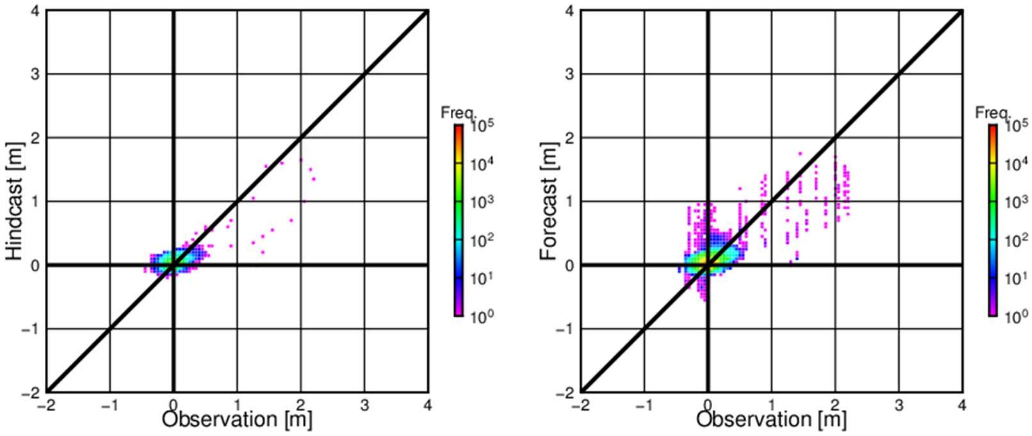


Figure 4.16 Scatter diagram of model storm surges against observation data from the eight stations for all named TCs forming in 2018 (left: hindcast; right: forecast)

4.5.2 Multi-Scenario Prediction

TY Mangkhut (1822) hit the southern coast of China in September 2018 with a maximum wind speed of 40 m/s and a minimum pressure of 960 hPa. Storm surges are a concern along the wide, shallow sea area off the Chinese coast because the phenomenon is particularly intensified there. Figure 4.17 shows the analysis track and predicted tracks (official and five selected instances) for TY Mangkhut covering the 24-hour period before the peak of the storm surge in Hong Kong. TY Mangkhut made landfall to the west of Hong Kong with a track similar to that of scenario 4, which is shifted eastward from the position of the official forecast. The maximum storm tide and surge values for Quarry Bay in the official forecast were 3.01 and 1.51 m, and those of scenario 4 were 3.47 and 1.95 m, respectively (Figure 4.18). The values for scenario 4 correspond closely to the observation values (3.73 and 2.18 m) with slight underestimation. In all scenarios, the initial rise in predicted storm surges was around five to six hours later than actually observed.

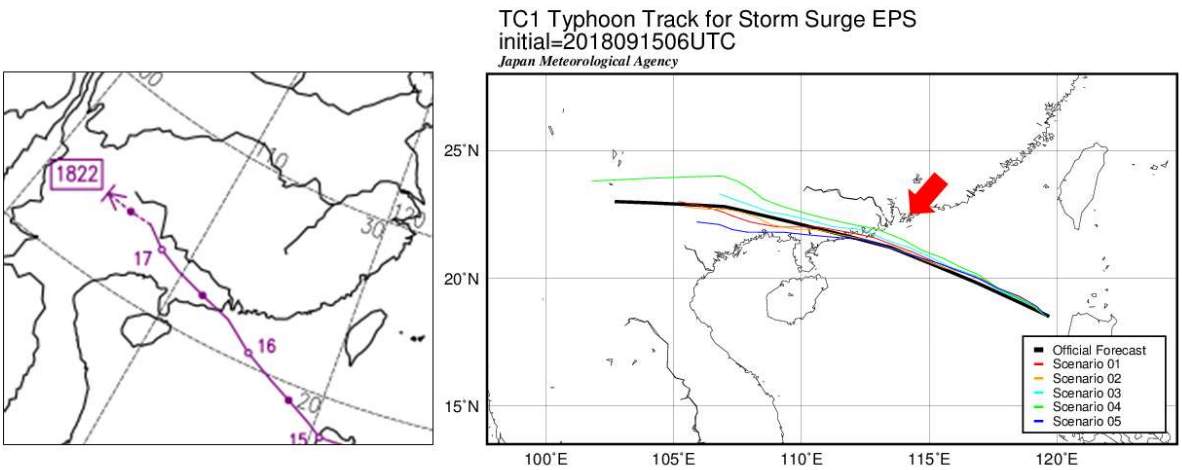


Figure 4.17 Analysis track (left) and predicted tracks (right) for TY Mangkhut. In the figure on the right, colored lines show the five selected tracks and the bold black line shows the official JMA forecast. The red arrow shows Quarry Bay.

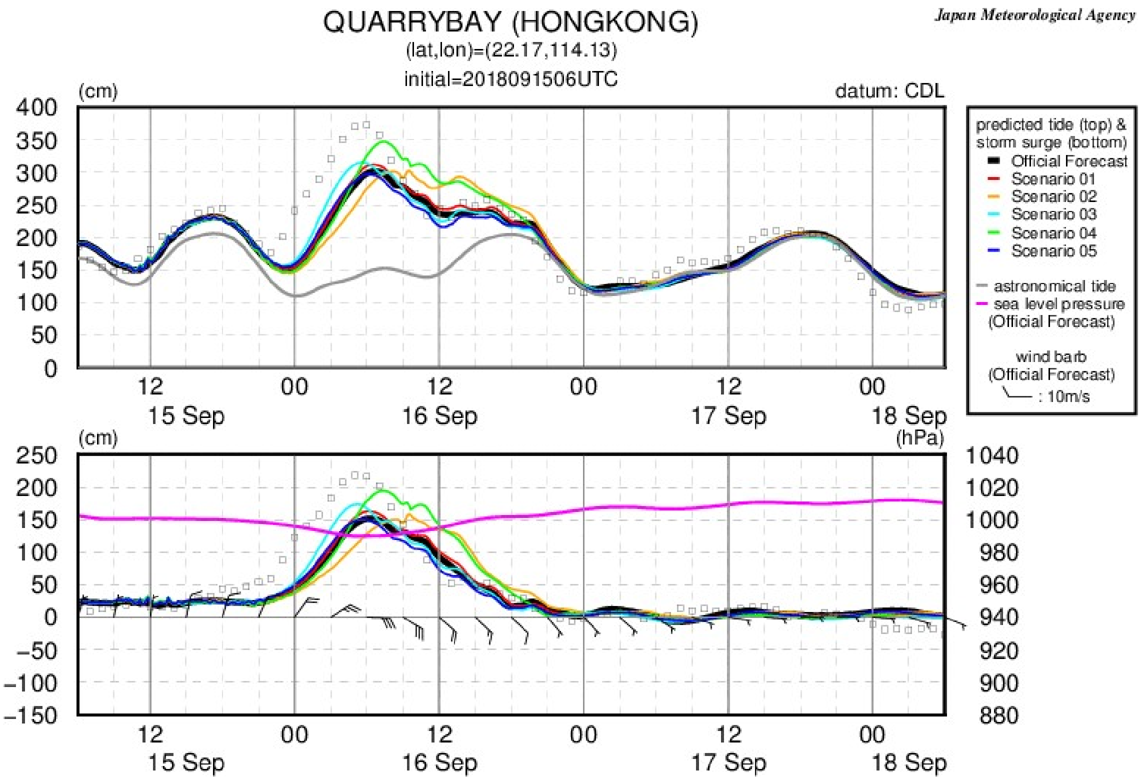


Figure 4.18 Time-series representation of storm tide and astronomical tide (top), storm surge, sea level pressure and surface wind (bottom) for Quarry Bay (Hong Kong).
Squares show hourly observation values.

[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

Appendix 1

RSMC Tropical Cyclone Best Track Data in 2018

Bolaven (1801)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Dec.	29/18	7.4	138.0	1006	-	-	TD
	30/00	8.0	137.5	1006	-	-	TD
	30/06	8.6	136.9	1004	-	0.5	TD
	30/12	9.1	136.1	1006	-	0.5	TD
	30/18	9.4	135.2	1004	-	0.5	TD
	31/00	9.5	134.3	1006	-	0.5	TD
	31/06	9.5	133.3	1004	-	1.0	TD
	31/12	9.3	132.3	1004	-	1.0	TD
	31/18	9.0	131.0	1004	-	1.0	TD
Jan.	01/00	8.8	129.9	1004	-	1.0	TD
	01/06	8.7	128.4	1002	-	1.0	TD
	01/12	9.2	126.7	1004	-	1.5	TD
	01/18	9.2	124.5	1004	-	1.5	TD
	02/00	9.2	122.4	1004	-	1.5	TD
	02/06	9.1	120.8	1004	-	1.5	TD
	02/12	9.3	119.2	1004	-	1.5	TD
	02/18	10.0	117.3	1004	-	1.5	TD
	03/00	10.4	116.0	1002	35	2.0	TS
	03/06	11.2	114.8	1002	35	2.0	TS
	03/12	11.4	113.3	1002	35	2.0	TS
	03/18	11.8	112.2	1002	35	2.0	TS
	04/00	12.3	111.0	1006	-	1.5	TD
	04/06	12.3	110.0	1008	-	1.5	TD
	04/12						Dissip.

Sanba (1802)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Feb.	08/00	8.1	150.8	1006	-	0.5	TD
	08/06	9.1	150.1	1004	-	0.5	TD
	08/12	10.8	149.8	1006	-	0.0	TD
	08/18	11.0	148.6	1004	-	0.0	TD
	09/00	10.4	147.4	1006	-	0.0	TD
	09/06	10.1	146.9	1004	-	0.0	TD
	09/12	9.4	146.0	1008	-	0.0	TD
	09/18	9.1	145.0	1006	-	0.0	TD
	10/00	8.5	143.3	1008	-	0.0	TD
	10/06	7.8	142.3	1004	-	0.5	TD
	10/12	6.9	140.8	1004	-	0.5	TD
	10/18	6.8	139.0	1002	-	1.0	TD
	11/00	6.7	137.4	1002	-	1.5	TD
	11/06	6.8	135.8	1000	35	1.5	TS
	11/12	7.0	134.4	1000	35	1.5	TS
	11/18	7.0	133.1	1000	35	1.5	TS
	12/00	7.1	131.9	1000	35	2.0	TS
	12/06	7.2	130.7	1000	35	2.0	TS
	12/12	7.7	129.3	1000	35	2.5	TS
	12/18	8.4	128.0	1000	35	2.5	TS
	13/00	9.4	126.4	1002	35	2.5	TS
	13/06	9.6	124.6	1006	-	2.5	TD
	13/12	9.1	123.9	1008	-	2.5	TD
	13/18	8.6	122.0	1008	-	2.0	TD
	14/00	7.2	120.5	1008	-	2.0	TD
	14/06	6.5	119.9	1008	-	1.5	TD
	14/12	6.7	120.0	1010	-	1.0	TD
	14/18	7.2	120.0	1008	-	1.0	TD
	15/00	8.1	119.4	1010	-	1.0	TD
	15/06	8.7	119.2	1008	-	1.0	TD
	15/12	8.9	118.5	1010	-	1.0	TD
	15/18	9.4	117.7	1010	-	0.5	TD
	16/00	10.0	116.1	1012	-	0.5	TD
	16/06	9.8	115.7	1010	-	0.5	TD
	16/12						Dissip.

Jelawat (1803)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Mar.	24/18	5.8	143.0	1004	-	1.5	TD
	25/00	6.2	141.7	1002	-	1.5	TD
	25/06	6.6	140.3	1000	35	2.0	TS
	25/12	7.0	139.2	1000	35	2.0	TS
	25/18	7.3	138.4	1000	35	2.0	TS
	26/00	7.6	137.6	1000	35	2.0	TS
	26/06	8.0	136.7	1000	35	2.0	TS
	26/12	8.7	135.8	1000	35	2.0	TS
	26/18	9.4	135.3	1000	35	2.0	TS
	27/00	10.3	135.0	1000	35	2.0	TS
	27/06	11.0	134.9	1000	35	2.0	TS
	27/12	11.6	134.8	1000	35	2.0	TS
	27/18	12.3	134.8	998	40	2.5	TS
	28/00	13.0	134.9	994	45	3.0	TS
	28/06	13.7	135.0	990	50	3.0	STS
	28/12	14.5	135.2	990	50	3.0	STS
	28/18	15.3	135.3	985	55	3.5	STS
	29/00	15.3	135.3	975	65	4.0	TY
	29/06	15.3	135.6	965	70	4.5	TY
	29/12	15.3	136.2	955	80	5.0	TY
	29/18	15.5	136.8	945	85	5.5	TY
	30/00	15.7	137.3	935	95	6.0	TY
	30/06	16.2	138.1	915	105	7.0	TY
	30/12	16.8	139.0	915	105	7.0	TY
	30/18	17.6	139.8	925	100	7.0	TY
	31/00	18.2	140.8	955	80	6.0	TY
	31/06	18.6	141.7	965	70	5.5	TY
	31/12	18.9	142.6	975	65	5.0	TY
	31/18	19.1	143.5	992	35	4.5	TS
Apr.	01/00	19.3	144.4	996	-	4.0	TD
	01/06	19.1	145.6	996	-	3.5	TD
	01/12						Dissip.

Ewiniar (1804)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jun.	02/18	14.2	112.0	1004	-	-	TD
	03/00	14.5	111.6	1002	-	-	TD
	03/06	14.9	111.3	1002	-	-	TD
	03/12	15.2	111.0	1002	-	0.0	TD
	03/18	15.4	110.9	1002	-	0.5	TD
	04/00	15.6	110.7	1002	-	1.0	TD
	04/06	15.8	110.6	1002	-	1.0	TD
	04/12	16.2	110.7	1002	-	1.5	TD
	04/18	16.8	111.1	1000	-	1.5	TD
	05/00	17.5	111.4	1000	35	2.0	TS
	05/06	18.5	111.5	1000	35	2.0	TS
	05/12	19.7	111.4	1000	35	2.0	TS
	05/18	20.5	111.0	1000	35	2.0	TS
	06/00	20.7	110.7	1000	35	2.0	TS
	06/06	20.1	110.4	998	35	2.0	TS
	06/12	20.2	111.0	998	35	2.0	TS
	06/18	20.4	111.3	998	35	2.0	TS
	07/00	20.7	111.3	998	35	2.0	TS
	07/06	21.0	111.4	998	40	2.5	TS
	07/12	21.4	111.7	998	40	2.5	TS
	07/18	21.9	111.9	998	40	2.5	TS
	08/00	22.5	112.1	998	40	2.0	TS
	08/06	23.0	112.3	998	35	2.0	TS
	08/12	23.3	112.6	998	35	1.5	TS
	08/18	23.1	113.3	998	-	1.5	TD
	09/00	22.9	113.9	998	-	1.0	TD
	09/06	23.0	114.4	998	-	-	TD
	09/12	23.0	114.6	998	-	-	TD
	09/18	22.8	115.3	998	-	-	TD
	10/00	22.7	116.4	1000	-	-	TD
	10/06	23.1	118.6	998	-	-	TD
	10/12	23.4	121.8	1000	-	-	TD
	10/18	23.9	122.8	998	-	-	TD
	11/00	24.6	123.7	998	-	-	TD
	11/06	24.9	125.3	998	-	-	TD
	11/12						Dissip.

Maliksi (1805)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jun.	03/18	9.7	131.8	1004	-	0.5	TD
	04/00	9.6	131.9	1006	-	1.0	TD
	04/06	9.8	132.0	1004	-	0.5	TD
	04/12	9.9	132.0	1004	-	1.0	TD
	04/18	10.0	132.0	1004	-	1.0	TD
	05/00	10.1	132.0	1004	-	0.5	TD
	05/06	10.6	132.1	1004	-	0.5	TD
	05/12	11.0	132.2	1004	-	1.0	TD
	05/18	12.1	131.7	1002	-	0.5	TD
	06/00	13.0	131.3	1004	-	1.0	TD
	06/06	13.8	130.7	1002	-	1.0	TD
	06/12	14.7	130.0	1004	-	1.5	TD
	06/18	15.4	129.2	1004	-	1.5	TD
	07/00	16.0	128.5	1002	-	1.5	TD
	07/06	16.2	128.4	1000	-	1.5	TD
	07/12	16.8	128.0	1000	-	1.5	TD
	07/18	17.3	127.9	996	35	1.5	TS
	08/00	17.8	127.8	996	35	1.5	TS
	08/06	18.9	127.2	996	35	1.5	TS
	08/12	19.7	126.8	996	35	2.0	TS
	08/18	20.4	126.7	992	40	2.5	TS
	09/00	21.9	127.0	990	45	2.5	TS
	09/06	22.3	127.5	985	50	3.0	STS
	09/12	22.8	128.1	985	50	3.5	STS
	09/15	23.1	128.6	985	50	-	STS
	09/18	23.5	129.4	975	55	4.0	STS
	09/21	24.3	130.1	975	55	-	STS
	10/00	25.0	130.7	970	60	4.0	STS
	10/03	25.8	131.4	970	60	-	STS
	10/06	26.3	132.3	970	60	4.0	STS
	10/09	26.8	133.4	970	60	-	STS
	10/12	27.6	134.4	975	55	4.0	STS
	10/18	28.9	136.5	980	55	3.5	STS
	11/00	30.6	139.0	980	50	3.0	STS
	11/06	32.7	141.2	980	50	2.5	STS
	11/12	34.6	144.8	980	50	2.0	STS
	11/18	36.5	148.0	984	-	2.0	L
	12/00	37.8	149.8	984	-	-	L
	12/06	38.8	152.0	984	-	-	L
	12/12	39.0	155.4	992	-	-	L
	12/18	38.8	157.7	996	-	-	L
	13/00						Dissip.

Gaemi (1806)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jun.	13/12	21.6	117.1	996	-	0.5	TD
	13/18	21.7	117.9	996	-	1.0	TD
	14/00	21.8	118.6	996	-	1.5	TD
	14/06	22.0	119.2	994	-	1.5	TD
	14/12	22.4	119.8	994	-	1.5	TD
	14/18	22.6	120.1	994	-	1.5	TD
	15/00	22.7	120.2	994	35	2.0	TS
	15/06	23.3	122.2	994	35	2.0	TS
	15/12	24.9	123.9	994	35	2.0	TS
	15/18	25.2	125.1	994	40	2.0	TS
	16/00	26.3	127.1	992	40	2.0	TS
	16/06	26.8	128.9	990	45	2.0	TS
	16/12	27.2	130.8	992	40	2.0	TS
	16/18	27.7	131.5	992	40	2.0	TS
	17/00	28.5	132.1	996	-	2.0	L
	17/06	29.4	132.7	996	-	-	L
	17/12	30.0	133.5	996	-	-	L
	17/18	30.5	134.2	996	-	-	L
	18/00	31.2	135.3	996	-	-	L
	18/06	31.7	137.2	996	-	-	L
	18/12	32.0	139.0	998	-	-	L
	18/18	32.6	141.4	998	-	-	L
	19/00	33.7	144.0	998	-	-	L
	19/06	34.7	146.2	996	-	-	L
	19/12	35.8	148.1	992	-	-	L
	19/18	36.1	150.2	994	-	-	L
	20/00	36.7	151.0	996	-	-	L
	20/06	37.3	151.5	998	-	-	L
	20/12	38.1	152.1	1000	-	-	L
	20/18	38.7	152.5	1000	-	-	L
	21/00	39.3	153.2	1002	-	-	L
	21/06	40.0	154.1	1002	-	-	L
	21/12	41.0	154.1	998	-	-	L
	21/18						Dissip.

Prapiroon (1807)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jun.	28/00	19.8	132.8	1006	-	0.5	TD
	28/06	19.8	132.2	1004	-	1.0	TD
	28/12	19.8	131.4	1004	-	1.0	TD
	28/18	19.8	130.8	1002	-	1.5	TD
	29/00	19.8	130.3	998	35	2.0	TS
	29/06	19.8	129.9	998	35	2.0	TS
	29/12	19.8	129.8	996	40	2.5	TS
	29/18	19.9	129.7	996	40	2.5	TS
	30/00	20.4	129.6	992	45	3.0	TS
	30/06	21.0	129.4	992	45	3.0	TS
	30/12	21.8	128.8	992	45	3.0	TS
	30/18	22.9	128.2	992	45	3.0	TS
Jul.	01/00	23.6	127.7	985	50	3.0	STS
	01/03	23.9	127.3	985	50	-	STS
	01/06	24.5	127.2	980	55	3.0	STS
	01/09	25.0	127.0	980	55	-	STS
	01/12	25.4	126.9	980	55	3.0	STS
	01/15	25.8	126.8	980	55	-	STS
	01/18	26.1	126.8	970	60	3.5	STS
	01/21	26.7	126.8	970	60	-	STS
	02/00	27.2	127.0	965	65	4.0	TY
	02/03	27.7	127.1	965	65	-	TY
	02/06	28.2	127.4	965	65	4.0	TY
	02/09	28.8	127.7	965	65	-	TY
	02/12	29.5	128.1	965	65	4.0	TY
	02/15	30.1	127.9	965	65	-	TY
	02/18	30.7	127.8	960	65	4.0	TY
	02/21	31.4	127.9	960	65	-	TY
	03/00	32.0	128.2	965	60	3.5	STS
	03/03	32.7	128.6	965	60	-	STS
	03/06	33.2	128.9	965	60	3.5	STS
	03/09	33.9	129.3	970	60	-	STS
	03/12	34.4	129.6	975	55	3.5	STS
	03/15	35.0	130.2	975	55	-	STS
	03/18	35.6	130.8	980	50	3.0	STS
	04/00	37.3	132.5	985	45	2.5	TS
	04/06	39.6	134.8	986	-	2.5	L
	04/12	40.6	136.6	986	-	-	L
	04/18	40.9	138.3	986	-	-	L
	05/00	41.3	139.5	992	-	-	L
	05/06	41.7	140.2	1002	-	-	L
	05/12						Dissip.

Maria (1808)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	03/00	10.1	147.8	1004	-	0.5	TD
	03/06	10.6	147.6	1004	-	0.5	TD
	03/12	11.3	147.1	1004	-	1.0	TD
	03/18	11.4	146.7	1002	-	1.0	TD
	04/00	11.6	146.5	1002	-	1.5	TD
	04/06	12.1	146.2	1002	-	1.5	TD
	04/12	12.6	145.6	1000	35	2.0	TS
	04/18	13.6	144.8	992	45	2.5	TS
	05/00	14.1	144.1	990	50	3.0	STS
	05/06	14.5	143.3	985	55	3.5	STS
	05/12	14.8	142.7	970	70	4.5	TY
	05/18	15.4	142.3	955	80	5.0	TY
	06/00	16.0	142.0	950	85	5.5	TY
	06/06	16.5	141.6	935	95	6.0	TY
	06/12	16.7	141.3	925	100	6.5	TY
	06/18	16.9	141.0	925	100	6.5	TY
	07/00	17.1	140.8	935	95	6.0	TY
	07/06	17.6	140.7	935	95	6.0	TY
	07/12	18.0	140.3	935	95	6.0	TY
	07/18	18.5	139.6	935	95	6.0	TY
	08/00	19.0	138.9	935	95	6.0	TY
	08/06	19.9	137.8	925	100	6.5	TY
	08/12	20.5	136.6	925	100	6.5	TY
	08/18	21.1	135.1	925	100	6.5	TY
	09/00	21.8	133.5	915	105	7.0	TY
	09/06	22.4	131.9	915	105	7.0	TY
	09/12	23.0	130.3	915	105	7.0	TY
	09/15	23.1	129.5	925	100	-	TY
	09/18	23.4	128.7	935	95	6.0	TY
	09/21	23.7	127.9	935	95	-	TY
	10/00	24.0	127.2	940	90	5.5	TY
	10/03	24.5	126.3	940	90	-	TY
	10/06	24.7	125.5	940	90	5.5	TY
	10/09	25.1	124.8	940	90	-	TY
	10/12	25.3	124.0	950	85	5.5	TY
	10/15	25.7	123.3	950	85	-	TY
	10/18	26.2	122.3	950	85	5.5	TY
	10/21	26.4	121.0	950	85	-	TY
	11/00	26.4	120.0	950	85	5.5	TY
	11/06	26.4	117.8	975	65	5.0	TY
	11/12	26.7	116.7	992	45	4.0	TS
	11/18	27.9	115.6	998	-	3.5	TD
	12/00	28.6	114.4	1000	-	3.5	TD
	12/06	29.3	113.7	1000	-	3.0	TD
	12/12	30.2	112.7	1002	-	2.5	TD
	12/18	30.6	111.8	1002	-	2.0	TD
	13/00						Dissip.

Son-tinh (1809)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	16/00	18.4	125.3	1000	-	1.0	TD
	16/06	18.6	124.0	998	-	1.5	TD
	16/12	18.9	122.4	998	-	1.5	TD
	16/18	19.3	120.8	998	-	1.5	TD
	17/00	19.4	118.5	996	35	2.0	TS
	17/06	19.2	115.9	996	35	2.5	TS
	17/12	19.0	113.6	994	40	3.0	TS
	17/18	18.8	111.3	994	40	3.0	TS
	18/00	18.6	109.3	996	35	3.0	TS
	18/06	18.8	107.9	994	40	3.0	TS
	18/12	18.8	106.8	994	40	3.0	TS
	18/18	18.8	105.6	994	35	3.0	TS
	19/00	19.1	104.4	998	-	2.5	TD
	19/06	19.5	103.3	1000	-	2.0	TD
	19/12	19.5	102.9	1000	-	1.5	TD
	19/18	19.6	103.4	1000	-	-	TD
	20/00	19.8	103.9	1002	-	-	TD
	20/06	20.1	104.3	1000	-	-	TD
	20/12	20.4	104.6	1000	-	-	TD
	20/18	20.4	105.1	1000	-	-	TD
	21/00	20.2	105.5	1000	-	-	TD
	21/06	19.9	106.0	998	-	1.5	TD
	21/12	19.7	106.6	998	-	1.5	TD
	21/18	19.5	107.1	996	-	1.5	TD
	22/00	19.3	107.6	996	-	1.5	TD
	22/06	19.1	108.2	996	-	1.5	TD
	22/12	19.1	109.0	994	-	1.5	TD
	22/18	19.5	109.5	994	-	1.0	TD
	23/00	19.9	109.9	996	-	1.0	TD
	23/06	20.4	110.4	994	-	1.0	TD
	23/12	20.7	110.7	994	-	1.0	TD
	23/18	21.2	110.7	994	-	1.0	TD
	24/00	22.1	109.5	998	-	1.0	TD
	24/06	22.6	108.9	998	-	1.0	TD
	24/12	23.1	108.3	998	-	-	TD
	24/18	23.6	107.6	1000	-	-	TD
	25/00						Dissip.

Ampil (1810)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	17/12	18.4	127.9	1000	-	0.5	TD
	17/18	18.8	128.2	1000	-	1.0	TD
	18/00	19.1	128.7	1000	-	1.5	TD
	18/06	19.4	129.4	1000	-	1.5	TD
	18/12	19.7	130.0	996	35	2.0	TS
	18/18	19.8	130.4	996	35	2.0	TS
	19/00	20.0	130.8	994	40	2.5	TS
	19/06	20.9	131.7	994	40	2.5	TS
	19/12	21.6	131.6	990	45	2.5	TS
	19/18	22.3	131.2	985	50	3.0	STS
	20/00	22.5	130.8	985	50	3.0	STS
	20/06	23.1	130.5	985	50	3.0	STS
	20/09	23.8	130.3	985	50	-	STS
	20/12	24.5	129.9	985	50	3.0	STS
	20/15	24.9	129.5	985	50	-	STS
	20/18	25.6	129.0	985	50	3.0	STS
	20/21	26.2	128.7	985	50	-	STS
	20/23	26.6	128.3	985	50	-	STS
	21/00	26.7	127.9	985	50	3.0	STS
	21/03	27.3	127.3	985	50	-	STS
	21/06	27.8	126.7	985	50	3.0	STS
	21/12	28.6	125.9	985	50	3.0	STS
	21/18	29.6	124.5	985	50	3.0	STS
	22/00	30.7	123.2	985	45	2.5	TS
	22/06	31.8	121.9	985	45	2.5	TS
	22/12	32.7	120.7	985	40	2.0	TS
	22/18	33.4	119.8	990	35	2.0	TS
	23/00	34.5	119.2	992	35	2.0	TS
	23/06	35.1	118.7	992	35	2.0	TS
	23/12	36.5	117.9	996	-	2.0	TD
	23/18	37.5	117.3	996	-	1.5	TD
	24/00	39.1	117.3	996	-	1.0	TD
	24/06	39.9	118.3	996	-	0.5	TD
	24/12	41.6	119.9	996	-	0.5	TD
	24/18	43.5	122.0	996	-	0.5	TD
	25/00	45.1	124.5	996	-	-	L
	25/06	46.1	127.6	996	-	-	L
	25/12	46.9	131.8	998	-	-	L
	25/18	47.3	134.9	1000	-	-	L
	26/00	47.4	136.5	1002	-	-	L
	26/06	47.5	137.8	1004	-	-	L
	26/12						Dissip.

Wukong (1811)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	22/00	22.0	159.6	1008	-	0.5	TD
	22/06	22.8	159.7	1006	-	0.5	TD
	22/12	23.7	159.5	1008	-	0.5	TD
	22/18	24.5	159.2	1004	-	1.0	TD
	23/00	25.3	159.8	1002	-	1.5	TD
	23/06	26.3	159.6	1000	-	2.0	TD
	23/12	27.3	159.4	998	35	2.0	TS
	23/18	28.4	159.1	996	40	2.5	TS
	24/00	29.3	159.0	992	45	2.5	TS
	24/06	30.2	158.8	992	45	2.5	TS
	24/12	30.8	158.6	992	45	2.5	TS
	24/18	31.6	158.4	992	45	2.5	TS
	25/00	32.7	158.2	990	50	3.0	STS
	25/06	33.9	157.9	990	50	3.0	STS
	25/12	35.4	157.3	990	50	3.0	STS
	25/18	37.0	156.0	992	45	3.0	TS
	26/00	38.4	154.7	996	40	3.0	TS
	26/06	39.4	153.9	996	40	3.0	TS
	26/12	41.4	152.7	1002	35	2.5	TS
	26/18	42.7	152.3	1002	35	2.0	TS
	27/00	44.3	152.2	1008	-	1.5	L
	27/06	45.8	153.4	1008	-	-	L
	27/12	47.9	155.7	1008	-	-	L
	27/18						Dissip.

Jongdari (1812)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	23/18	17.4	137.0	1002	-	1.0	TD
	24/00	18.2	136.9	1002	-	1.5	TD
	24/06	19.2	136.7	1002	-	1.5	TD
	24/12	19.7	136.7	998	35	1.5	TS
	24/18	20.3	136.6	998	35	2.0	TS
	25/00	20.7	136.8	998	35	2.0	TS
	25/06	21.5	137.0	994	40	2.5	TS
	25/12	21.8	137.3	990	50	3.0	STS
	25/18	21.9	137.7	985	55	3.5	STS
	26/00	22.1	138.2	985	55	3.5	STS
	26/06	22.6	139.2	985	55	3.5	STS
	26/12	23.2	140.2	980	60	4.0	STS
	26/18	23.9	141.1	965	70	4.5	TY
	27/00	25.0	142.4	960	75	5.0	TY
	27/03	25.6	143.2	960	75	-	TY
	27/06	26.4	143.8	960	75	5.0	TY
	27/09	27.2	144.4	960	75	-	TY
	27/12	28.2	144.6	960	75	5.0	TY
	27/15	29.3	144.7	960	75	-	TY
	27/18	30.3	144.3	960	75	5.0	TY
	27/21	31.2	143.9	960	75	-	TY
	28/00	32.3	143.0	960	75	5.0	TY
	28/03	33.3	141.8	960	75	-	TY
	28/06	33.8	140.5	965	70	4.5	TY
	28/09	33.8	139.3	965	70	-	TY
	28/12	34.1	138.3	965	70	4.5	TY
	28/15	34.4	137.2	970	65	-	TY
	28/16	34.5	136.7	970	65	-	TY
	28/18	34.6	135.8	975	60	4.0	STS
	28/21	34.7	134.6	980	55	-	STS
	29/00	34.6	133.3	990	45	3.5	TS
	29/03	34.5	132.6	990	45	-	TS
	29/06	34.1	131.4	992	45	3.0	TS
	29/08	33.8	131.2	992	40	-	TS
	29/09	33.6	131.0	992	40	-	TS
	29/12	33.1	130.4	994	35	2.5	TS
	29/14	32.8	130.1	994	35	-	TS
	29/18	31.9	129.8	994	35	2.5	TS
	30/00	31.1	129.4	994	35	2.5	TS
	30/06	30.3	129.5	994	35	2.5	TS
	30/12	29.2	129.7	994	-	2.0	TD
	30/18	29.0	131.0	994	-	2.0	TD
	31/00	29.8	131.7	992	35	2.0	TS
	31/06	30.6	131.7	990	35	2.0	TS
	31/12	30.8	130.3	985	40	2.0	TS
	31/18	30.8	128.7	985	40	2.0	TS
Aug.	01/00	30.2	128.0	990	35	2.0	TS
	01/06	29.6	127.0	990	35	2.0	TS
	01/12	28.9	126.5	990	35	2.0	TS
	01/18	28.4	126.3	990	35	2.0	TS
	02/00	28.6	127.0	990	35	2.0	TS
	02/06	29.4	126.7	990	35	2.0	TS
	02/12	30.4	125.2	990	35	1.5	TS
	02/18	30.7	122.5	990	35	1.5	TS
	03/00	30.6	121.5	994	-	1.5	TD
	03/06	30.9	121.1	994	-	1.5	TD
	03/12	31.8	120.4	998	-	1.0	TD
	03/18	33.2	119.2	998	-	-	TD
	04/00	33.7	118.1	1000	-	-	TD
	04/06	34.0	117.2	1000	-	-	TD
	04/12	34.1	115.7	1002	-	-	TD
	04/18						Dissip.

Shanshan (1813)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	02/06	18.1	152.0	1002	-	1.0	TD
	02/12	17.7	151.8	1002	-	1.0	TD
	02/18	17.7	151.3	1000	-	1.5	TD
	03/00	17.7	150.9	998	35	2.0	TS
	03/06	18.0	150.6	996	40	2.5	TS
	03/12	18.2	150.3	990	50	3.0	STS
	03/18	18.9	150.0	990	50	3.0	STS
	04/00	20.1	149.3	985	55	3.5	STS
	04/06	20.9	148.7	975	65	4.0	TY
	04/12	21.6	148.4	975	65	4.5	TY
	04/18	22.5	147.7	970	70	4.5	TY
	05/00	22.9	147.4	970	70	4.5	TY
	05/06	23.8	147.5	970	70	4.5	TY
	05/12	24.6	147.3	970	70	4.5	TY
	05/18	25.6	146.7	970	70	4.5	TY
	06/00	26.5	146.2	970	70	4.5	TY
	06/06	27.5	146.0	970	70	4.5	TY
	06/12	28.5	145.7	970	70	4.0	TY
	06/18	29.7	145.0	970	70	4.0	TY
	07/00	30.5	144.3	970	70	4.5	TY
	07/06	31.3	143.9	970	70	4.5	TY
	07/12	32.0	143.1	970	70	4.5	TY
	07/18	32.5	142.2	970	70	4.5	TY
	08/00	33.3	141.9	970	70	4.5	TY
	08/03	33.5	141.5	975	65	-	TY
	08/06	33.8	141.2	975	65	4.0	TY
	08/09	34.1	141.3	975	65	-	TY
	08/12	34.5	141.3	975	65	4.0	TY
	08/15	34.8	141.2	975	65	-	TY
	08/18	35.3	141.0	975	65	3.5	TY
	08/21	35.8	141.0	975	65	-	TY
	09/00	36.2	141.1	980	60	3.5	STS
	09/03	36.8	141.2	980	60	-	STS
	09/06	37.3	141.4	980	60	3.5	STS
	09/09	37.6	141.9	980	55	-	STS
	09/12	37.9	142.5	985	50	3.0	STS
	09/18	39.1	144.1	990	45	2.5	TS
	10/00	40.0	147.2	992	45	2.0	TS
	10/06	41.0	151.0	992	-	1.5	L
	10/12	41.3	154.6	992	-	-	L
	10/18	41.2	158.4	994	-	-	L
	11/00	41.1	163.4	996	-	-	L
	11/06	40.6	169.4	998	-	-	L
	11/12						Dissip.

Yagi (1814)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	06/00	18.2	134.1	1000	-	1.0	TD
	06/06	18.5	134.0	1000	-	1.0	TD
	06/12	18.7	133.9	998	-	1.0	TD
	06/18	19.0	133.6	998	-	1.0	TD
	07/00	19.1	133.3	998	-	1.0	TD
	07/06	19.1	132.8	996	-	1.0	TD
	07/12	19.1	132.6	996	-	1.5	TD
	07/18	19.1	132.5	996	-	1.5	TD
	08/00	19.2	132.5	994	35	2.0	TS
	08/06	19.5	133.4	994	35	2.0	TS
	08/12	19.9	134.0	994	35	2.0	TS
	08/18	20.6	134.0	994	35	2.0	TS
	09/00	21.0	133.7	994	35	2.0	TS
	09/06	20.9	133.4	994	35	2.0	TS
	09/12	20.9	133.4	994	35	2.0	TS
	09/18	22.2	133.0	994	35	2.0	TS
	10/00	22.8	132.3	994	35	2.0	TS
	10/06	22.7	131.9	994	35	2.0	TS
	10/12	23.3	132.0	994	35	2.0	TS
	10/18	24.2	130.9	994	35	2.0	TS
	11/00	25.0	129.6	994	35	2.0	TS
	11/06	25.0	128.0	992	35	2.0	TS
	11/12	25.0	126.8	990	40	2.5	TS
	11/18	25.2	125.5	990	40	2.5	TS
	12/00	25.6	124.8	990	40	2.5	TS
	12/06	26.5	123.6	990	40	2.5	TS
	12/12	27.6	122.3	990	40	2.5	TS
	12/18	29.0	120.7	990	35	2.0	TS
	13/00	30.7	118.9	994	-	2.0	TD
	13/06	31.9	117.7	994	-	1.5	TD
	13/12	32.9	117.0	996	-	-	TD
	13/18	34.2	116.1	998	-	-	TD
	14/00	35.5	116.4	1000	-	-	TD
	14/06	36.9	117.0	1000	-	-	TD
	14/12	37.7	117.6	1000	-	-	TD
	14/18	37.9	118.9	1002	-	-	TD
	15/00	37.9	119.5	1002	-	-	TD
	15/06	37.9	119.7	1000	-	-	L
	15/12	37.2	119.3	1000	-	-	L
	15/18	36.6	117.9	1004	-	-	L
	16/00	35.3	116.1	1006	-	-	L
	16/06						Dissip.

Leepi (1815)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	10/12	17.5	145.0	1006	-	0.5	TD
	10/18	18.2	144.4	1004	-	0.5	TD
	11/00	18.6	144.0	1004	-	1.0	TD
	11/06	19.0	143.8	1004	-	1.5	TD
	11/12	19.7	143.4	1000	35	2.0	TS
	11/18	20.7	143.0	998	40	2.5	TS
	12/00	21.4	142.7	998	40	2.5	TS
	12/06	22.5	142.0	998	40	2.5	TS
	12/12	23.4	141.2	998	40	2.5	TS
	12/18	24.4	140.5	996	45	2.5	TS
	13/00	25.3	139.9	996	45	2.5	TS
	13/06	26.5	138.6	994	50	3.0	STS
	13/12	27.1	138.2	994	50	3.0	STS
	13/18	28.3	137.2	994	50	3.0	STS
	14/00	29.4	136.2	994	50	3.0	STS
	14/06	30.5	134.9	994	50	3.0	STS
	14/09	30.9	134.1	994	50	-	STS
	14/12	31.4	133.2	994	50	3.0	STS
	14/15	31.8	132.4	996	45	-	TS
	14/17	32.4	131.9	998	40	-	TS
	14/18	32.5	131.4	1000	40	2.5	TS
	14/21	33.2	130.6	1002	35	-	TS
	15/00	33.9	130.0	1006	-	2.0	TD
	15/06	34.9	129.4	1006	-	1.5	TD
	15/12	35.7	129.3	1006	-	-	TD
	15/18						Dissip.

Bebinca (1816)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	09/18	19.9	111.6	998	-	-	TD
	10/00	20.3	111.7	998	-	-	TD
	10/06	20.7	111.9	998	-	-	TD
	10/12	20.9	112.1	998	-	-	TD
	10/18	21.0	112.2	996	-	0.5	TD
	11/00	21.2	112.3	994	-	0.5	TD
	11/06	22.1	112.2	994	-	1.0	TD
	11/12	21.5	112.3	994	-	1.0	TD
	11/18	21.2	112.1	994	-	1.0	TD
	12/00	21.0	112.1	992	-	1.0	TD
	12/06	20.9	112.2	992	-	1.0	TD
	12/12	20.6	112.3	992	-	1.5	TD
	12/18	20.6	112.7	992	-	2.0	TD
	13/00	20.6	112.9	990	35	2.0	TS
	13/06	20.6	113.3	990	35	2.0	TS
	13/12	20.6	113.5	990	35	2.0	TS
	13/18	20.7	113.7	990	35	2.0	TS
	14/00	20.9	113.9	990	35	2.0	TS
	14/06	21.0	113.6	990	35	2.0	TS
	14/12	21.0	113.3	990	35	2.0	TS
	14/18	21.0	112.9	990	35	2.0	TS
	15/00	20.9	112.0	990	35	2.0	TS
	15/06	21.0	111.4	990	40	2.5	TS
	15/12	20.8	110.7	990	40	2.5	TS
	15/18	20.7	109.6	990	40	2.5	TS
	16/00	20.5	108.3	990	40	3.0	TS
	16/06	20.1	107.9	985	45	3.0	TS
	16/12	19.8	107.2	985	45	3.0	TS
	16/18	19.7	106.5	990	40	3.5	TS
	17/00	19.5	105.1	992	35	3.0	TS
	17/06	19.0	104.0	994	-	2.5	TD
	17/12	20.2	102.2	996	-	2.0	TD
	17/18	19.8	100.3	996	-	1.5	TD
	18/00						Dissip.

Hector (1817)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	13/12	25.2	180.6	998	40	3.0	Out
	13/18	25.8	178.9	998	40	3.0	TS
	14/00	26.3	176.9	998	40	3.0	TS
	14/06	26.5	175.8	1000	35	2.5	TS
	14/12	27.0	174.4	1004	35	2.0	TS
	14/18	27.8	172.6	1004	35	2.0	TS
	15/00	28.7	170.6	1004	35	2.0	TS
	15/06	29.3	168.9	1004	35	2.0	TS
	15/12	29.9	167.9	1008	-	1.5	TD
	15/18	30.7	167.1	1012	-	1.5	TD
	16/00	31.6	166.4	1014	-	1.5	TD
	16/06	32.2	165.8	1014	-	1.5	TD
	16/12	32.7	165.7	1014	-	1.0	TD
	16/18	33.6	165.7	1014	-	1.0	TD
	17/00						Dissip.

Rumbia (1818)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	14/00	22.9	128.7	998	-	0.5	TD
	14/06	23.6	128.2	998	-	1.0	TD
	14/12	24.4	127.8	998	-	1.0	TD
	14/18	25.5	127.5	998	-	1.0	TD
	15/00	27.0	127.3	996	-	1.5	TD
	15/06	28.2	126.9	994	35	2.0	TS
	15/12	29.1	126.0	992	35	2.0	TS
	15/18	29.6	125.3	990	40	2.0	TS
	16/00	30.0	124.6	990	40	2.0	TS
	16/06	30.3	123.9	990	40	2.0	TS
	16/12	30.5	122.9	985	45	2.0	TS
	16/18	30.7	121.7	985	45	2.5	TS
	17/00	31.1	120.4	985	45	3.0	TS
	17/06	31.5	118.8	985	40	3.0	TS
	17/12	31.7	117.4	990	35	2.5	TS
	17/18	31.9	116.1	990	35	2.0	TS
	18/00	32.2	115.3	992	-	1.5	TD
	18/06	32.4	114.9	994	-	1.5	TD
	18/12	32.7	114.5	994	-	1.0	TD
	18/18	33.2	114.3	996	-	1.0	TD
	19/00	33.6	114.7	998	-	0.5	TD
	19/06	33.8	115.3	998	-	-	TD
	19/12	34.1	116.4	998	-	-	TD
	19/18						Dissip.

Soulik (1819)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	15/06	11.7	144.7	1000	-	0.5	TD
	15/12	12.8	144.1	1002	-	1.0	TD
	15/18	14.1	143.5	1000	-	1.5	TD
	16/00	15.6	143.0	998	35	2.0	TS
	16/06	17.3	142.3	998	35	2.0	TS
	16/12	18.9	141.7	994	40	2.5	TS
	16/18	20.0	141.4	990	45	3.0	TS
	17/00	21.4	141.0	985	50	3.0	STS
	17/06	23.0	140.5	980	55	3.5	STS
	17/12	23.8	140.2	970	65	4.0	TY
	17/18	24.4	140.1	965	70	4.5	TY
	18/00	24.6	140.1	960	75	4.5	TY
	18/06	24.8	140.0	955	80	5.0	TY
	18/12	24.9	139.9	955	80	5.0	TY
	18/18	25.0	139.6	955	80	5.0	TY
	19/00	25.1	139.0	955	80	5.0	TY
	19/06	25.2	138.6	955	80	5.0	TY
	19/12	25.4	137.9	960	75	4.5	TY
	19/18	25.6	137.1	965	70	4.5	TY
	20/00	25.8	136.4	960	75	4.5	TY
	20/06	26.1	135.5	955	80	5.0	TY
	20/12	26.4	134.5	955	80	5.0	TY
	20/15	26.7	134.0	955	80	-	TY
	20/18	27.0	133.3	950	85	5.0	TY
	20/21	27.4	132.7	950	85	-	TY
	21/00	27.7	132.1	950	85	5.0	TY
	21/03	28.0	131.6	950	85	-	TY
	21/06	28.3	130.9	950	85	5.0	TY
	21/09	28.8	130.4	950	85	-	TY
	21/12	28.9	129.8	950	85	5.0	TY
	21/15	29.4	129.3	950	85	-	TY
	21/18	29.7	128.7	950	85	5.0	TY
	21/21	30.1	128.2	950	85	-	TY
	22/00	30.4	127.6	950	85	5.0	TY
	22/03	30.7	127.2	950	85	-	TY
	22/06	31.2	126.8	955	80	5.0	TY
	22/09	31.6	126.5	955	80	-	TY
	22/12	31.9	126.2	960	75	5.0	TY
	22/18	32.6	125.7	965	70	4.5	TY
	23/00	33.0	125.5	965	70	4.0	TY
	23/06	33.6	125.7	970	65	4.0	TY
	23/12	34.3	126.1	975	60	3.5	STS
	23/18	35.7	127.3	985	45	3.0	TS
	24/00	37.5	128.9	985	45	2.5	TS
	24/06	38.9	130.4	985	45	2.5	TS
	24/12	40.1	132.0	990	40	2.0	TS
	24/18	41.1	133.9	992	-	1.5	L
	25/00	42.1	135.5	996	-	1.0	L
	25/06	42.7	136.6	998	-	1.0	L
	25/12	43.5	138.6	1002	-	-	L
	25/18	44.2	140.8	1002	-	-	L
	26/00	44.5	142.4	1004	-	-	L
	26/06	43.9	144.4	1004	-	-	L
	26/12	43.1	147.8	1004	-	-	L
	26/18	42.8	151.5	1002	-	-	L
	27/00	42.6	154.6	1002	-	-	L
	27/06	43.5	157.4	1000	-	-	L
	27/12	43.4	160.0	998	-	-	L
	27/18	43.5	162.2	992	-	-	L
	28/00	44.0	165.5	992	-	-	L
	28/06	44.6	167.8	992	-	-	L
	28/12	45.8	171.3	994	-	-	L
	28/18	47.9	174.8	994	-	-	L
	29/00	51.7	178.1	994	-	-	L
	29/06	54.6	178.7	990	-	-	L
	29/12	56.5	178.5	990	-	-	L
	29/18	57.4	178.9	988	-	-	L
	30/00	58.1	179.4	988	-	-	L
	30/06	58.7	181.8	992	-	-	Out

Cimaron (1820)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	16/12	11.3	160.3	1008	-	0.0	TD
	16/18	11.7	159.6	1006	-	0.0	TD
	17/00	12.0	158.9	1008	-	0.0	TD
	17/06	12.2	158.1	1006	-	0.5	TD
	17/12	12.5	156.9	1008	-	0.5	TD
	17/18	12.9	155.5	1006	-	1.0	TD
	18/00	13.3	154.6	1006	-	1.5	TD
	18/06	13.7	154.3	1004	-	1.5	TD
	18/12	14.0	153.9	1000	35	2.0	TS
	18/18	14.4	153.2	998	35	2.5	TS
	19/00	14.8	152.4	996	40	2.5	TS
	19/06	15.3	151.7	992	45	3.0	TS
	19/12	15.8	150.9	990	50	3.0	STS
	19/18	16.4	150.0	985	55	3.0	STS
	20/00	17.0	149.1	985	55	3.0	STS
	20/06	17.7	148.2	985	55	3.0	STS
	20/12	18.5	147.3	980	60	3.5	STS
	20/18	19.2	146.3	980	60	3.5	STS
	21/00	20.1	145.1	975	65	4.0	TY
	21/06	21.2	144.1	970	70	4.5	TY
	21/12	21.9	142.7	965	70	4.5	TY
	21/18	23.1	141.4	960	75	5.5	TY
	22/00	24.2	140.0	955	80	5.5	TY
	22/06	25.5	138.8	950	85	5.5	TY
	22/12	26.9	137.3	950	85	5.5	TY
	22/15	27.6	136.6	950	85	-	TY
	22/18	28.4	135.9	955	80	5.0	TY
	22/21	29.0	135.4	955	80	-	TY
	23/00	29.8	135.0	955	80	4.5	TY
	23/03	31.0	134.7	955	80	-	TY
	23/06	31.8	134.5	955	80	4.5	TY
	23/09	32.8	134.5	965	75	-	TY
	23/12	33.8	134.6	970	75	4.0	TY
	23/14	34.6	134.6	975	70	-	TY
	23/15	35.0	134.7	980	65	-	TY
	23/18	36.5	135.1	985	60	3.5	STS
	23/21	38.0	135.3	990	55	-	STS
	24/00	39.2	136.2	990	50	3.0	STS
	24/06	40.7	137.4	994	40	2.5	TS
	24/12	41.7	139.7	1000	-	-	L
	24/18						Dissip.

Jebi (1821)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	26/18	11.0	160.5	1008	-	1.0	TD
	27/00	11.9	159.7	1008	-	1.5	TD
	27/06	12.8	159.2	1008	-	1.5	TD
	27/12	13.6	158.9	1008	-	1.5	TD
	27/18	14.5	157.9	1004	35	2.0	TS
	28/00	15.4	157.0	1000	40	2.5	TS
	28/06	16.2	156.3	1000	40	2.5	TS
	28/12	16.6	155.6	996	45	3.0	TS
	28/18	16.7	154.4	992	50	3.5	STS
	29/00	17.0	153.5	990	60	4.0	STS
	29/06	17.3	152.3	985	65	4.5	TY
	29/12	17.3	151.4	980	70	5.0	TY
	29/18	17.4	150.5	965	80	5.0	TY
	30/00	17.6	149.1	955	85	5.0	TY
	30/06	17.7	148.1	940	90	6.0	TY
	30/12	17.8	146.9	935	95	6.5	TY
	30/18	17.8	145.4	925	100	6.5	TY
	31/00	17.9	144.2	915	105	7.0	TY
	31/06	18.3	142.7	915	105	7.0	TY
	31/12	18.5	141.5	915	105	7.0	TY
	31/18	19.1	140.2	915	105	7.0	TY
Sep.	01/00	19.6	139.2	915	105	7.0	TY
	01/06	20.4	138.3	915	105	7.0	TY
	01/12	21.0	137.3	925	100	6.0	TY
	01/18	21.8	136.5	935	95	5.5	TY
	02/00	22.7	135.8	935	95	5.5	TY
	02/06	23.7	135.0	935	95	5.5	TY
	02/12	24.5	134.4	935	95	5.5	TY
	02/18	25.5	133.8	935	95	5.5	TY
	03/00	26.6	133.2	940	90	5.5	TY
	03/06	27.5	132.6	940	90	5.5	TY
	03/12	28.6	132.6	940	90	5.0	TY
	03/15	29.4	132.6	945	85	-	TY
	03/18	30.3	132.8	945	85	5.0	TY
	03/21	31.3	133.2	950	85	-	TY
	04/00	32.4	133.7	950	85	5.0	TY
	04/02	33.3	134.2	950	85	-	TY
	04/03	33.8	134.5	950	85	-	TY
	04/04	34.3	134.8	955	85	-	TY
	04/06	35.6	135.7	965	75	4.5	TY
	04/09	37.1	136.4	965	70	-	TY
	04/12	39.2	137.7	970	65	4.0	TY
	04/15	41.3	139.2	975	50	-	STS
	04/18	43.2	139.9	975	50	3.5	STS
	04/21	45.0	140.2	975	50	-	STS
	05/00	46.5	139.0	976	-	3.0	L
	05/06	49.3	137.5	976	-	-	L
	05/12	51.2	136.3	980	-	-	L
	05/18	52.8	136.2	980	-	-	L
	06/00	54.0	136.5	982	-	-	L
	06/06	54.9	136.9	984	-	-	L
	06/12	55.7	137.5	986	-	-	L
	06/18	56.7	137.8	990	-	-	L
	07/00	58.7	137.8	992	-	-	L
	07/06	62.1	136.3	996	-	-	Out

Mangkhut (1822)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep.	06/12	11.8	170.2	1008	-	1.0	TD
	06/18	12.0	169.2	1008	-	1.0	TD
	07/00	12.0	167.8	1008	-	1.5	TD
	07/06	12.3	166.6	1006	-	1.5	TD
	07/12	12.7	165.4	1000	35	2.0	TS
	07/18	13.0	163.9	1000	35	2.0	TS
	08/00	13.6	162.3	998	40	2.5	TS
	08/06	14.3	160.6	996	40	2.5	TS
	08/12	14.5	159.2	992	45	3.0	TS
	08/18	14.6	157.4	990	50	3.5	STS
	09/00	14.8	155.2	975	65	4.0	TY
	09/06	15.3	152.9	975	65	4.0	TY
	09/12	15.1	151.4	970	70	4.5	TY
	09/18	14.6	149.1	955	80	5.0	TY
	10/00	14.6	147.5	955	80	5.0	TY
	10/06	14.4	145.6	955	80	5.0	TY
	10/12	14.2	144.2	950	85	5.5	TY
	10/18	14.0	142.6	940	90	6.5	TY
	11/00	14.0	141.3	935	95	6.5	TY
	11/06	13.9	139.8	915	105	7.0	TY
	11/12	13.7	138.7	905	110	7.0	TY
	11/18	14.0	137.4	905	110	7.0	TY
	12/00	13.9	136.2	905	110	7.0	TY
	12/06	14.0	135.2	905	110	7.0	TY
	12/12	14.3	134.0	905	110	7.0	TY
	12/18	14.4	132.5	905	110	7.0	TY
	13/00	14.5	131.4	905	110	7.0	TY
	13/06	14.8	130.0	905	110	7.0	TY
	13/12	14.9	128.9	905	110	7.0	TY
	13/18	15.2	127.9	905	110	7.0	TY
	14/00	16.0	126.9	905	110	7.0	TY
	14/06	16.7	125.7	905	110	7.0	TY
	14/12	17.4	124.1	905	110	7.0	TY
	14/18	18.0	122.3	905	110	7.0	TY
	15/00	18.0	120.5	940	90	6.0	TY
	15/06	18.5	119.7	940	90	5.5	TY
	15/12	19.2	118.3	950	85	5.0	TY
	15/18	19.8	117.0	955	80	5.0	TY
	16/00	20.6	115.3	960	75	4.0	TY
	16/06	21.7	113.5	960	75	4.0	TY
	16/12	22.2	111.6	970	65	4.0	TY
	16/18	22.7	109.7	980	55	3.5	STS
	17/00	23.2	108.3	992	45	3.0	TS
	17/06	24.0	107.0	998	-	2.5	TD
	17/12	24.0	105.6	1002	-	-	TD
	17/18	24.1	103.9	1004	-	-	TD
	18/00						Dissip.

Barijat (1823)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep.	08/06	20.5	121.8	1006	-	0.0	TD
	08/12	20.9	122.3	1008	-	0.0	TD
	08/18	21.1	122.5	1006	-	0.5	TD
	09/00	21.3	122.8	1006	-	0.5	TD
	09/06	21.4	123.0	1006	-	0.0	TD
	09/12	21.7	122.6	1008	-	0.5	TD
	09/18	21.7	122.2	1006	-	0.5	TD
	10/00	21.5	121.8	1006	-	1.0	TD
	10/06	21.3	121.0	1006	-	1.5	TD
	10/12	21.2	120.2	1006	-	1.5	TD
	10/18	21.1	119.5	1004	-	1.5	TD
	11/00	20.9	118.7	1000	35	2.0	TS
	11/06	20.7	118.0	998	40	2.5	TS
	11/12	20.4	117.4	998	40	2.5	TS
	11/18	20.5	116.4	998	40	2.5	TS
	12/00	20.7	115.4	998	40	2.5	TS
	12/06	20.9	114.5	998	40	2.5	TS
	12/12	20.9	113.5	998	40	2.5	TS
	12/18	20.8	112.1	998	40	2.5	TS
	13/00	21.5	110.6	1002	35	2.5	TS
	13/06	22.0	109.9	1006	-	2.0	TD
	13/12						Dissip.

Trami (1824)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep.	20/06	11.8	146.7	1002	-	0.5	TD
	20/12	12.8	146.0	1004	-	0.5	TD
	20/18	13.6	145.4	1002	-	1.0	TD
	21/00	14.5	144.4	1002	-	1.5	TD
	21/06	15.0	143.7	1000	35	1.5	TS
	21/12	15.3	142.8	1000	40	2.0	TS
	21/18	15.5	141.6	998	45	2.5	TS
	22/00	15.9	140.2	994	50	2.5	STS
	22/06	16.8	138.7	990	55	3.0	STS
	22/12	17.1	137.8	985	60	3.5	STS
	22/18	17.1	136.2	975	65	4.0	TY
	23/00	17.1	135.2	970	70	4.5	TY
	23/06	17.3	134.3	955	80	5.0	TY
	23/12	17.5	133.3	950	85	5.5	TY
	23/18	18.1	132.2	940	90	6.0	TY
	24/00	18.4	131.3	935	95	6.0	TY
	24/06	18.9	130.4	925	100	6.5	TY
	24/12	19.3	129.7	925	100	6.5	TY
	24/18	19.6	129.1	915	105	7.0	TY
	25/00	19.6	128.7	915	105	7.0	TY
	25/06	19.8	128.9	915	105	7.0	TY
	25/12	20.0	128.9	925	100	6.5	TY
	25/18	20.3	128.9	935	95	6.0	TY
	26/00	20.7	129.0	950	85	5.5	TY
	26/06	20.9	129.2	950	85	5.5	TY
	26/12	21.3	129.2	950	85	5.5	TY
	26/18	21.5	129.2	950	85	5.5	TY
	27/00	21.6	129.1	950	85	5.5	TY
	27/06	21.7	129.0	950	85	5.5	TY
	27/12	21.9	128.8	950	85	5.5	TY
	27/18	22.2	128.4	950	85	5.5	TY
	28/00	22.5	128.0	950	85	5.5	TY
	28/03	22.8	127.5	950	85	-	TY
	28/06	23.1	127.3	950	85	5.5	TY
	28/09	23.5	127.2	950	85	-	TY
	28/12	23.8	126.9	950	85	5.5	TY
	28/15	24.1	126.9	950	85	-	TY
	28/18	24.5	126.8	950	85	5.0	TY
	28/21	25.0	126.8	950	85	-	TY
	29/00	25.4	126.9	950	85	5.0	TY
	29/03	26.0	126.9	950	85	-	TY
	29/06	26.5	127.4	950	85	5.0	TY
	29/09	27.1	127.9	950	85	-	TY
	29/12	27.8	128.3	950	85	5.0	TY
	29/15	28.4	128.7	950	85	-	TY
	29/18	29.1	129.3	950	85	5.0	TY
	29/21	29.8	129.9	950	85	-	TY
	30/00	30.6	130.8	950	85	5.0	TY
	30/03	31.6	131.8	950	85	-	TY
	30/06	32.3	132.9	955	80	5.0	TY
	30/09	33.2	134.3	955	80	-	TY
	30/11	33.8	135.5	960	80	-	TY
	30/12	34.3	136.0	960	80	4.5	TY
	30/15	35.8	137.9	970	75	-	TY
	30/18	37.2	139.9	970	70	4.0	TY
	30/21	39.4	141.8	970	65	-	TY
Oct.	01/00	41.3	144.2	970	-	3.5	L
	01/06	44.1	150.7	970	-	-	L
	01/12	47.2	157.3	970	-	-	L
	01/18	49.8	163.3	968	-	-	L
	02/00	51.8	168.1	968	-	-	L
	02/06	53.8	172.2	966	-	-	L
	02/12	55.7	174.7	964	-	-	L
	02/18	56.7	175.3	960	-	-	L
	03/00	56.9	174.2	956	-	-	L
	03/06	55.7	175.1	956	-	-	L
	03/12	55.1	179.9	956	-	-	L
	03/18	55.3	184.8	958	-	-	Out

Kong-rey (1825)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep.	28/00	7.4	150.9	1006	-	1.0	TD
	28/06	8.5	149.5	1004	-	1.0	TD
	28/12	9.6	148.0	1004	-	1.5	TD
	28/18	11.0	146.5	1002	-	1.5	TD
	29/00	12.0	144.2	1004	-	1.5	TD
	29/06	12.6	142.6	1000	35	2.0	TS
	29/12	12.8	141.4	996	40	2.5	TS
	29/18	13.1	139.9	990	50	3.0	STS
	30/00	13.7	138.9	980	60	3.5	STS
	30/06	14.5	138.1	975	65	4.0	TY
	30/12	14.9	137.2	965	75	5.0	TY
	30/18	15.4	136.4	950	85	5.5	TY
Oct.	01/00	15.6	135.9	940	90	6.0	TY
	01/06	16.1	135.2	925	100	6.5	TY
	01/12	16.8	134.4	900	115	7.5	TY
	01/18	17.3	133.6	900	115	7.5	TY
	02/00	17.7	132.7	900	115	7.5	TY
	02/06	18.2	132.0	900	115	7.5	TY
	02/12	18.9	131.2	915	105	7.0	TY
	02/18	19.5	130.4	940	90	6.0	TY
	03/00	20.1	129.7	950	85	5.5	TY
	03/06	20.9	129.2	955	80	5.0	TY
	03/12	21.6	128.8	970	70	4.5	TY
	03/18	22.5	128.1	975	65	4.0	TY
	04/00	23.2	127.7	975	65	3.5	TY
	04/03	23.8	127.4	975	65	-	TY
	04/06	24.3	127.1	975	60	3.0	STS
	04/09	24.9	126.9	975	60	-	STS
	04/12	25.4	126.7	975	60	2.5	STS
	04/15	26.2	126.4	975	60	-	STS
	04/18	26.7	126.1	975	60	2.5	STS
	04/21	27.5	125.9	975	60	-	STS
	05/00	28.0	125.9	975	60	2.5	STS
	05/03	28.7	125.9	975	60	-	STS
	05/06	29.5	125.9	975	65	3.0	TY
	05/09	30.5	126.1	975	65	-	TY
	05/12	31.3	126.0	975	65	3.0	TY
	05/15	32.2	126.1	975	65	-	TY
	05/18	32.9	126.5	975	65	3.0	TY
	05/21	33.7	127.3	975	65	-	TY
	06/00	34.7	128.1	975	60	3.0	STS
	06/03	35.8	129.1	980	55	-	STS
	06/06	37.1	130.4	980	55	3.0	STS
	06/09	37.9	131.7	980	55	-	STS
	06/12	38.9	133.7	984	-	3.0	L
	06/18	41.0	137.2	988	-	2.5	L
	07/00	42.0	141.0	994	-	-	L
	07/06	42.3	147.2	994	-	-	L
	07/12	41.2	152.0	996	-	-	L
	07/18						Dissip.

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Yutu (1826)							
Oct.	20/18	8.4	160.7	1008	-	0.5	TD
	21/00	8.5	159.9	1008	-	0.5	TD
	21/06	8.6	158.9	1004	-	1.0	TD
	21/12	8.7	158.0	1006	-	1.5	TD
	21/18	8.9	157.1	1004	-	1.5	TD
	22/00	9.4	156.1	1002	35	2.0	TS
	22/06	10.2	155.2	996	40	2.5	TS
	22/12	10.9	154.0	992	45	2.5	TS
	22/18	11.3	152.8	990	50	3.0	STS
	23/00	11.6	151.8	975	65	4.0	TY
	23/06	11.9	150.6	970	70	4.0	TY
	23/12	12.2	149.7	955	80	4.5	TY
	23/18	12.7	148.9	950	85	5.5	TY
	24/00	13.4	148.0	925	100	6.0	TY
	24/06	14.0	147.1	915	105	6.0	TY
	24/12	14.7	146.2	900	115	6.5	TY
	24/18	15.4	145.3	900	115	7.0	TY
	25/00	15.8	144.1	900	115	7.0	TY
	25/06	16.1	143.1	915	105	7.0	TY
	25/12	16.3	142.3	935	95	7.0	TY
	25/18	16.6	141.4	935	95	6.0	TY
	26/00	16.9	140.3	935	95	6.0	TY
	26/06	17.0	139.1	925	100	6.5	TY
	26/12	17.3	137.6	925	100	6.5	TY
	26/18	17.6	136.1	915	105	7.0	TY
	27/00	17.8	134.7	915	105	7.0	TY
	27/06	18.0	133.3	915	105	7.0	TY
	27/12	18.0	132.2	915	105	7.0	TY
	27/18	18.0	131.2	925	100	6.5	TY
	28/00	18.0	130.2	935	95	6.0	TY
	28/06	18.0	129.0	950	85	5.5	TY
	28/12	17.8	128.0	955	80	5.0	TY
	28/18	17.5	127.0	970	70	4.5	TY
	29/00	17.0	126.1	970	70	4.5	TY
	29/06	16.8	125.2	955	80	5.0	TY
	29/12	16.8	124.2	955	80	5.0	TY
	29/18	16.8	123.0	955	80	5.0	TY
	30/00	16.6	121.6	970	70	5.0	TY
	30/06	16.5	120.1	985	55	4.5	STS
	30/12	16.9	119.1	985	55	3.5	STS
	30/18	17.1	118.6	990	50	3.0	STS
	31/00	17.5	118.2	990	50	3.0	STS
	31/06	18.1	117.7	992	45	2.5	TS
	31/12	18.6	117.4	992	45	2.5	TS
	31/18	19.0	117.2	992	45	2.5	TS
Nov.	01/00	19.5	116.9	994	45	2.5	TS
	01/06	19.9	116.8	994	45	2.5	TS
	01/12	20.2	116.8	994	45	2.5	TS
	01/18	20.6	116.8	1000	40	2.0	TS
	02/00	20.7	116.4	1008	35	2.0	TS
	02/06	20.7	116.1	1008	-	2.0	TD
	02/12	20.5	116.0	1012	-	-	TD
	02/18	20.2	115.9	1012	-	-	TD
	03/00	19.9	115.7	1014	-	-	TD
	03/06						Dissip.

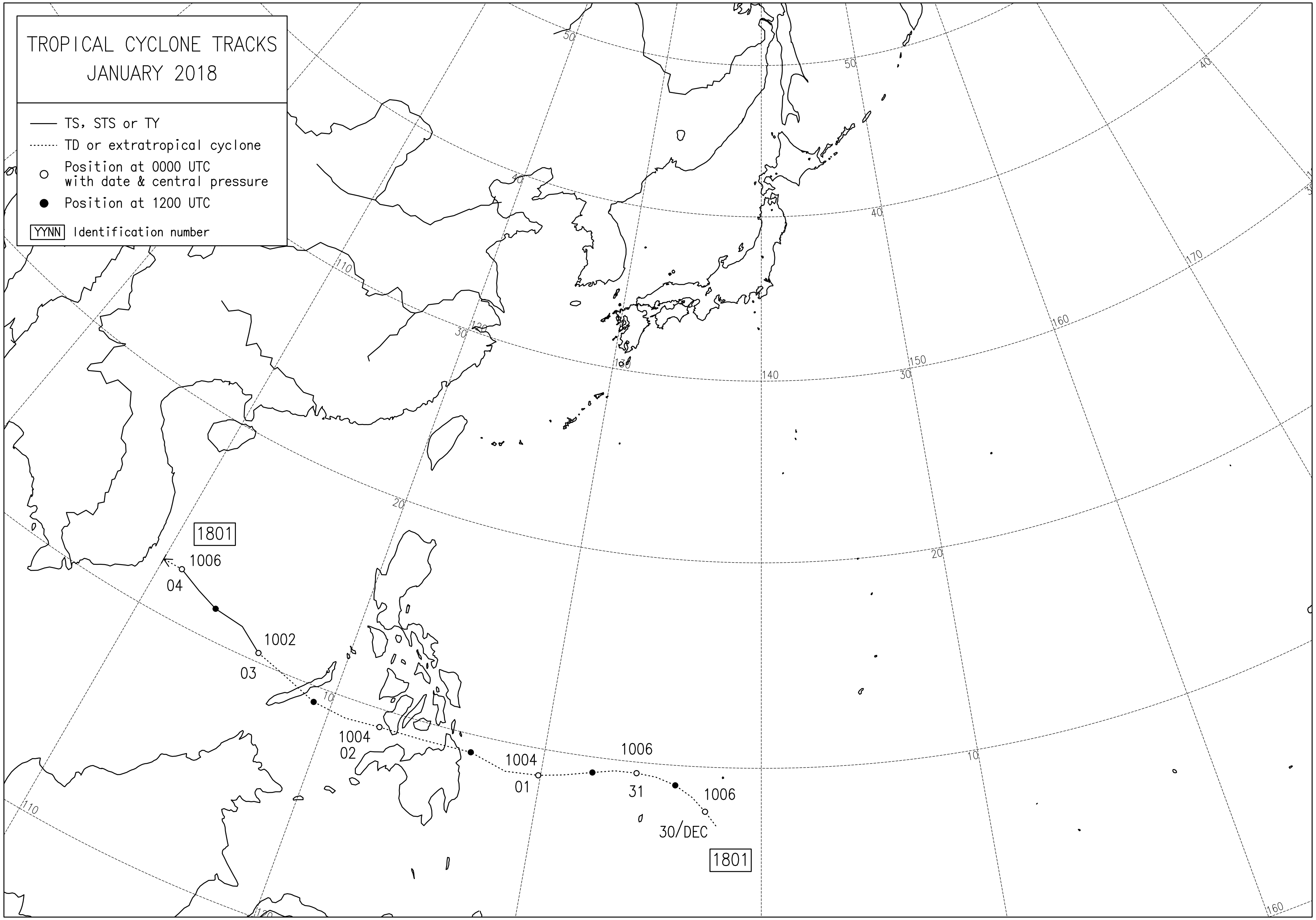
Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Toraji (1827)							
Nov.	16/18	10.0	112.5	1008	-	1.0	TD
	17/00	10.6	111.8	1008	-	1.5	TD
	17/06	10.9	111.3	1004	35	2.0	TS
	17/12	11.2	110.7	1004	35	2.5	TS
	17/18	11.4	110.1	1006	35	2.5	TS
	18/00	11.6	109.5	1008	-	2.5	TD
	18/06	11.7	108.9	1008	-	2.5	TD
	18/12	11.8	108.2	1010	-	2.0	TD
	18/18						Dissip.

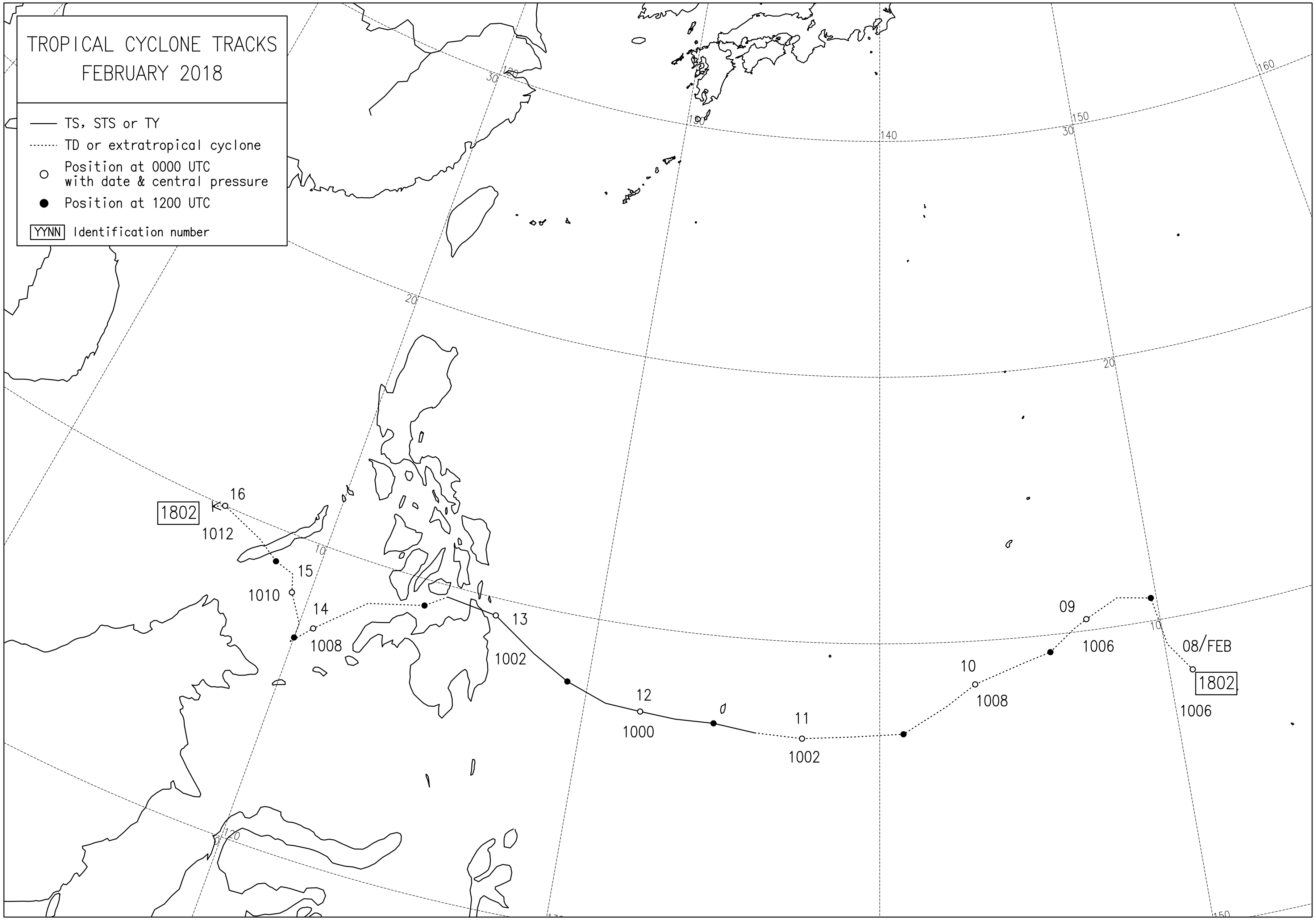
Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Man-yi (1828)							
Nov.	20/12	5.0	152.6	1004	-	2.0	TD
	20/18	5.8	152.2	1000	35	2.5	TS
	21/00	6.4	150.8	1000	35	2.5	TS
	21/06	7.7	149.5	1000	35	2.5	TS
	21/12	8.6	146.5	998	40	2.5	TS
	21/18	9.4	143.8	992	45	3.0	TS
	22/00	10.4	141.7	985	55	3.5	STS
	22/06	11.8	139.8	980	60	3.5	STS
	22/12	12.9	138.2	975	65	4.0	TY
	22/18	13.4	136.9	970	70	4.5	TY
	23/00	14.8	136.1	965	75	5.0	TY
	23/06	15.7	135.8	965	75	5.0	TY
	23/12	16.4	135.6	965	75	5.0	TY
	23/18	17.4	135.3	965	75	5.0	TY
	24/00	18.1	135.3	965	75	5.0	TY
	24/06	18.3	135.9	965	75	5.0	TY
	24/12	18.7	136.2	960	80	5.0	TY
	24/18	18.5	136.1	960	80	5.0	TY
	25/00	18.3	136.0	960	80	5.0	TY
	25/06	18.2	135.6	970	75	5.0	TY
	25/12	18.3	134.9	980	65	5.0	TY
	25/18	19.1	134.0	992	50	4.5	STS
	26/00	19.7	133.0	998	40	4.0	TS
	26/06	20.2	132.4	1000	35	3.5	TS
	26/12	21.0	132.0	1008	-	3.0	TD
	26/18	21.9	132.0	1010	-	3.0	TD
	27/00	22.7	132.3	1006	35	3.0	TS
	27/06	23.5	132.4	1008	-	3.0	TD
	27/12	23.3	133.2	1012	-	2.5	TD
	27/18	24.3	134.5	1012	-	2.0	TD
	28/00	25.6	135.8	1012	-	2.0	TD
	28/06	27.8	137.9	1010	-	1.5	L
	28/12	30.8	141.1	1008	-	1.5	L
	28/18	32.2	144.9	1006	-	-	L
	29/00	33.7	149.4	1002	-	-	L
	29/06	35.1	154.5	1000	-	-	L
	29/12	36.7	159.5	1000	-	-	L
	29/18	37.7	164.2	998	-	-	L
	30/00	39.2	169.4	1000	-	-	L
	30/06	40.8	174.6	1000	-	-	L
	30/12	42.5	180.2	1000	-	-	Out

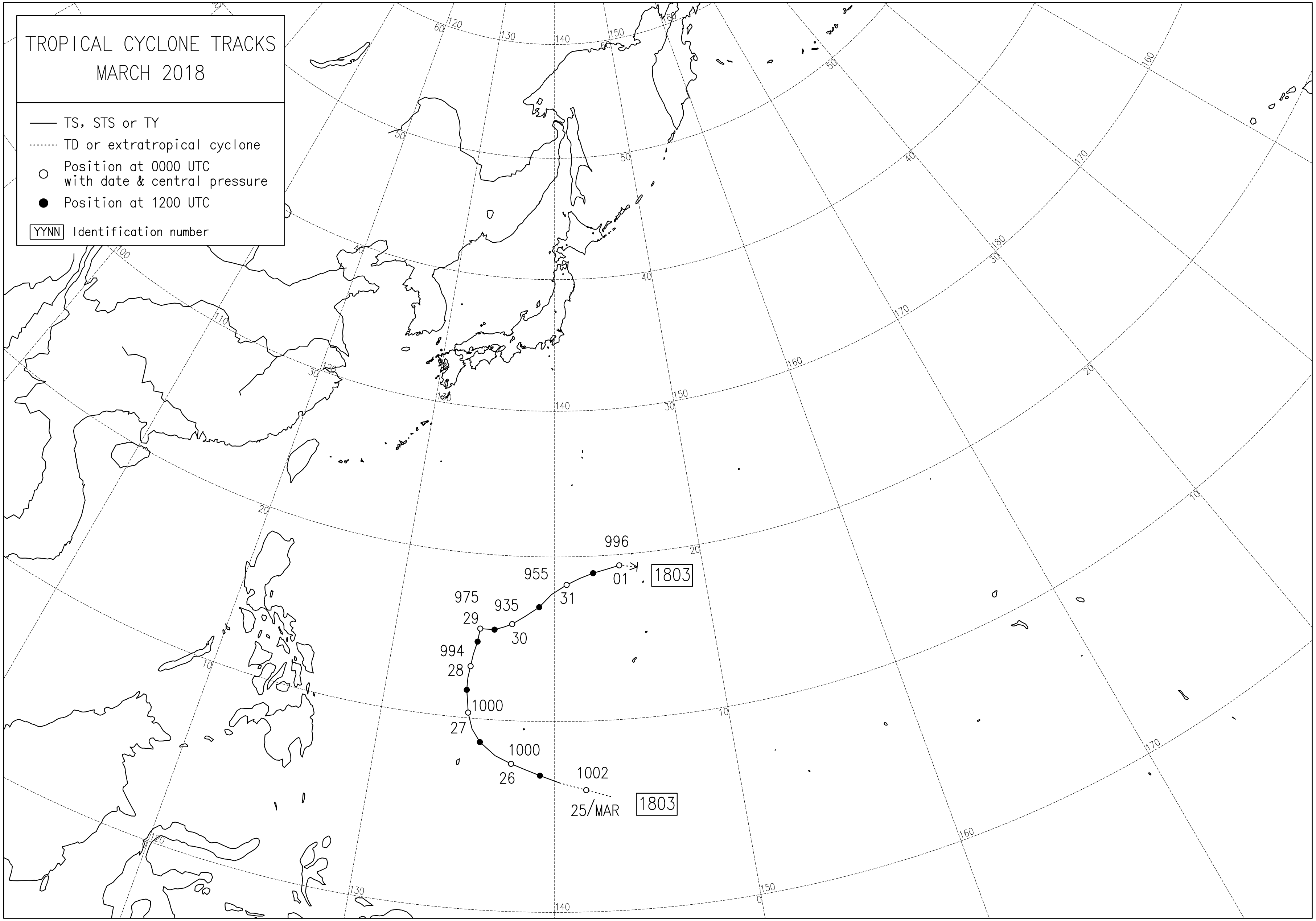
Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Usagi (1829)							
Nov.	13/00	9.2	156.7	1006	-	0.5	TD
	13/06	8.7	155.8	1004	-	0.5	TD
	13/12	8.2	155.0	1006	-	0.5	TD
	13/18	7.9	154.0	1004	-	0.0	TD
	14/00	7.6	153.0	1006	-	0.5	TD
	14/06	7.4	152.1	1004	-	0.5	TD
	14/12	7.6	151.2	1006	-	0.5	TD
	14/18	8.1	150.3	1004	-	0.5	TD
	15/00	8.8	149.4	1006	-	0.0	TD
	15/06	9.0	148.5	1004	-	0.5	TD
	15/12	9.0	147.6	1006	-	0.0	TD
	15/18	9.0	146.7	1004	-	0.5	TD
	16/00	9.0	145.8	1006	-	0.0	TD
	16/06	8.7	144.7	1004	-	0.0	TD
	16/12	8.4	143.4	1006	-	0.5	TD
	16/18	7.9	142.2	1004	-	0.5	TD
	17/00	7.5	140.9	1004	-	0.5	TD
	17/06	7.3	139.5	1004	-	0.0	TD
	17/12	7.0	137.9	1004	-	0.5	TD
	17/18	6.8	136.8	1004	-	1.0	TD
	18/00	6.6	135.5	1004	-	1.5	TD
	18/06	6.4	134.4	1002	-	1.5	TD
	18/12	6.7	133.6	1004	-	1.5	TD
	18/18	7.1	133.0	1002	-	1.5	TD
	19/00	7.9	132.1	1004	-	1.5	TD
	19/06	8.7	131.2	1002	-	1.5	TD
	19/12	9.2	130.4	1004	-	1.5	TD
	19/18	9.8	129.5	1002	-	1.5	TD
	20/00	10.1	128.8	1004	-	1.5	TD
	20/06	10.6	127.7	1002	-	1.5	TD
	20/12	11.0	126.8	1004	-	1.5	TD
	20/18	11.4	125.4	1004	-	1.5	TD
	21/00	11.0	123.5	1006	-	1.5	TD
	21/06	10.7	121.6	1004	-	1.5	TD
	21/12	10.5	120.1	1006	-	1.5	TD
	21/18	10.8	118.4	1006	-	1.5	TD
	22/00	11.3	117.0	1004	35	2.0	TS
	22/06	11.6	115.6	1004	35	2.5	TS
	22/12	11.2	114.3	1004	35	2.5	TS
	22/18	10.9	113.5	1004	35	2.5	TS
	23/00	10.7	112.6	1000	45	3.0	TS
	23/06	10.6	111.6	996	50	3.5	STS
	23/12	10.2	110.9	996	50	3.5	STS
	23/18	9.7	110.1	996	50	3.5	STS
	24/00	9.7	109.5	990	60	4.0	STS
	24/06	9.7	108.7	990	60	4.0	STS
	24/12	9.7	108.3	992	55	4.0	STS
	24/18	9.7	107.7	992	55	4.0	STS
	25/00	9.9	107.4	998	45	3.5	TS
	25/06	10.1	107.0	1000	40	3.0	TS
	25/12	10.7	107.0	1002	35	2.5	TS
	25/18	11.3	106.6	1004	35	2.0	TS
	26/00	11.4	105.9	1008	-	2.0	TD
	26/06	11.5	105.4	1008	-	1.5	TD
	26/12	11.7	104.9	1010	-	1.0	TD
	26/18	12.0	104.0	1010	-	0.5	TD
	27/00						Dissip.

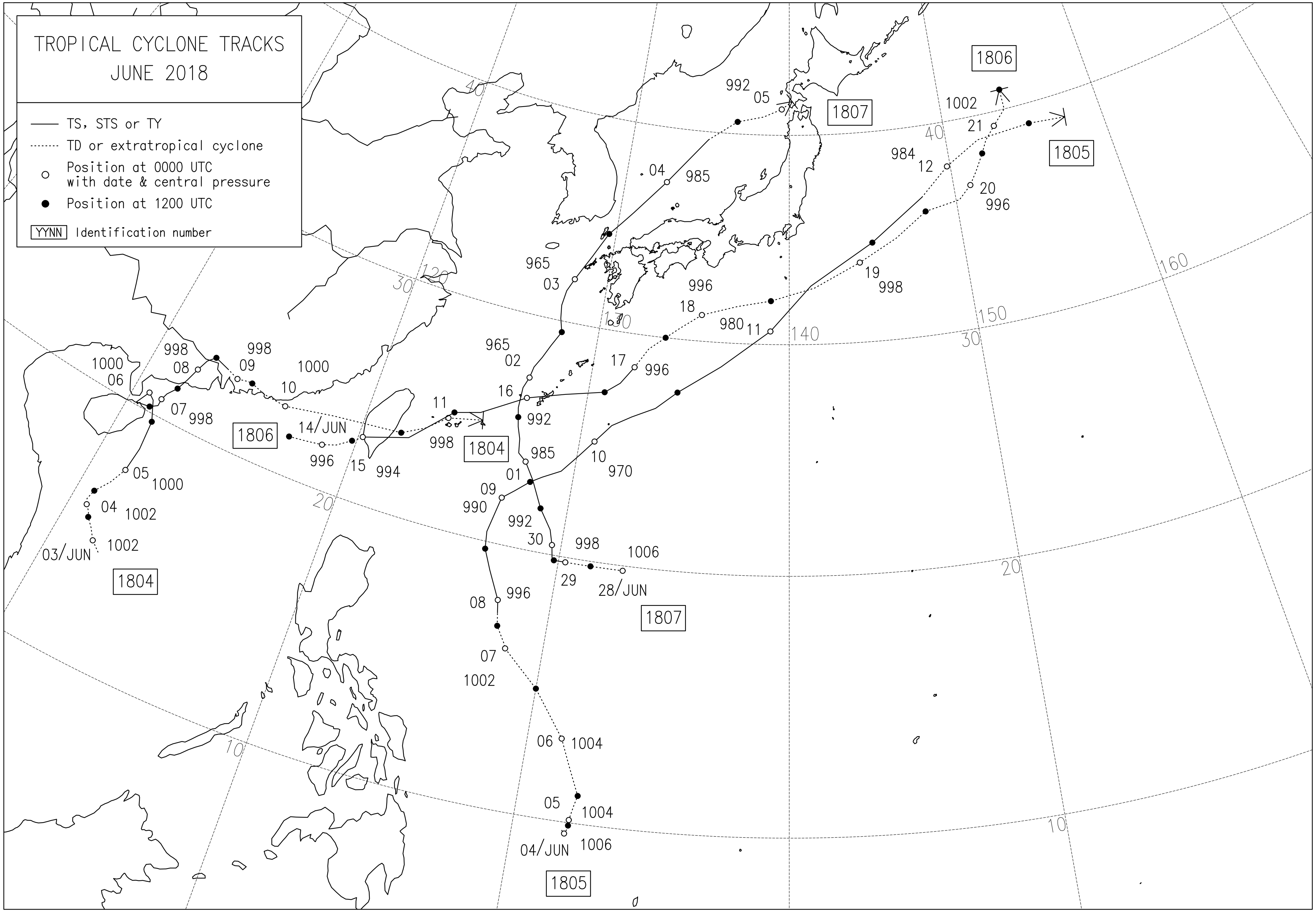
Appendix 2

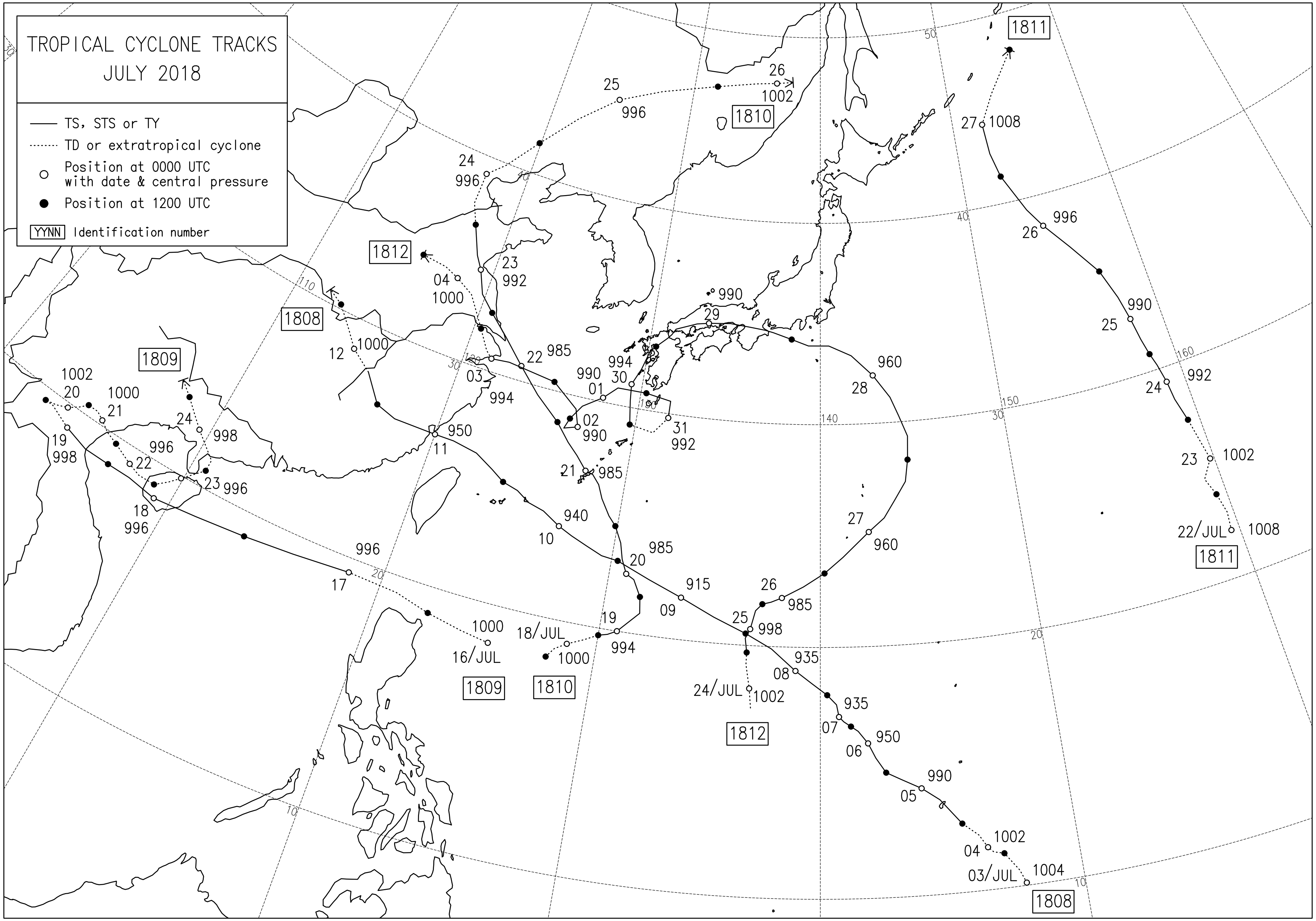
Monthly Tracks of Tropical Cyclones in 2018

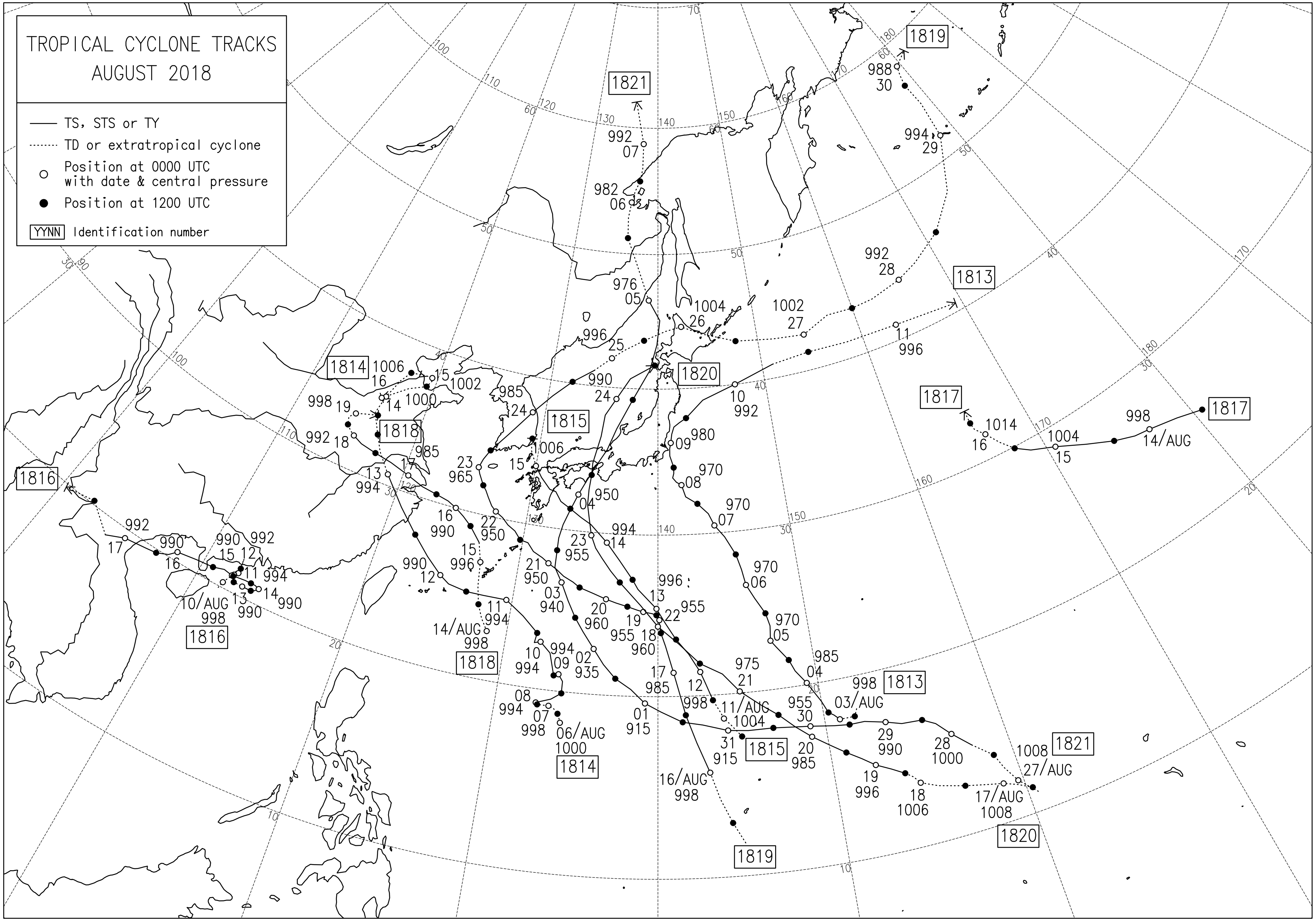

TROPICAL CYCLONE TRACKS
JANUARY 2018
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1801
1006
04
1002
03
1004
02
1004
01
1006
31
1006
30/DEC
1801
50
40
30
20
10
110
120
130
140
150
160
170

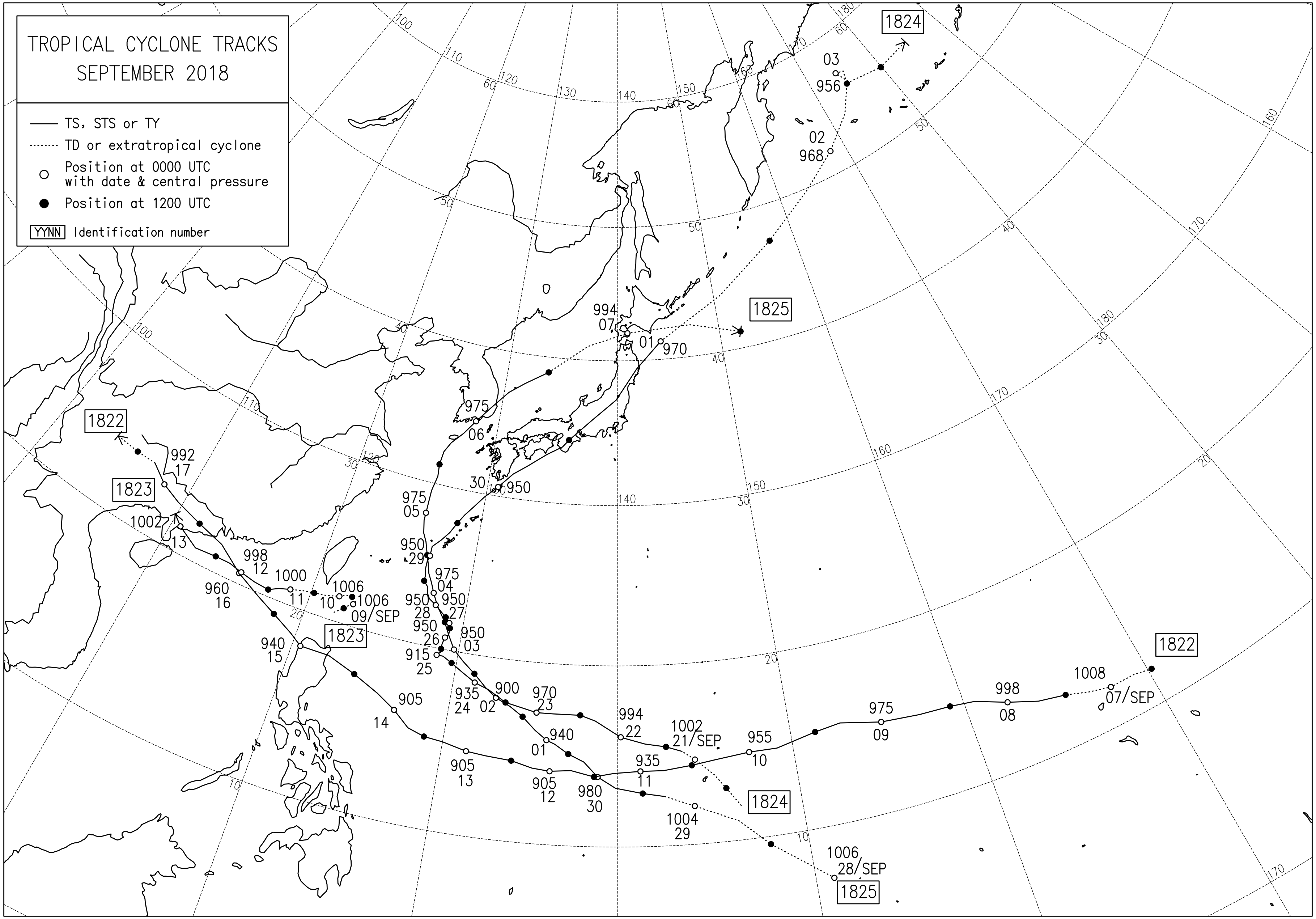

TROPICAL CYCLONE TRACKS
FEBRUARY 2018
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1802
16
1012
15
1010
14
1008
13
1002
12
1000
11
1002
10
1008
09
1006
08/FEB
1802
1006

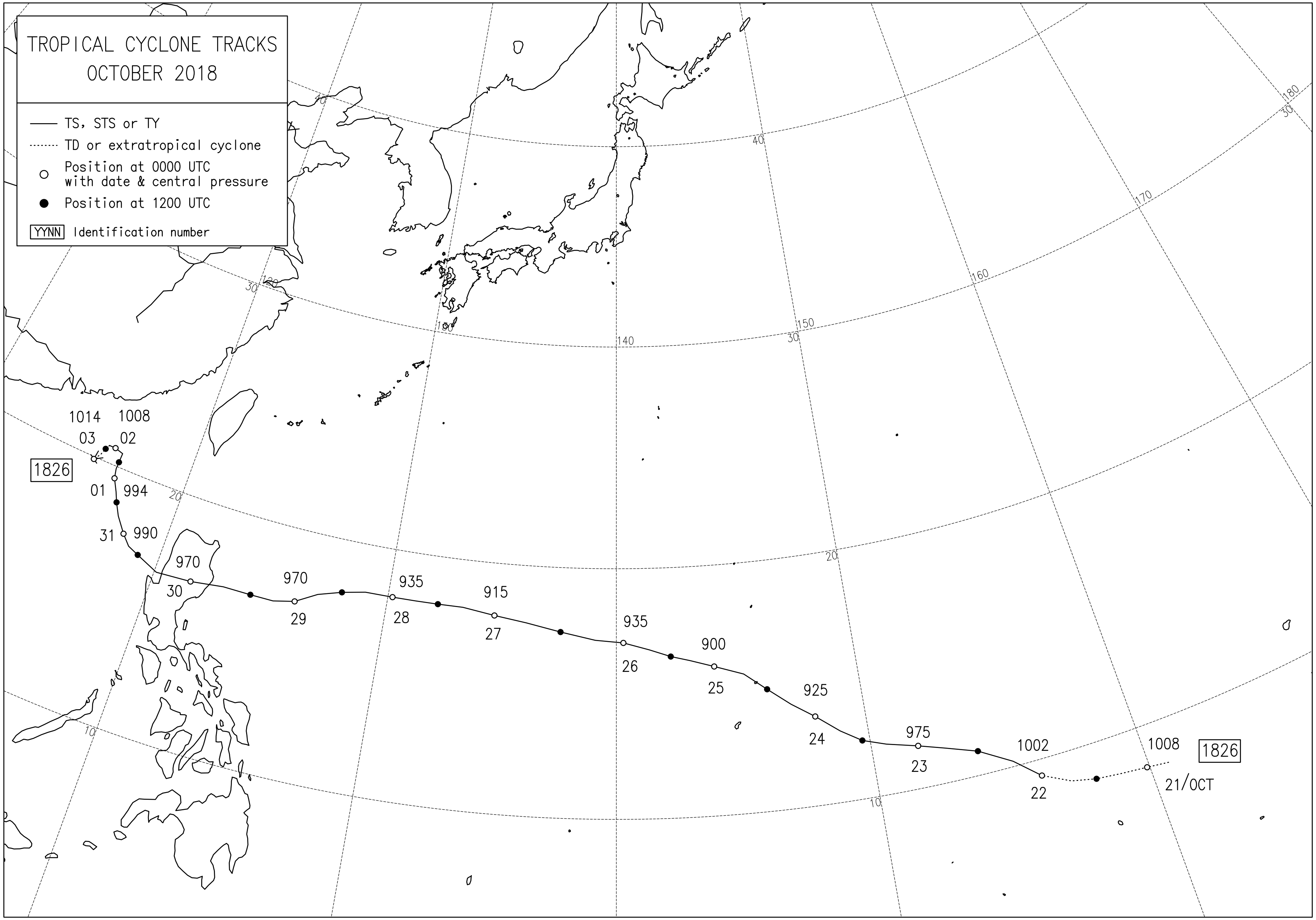

TROPICAL CYCLONE TRACKS
MARCH 2018
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
996
01
1803
955
31
975
935
29
30
994
28
1000
27
1000
26
1002
25/MAR
1803

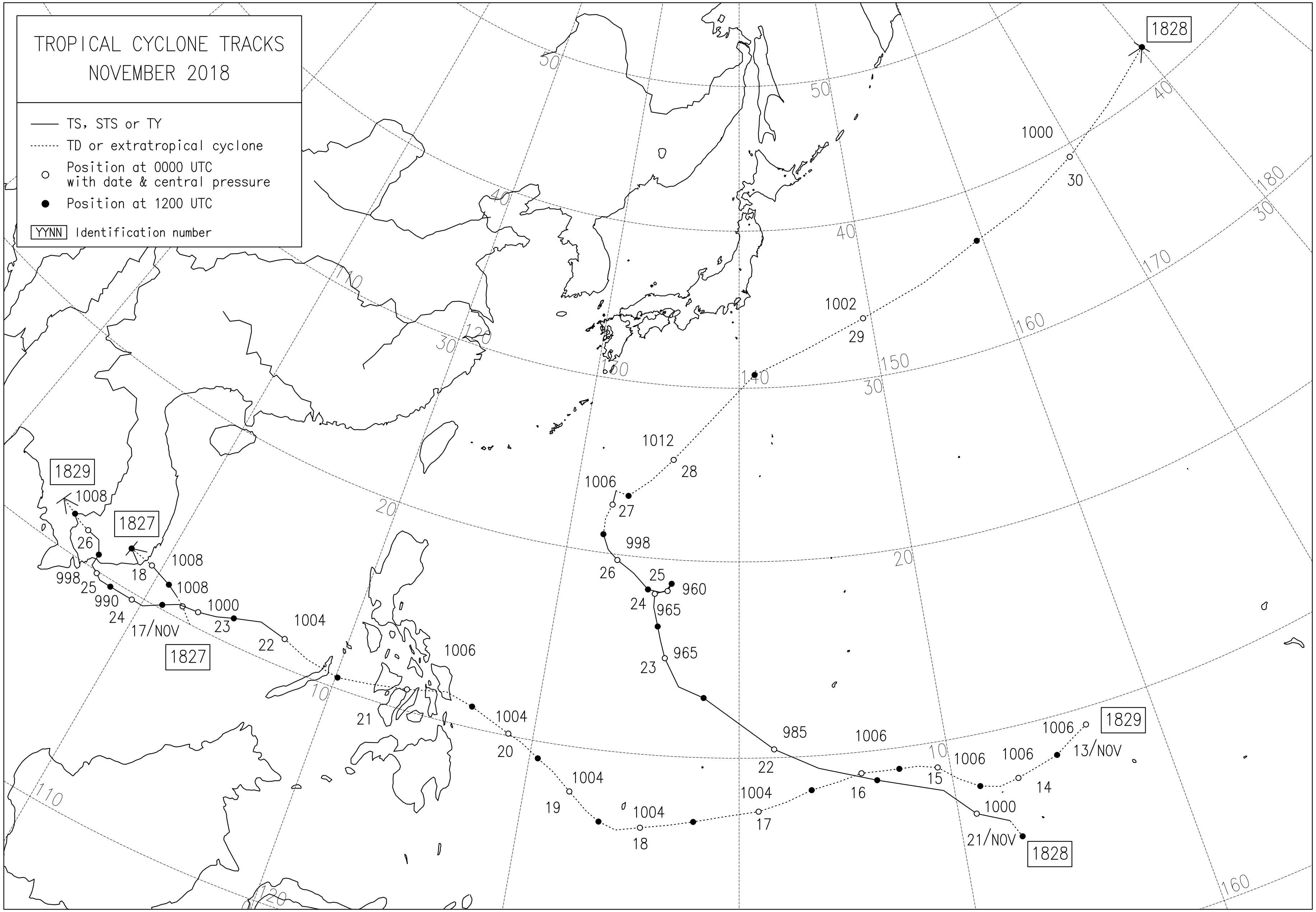

TROPICAL CYCLONE TRACKS
JUNE 2018
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1804
03/JUN
1002
04
1002
05
1000
06
1000
07
998
08
998
09
998
10
1000
1805
04/JUN
1006
05
1004
06
1004
07
1002
08
996
09
990
10
970
11
980
12
984
1806
14/JUN
996
15
994
16
992
17
996
18
996
19
998
20
996
21
1002
1807
28/JUN
1006
29
998
30
992
01
985
02
965
03
965
04
985
05
992
11
998
120
130
140
150
160
10
20
30
40


TROPICAL CYCLONE TRACKS
JULY 2018
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1808
03/JUL 1004
04 1002
05 990
06 950
07 935
08 935
09 915
10 940
11 950
12 1000
1809
16/JUL 1000
17 996
18 996
19 998
20 1002
21 1000
22 996
23 996
24 998
1810
18/JUL 1000
19 994
20 985
21 985
22 985
23 992
24 996
25 996
26 1002
1811
22/JUL 1008
23 1002
24 992
25 990
26 996
27 1008
1812
24/JUL 1002
25 998
26 985
27 960
28 960
29 990
30 994
31 992
01 990
02 990
03 994
04 1000


TROPICAL CYCLONE TRACKS
AUGUST 2018
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
1813
1814
1815
1816
1817
1818
1819
1820
1821


TROPICAL CYCLONE TRACKS
SEPTEMBER 2018
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1822
1823
1824
1825
07/SEP
09/SEP
21/SEP
28/SEP


TROPICAL CYCLONE TRACKS
OCTOBER 2018
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1826
1014
03
1008
02
01
994
31
990
970
30
970
29
935
28
915
27
935
26
900
25
925
24
975
23
1002
22
1008
21/OCT
1826


TROPICAL CYCLONE TRACKS
NOVEMBER 2018
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1827
17/NOV
1008
18
1008
1000
23
1004
22
1006
21
1004
20
1004
19
1004
18
1004
17
16
1006
15
1006
14
1006
13/NOV
1006
1829
998
24
990
25
998
26
1008
1829
1000
21/NOV
1828
985
22
965
23
965
24
960
25
998
26
1006
27
1012
28
1002
29
1000
30
1828
1827

Appendix 3

Errors of Track and Intensity Forecasts for Each Tropical Cyclone in 2018

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TS Bolaven (1801)													
Jan.	03/00	35											
	03/06	22											
	03/12	33											
	03/18	22											
	mean	28	--	--	--	--	--	--	--	--	--	--	--
	sample	4	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	T=24	=48	=72
TS Sanba (1802)													
Feb.	11/06	22	160					-2			5		
	11/12	35	127					-2			5		
	11/18	33	35					-2			5		
	12/00	31	157					-4			5		
	12/06	25											
	12/12	35											
	12/18	40											
	13/00	46											
	mean	33	120	--	--	--	--	-2	--	--	5	--	--
	sample	8	4	0	0	0	0	4	0	0	4	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	T=24	=48	=72
TY Jelawat (1803)													
Mar.	25/06	46	45	69	130	158	336	-2	-8	-10	0	10	5
	25/12	59	164	56	89	224	320	-4	-8	0	5	10	0
	25/18	33	105	90	112	281	323	-4	-8	-5	5	10	5
	26/00	0	11	103	140	343	345	-8	-4	5	10	5	-5
	26/06	0	108	103	183	355	353	-8	0	15	10	0	-10
	26/12	33	93	98	253	361	401	-4	0	25	5	-5	-25
	26/18	25	77	86	267	308	329	-2	5	35	0	-10	-30
	27/00	60	93	93	330	359		2	15	45	-5	-20	-40
	27/06	134	132	170	338	469		6	25	65	-15	-25	-50
	27/12	192	137	97	302	394		6	37	75	-10	-35	-55
	27/18	164	79	134	287	473		11	47	65	-15	-40	-50
	28/00	159	165	79	266			15	50	30	-20	-45	-30
	28/06	79	15	156	289			20	65	20	-15	-45	-15
	28/12	15	84	189	347			25	65	10	-20	-45	-15
	28/18	0	111	180	368			35	60	-7	-25	-45	15
	29/00	0	126	270				45	30		-35	-25	
	29/06	0	107	242				65	20		-45	-15	
	29/12	0	65	234				65	10		-45	-10	
	29/18	0	24	234				55	-7		-40	20	
	30/00	0	85					25			-20		
	30/06	0	67					10			-5		
	30/12	0	85					-5			5		
	30/18	0	95					-17			30		
	31/00	0											
	31/06	54											
	31/12	48											
	31/18	54											
	mean	43	90	141	247	339	344	14	21	25	-11	-16	-20
	sample	27	23	19	15	11	7	23	19	15	23	19	15

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TS Ewiniar (1804)													
Jun.	05/00	24	85	24				0	2		0	0	
	05/06	46	90					2			0		
	05/12	15	15	71				2	2		0	-5	
	05/18	0	52					0			0		
	06/00	0	33	157				2	2		0	-5	
	06/06	15	33	168				2	2		-5	0	
	06/12	0	68	190				2	2		-5	0	
	06/18	0	64					2			-5		
	07/00	10	79					2			-5		
	07/06	0	121					2			0		
	07/12	33	23					4			-10		
	07/18	0											
	08/00	11											
	08/06	31											
	08/12	20											
	mean	14	60	122	--	--	--	2	2	--	-3	-2	--
	sample	15	11	5	0	0	0	11	5	0	11	5	0

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
STS Maliksi (1805)													
Jun.	07/18	40	127	147	102			-2	0	-5	5	5	5
	08/00	46	188	138	131			-5	5	-5	5	0	10
	08/06	87	56	78	202			0	5	0	0	0	5
	08/12	43	49	59	177			0	0	0	0	5	5
	08/18	0	10	77				5	-5		0	5	
	09/00	0	30	65				5	0		0	5	
	09/06	0	32	78				5	5		0	0	
	09/12	0	83	92				0	10		5	-5	
	09/18	0	76					-5			0		
	10/00	0	19					0			5		
	10/06	0	24					0			5		
	10/12	15	114					0			0		
	10/18	0											
	11/00	0											
	11/06	0											
	11/12	11											
	mean	15	67	92	153	--	--	0	3	-2	2	2	6
	sample	16	12	8	4	0	0	12	8	4	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	T=24	=48	=72
TS Gaemi (1806)													
Jun.	15/00	11	56					0			-5		
	15/06	39	86					0			-5		
	15/12	0	181					-2			0		
	15/18	0	240					2			0		
	16/00	0											
	16/06	0											
	16/12	11											
	16/18	119											
	mean	23	141	--	--	--	--	0	--	--	-2	--	--
	sample	8	4	0	0	0	0	4	0	0	4	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	T=24	=48	=72
TY Prapiroon (1807)												
Jun. 29/00	25	137	240	629	845	898	0	-5	20	0	10	-10
29/06	22	152	281	805	932		-2	0	25	5	5	-15
29/12	11	108	345	840	877		-2	0	27	5	5	-20
29/18	0	61	362	748	814		-2	15	38	5	-5	-30
30/00	21	67	299	523			0	20	33	5	-10	-25
30/06	30	49	353	484			5	20	33	0	-10	-25
30/12	0	67	337	402			5	15	21	0	-5	-15
30/18	0	94	273	378			10	25	14	0	-10	-10
Jul. 01/00	0	78	205	234			10	25	11	0	-10	-10
01/06	23	89	152				10	25		0	-10	
01/12	11	110	128				15	15		-5	-10	
01/18	0	89	156				20	12		-10	-10	
02/00	0	56	89				15	5		-5	0	
02/06	20	24					15			-5		
02/12	22	50					10			-5		
02/18	0	24					5			-5		
03/00	15	54					5			-5		
03/06	29											
03/12	0											
03/18	0											
04/00	0											
mean	11	77	248	560	867	898	7	13	25	-1	-5	-18
sample	21	17	13	9	4	1	17	13	9	17	13	9

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TY Maria (1808)												
Jul. 04/12	69	183	122	161	206	300	22	55	30	-25	-40	-20
04/18	16	85	144	194	197	361	35	50	25	-25	-30	-15
05/00	24	46	119	172	202	337	35	25	15	-25	-15	-5
05/06	11	15	103	122	248	362	45	25	15	-30	-15	-5
05/12	15	25	101	179	284	368	40	5	0	-25	-5	0
05/18	11	75	116	182	279	314	15	-10	-10	-10	5	5
06/00	11	88	128	218	307	494	-10	-20	-10	5	10	5
06/06	0	65	120	226	344	657	-20	-20	-10	10	10	5
06/12	0	63	125	247	328	567	-25	-20	-10	15	15	10
06/18	15	57	106	194	280		-25	-20	-25	15	15	15
07/00	11	39	145	194	339		-25	-10	-30	15	10	20
07/06	0	47	145	181	339		-15	-5	-20	10	5	15
07/12	11	61	167	180	242		-10	0	-15	5	0	10
07/18	21	61	122	172			-10	-20	-15	5	10	10
08/00	0	64	60	60			0	-15	0	0	10	-5
08/06	0	45	45	109			10	-10	-5	-5	5	0
08/12	0	54	73	155			10	-15	-12	-5	5	10
08/18	0	39	83				-10	-5		5	0	
09/00	10	24	68				-15	0		5	-5	
09/06	0	33	80				0	-10		5	10	
09/12	10	49	74				-5	-2		5	5	
09/18	10	63					-5			5		
10/00	0	73					5			0		
10/06	10	74					-10			10		
10/12	15	59					-2			0		
10/18	0											
11/00	10											
11/06	0											
11/12	0											
mean	10	60	107	173	276	418	1	-1	-5	-1	0	3
sample	29	25	21	17	13	9	25	21	17	25	21	17

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TS Son-tinh (1809)												
Jul. 17/00	0	75					-2			5		
17/06	15	15					0			0		
17/12	22	22					0			0		
17/18	0	70					0			5		
18/00	34											
18/06	0											
18/12	21											
18/18	0											
mean	12	45	--	--	--	--	0	--	--	3	--	--
sample	8	4	0	0	0	0	4	0	0	4	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	T=24	=48	=72
STS Ampil (1810)												
Jul. 18/12	115	115	69	148	334		4	-5	-10	-5	5	10
18/18	107	111	60	150	337		5	-10	-10	-5	10	10
19/00	52	83	68	212	349		5	-10	-10	-5	10	15
19/06	21	128	72	181	357		0	-10	0	0	10	5
19/12	61	93	110	207			-5	-10	5	5	10	5
19/18	39	117	135	231			-10	-10	6	10	10	0
20/00	53	68	103	229			-10	-10	4	10	15	0
20/06	20	81	188	306			-10	-5	6	10	10	-10
20/12	0	78	139				-10	0		10	10	
20/18	0	97	129				-5	0		5	0	
21/00	0	80	124				-5	-2		10	0	
21/06	0	58	123				0	2		5	-10	
21/12	0	67					5			5		
21/18	0	14					0			5		
22/00	48	81					0			0		
22/06	0	35					4			-10		
22/12	28											
22/18	22											
23/00	9											
23/06	22											
mean	30	82	110	208	344	--	-2	-6	-1	3	7	4
sample	20	16	12	8	4	0	16	12	8	16	12	8

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
STS Wukong (1811)												
Jul. 23/12	22	53	141	111			0	0	-4	0	0	0
23/18	35	82	130	208			-2	-2	-4	5	5	0
24/00	24	60	75				0	-4		0	5	
24/06	24	71	122				0	0		0	0	
24/12	11	49	67				0	-6		0	5	
24/18	9	56	88				0	6		0	-10	
25/00	24	69					-4			5		
25/06	0	44					-4			5		
25/12	11	34					-4			5		
25/18	27	33					-4			0		
26/00	11											
26/06	9											
26/12	187											
26/18	41											
mean	31	55	104	160	--	--	-2	-1	-4	2	1	0
sample	14	10	6	2	0	0	10	6	2	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	T=24	=48	=72
TY Jongdari (1812)												
Jul. 24/12	52	103	35				8	16		-15	-20	
24/18	0	46	52	154	237	922	11	20	20	-15	-15	-15
25/00	21	25	74	66	304	767	7	20	20	-10	-15	-15
25/06	11	68	173	60	540	980	5	15	10	-5	-10	-5
25/12	0	102	163	150	529		0	10	15	0	-5	-10
25/18	31	127	62	246	712		10	5	15	-5	0	-10
26/00	23	144	28	281	556	646	10	10	2	-5	-5	0
26/06	0	86	22	279	590	624	10	5	0	-5	0	0
26/12	22	41	24	225		486	5	0	-2	0	5	10
26/18	0	89	97	267		369	5	10	-2	0	-5	10
27/00	0	106	38	206	618	444	-5	0	0	5	5	5
27/06	10	107	46	336	646	515	-10	-2	0	10	5	5
27/12	0	74	112		561	582	-10	-4		10	15	
27/18	0	14	246		445	661	-5	-2		10	10	
28/00	0	115	349	606			-5	0	6	10	5	-10
28/06	0	95	336	554			-7	0	8	5	5	-10
28/12	9	67		332			-4		13	10		-15
28/18	0	152		195			-4		13	10		-15
29/00	27	91	322	150	372		0	-2	0	0	5	5
29/06	18	59	301	121	331		0	0	-5	0	5	10
29/12	11		162	142	227			5	-5		0	10
29/18	0		10	243	45			0	-5		5	10
30/00	59	67	125	256			-2	-5	-5	5	10	10
30/06	40	11	156	238			0	-5	-5	5	10	10
30/12												
30/18												
31/00	24	58	119				-5	-10		10	15	
31/06	11	89	102				-5	-10		10	15	
31/12	10	46	89				-5	-10		10	15	
31/18	22	73	95				-10	-10		15	15	
Aug. 01/00	0	148					-10			15		
01/06	0	183					-10			15		
01/12	0	88					-10			15		
01/18	10	24					-5			10		
02/00	81											
02/06	11											
02/12	0											
02/18	29											
mean	15	83	128	243	448	636	-1	2	4	4	3	-1
sample	36	30	26	21	15	11	30	26	21	30	26	21

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TY Shanshan (1813)												
Aug. 03/00	44	148	215	128	89	248	7	15	0	-10	-15	0
03/06	21	96	117	30	150	113	15	10	0	-15	-10	0
03/12	79	118	132	51	22	59	10	5	-5	-10	-5	5
03/18	64	47	122	88	29	77	10	0	-5	-10	0	5
04/00	0	73	102	84	93	193	0	-15	-5	0	10	5
04/06	0	97	128	138	150	316	0	-15	-5	0	10	5
04/12	0	78	108	91	121	258	-15	-20	-15	10	15	10
04/18	0	83	88	67	184	393	-20	-20	-5	15	15	5
05/00	0	60	67	82	138	149	-20	-15	-5	15	10	0
05/06	0	51	97	143	371		-20	-15	-10	15	10	5
05/12	0	54	66	186	353		-15	-5	-5	10	5	0
05/18	0	44	39	179	416		-15	-5	0	10	5	-5
06/00	0	38	101	225	411		-5	0	0	5	0	-5
06/06	0	56	137	250			-5	-5	0	5	5	-5
06/12	0	48	158	145			0	0	0	0	0	0
06/18	0	22	45	17			0	0	-5	0	0	5
07/00	0	36	63	82			0	-5	-7	0	5	5
07/06	0	22	62				-5	5		5	-5	
07/12	0	37	62				-5	0		5	5	
07/18	0	29	22				0	-5		0	5	
08/00	0	38	138				0	-7		0	5	
08/06	0	14					0			0		
08/12	0	22					-5			5		
08/18	0	9					-10			10		
09/00	0	26					-12			10		
09/06	0											
09/12	0											
09/18	0											
10/00	0											
mean	7	54	99	117	194	201	-4	-5	-4	3	3	2
sample	29	25	21	17	13	9	25	21	17	25	21	17

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TS Yagi (1814)												
Aug. 08/00	24	15	145				0	-4		0	5	
08/06	0	109	221	338	420		0	0	2	0	0	0
08/12	33	139	167	351	345		0	0	4	0	0	-5
08/18	25	108	200	436	509		0	0	4	0	0	-5
09/00	10	121	215	420			0	0	0	0	0	0
09/06	15	103	286	475			0	2	0	0	0	0
09/12	0	67	277	429			0	4	0	0	-5	5
09/18	0	122	272	347			-2	0	0	0	0	5
10/00	0	90	325				-2	0		0	0	
10/06	0	69	267				-2	-5		5	5	
10/12	0	98	267				0	-5		0	5	
10/18	0	139	174				0	-5		0	10	
11/00	0	193					-5			5		
11/06	0	155					-5			5		
11/12	0	128					-5			5		
11/18	0	92					0			5		
12/00	32											
12/06	32											
12/12	15											
12/18	11											
mean	10	109	235	400	425	--	-1	-1	1	2	2	0
sample	20	16	12	7	3	0	16	12	7	16	12	7

Date/Time (UTC)		Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
STS Leepi (1815)													
Aug.	11/12	57											
	11/18	66	137	256				4	14		-5	-25	
	12/00	25	83	330				4	14		-5	-25	
	12/06	35	124	308				6	10		-15	-25	
	12/12	23	221	372				6	10		-15	-25	
	12/18	10	187	432				6	4		-15	-15	
	13/00	20	235					6			-15		
	13/06	0	259					4			-5		
	13/12	11	214					4			-5		
	13/18	0	141					-2			5		
	14/00	11											
	14/06	31											
	14/12	40											
	14/18	0											
	mean	23	178	340	--	--	--	4	10	--	-8	-23	--
	sample	14	9	5	0	0	0	9	5	0	9	5	0

Date/Time (UTC)		Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
TS Bebinca (1816)													
Aug.	13/00	10	86	76	59	120		-5	0	0	5	0	-5
	13/06	10	47	15	137			-5	2	7	5	-5	-10
	13/12	25	15	84	99			-5	2	7	5	-5	-10
	13/18	85	21	109	107			-5	2	2	5	-5	-5
	14/00	10	174	154	79			-5	2	2	5	-5	-10
	14/06	10	79	68				-5	7		0	-10	
	14/12	10	96	143				2	7		-5	-10	
	14/18	24	125	84				2	2		-5	-5	
	15/00	11	177	163				2	0		-5	0	
	15/06	0	147					5			-5		
	15/12	0	199					5			-5		
	15/18	33	163					0			0		
	16/00	11	95					-2			5		
	16/06	0											
	16/12	10											
	16/18	24											
	17/00	24											
	mean	18	110	100	96	120	--	-1	3	4	0	-5	-8
	sample	17	13	9	5	1	0	13	9	5	13	9	5

Date/Time (UTC)		Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
TS Hector (1817)													
Aug.	13/18	40	67					-4			5		
	14/00	0	22					-4			5		
	14/06	15											
	14/12	11											
	14/18	11											
	15/00	51											
	mean	21	45	--	--	--	--	-4	--	--	5	--	--
	sample	6	2	0	0	0	0	2	0	0	2	0	0

Date/Time (UTC)		Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
TS Rumbia (1818)													
Aug.	15/06	22	44	184				4	9		0	0	
	15/12	37	40	126				9	6		-5	0	
	15/18	50	22	22				9	6		-5	0	
	16/00	22	10					11			-10		
	16/06	66	53					11			-5		
	16/12	59	22					6			0		
	16/18	29	86					4			0		
	17/00	86											
	17/06	0											
	17/12	15											
	17/18	29											
	mean	38	39	111	--	--	--	8	7	--	-4	0	--
	sample	11	7	3	0	0	0	7	3	0	7	3	0

Date/Time (UTC)		Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
TY Soulik (1819)													
Aug.	16/00	74	46	24	107	205	294	7	25	20	-5	-20	-15
	16/06	39	0	32	67	170	247	12	25	15	-10	-20	-10
	16/12	57	24	32	35	87	96	20	20	5	-15	-15	0
	16/18	0	30	71	117	202	418	15	15	0	-10	-10	5
	17/00	0	44	30	112	139	278	10	0	-10	-5	0	10
	17/06	0	15	20	92	150	421	15	0	-5	-10	0	5
	17/12	0	24	46	126	231	502	10	-10	-5	-5	10	5
	17/18	32	30	73	126	245	738	0	-15	0	0	15	0
	18/00	0	15	78	89	275	762	-5	-10	0	5	10	0
	18/06	0	24	49	78	254	775	-5	-5	0	5	5	0
	18/12	15	11	75	89	349	878	-10	-5	0	10	5	0
	18/18	15	30	54	63	213	631	-15	0	5	15	0	-5
	19/00	0	37	50	93	378	661	-10	0	5	10	0	-5
	19/06	35	37	41	115	490	606	-5	0	10	5	0	-5
	19/12	45	22	67	168	707	759	-5	0	5	5	0	0
	19/18	20	30	39	189	668		0	0	0	0	0	5
	20/00	0	15	45	333	581		0	0	5	0	0	0
	20/06	0	10	38	267	411		0	0	20	0	0	-15
	20/12	0	0	67	356	380		0	-5	15	0	5	-10
	20/18	0	22	80	303			0	0	5	0	5	5
	21/00	15	10	91	197			0	0	7	0	5	0
	21/06	15	10	138	393			-5	5	5	5	0	-5
	21/12	11	19	165	492			-5	0	6	5	5	-15
	21/18	10	30	148				0	-5		5	15	
	22/00	15	57	239				5	0		0	5	
	22/06	15	68	180				0	5		0	0	
	22/12	0	57	152				0	0		0	5	
	22/18	22	42					-5			10		
	23/00	0	52					-5			5		
	23/06	19	24					-5			5		
	23/12	14	17					-5			5		
	23/18	49											
	24/00	0											
	24/06	91											
	24/12	17											
	mean	18	28	79	174	323	538	0	1	5	1	1	-2
	sample	35	31	27	23	19	15	31	27	23	31	27	23

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
						TY Cimaron (1820)							
Aug.	18/12	70	21	87	0	128	221	8	16	20	-10	-10	-5
	18/18	54	55	86	30	98	166	9	10	20	-10	-5	-10
	19/00	31	115	47	22	87	207	9	15	25	-10	-10	-15
	19/06	85	125	53	35	135	378	7	15	25	-5	-10	-15
	19/12	102	118	15	78	201		10	15	25	-5	-5	-15
	19/18	46	54	24	74	194		5	15	20	0	-5	-10
	20/00	21	100	121	77	273		0	15	15	5	-5	-5
	20/06	35	115	108	67	238		0	15	10	0	-10	-5
	20/12	56	44	78	159			5	15	-5	0	-10	0
	20/18	39	59	89	275			10	10	-10	-5	-5	5
	21/00	11	63	59	282			15	10	-5	-10	-5	5
	21/06	0	11	66	212			5	10	-14	-5	-5	15
	21/12	10	35	100				5	0		-5	-5	
	21/18	10	24	121				0	-10		0	5	
	22/00	0	0	162				-5	-10		5	5	
	22/06	15	35	205				-5	-2		5	5	
	22/12	10	75					0			-5		
	22/18	10	100					0			-10		
	23/00	0	112					-5			0		
	23/06	9	75					-9			10		
	23/12	0											
	23/18	11											
	24/00	11											
	24/06	60											
	mean	29	67	89	109	169	243	3	9	11	-3	-5	-5
	sample	24	20	16	12	8	4	20	16	12	20	16	12

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
						TY Jebi (1821)							
Aug.	27/18	11	24					6			-10		
	28/00	0	15	65	148	231	328	8	30	50	-15	-20	-20
	28/06	0	55	46	107	85	215	7	40	50	-10	-20	-20
	28/12	0	77	24	74	73	185	10	40	45	-10	-20	-15
	28/18	0	21	25	70	83	229	15	35	35	-15	-20	-15
	29/00	0	11	25	85	103	276	15	35	25	-10	-15	-10
	29/06	0	15	48	84	134	267	15	25	20	-5	-10	-5
	29/12	0	21	85	130	133	191	15	20	10	-5	-5	0
	29/18	0	64	104	131	151	255	15	20	0	-5	-5	5
	30/00	0	39	109	121	183	329	25	20	0	-10	-5	5
	30/06	0	74	63	92	170	536	20	0	-20	-10	0	10
	30/12	0	57	53	82	166	893	10	-10	-10	-5	5	5
	30/18	0	33	33	60	180	955	-10	-30	-20	5	15	10
	31/00	0	31	53	126	303		-10	-20	-20	5	10	10
	31/06	0	42	84	142	498		0	-15	-15	0	5	5
	31/12	0	47	82	110	602		-10	-15	-15	5	5	5
	31/18	11	15	98	137	406		-20	-15	-10	10	5	5
Sep.	01/00	0	30	60	101			-15	-15	-5	5	5	0
	01/06	0	42	69	124			-15	-15	-5	5	5	0
	01/12	0	24	24	233			-10	-5	0	5	0	0
	01/18	0	24	59	269			0	0	0	0	0	10
	02/00	22	67	113				-5	-5		5	0	
	02/06	0	70	330				0	-20		0	10	
	02/12	0	35	239				0	0		0	0	
	02/18	0	45	170				0	0		0	10	
	03/00	0	53					-5			0		
	03/06	0	82					-5			0		
	03/12	0	67					-5			0		
	03/18	0	58					-5			10		
	04/00	19											
	04/06	0											
	04/12	70											
	04/18	8											
	mean	4	43	86	121	219	388	2	4	6	-2	-2	-1
	sample	33	29	24	20	16	12	29	24	20	29	24	20

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
						TY Mangkhut (1822)							
Sep.	07/12	25	33	193	273	487	674	4	20	25	-5	-20	-20
	07/18	0	46	179	295	433	577	2	25	25	-5	-20	-15
	08/00	0	87	203	298	410	551	15	20	20	-15	-15	-15
	08/06	54	160	190	289	368	568	10	15	35	-10	-10	-20
	08/12	0	63	127	205	267	450	0	-10	30	0	5	-15
	08/18	0	99	110	151	195	270	5	-5	5	0	10	0
	09/00	21	64	110	147	194	223	-5	-10	0	5	5	0
	09/06	0	55	110	116	185	153	-15	10	0	10	-5	0
	09/12	0	87	77	49	123	109	-10	20	0	5	-10	0
	09/18	0	58	45	76	154	187	-5	10	0	5	-5	0
	10/00	0	86	76	136	193	347	0	10	0	0	-5	0
	10/06	0	45	79	169	155	279	20	10	0	-10	-5	0
	10/12	0	55	66	165	186	261	30	10	0	-15	-5	0
	10/18	0	22	92	171	253	244	30	10	0	-15	-5	0
	11/00	0	39	85	104	223	182	10	0	0	-5	0	0
	11/06	0	31	77	62	139	202	10	0	-5	-5	0	5
	11/12	0	24	78	101	148	211	10	0	-5	-5	0	5
	11/18	0	55	93	148	124	220	0	-5	-5	0	5	5
	12/00	0	49	62	168	84	211	0	-5	-35	0	5	20
	12/06	0	58	39	71	152		-5	-5	-15	5	5	10
	12/12	0	70	65	64	199		-5	-5	-15	5	5	10
	12/18	0	40	77	54	243		-5	-5	-15	5	5	10
	13/00	0	21	96	115	284		-5	-25	-10	5	15	5
	13/06	0	35	35	168			0	0	-10	0	0	5
	13/12	0	55	59	163			0	-5	-20	0	0	15
	13/18	0	74	59	150			0	0	-10	0	0	10
	14/00	0	53	67	181			0	-10	-27	0	5	10
	14/06	0	15	108				5	-10		-5	5	
	14/12	0	22	99				-5	-20		0	15	
	14/18	0	21	94				-10	-20		5	15	
	15/00	0	0	80				-10	-17		5	10	
	15/06	0	56					-10			5		
	15/12	0	44					-10			10		
	15/18	0	68					5			-5		
	16/00	0	69					2			-5		
	16/06	0											
	16/12	0											
	16/18	0											
	17/00	0											
	mean	3	53	95	151	226	311	2	0	-1	-1	0	1
	sample	39	35	31	27	23	19	35	31	27	35	31	27

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
						TS Barijat (1823)							
Sep.	11/00	42	24	103				0	-10		0	15	
	11/06	24	57					-6			10		
	11/12	31	103					-6			10		
	11/18	24	11					-6			10		
	12/00	21	59					-8			10		
	12/06	0											
	12/12	0											
	12/18	38											
	13/00	103											
	mean	31	51	103	--	--	--	-5	-10	--	8	15	--
	sample	9	5	1	0	0	0	5	1	0	5	1	0

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TY Trami (1824)													
Sep.	21/06	0	98					10			-20		
	21/12	11	85	11	92	74	157	5	20	25	-5	-10	-10
	21/18	0	111	77	104	79	183	10	20	35	-5	-10	-15
	22/00	86	149	108	119	146	251	10	5	20	-5	0	-5
	22/06	78	78	85	69	154	254	10	-10	10	-5	5	-5
	22/12	11	78	77	49	152	239	5	-10	-10	-5	5	5
	22/18	0	39	64	30	185	362	10	10	-20	-5	-5	10
	23/00	25	33	24	115	250	441	5	10	-35	-5	-5	20
	23/06	0	25	10	127	221	378	10	10	-35	-5	-5	20
	23/12	0	39	31	130	202	353	0	-10	-35	0	5	20
	23/18	11	21	35	127	164	319	10	-20	-35	-5	10	20
	24/00	0	33	56	84	95	203	0	-35	-25	0	20	15
	24/06	0	11	56	46	42	266	0	-35	-25	0	20	15
	24/12	0	11	90	54	84	373	-10	-35	-25	5	20	15
	24/18	0	11	46	47	149	553	-20	-35	-25	10	20	15
	25/00	0	35	35	98	271	712	-35	-35	-25	20	20	15
	25/06	0	35	64	76	260	742	-35	-35	-25	20	20	15
	25/12	0	44	61	106	380	850	-25	-25	-15	15	15	10
	25/18	0	39	85	162	465	1033	-15	-15	-10	10	10	5
	26/00	0	31	92	121	249		-15	-15	-10	10	10	5
	26/06	10	43	62	110	118		-15	-15	-10	10	10	5
	26/12	0	41	52	111	102		-15	-15	-10	10	10	5
	26/18	0	23	71	79	205		-15	-15	-10	10	10	5
	27/00	15	21	60	95			-15	-15	-10	10	10	5
	27/06	0	23	83	94			-10	-15	-15	5	10	10
	27/12	15	46	82	64			-10	-15	5	5	10	-5
	27/18	11	46	81	171			-10	-15	0	5	10	0
	28/00	0	49	56				-15	-5		10	5	
	28/06	0	59	22				-15	-10		10	10	
	28/12	0	30	35				-15	-5		10	0	
	28/18	0	22	24				-15	-5		10	0	
	29/00	0	44					-10			5		
	29/06	0	48					-15			10		
	29/12	11	56					-5			0		
	29/18	37	125					-10			0		
	30/00	0											
	30/06	0											
	30/12	0											
	30/18	29											
	mean	9	48	58	95	184	426	-7	-12	-12	4	8	8
	sample	39	35	30	26	22	18	35	30	26	35	30	26

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TY Kong-rey (1825)													
Sep.	29/06	0	46	121	111	137	285	19	60	75	-20	-40	-45
	29/12	11	109	106	114	103	323	25	75	50	-25	-50	-30
	29/18	24	117	96	110	115	367	30	70	15	-25	-45	-10
	30/00	25	75	88	71	145	424	30	55	0	-20	-35	0
	30/06	0	81	34	49	190	466	25	35	-20	-15	-20	15
	30/12	15	15	33	90	281	603	50	20	-35	-30	-10	25
	30/18	21	22	31	89	267	570	40	-5	-40	-25	5	30
Oct.	01/00	21	32	43	123	357	883	40	-15	-40	-25	10	30
	01/06	0	42	30	157	395	1080	40	-20	-40	-25	15	35
	01/12	0	11	56	202	492		0	-45	-40	0	30	35
	01/18	15	31	84	250	569		-25	-50	-40	15	35	35
	02/00	0	25	84	252	622		-25	-40	-35	15	30	30
	02/06	15	46	145	304	694		-30	-40	-30	20	30	20
	02/12	15	35	167	362			-45	-30	-25	25	25	15
	02/18	0	39	145	315			-35	-30	-10	25	25	5
	03/00	10	45	180	363			-30	-25	-10	20	20	10
	03/06	11	67	184	470			-20	-15	-10	20	10	10
	03/12	0	78	204				-15	-15		15	10	
	03/18	11	67	115				-10	-10		10	5	
	04/00	11	78	165				-10	-10		10	10	
	04/06	11	45	147				-10	-10		5	10	
	04/12	15	44					-10			5		
	04/18	0	11					-10			0		
	05/00	0	33					-10			5		
	05/06	22	58					-10			5		
	05/12	15											
	05/18	0											
	06/00	0											
	06/06	0											
	mean	9	50	107	202	336	556	0	-2	-14	-1	3	12
	sample	29	25	21	17	13	9	25	21	17	25	21	17

Date/Time (UTC)	Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
TY Yutu (1826)												
Oct. 22/00	40	128	168	258	426	738	17	50	50	-15	-30	-25
22/06	25	154	178	270	465	764	10	40	20	-10	-25	-10
22/12	0	194	167	270	495	609	20	50	-10	-15	-30	5
22/18	24	114	154	270	470	536	5	35	-20	-5	-20	10
23/00	40	74	151	246	434	508	25	25	-20	-15	-15	10
23/06	16	55	129	224	423	462	25	10	-10	-15	-5	5
23/12	25	33	97	234	367	524	25	-20	-10	-15	10	5
23/18	0	44	86	163	244	343	25	-20	0	-15	10	0
24/00	11	24	72	125	105	240	10	-25	5	-5	15	0
24/06	0	55	75	118	108	249	-5	-5	10	5	5	-5
24/12	11	34	78	77	128	278	-35	-20	-5	25	15	5
24/18	0	34	85	57	162	302	-35	-10	-10	25	10	5
25/00	11	33	54	40	188	413	-30	-5	-10	20	5	5
25/06	11	56	48	31	177	407	-15	0	-25	10	0	15
25/12	0	64	24	46	78	248	0	20	-20	0	-10	15
25/18	11	24	22	72	149	300	20	0	-45	-10	0	30
26/00	11	33	11	85	176	212	20	-10	-45	-10	5	30
26/06	0	11	22	92	210	158	10	-25	-30	-5	15	20
26/12	11	25	46	102	213	131	10	-30	-30	-5	20	20
26/18	0	34	49	102	117	140	0	-45	-30	0	30	20
27/00	11	24	109	221	213	229	-20	-55	-55	10	35	35
27/06	11	15	77	254	233	212	-25	-30	-40	15	15	30
27/12	0	11	34	234	170	123	-30	-15	-15	20	10	15
27/18	0	24	11	57	173	254	-35	-5	-15	25	5	15
28/00	11	15	58	109	222	203	-35	-5	-15	25	5	15
28/06	11	15	0	113	200		-25	-15	-22	15	10	20
28/12	0	21	46	124	246		-20	-5	-27	15	5	25
28/18	11	15	33	153	189		-15	-15	-27	10	10	25
29/00	0	11	55	99	62		15	0	-9	-20	-5	5
29/06	11	24	68	77			5	0	-4	-5	0	5
29/12	0	46	79	71			0	-7	-9	0	10	10
29/18	11	33	44	53			-5	-7	-10	5	10	10
30/00	11	35	31	38			-5	-9	-16	5	10	10
30/06	25	15	25				-7	-9		10	10	
30/12	24	54	64				-7	-4		10	5	
30/18	25	35	99				-2	-10		5	10	
31/00	15	39	86				-2	-12		0	5	
31/06	34	46					-2			0		
31/12	55	38					-4			5		
31/18	33	38					-8			5		
Nov. 01/00	0	25					-10			0		
01/06	31											
01/12	43											
01/18	24											
02/00	21											
mean	15	44	71	136	236	343	-3	-5	-15	2	4	12
sample	45	41	37	33	29	25	41	37	33	41	37	33

Date/Time (UTC)	Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
TS Toraji (1827)												
Nov. 17/06	101											
17/12	0											
17/18	35											
mean	45	--	--	--	--	--	--	--	--	--	--	--
sample	3	0	0	0	0	0	0	0	0	0	0	0

Date/Time (UTC)	Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
TY Man-yi (1828)												
Nov. 20/18	105	200	304	263	181	411	-2	10	5	5	-10	-5
21/00	25	197	226	272	409	618	-5	5	0	5	-5	0
21/06	49	222	173	181	245	373	12	25	10	-10	-20	-5
21/12	78	140	140	119	70		17	20	20	-15	-15	-15
21/18	33	104	131	119	232		20	15	15	-20	-15	-15
22/00	0	118	134	170	193		10	5	5	-10	-5	-5
22/06	11	25	101	191	162		5	5	0	-5	-5	-5
22/12	22	44	178	270			0	10	-5	0	-10	-5
22/18	0	112	239	359			0	5	-12	0	-10	5
23/00	56	122	239	244			-10	5	-28	5	-10	25
23/06	63	101	202	113			-10	-5	-35	5	-5	35
23/12	72	164	296				-5	-15		0	5	
23/18	40	124	221				-5	-27		0	20	
24/00	0	169	137				0	-33		-5	30	
24/06	44	172	53				-10	-35		0	35	
24/12	15	88					-10			5		
24/18	22	24					-27			25		
25/00	0	64					-33			35		
25/06	24	69					-30			35		
25/12	64											
25/18	120											
26/00	31											
26/06	0											
26/12												
mean	38	119	185	209	213	467	-4	-1	-2	3	-1	1
sample	23	19	15	11	7	3	19	15	11	19	15	11

Date/Time (UTC)	Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
STS Usagi (1829)												
Nov. 22/00	22	90	125				0	0		-10	-5	
22/06	0	35					4			-15		
22/12	25	11	112	102			-2	0	2	-5	-5	-10
22/18	45	56	44	80			-2	0	0	-5	-5	-10
23/00	25	71	92				0	-2		-10	-5	
23/06	16	100	89				-10	0		0	0	
23/12	70	114	55				-12	-2		5	5	
23/18	67	102	25				-12	-2		5	0	
24/00	0	50					-18			15		
24/06	0	33					-15			15		
24/12	0	40					-6			5		
24/18	0	70					-8			5		
25/00	11											
25/06	0											
25/12	16											
25/18	55											
mean	22	64	77	91	--	--	-7	-1	1	0	-2	-10
sample	16	12	7	2	0	0	12	7	2	12	7	2

Appendix 4

Monthly and Annual Frequencies of Tropical Cyclones

Monthly and annual frequencies of tropical cyclones that attained TS intensity or higher in the western North Pacific and the South China Sea for 1951 - 2018

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
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 (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 for Five-day Track Forecast (WTPQ50-55 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
48HF $YYGGgg_F$ 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
72HF $YYGGgg_F$ 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
96HF YYGGggF UTC LaLa.LaF N LoLoLo.LoF E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
120HF YYGGggF UTC LaLa.LaF N LoLoLo.LoF E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT=

Notes:

a. Underlined parts are fixed.

b. Abbreviations and symbolic letters are the same as those used in RSMC Tropical Cyclone Advisory (WTPQ20-25 RJTD).

Example:

```
WTPQ50 RJTD 060000
RSMC TROPICAL CYCLONE ADVISORY
NAME    TY 0908 MORAKOT (0908)
ANALYSIS
PSTN    060000UTC 23.4N 128.3E FAIR
MOVE    WNW 09KT
PRES    960HPA
MXWD    075KT
GUST    105KT
50KT    80NM
30KT    350NM SOUTH 300NM NORTH
FORECAST
24HF    070000UTC 24.0N 123.9E 70NM 70%
MOVE    W 10KT
PRES    925HPA
MXWD    090KT
GUST    130KT
48HF    080000UTC 25.3N 121.8E 110NM 70%
MOVE    WNW 06KT
PRES    950HPA
MXWD    080KT
GUST    115KT
72HF    090000UTC 26.5N 119.7E 160NM 70%
MOVE    WNW 06KT
PRES    970HPA
MXWD    065KT
GUST    095KT
96HF    100000UTC 28.0N 118.8E 240NM 70%
MOVE    NNW SLOWLY
120HF 110000UTC 29.6N 118.2E 375NM 70%
MOVE    NNW SLOWLY =
```

(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)

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 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

i i	:	'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

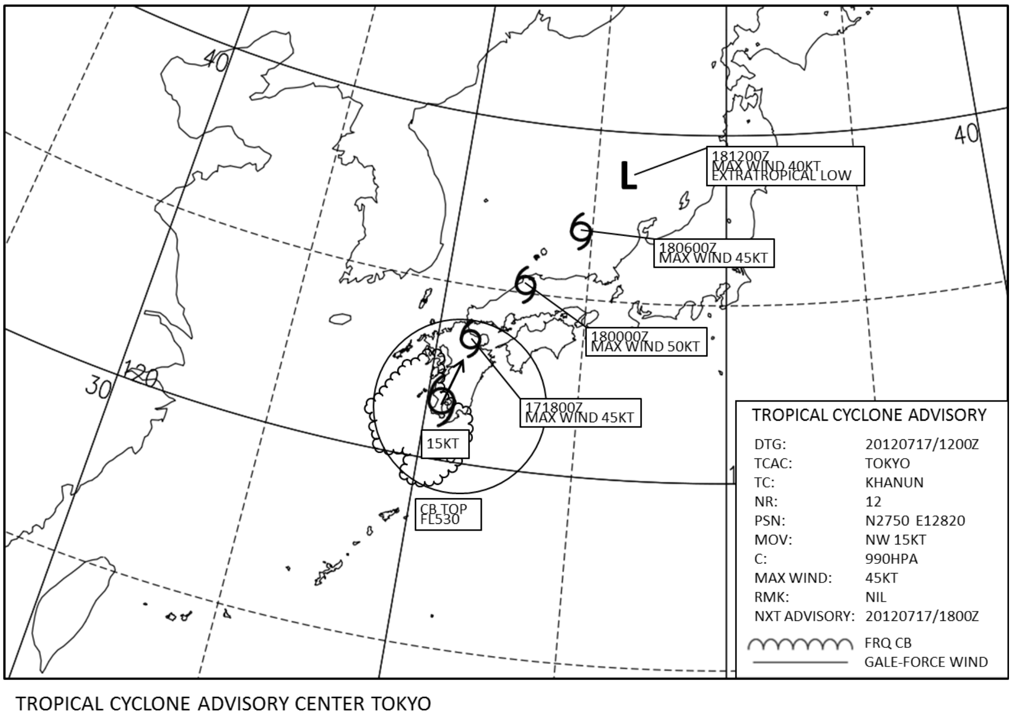
i i	:	'30', '31', '32', '33', '34' or '35'
YYGGgg	:	Date(YY), hour(GG) and minute(gg) in UTC (Using "Z")
yyyymmdd/time	:	Year(yyyy), month(mm), date(dd), hour and minute (time) in UTC (Using "Z")
name	:	Name assigned to the tropical cyclone by RSMC Tokyo-Typhoon Center
Number	:	Advisory number (starting 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:



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 6.1.

Table 6.1 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 (4DVAR) Outer resolution: TL959L100 Inner resolution: TL319L100 Window: Init-3h to Init + 3h	Unperturbed condition: Truncated GSM initial condition Initial perturbation: LETKF-based perturbation and SV-based perturbation Ensemble size: 27 (26 perturbed members and 1 control member) 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) 264h (12 UTC)	264 hours (00, 12 UTC) 132 hours (06, 18 UTC)
Operational as from	18 March 2014	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 Yonehara et al. (2014).

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 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 GSM and the Global Data Assimilation System]

GSM:

- The forecast period was extended to 132 hours at 00, 06 and 18 UTC (June 2018)

Global Data Assimilation System:

- Usage of surface-sensitive Clear-Sky Radiance (CSR) data from Himawari-8 Band 9 and 10 and Meteosat-8, 11 Channel 6 started (October 2018)
- Usage of hourly CSR data from Meteosat-8, 11 and GOES-15 with cessation of data thinning every two hours (October 2018)

[References]

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

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

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

Tokuhiro, T., 2018: Introduction to JMA's new Global Ensemble Prediction System. RSMC Tokyo – Typhoon Center Technical Review, 20.
http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/techrev/text17-1.pdf

Yonehara, H., M. Ujiie, T. Kanehama, R. Sekiguchi and Y. Hayashi, 2014: Upgrade of JMA's Operational NWP Global Model, CAS/JSC WGNE Res. Activ. Atmos. Oceanic Modell., 44, 06.19-06.20.

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

Model	GEPS
Area and resolution	Whole globe, 2.5°×2.5°
Levels and elements	250 hPa: μU, σU, μV, σV 500 hPa: μZ, σZ 850 hPa: μU, σU, μV, σV, μT, σT 1000 hPa: μZ, σZ 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, Whole globe 0.25° × 0.25°	5S-90N and 30E-165W, Whole globe 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 20 hPa: Z, U, V, T, H, ω 30 hPa: Z, U, V, T, H, ω 50 hPa: Z, U, V, T, H, ω 70 hPa: Z, U, V, T, H, ω 100 hPa: Z, U, V, T, H, ω 150 hPa: Z, U, V, T, H, ω 200 hPa: Z, U, V, T, H, ω, ψ, χ 250 hPa: Z, U, V, T, H, ω 300 hPa: Z, U, V, T, H, ω 400 hPa: Z, U, V, T, H, ω 500 hPa: Z, U, V, T, H, ω, ζ 600 hPa: Z, U, V, T, H, ω 700 hPa: Z, U, V, T, H, ω 800 hPa: Z, U, V, T, H, ω 850 hPa: Z, U, V, T, H, ω, ψ, χ 900 hPa: Z, U, V, T, H, ω 925 hPa: Z, U, V, T, H, ω 950 hPa: Z, U, V, T, H, ω 975 hPa: Z, U, V, T, H, ω 1000 hPa: Z, U, V, T, H, ω Surface: U, V, T, H, P, Ps, R, Cla, Clh, Clm, Cll
Forecast hours	0–84 (every 3 hours) 90–264 (every 6 hours) are available for 12 UTC initial	0–84 (every 3 hours) 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) Himawari-8 (VIS, IR, WVx3: every hour), 60S-60N, 90E-170W Clear Sky Radiance (CSR) data (BUFR) Himawari-8 radiances and brightness temperatures averaged over cloud-free pixels: every hour
Tropical cyclone Information	Tropical cyclone related information (BUFR) • tropical cyclone analysis data (00, 06, 12 and 18 UTC)
Wave data	Global Wave Model (GRIB2) • significant wave height • prevailing wave period • wave direction Forecast hours: 0–84 every 6 hours (00, 06 and 18UTC) 0–84 every 6 hours and 96-192 every 12 hours (12 UTC)
Observational data	(a) Surface data (TAC/TDCF) SYNOP, SHIP, BUOY: Mostly 4 times a day (b) Upper-air data (TAC/TDCF) TEMP (parts A-D), PILOT (parts A-D): Mostly twice a day
SATAID service	(a) Satellite imagery (SATAID) Himawari-8 (b) Observation data (SATAID) SYNOP, SHIP, METAR, TEMP (A, B) and ASCAT sea-surface wind (c) NWP products (SATAID) GSM (Available at https://www.wis-jma.go.jp/cms/sataid/)

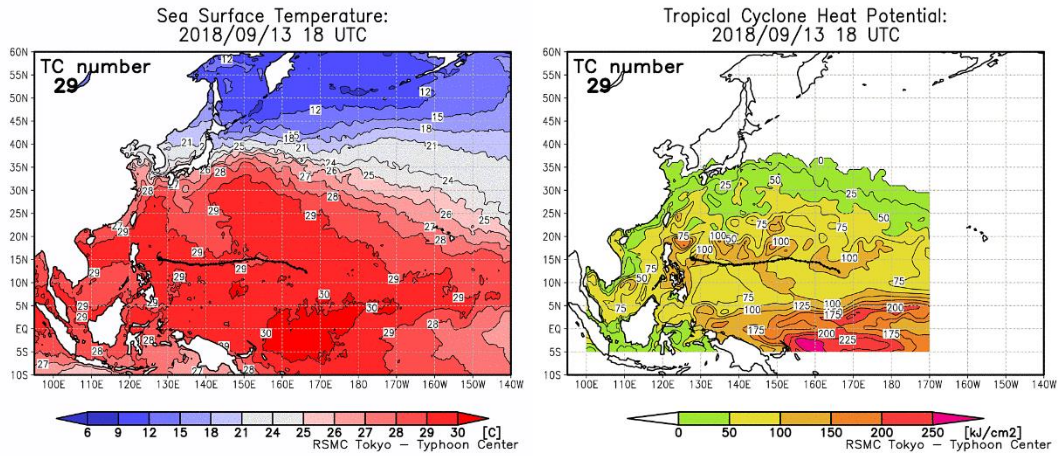
Products on NTP Website

List of products provided on the Numerical Typhoon Prediction (NTP) website:
https://tynwp-web.kishou.go.jp/

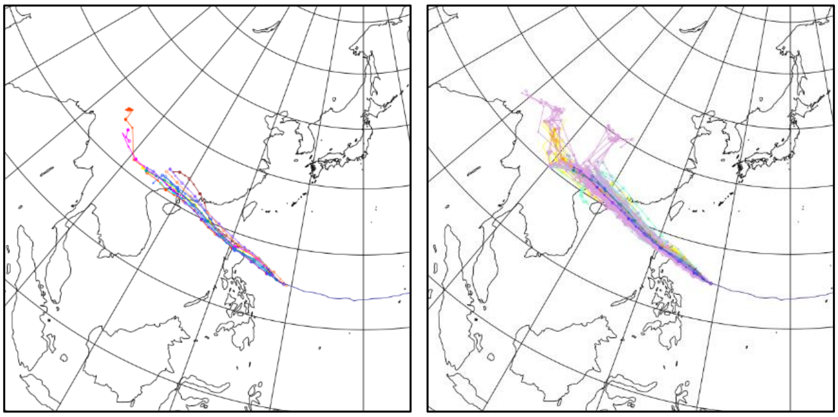
Products	Frequency	Details
Advisories		
Prognostic Reasoning	4 times/day	• RSMC Tokyo Tropical Cyclone Prognostic Reasoning (WTPQ3X)
RSMC TC Advisory	At least 8 times/day	• The Center's TC analysis, track forecasts up to 120 hours ahead and intensity forecasts up to 72 hours ahead (linked to the JMA website at https://www.jma.go.jp/en/typh/)
Graphical TC Advisory	4 times/day	• Graphical TC Advisory including the Center's TC analysis, track and intensity forecasts up to 24 hours ahead 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 at https://www.data.jma.go.jp/fcd/tca/data/index.html)
Operational Remarks		• Advance notice on TC status change from the Center
Track Bulletin	4 times/day	• RSMC Tokyo Tropical Cyclone Track Forecast Bulletin - Track forecast by GSM (FXPQ2X) - Track forecast by GEPS (FXPQ3X)
Observation/Analysis		
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 • Warm-core-based TC intensity estimates • Weighted consensus TC intensity estimates made using Dvorak analysis and satellite microwave warm-core-based intensity estimates
Radar	Every hour	• Radar composite imagery from the Typhoon Committee Regional Radar Network
Weather Maps	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/)
Upper-Air Analysis	4 times/day	• Upper-air analysis based on GSM initial field data - Streamlines at 850 and 200 hPa - Vertical wind shear between 200 and 850 hPa - Divergence at 200 hPa - Vorticity at 850 hPa
Ocean Analysis	Once/day	• Sea surface temperature and related differences from 24 hours ago • Tropical cyclone heat potential and related differences from 24 hours ago

Forecasting/NWP		
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 • TC track prediction of EPSs from four centers (ECMWF, NCEP, UKMO and JMA)
NWP Weather Maps	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)
TC Activity Prediction	Twice/day	• Two- and five-day TC activity prediction maps based on EPSs from four centers (ECMWF, UKMO, NCEP and JMA) and a related consensus
Storm Surge/Waves		
Storm Surge Forecasts	4 times/day	• Distribution maps of storm surges for the Center's TC track forecast and each of five TC track forecasts selected from GEPS ensemble members, and the maximum storm surge among these six TC track forecasts (up to 72 hours ahead) • Time-series storm surge forecast charts for the Center's TC track forecast and each of five TC track forecasts selected from GEPS ensemble members (up to 72 hours ahead)
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 ahead) • 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 ahead)

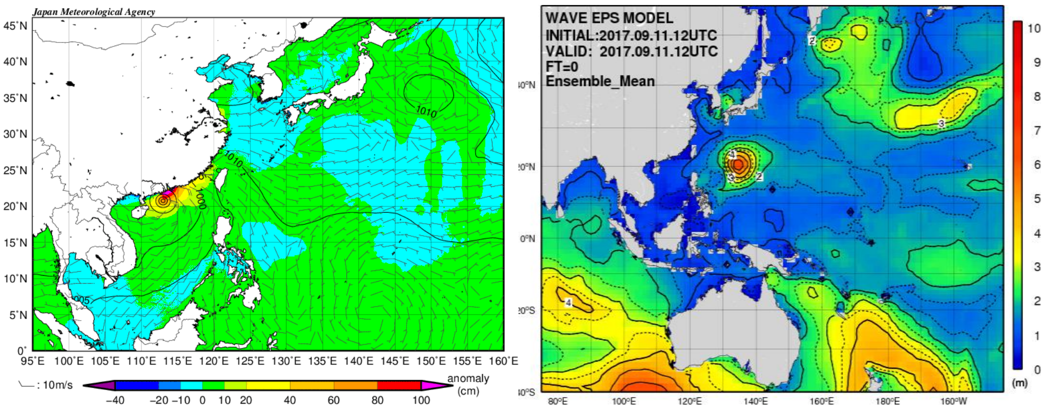
RSMC Tokyo - Typhoon Center product examples



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, MSC, CMA, 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.

Appendix 9

User's Guide to the DVD

Preface

This DVD contains all the texts, tables and charts of the RSMC Annual Report 2018 along with satellite images of the tropical cyclones that attained TS intensity or higher in the western North Pacific and the South China Sea in 2018. This document is a brief user's guide on how to use the DVD, which was mastered in ISO-9660 format.

Directory and File layout

```
[Root]
|------TopMenu.html (start menu html page)
|------Readme.txt (brief explanation of the DVD)
|------SATAIDmanual.pdf (user manual for the satellite image viewer)
|------Annual_Report
            |---Text (text of Annual Report 2018 in PDF)
            |---Figure (figures in PDF)
            |---Table (tables in PDF)
            |---Appendix (appendices for MS Word, Excel and PDF)
|------Best_Track
            |---E_BST_2018.txt (best track data for 2018)
            |---E_BST_201801.txt (best track data for TCs generated in January 2018)
                        :
            |---E_BST_201811.txt (best track data for TCs generated in November 2018)
|------SATAID
            |---Gmslpd.exe (viewer; tropical cyclone version in English for 32-bit OS)
            |---Gsetup.exe (setup program for 32-bit OS)
            |---Gmslpd64.exe (viewer; tropical cyclone version in English for 64-bit OS)
            |---Gsetup64.exe (setup program for 64-bit OS)
|------Satellite_Images
            |---T1801 (hourly satellite image data for T1801)
            |---T1802 (hourly satellite image data for T1802)
                  :
            |---T1829 (hourly satellite image data for T1829)
```

How to use the DVD

The start menu shown when the DVD is inserted or the TopMenu.html file is clicked contains links titled Annual Report 2018, SATAID Installation for 32-bit OS/64-bit OS, Satellite Images and About this DVD. Click the link or the file name of the content you wish to see and follow the instructions on the display.

Hardware/OS requirements for using the DVD:

Hardware	:	PC/AT compatible
OS	:	Microsoft Windows XP or later

< Annual Report 2018>

Annual Report 2018 is provided in two formats as PDF files and MS Word/Excel files.

- PDF files:

Click *Annual Report 2018* to open the text in PDF. If you cannot open it, download Adobe Reader from Adobe’s website (http://www.adobe.com/). Adobe Reader (or Adobe Acrobat) is required to view PDF files.

- MS Word/Excel files:

The original figures and tables prepared with Microsoft Word or Excel are contained in the Annual Report folder of the DVD.

< SATAID Installation >

- Installation of the program for displaying satellite images

Click *SATAID Installation for 32-bit OS/64-bit OS* to run the setup program (Gsetup.exe for 32-bit OS/Gsetup64.exe for 64-bit OS) for the satellite image viewer (SATAID). Follow the instructions to install SATAID (Gmslpd.exe for 32-bit OS/Gmslpd64.exe for 64-bit OS).

< Satellite Images >

- Displaying satellite images

After installing SATAID, click *Satellite Images* in Internet Explorer or Firefox to launch SATAID and display a list of tropical cyclones occurring in 2018 in the selection window. Choose and click a tropical cyclone from the list to see hourly satellite images of it. You can also display the track of the tropical cyclone superimposed onto the satellite image and measure its intensity using the Dvorak method.

- User manual for the viewer

Besides the above features, the viewer has many other useful functions. See the User Manual (SATAIDmanual.pdf) for further details on its use.

- Explanation of satellite image data

Satellite	: Himawari-8
Period	: From the TD formation to the time of dissipation
Images	: Infrared images (00 to 23 UTC) Visible images (00 to 12 and 17 to 23 UTC)
Range	: 40 degrees in both latitude and longitude (The image window moves to follow the track of the tropical cyclone so that its center remains in the middle of the window.)
Time interval	: Hourly
Resolution	: 0.05 degrees in both latitude and longitude
Compression of file	: Compressed using the *compress.exe* command of Microsoft Windows

< About this DVD >

Click *About this DVD* to open the *Readme.txt* file.

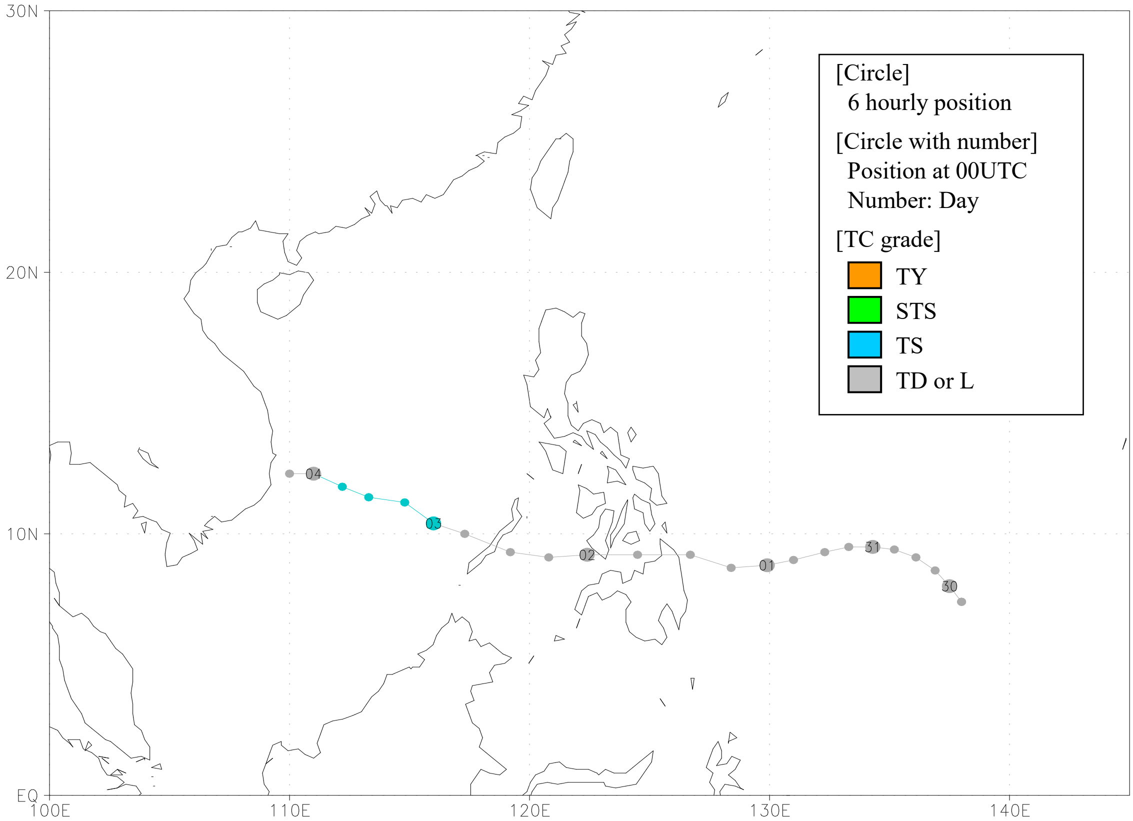
For further information, please contact:

RSMC Tokyo - Typhoon Center
Forecast Division
Forecast Department
Japan Meteorological Agency
1-3-4 Otemachi, Chiyoda-ku, Tokyo 100-8122, Japan
FAX: +81-3-3211-8303
E-mail: rsmc-tokyo@met.kishou.go.jp

Tropical Cyclones in 2018

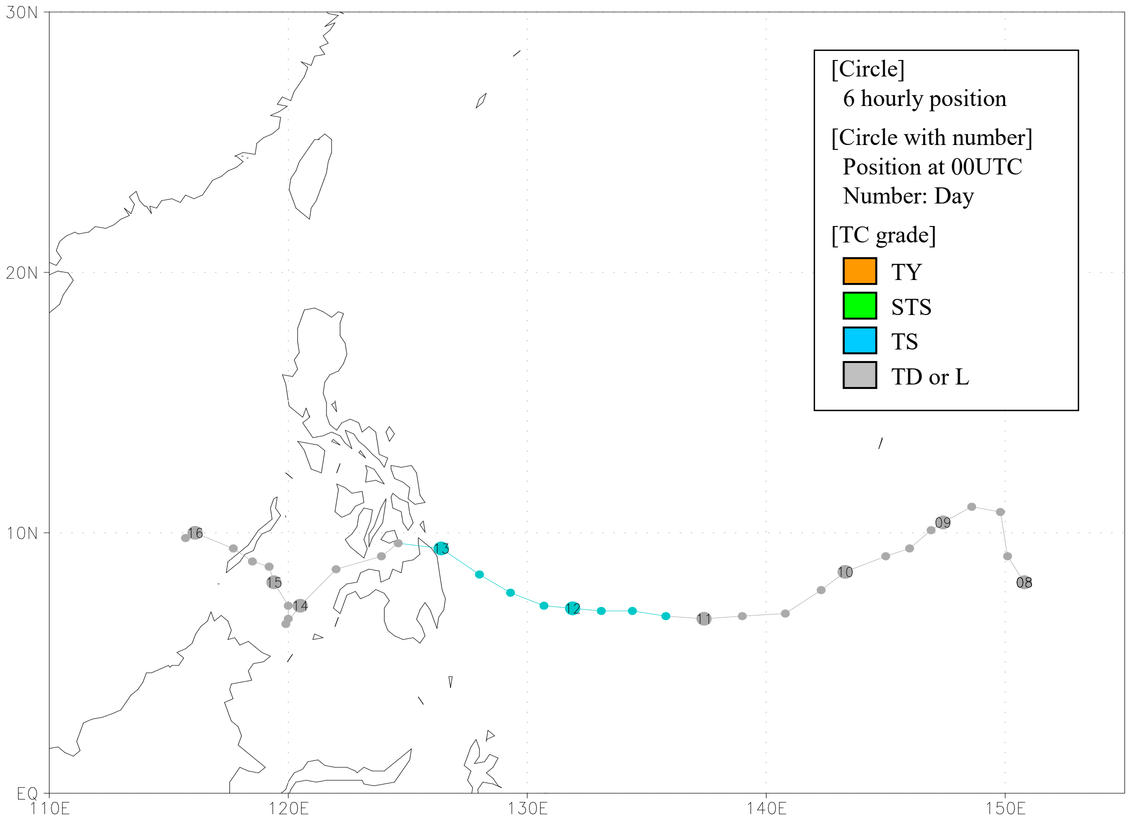
BOLAVEN (1801)

BOLAVEN formed as a tropical depression (TD) over the sea around the Caroline Islands at 18 UTC on 29 December 2017. Moving westward and hitting Mindanao Island with TD intensity after 12 UTC on 1 January 2018, BOLAVEN crossed the Sulu Sea and turned west-northwestward over the South China Sea after 12 UTC on 2 January. It was upgraded to tropical storm (TS) intensity and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 1002 hPa at 00 UTC on 3 January. BOLAVEN weakened to TD intensity over the sea east of Viet Nam at 00 UTC on 4 January and dissipated there at 12 UTC the same day.



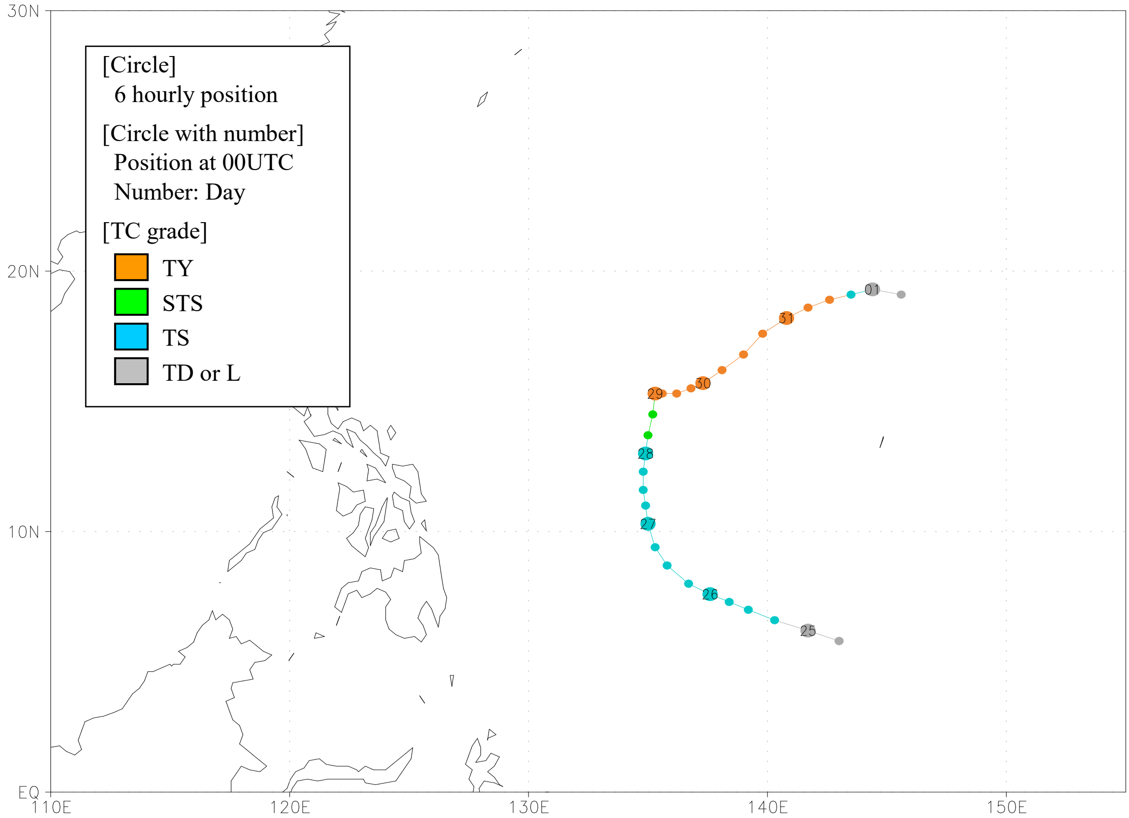
SANBA (1802)

SANBA formed as a tropical depression (TD) around the Chuuk Islands at 00 UTC on 8 February 2018. It moved northwestward and turned west-southwestward. SANBA was upgraded to tropical storm (TS) intensity and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 1000 hPa east of the Palau Islands at 06 UTC on 11 February. It moved west-northwestward and hit Mindanao Island early on 13 February. SANBA weakened to TD intensity over the Mindanao Sea at 06 UTC the same day. It moved southwestward and turned northwestward. SANBA dissipated over the South China Sea at 12 UTC on 16 February.



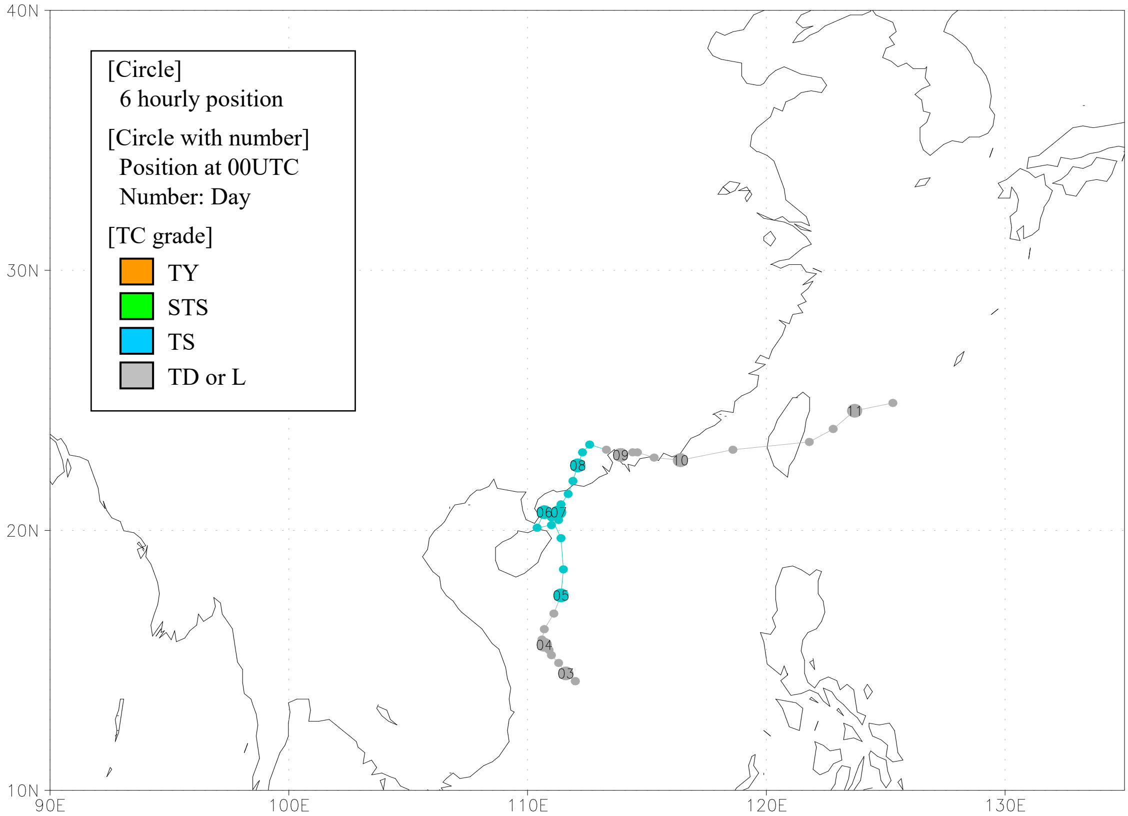
JELAWAT (1803)

JELAWAT formed as a tropical depression (TD) around the Caroline Islands at 18 UTC on 24 March 2018 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity over the same waters 12 hours later and turned northward gradually, decelerating northward, JELAWAT was upgraded to typhoon (TY) intensity around the sea east of the Philippines at 00 UTC on 29 March. After turning east-northeastward sharply, it reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 915 hPa southeast of Okinotorishima Island at 06 UTC on 30 March. JELAWAT was rapidly downgraded to TS intensity around sea west of the Northern Mariana Islands at 18 UTC on 31 March. It weakened to TD intensity over the same waters at 00 UTC on 1 April and dissipated there 12 hours later.



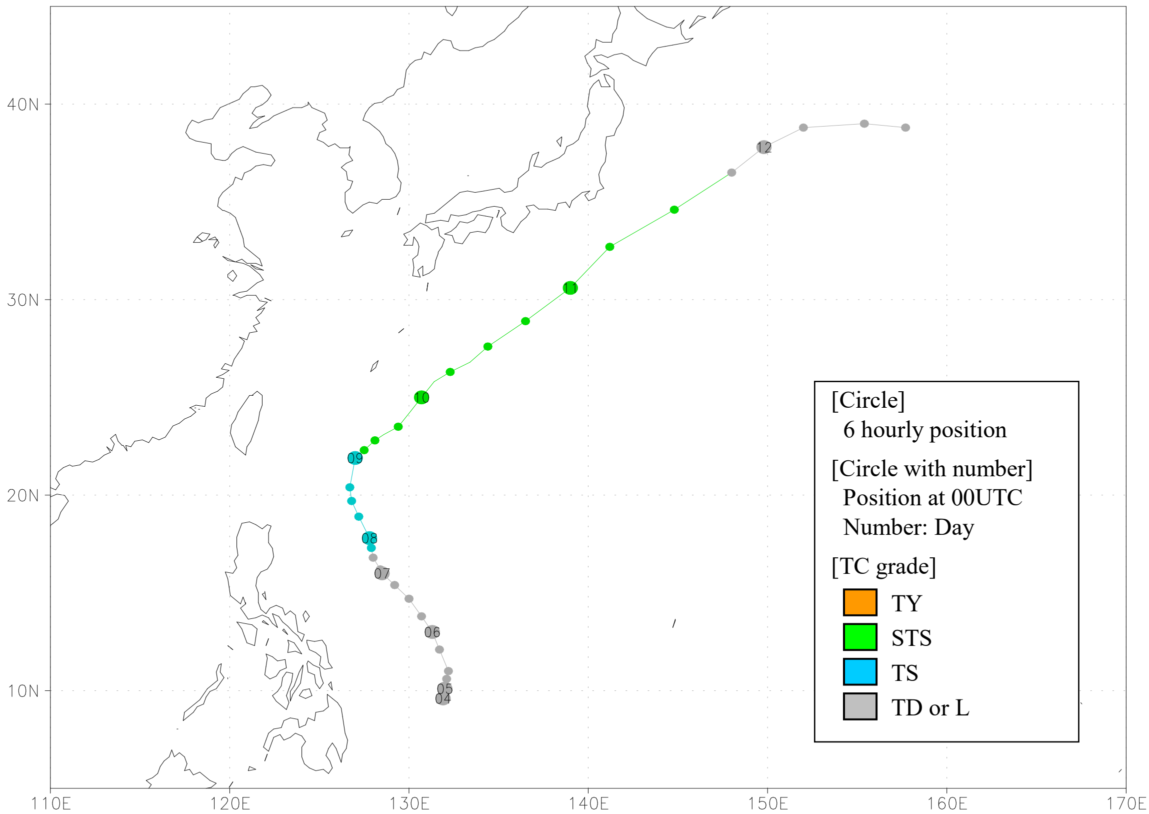
EWINIAR (1804)

EWINIAR formed as a tropical depression (TD) off the east coast of Viet Nam at 18 UTC on 2 June 2018 and moved northward. EWINIAR was upgraded to tropical storm (TS) intensity around Hainan Island at 00 UTC on 5 June. After turning in a counterclockwise direction to circle north of Hainan Island, EWINIAR reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 998 hPa over the same waters at 06 UTC on 7 June. It moved north-northeastward and hit southern China with TS intensity late on 7 June. After weakening to TD intensity in China at 18UTC on 8 June, EWINIAR turned eastward sharply and dissipated around Miyakojima Island at 12 UTC on 11 June.



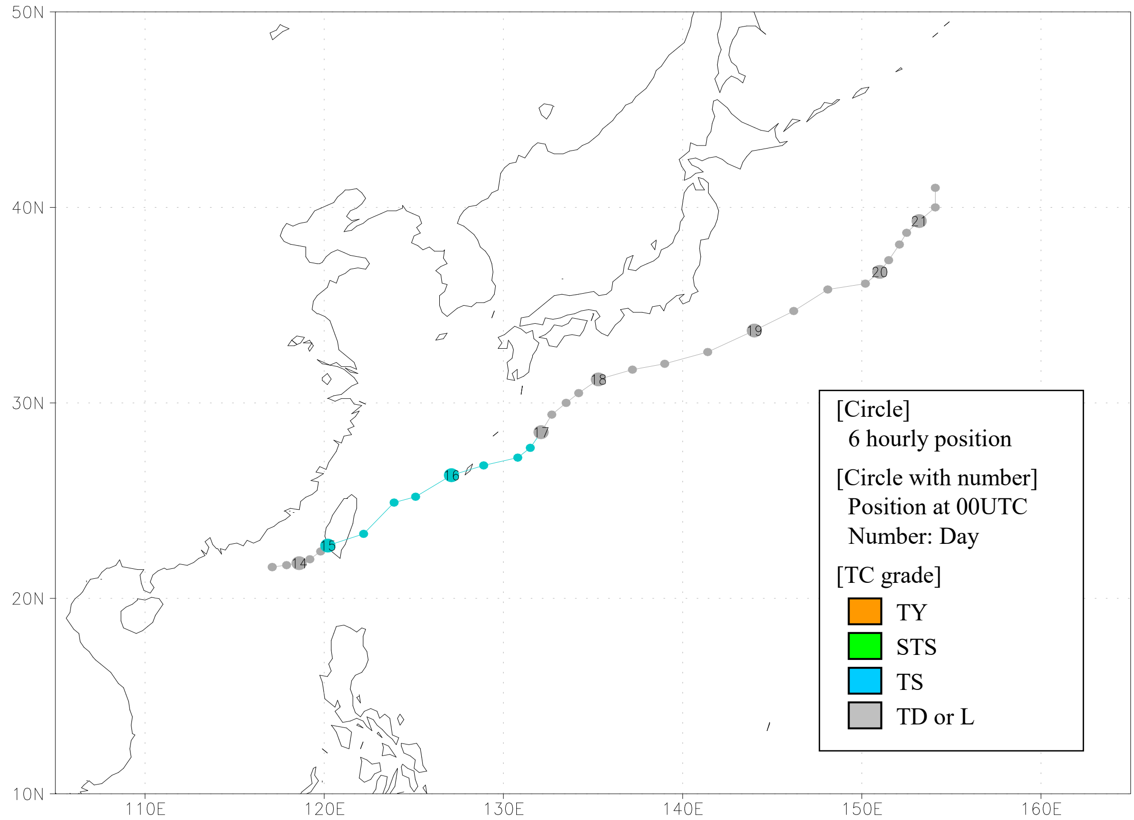
MALIKSI (1805)

MALIKSI formed as a tropical depression (TD) over the sea east of the Philippines at 18 UTC on 3 June 2018 and moved northward and then northwestward. MALIKSI was upgraded to tropical storm (TS) intensity at 18 UTC on 7 June over the same waters and then turned northeastward gradually. It was upgraded to severe tropical storm (STS) intensity south of Okinawa Island at 06 UTC on 9 June and reached its peak intensity with maximum sustained winds of 60 kt and a central pressure of 970 hPa southeast of Okinawa Island at 00 UTC the next day. Keeping the northeastward track, MALIKSI gradually weakened and then transformed into an extratropical cyclone east of Honshu Island at 18 UTC on 11 June. It turned eastward and dissipated around far off east of Japan at 00UTC on 13 June.



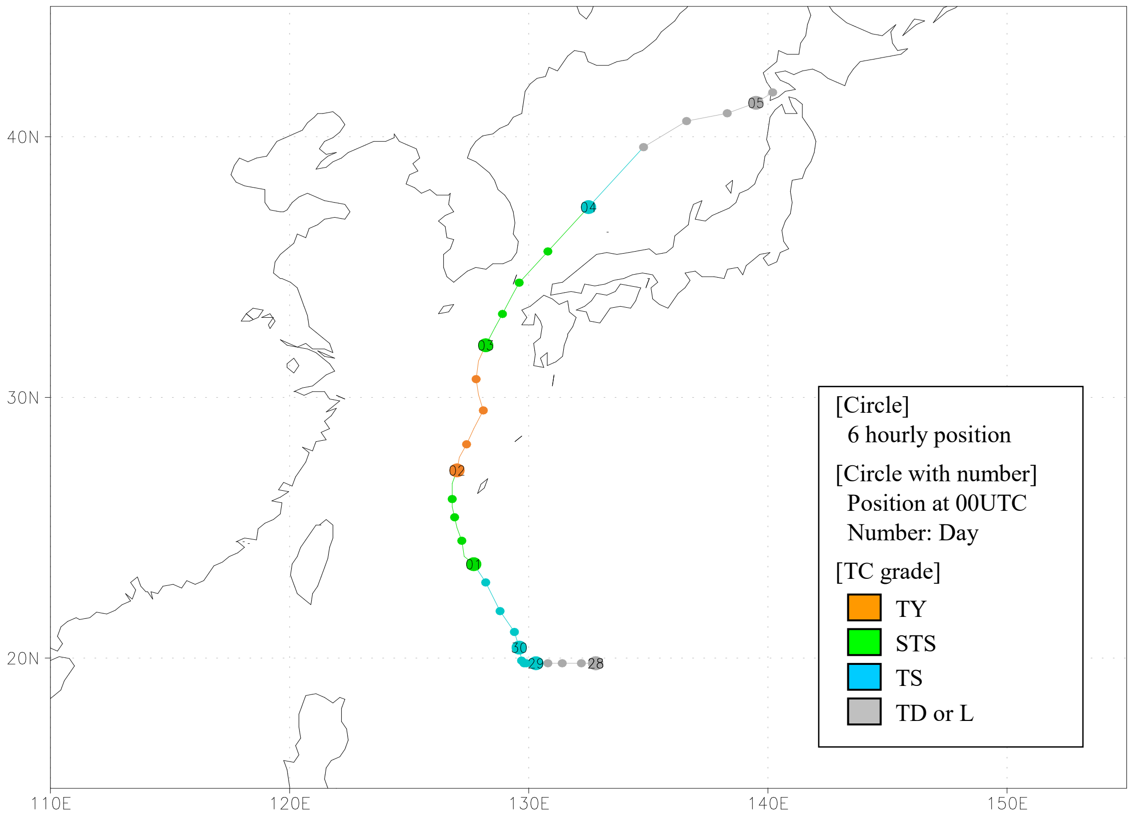
GAEMI (1806)

GAEMI formed as a tropical depression (TD) over the South China Sea at 12 UTC on 13 June 2018 and moved eastward. It was upgraded to tropical storm (TS) intensity around the Taiwan Strait at 00 UTC on 15 June and hit Taiwan Island immediately thereafter. GAEMI moved east-northeastward and reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 990 hPa near Okinawa Island at 06 UTC on 16 June. Keeping the east-northeastward track, GAEMI transformed into an extratropical cyclone south of Kyushu Island at 00 UTC on 17 June. After turning northeastward gradually, it dissipated around far off east of Japan at 18 UTC on 21 June.



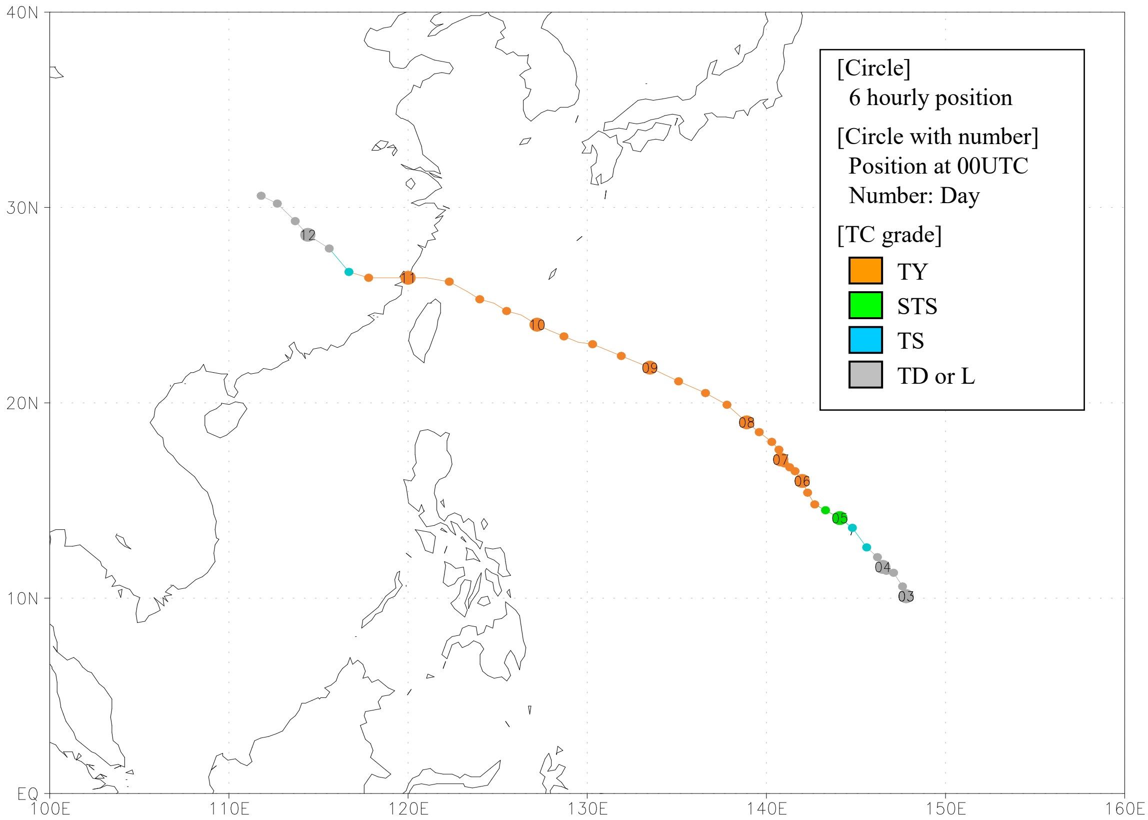
PRAPIROON (1807)

PRAPIROON formed as a tropical depression (TD) over the sea east of the Philippines at 00 UTC on 28 June 2018 and moved westward. It was upgraded to tropical storm (TS) intensity around the sea south-southeast of Okinawa Island at 00 UTC on 29 June and then turned northwestward. Gradually turning northeastward, PRAPIROON was upgraded to typhoon (TY) intensity around Okinawa Island at 00 UTC on 2 July and reached its peak intensity with maximum sustained winds of 65 kt and a central pressure of 960 hPa 18 hours later. Keeping its northeastward track, PRAPIROON gradually weakened and then transformed into an extratropical cyclone over the Sea of Japan at 06 UTC on 4 July. It dissipated around northern Japan at 12 UTC the next day.



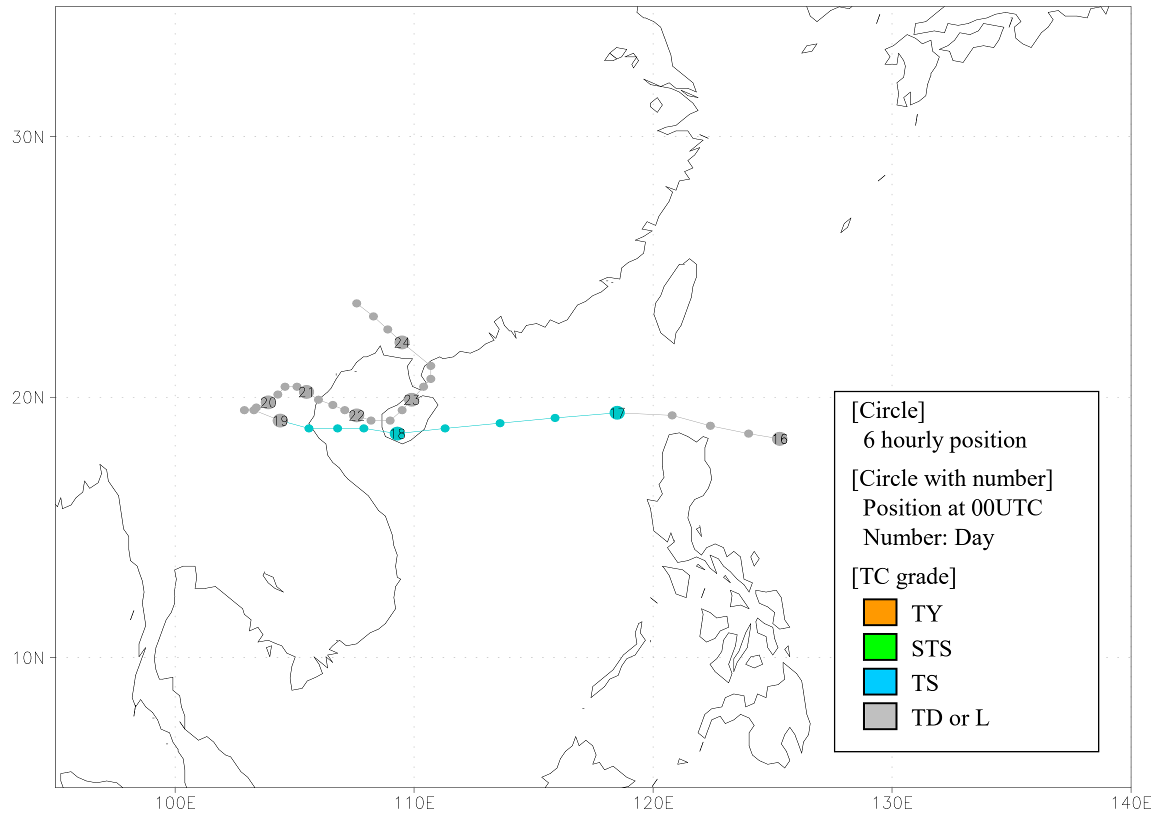
MARIA (1808)

MARIA formed as a tropical depression (TD) over the sea around the Mariana Islands at 00 UTC on 3 July 2018. Moving northwestward, it was upgraded to tropical storm (TS) intensity at 12 UTC on 4 July and was upgraded to typhoon (TY) intensity at 12 UTC on 5 July over the same waters. It reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 915 hPa over the sea northeast of the Philippines at 00 UTC on 9 July. MARIA hit the coast of southern China with TY intensity shortly after 00 UTC on 11 July and was downgraded to TS intensity at 12 UTC the same day. It weakened to TD intensity in central China at 18 UTC on 11 July and dissipated there at 00 UTC on 13 July.



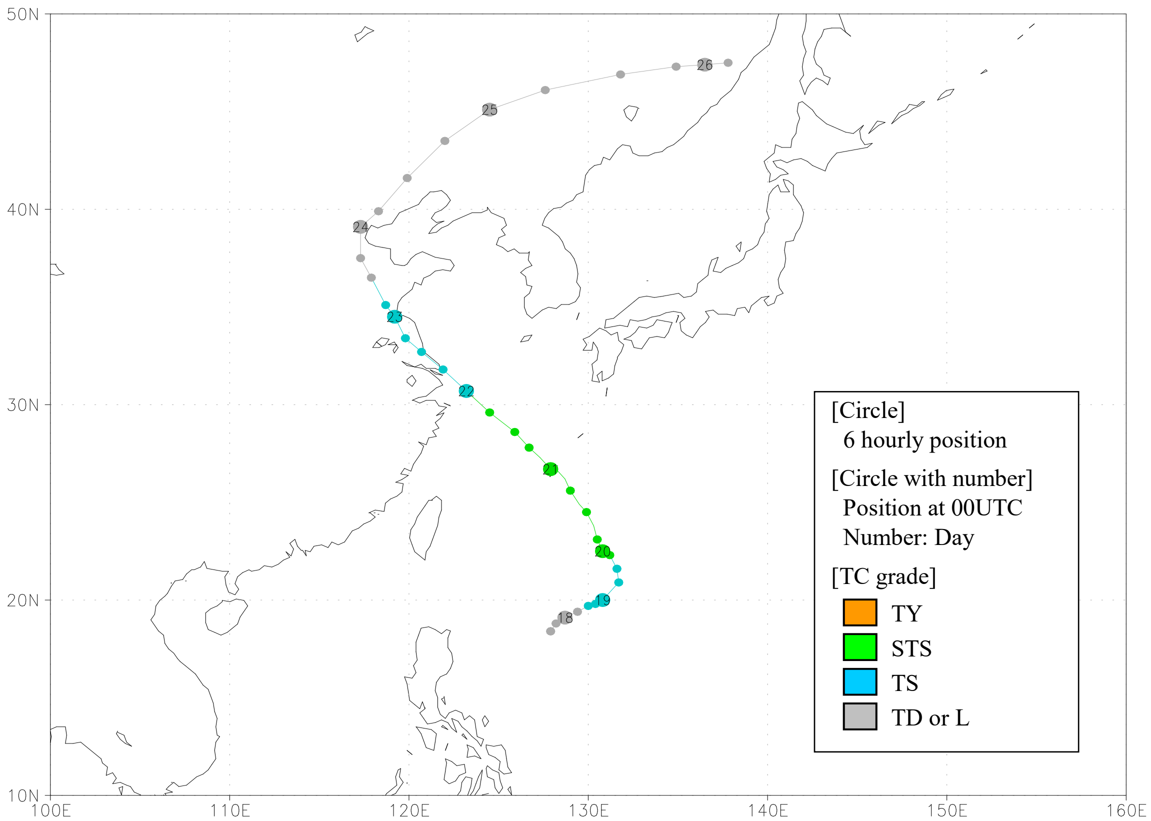
SON-TINH (1809)

SON-TINH formed as a tropical depression (TD) around the sea east of the Philippines at 00 UTC on 16 July 2018. After moving westward, it was upgraded to tropical storm (TS) intensity around the Luzon Strait 24 hours later. After reaching its peak intensity with maximum sustained winds of 40 kt and a central pressure of 994 hPa east of Hainan Island at 12 UTC on 17 July, SON-TINH crossed Hainan Island and the Gulf of Tonkin, and then made landfall over the northern part of Viet Nam all with TS intensity. With keeping westward track, it weakened to TD intensity in Viet Nam at 00 UTC on 19 July. After turning sharply to the east in Laos and crossing Hainan Island, SON-TINH turned northwestward and dissipated in the southern part of China at 00 UTC on 25 July.



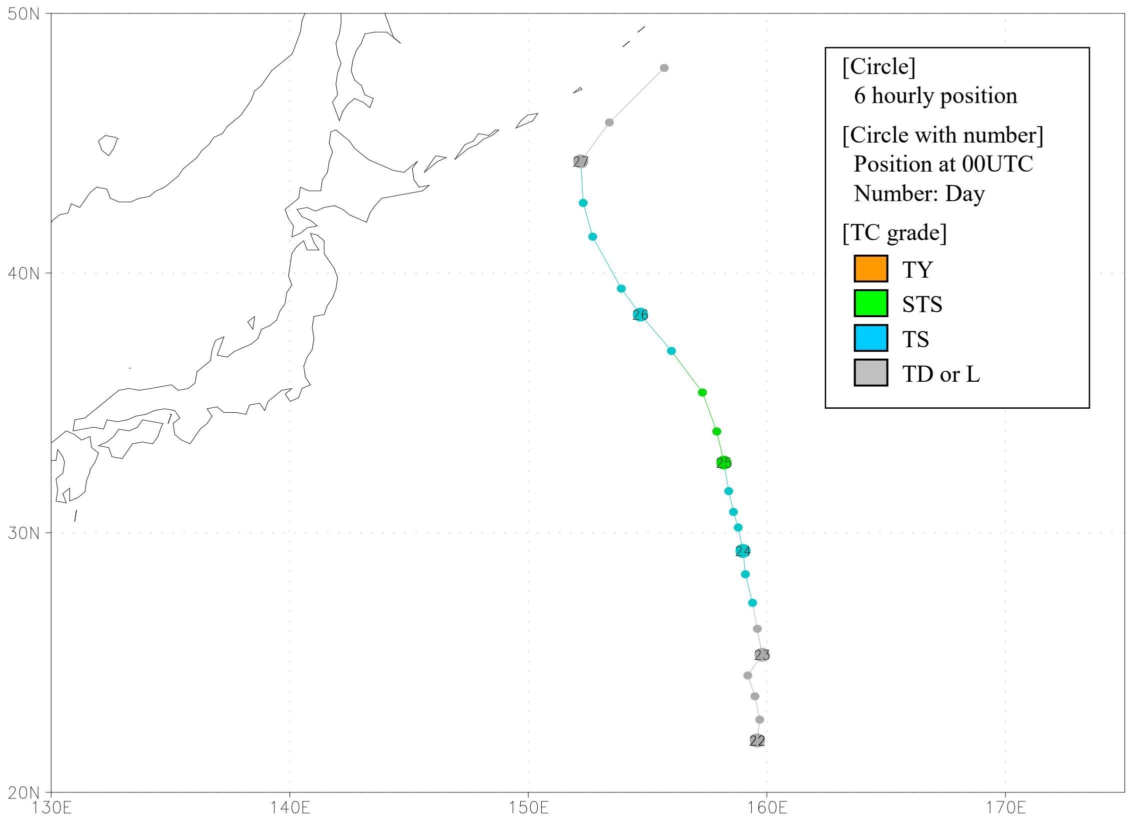
AMPIL (1810)

AMPIL formed as a tropical depression (TD) around the sea east of the Philippines at 12 UTC on 17 July 2018 and moved east-northeastward. It was upgraded to tropical storm (TS) intensity over the same waters 24 hours later. After turning northwestward gradually, it was upgraded to severe tropical storm (STS) intensity and reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 985 hPa around the sea southeast of Okinawa Island at 18 UTC on 19 July. Keeping its STS intensity and northwestward track, AMPIL passed over Okinawa Island after 23 UTC on 20 July. After moving northwestward over the East China Sea, it was downgraded to TS intensity over the same waters at 00 UTC on 22 July and crossed the coast line of central China. AMPIL weakened to TD intensity around lower Yellow River at 12 UTC on 23 July. After turning northeastward gradually, and holding its TD intensity 36 hours, AMPIL transformed into an extratropical cyclone around Northeast China and then dissipated around the Russian Primorsky Krai at 12 UTC on 26 July.



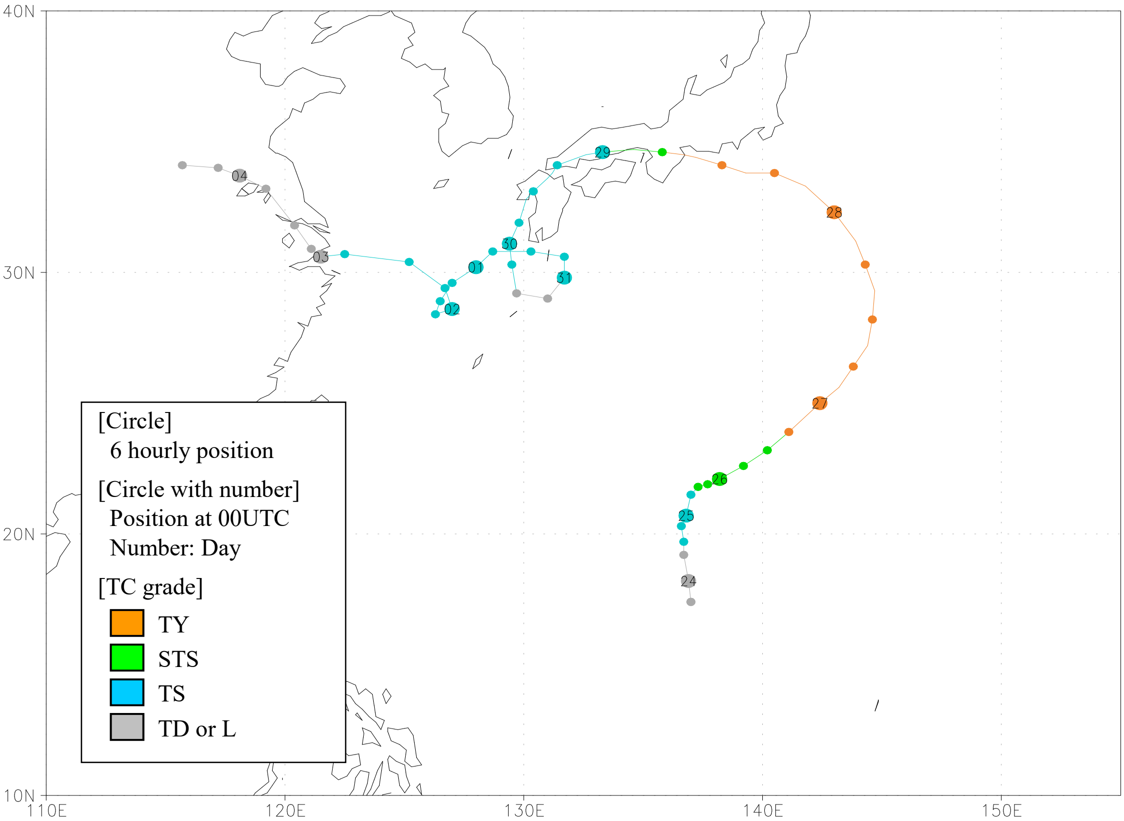
WUKONG (1811)

WUKONG formed as a tropical depression (TD) around Minamitorishima Island at 00 UTC on 22 July 2018 and moved north-northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on 23 July. It was upgraded to severe tropical storm (STS) intensity and reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 990 hPa far off east of Japan at 00 UTC on 25 July. Turning northwestward, WUKONG gradually weakened and then transformed into an extratropical cyclone around the Chishima Islands at 00 UTC on 27 July. It dissipated over the same waters 18 hours later.



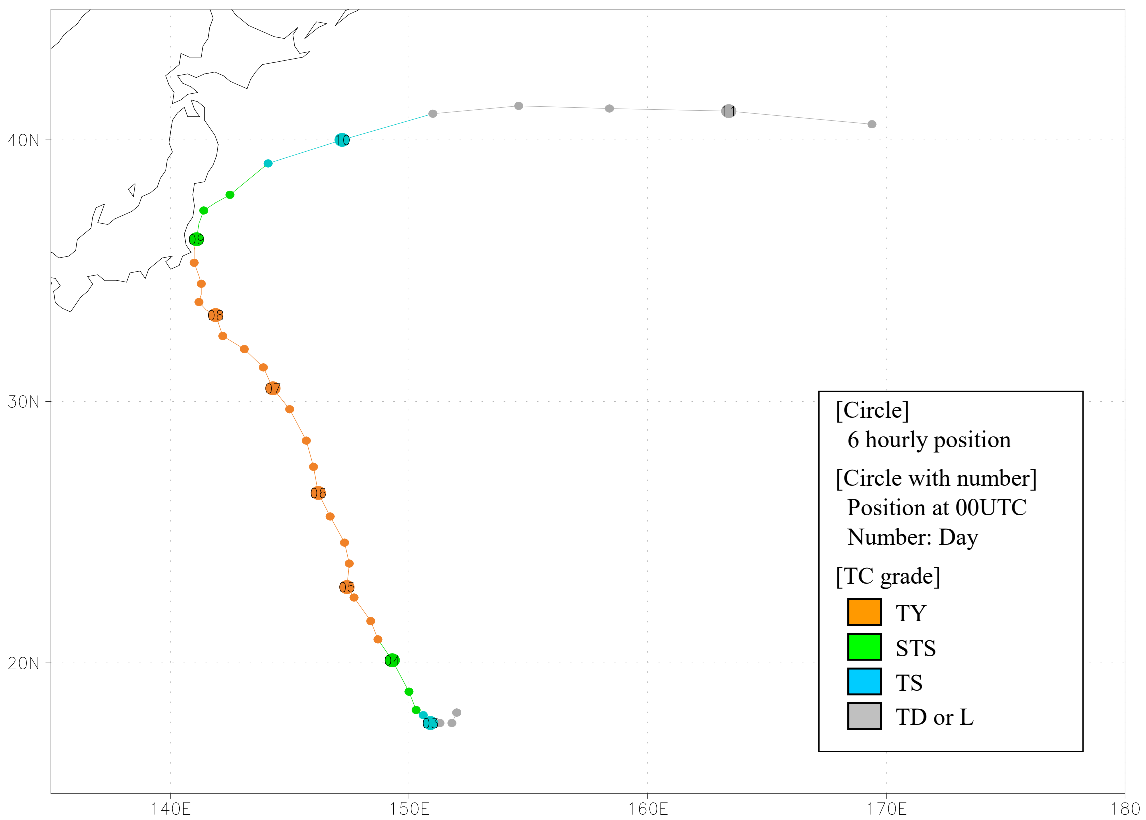
JONGDARI (1812)

JONGDARI formed as a tropical depression (TD) around east of the Philippines at 18 UTC on 23 July 2018 and moved northward. It was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on 24 July. After gradually turning northeastward, it was upgraded to typhoon (TY) intensity south of the Ogasawara Islands at 18 UTC on 26 July. JONGDARI reached its peak intensity with maximum sustained winds of 75 kt and a central pressure of 960 hPa over the same waters six hours later. After gradually turning in a counterclockwise direction, it made landfall on Ise City, Mie Prefecture with TY intensity around 16 UTC on 28 July. JONGDARI moved westward in the western Japan and made landfall again on Buzen City, Fukuoka Prefecture with TS intensity before 09 UTC on 29 July. After gradually turning southward and passing around the Shimabara Peninsula with TS intensity around 14 UTC on 29 July, it entered the East China Sea. JONGDARI turned in a counterclockwise direction to circle near Yakushima Island with temporary TD intensity period. After taking a counterclockwise track over the East China Sea, JONGDARI moved westward and hit central China. It weakened to TD intensity at 00 UTC on 3 August and dissipated in central China at 18 UTC the next day.



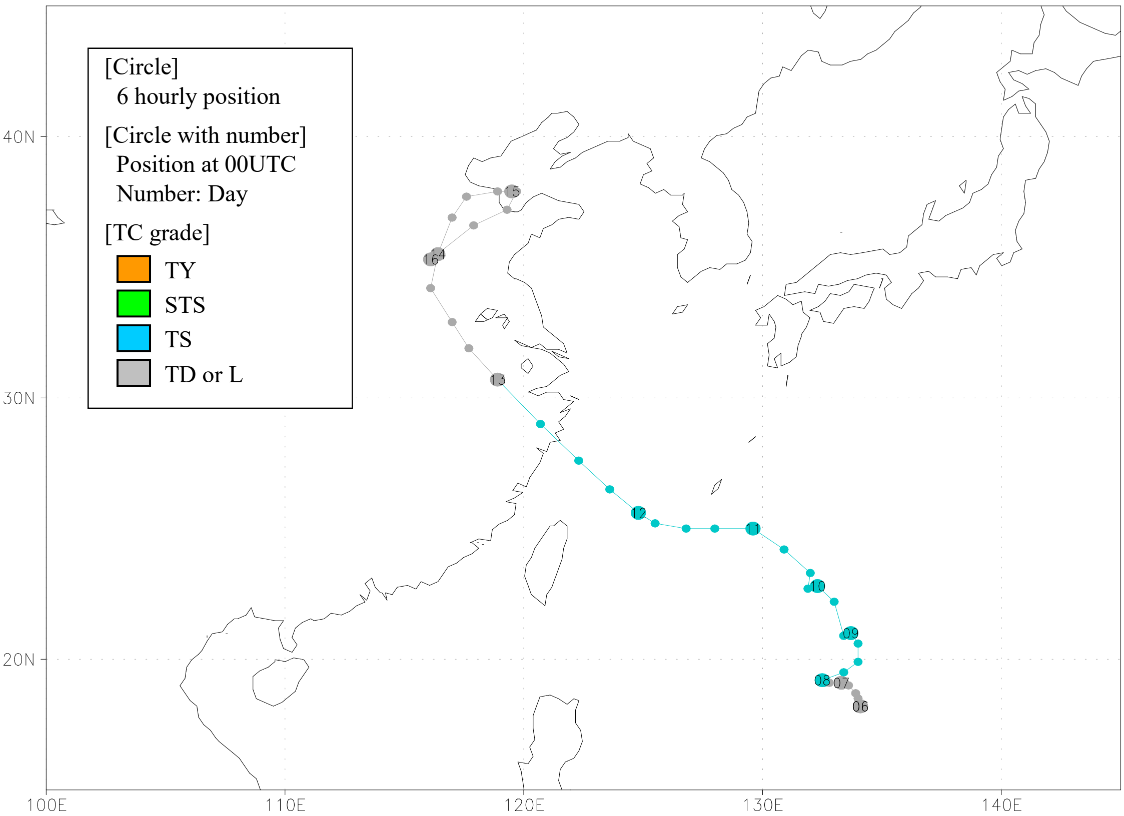
SHANSHAN (1813)

SHANSHAN formed as a tropical depression (TD) over the sea southwest of Minamitorishima Island at 06 UTC on 2 August 2018 and move north-northwestward. It was upgraded to tropical storm (TS) intensity around sea east of the Mariana Islands at 00 UTC on 3 August and was upgraded to typhoon (TY) intensity over the same waters at 06 UTC the next day. SHANSHAN reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 970 hPa around Minamitorishima Island at 18 UTC on 4 August. It gradually turned northward around sea east of Japan during 8 August and weakened to severe tropical storm (STS) intensity off the east coast of Ibaraki Prefecture at 00 UTC on 9 August. After accelerating northeastward, SHANSHAN transformed into an extratropical cyclone at 06 UTC on 10 August. It dissipated at 12 UTC the next day.



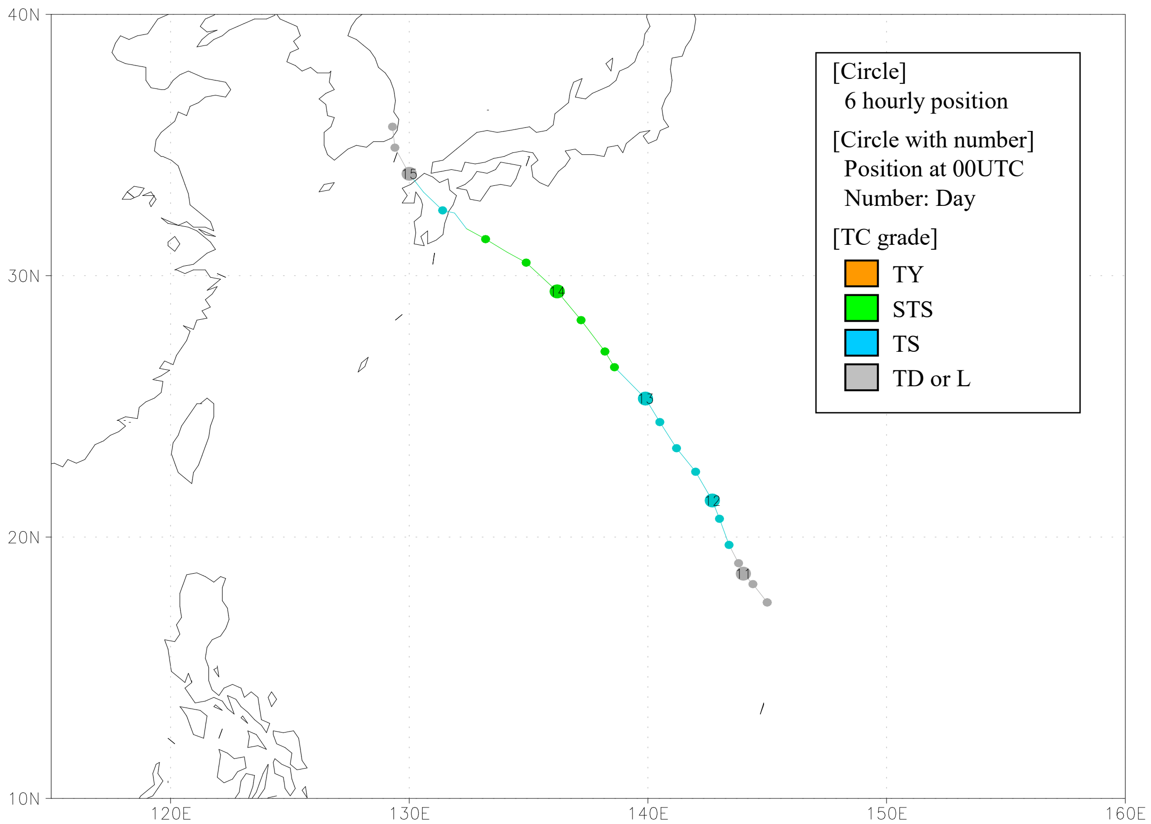
YAGI (1814)

YAGI formed as a tropical depression (TD) around the sea east of the Philippines at 00 UTC on 6 August 2018 and moved westward. It was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 8 August and sharply turned northeastward. After turning northwestward and then turned westward, YAGI reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 990 hPa east of Miyakojima Island at 12 UTC on 11 August. Keeping northwestward track, it hit the coast of central China with TS intensity after 12 UTC on 12 August and weakened to TD intensity in central China at 00 UTC on 13 August. YAGI turned northward and then transformed into an extratropical cyclone over the Bohai Sea at 06 UTC on 15 August. It dissipated in northern China 24 hours later.



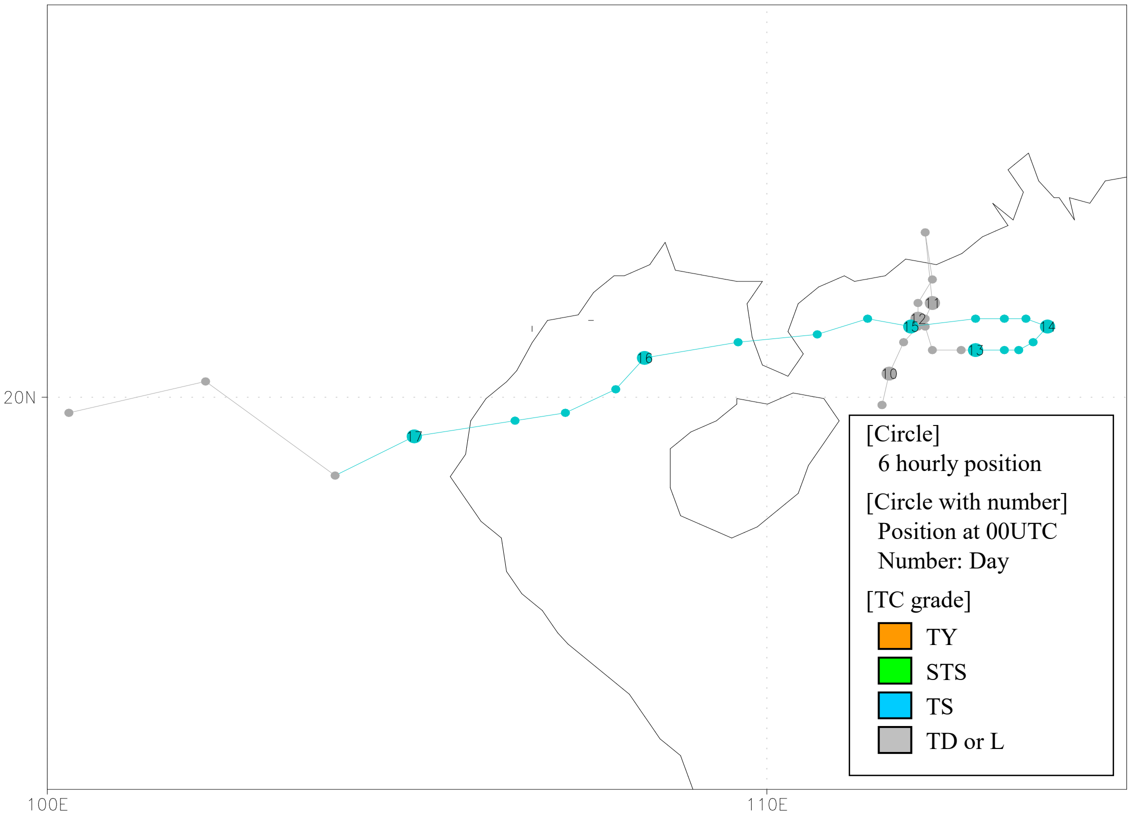
LEEPI (1815)

LEEPI formed as a tropical depression (TD) over the sea west of the Mariana Islands at 12 UTC on 10 August 2018 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on 11 August. Keeping its northwestward track, LEEPI was upgraded to severe tropical storm (STS) intensity and reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 994 hPa over the sea west of the Ogasawara Islands at 06 UTC on 13 August. It made landfall on Hyuga City, Miyazaki Prefecture with TS intensity around 1730 UTC on 14 August. LEEPI weakened to TD intensity around the Tsushima Strait at 00 UTC on 15 August. After turning northward gradually, it dissipated over the Sea of Japan at 18 UTC the same day.



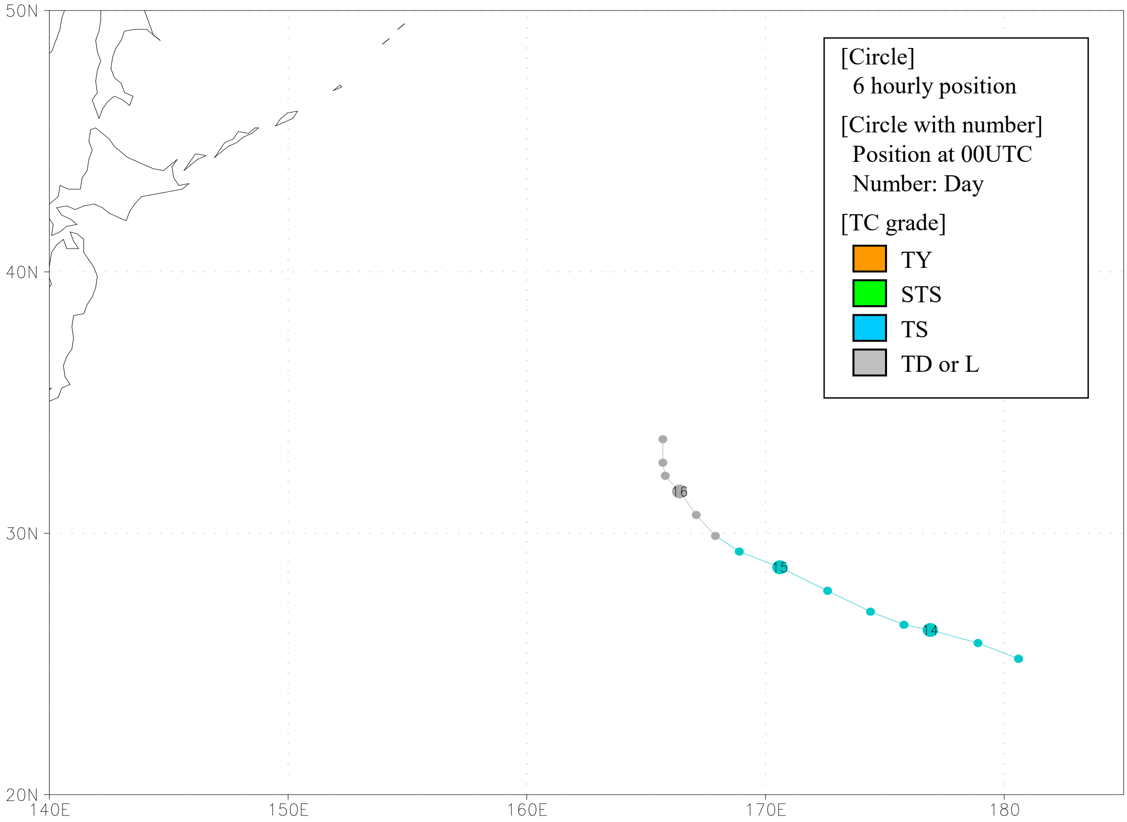
BEBINCA (1816)

BEBINCA formed as a tropical depression (TD) over the South China Sea east of Hainan Island at 18 UTC on 9 August 2018. It drifted north toward southern China, turned southward and began to move eastward before it was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 13 August. Subsequently it again changed direction and started to move westward. BEBINCA reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 985 hPa over the sea west of Hainan Island at 06 UTC on 16 August. It crossed the coastline of Viet Nam with TS intensity late on 16 August and weakened to TD intensity in northern Laos at 06 UTC on 17 August. BEBINCA dissipated there at 00 UTC on 18 August.



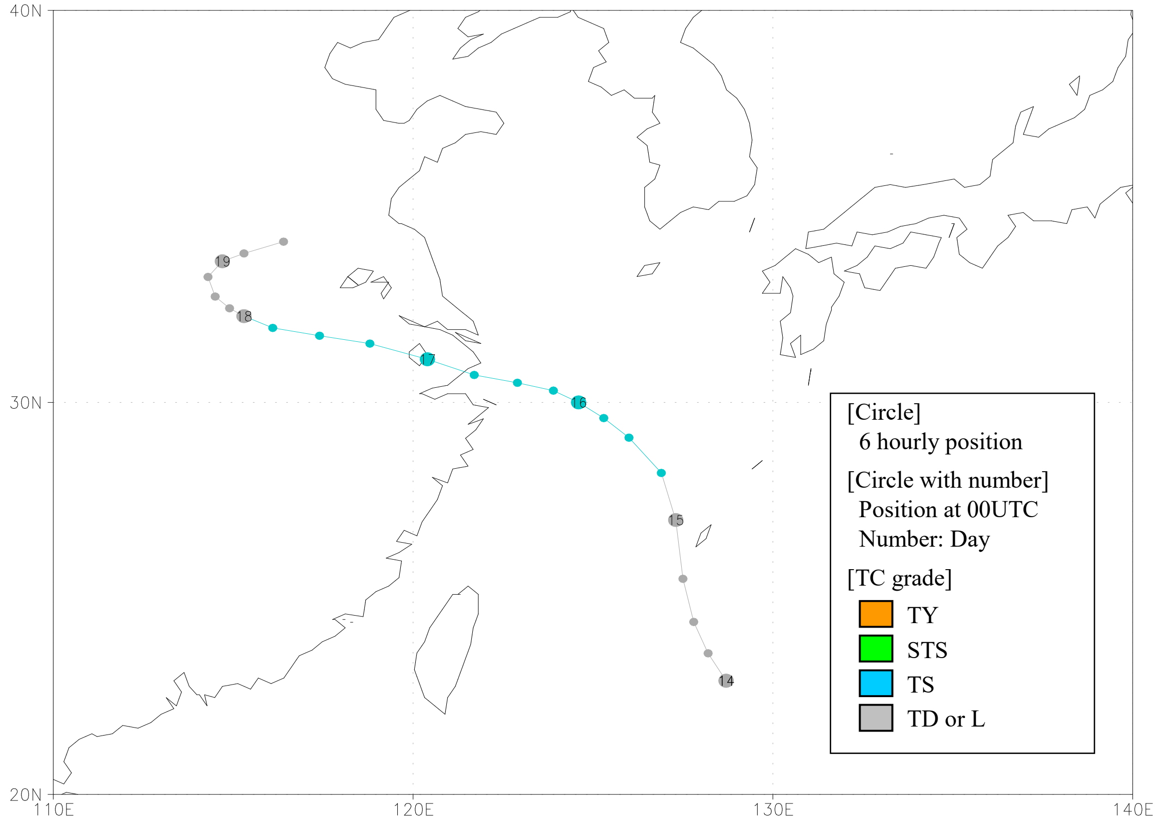
HECTOR (1817)

HECTOR crossed longitude 180 degrees east with tropical storm (TS) intensity over the sea northeast of Wake Island after 12 UTC on 13 August 2018 and entered the western North Pacific. Moving west-northwestward, it kept its maximum sustained winds of 40 kt and a central pressure of 998 hPa until 00 UTC on 14 August. HECTOR weakened to tropical depression (TD) intensity over the sea north of Wake Island at 12 UTC on 15 August. After gradually turning northward, it dissipated over the sea far east of Japan at 00 UTC on 17 August.



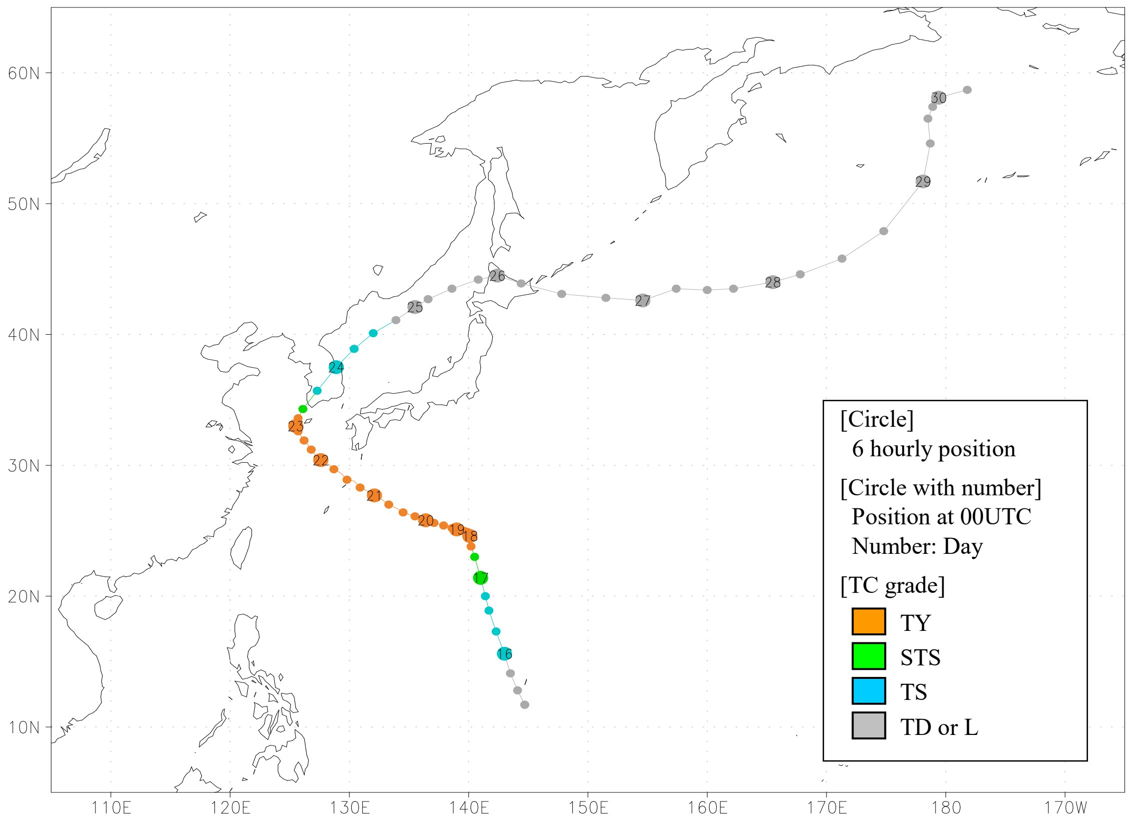
RUMBIA (1818)

RUMBIA formed as a tropical depression (TD) south of Okinawa Island at 00 UTC on 14 August 2018, and moved north-northwestward. Entering the East China Sea, it was upgraded to tropical storm (TS) intensity northwest of Okinawa Island at 06 UTC the next day. After turning west-northwestward, RUMBIA reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 985 hPa over the East China Sea at 12 UTC on 16 August. With keeping west-northwestward track, it made landfall on central China late on 16 August, and weakened to TD intensity there at 00 UTC on 18 August. After turning east-northeastward gradually, RUMBIA dissipated around the lower reaches of the Yellow River at 18 UTC on 19 August.



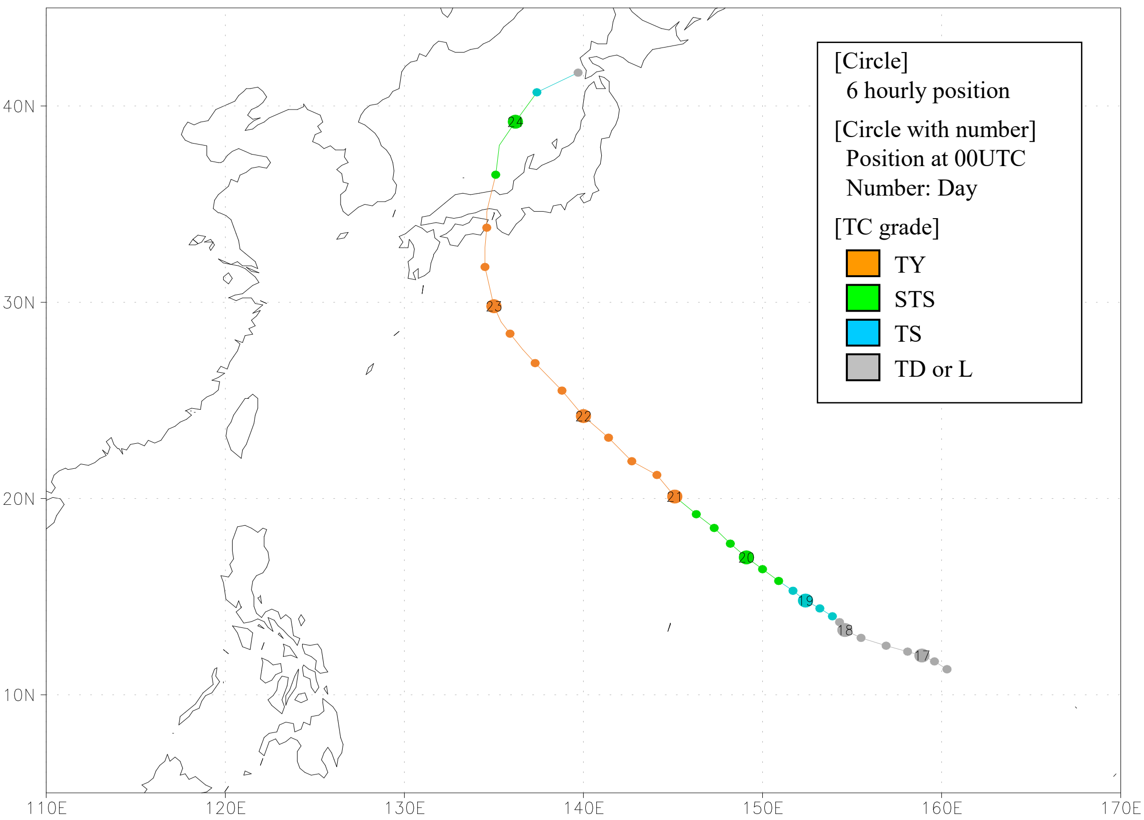
SOULIK (1819)

SOULIK formed as a tropical depression (TD) south of Guam Island at 06 UTC on 15 August 2018, and moved north-northwestward. It was upgraded to tropical storm (TS) intensity northwest of Guam Island at 00 UTC the next day. With keeping north-northwestward track, SOULIK was upgraded to typhoon (TY) intensity southwest of Iwoto Island at 12 UTC on 17 August. After turning west-northwestward sharply, SOULIK reached its peak intensity with maximum sustained winds of 85 kt and a central pressure of 950 hPa northeast of Minamidaitojima Island at 18 UTC on 20 August. After entering the East China Sea, SOULIK gradually weakened and turned northeastward west of Jeju Island. It hit the Korean Peninsula with TS intensity late on 23 August, and entered the Sea of Japan. With keeping its northeastward track, SOULIK transformed into an extratropical cyclone over the same waters at 18 UTC on 24 August. After turning eastward and then turning northward, it crossed longitude 180 degrees east over the Bering Sea before 06 UTC on 30 August.



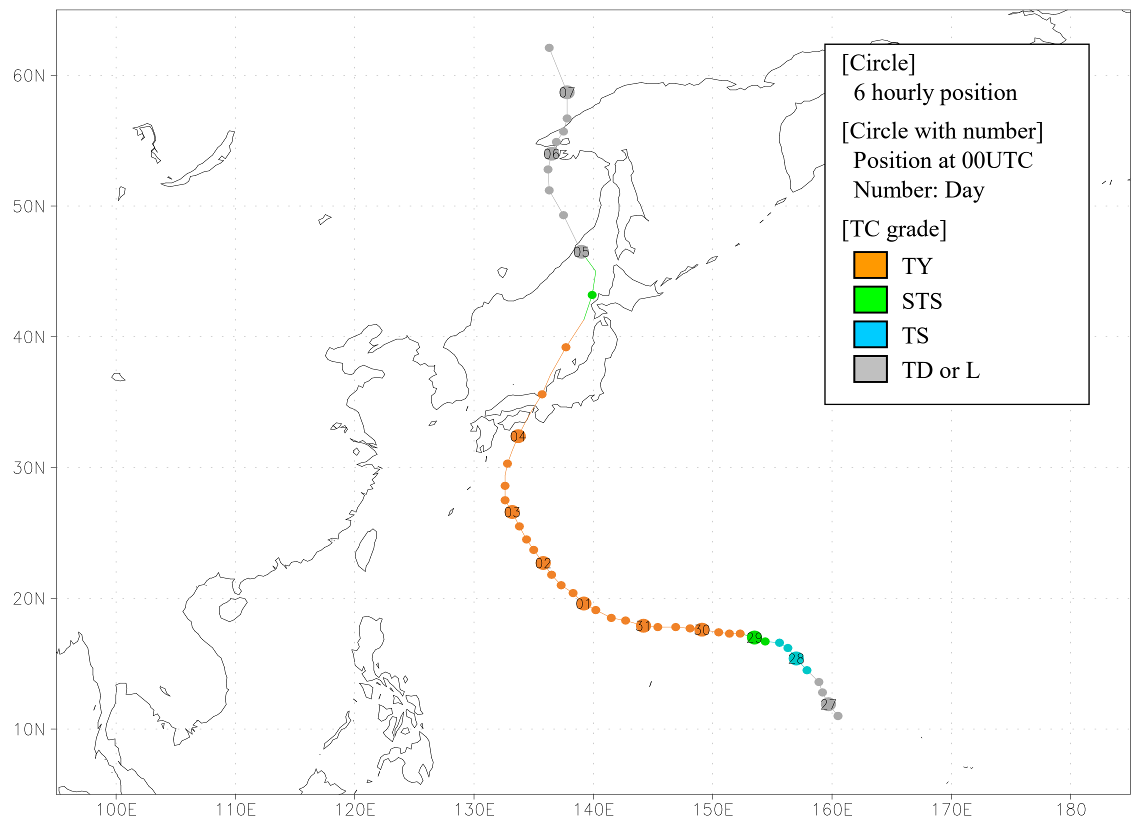
CIMARON (1820)

CIMARON formed as a tropical depression (TD) over the sea around the Marshall Islands at 12 UTC on 16 August 2018 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity over the sea north of the Chuuk Islands at 12 UTC on 18 August. Gradually turning northwestward, CIMARON was upgraded to typhoon (TY) intensity south of the Ogasawara Islands at 00 UTC on 21 August and reached its peak intensity with maximum sustained winds of 85 kt and a central pressure of 950 hPa over the sea west of the Ogasawara Islands at 06 UTC the next day. After turning northward, CIMARON made landfall on southern Tokushima Prefecture with TY intensity around 12 UTC on 23 August and made landfall again on Himeji City, Hyogo Prefecture with TY intensity around 1430 UTC the same day respectively. Turning north-northeastward, CIMARON weakened and transformed into an extratropical cyclone over the Sea of Japan at 12 UTC on 24 August. It dissipated over the same waters 6 hours later.



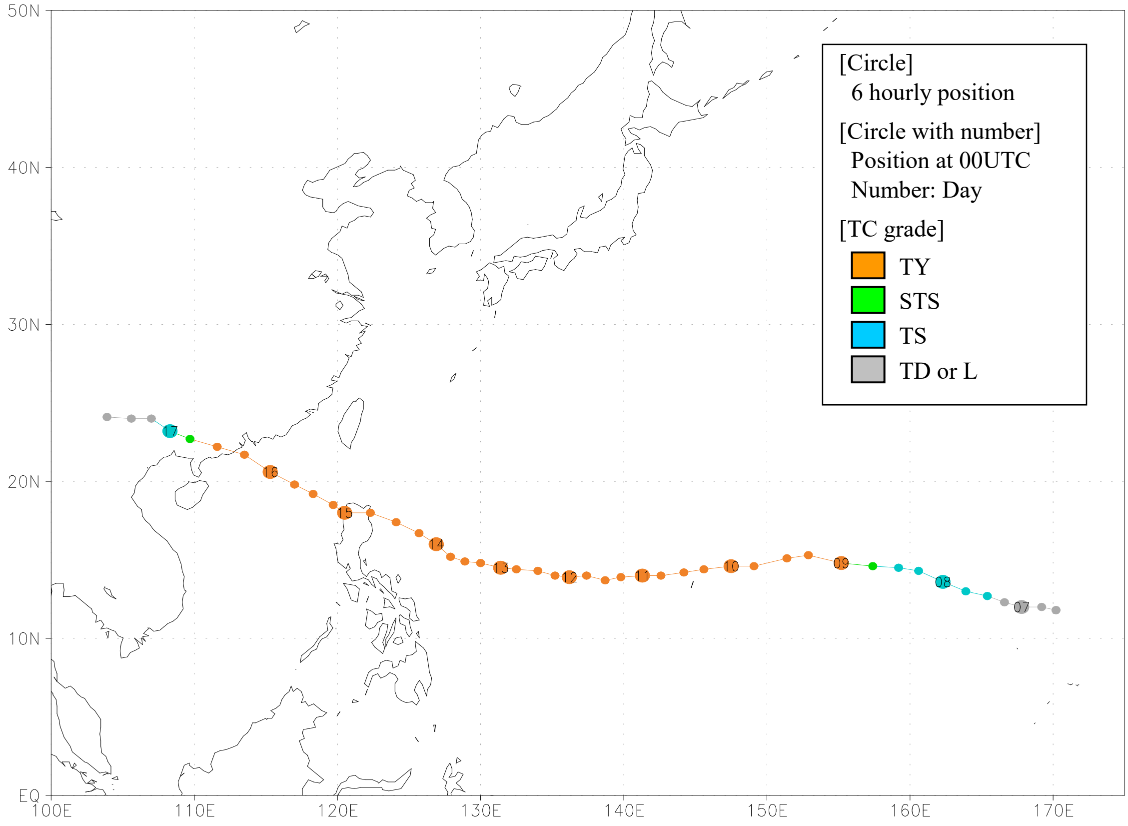
JEBI (1821)

JEBI formed as a tropical depression (TD) around the Marshall Islands at 18 UTC on 26 August 2018 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters 24 hours later and gradually turned westward. Keeping its westward track, JEBI developed rapidly and was upgraded to typhoon (TY) intensity around the sea east of the Mariana Islands at 06 UTC on 29 August. JEBI reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 915 hPa west of the Mariana Islands at 00 UTC on 31 August. After turning northwestward and maintaining its peak intensity for 30 hours, it gradually weakened and turned north-northeastward. Holding very strong TY intensity, JEBI made landfall on the southern part of Tokushima Prefecture before 03 UTC on 4 September and made landfall again around Kobe City, Hyogo Prefecture before 05 UTC the same day respectively. After crossing Honshu Island, it was downgraded to severe tropical storm (STS) intensity over the Sea of Japan at 15 UTC the same day. JEBI turned north-northwestward and transformed into an extratropical cyclone off the coast of the Russian Primorsky Krai at 00 UTC on 5 September. After crossing the coast line of Russia at early on 5 September, it moved northward meandering and crossed latitude 60 degrees north at 06 UTC on 7 September.



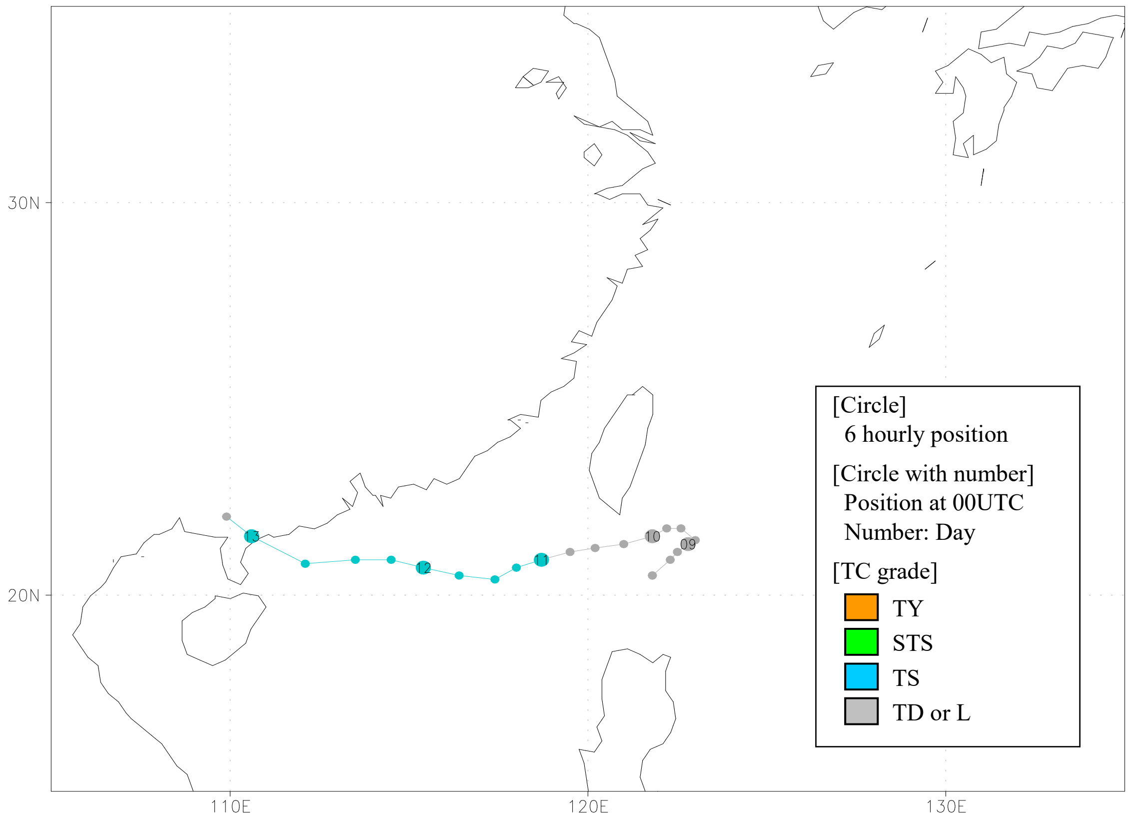
MANGKHUT (1822)

MANGKHUT formed as a tropical depression (TD) around the Marshall Islands at 12 UTC on 6 September 2018 and moved westward. It was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on 7 September. Keeping its westward track, MANGKHUT was upgraded to typhoon (TY) intensity around sea east of the Mariana Islands at 00 UTC on 9 September. MANGKHUT reached its peak intensity with maximum sustained winds of 110 kt and a central pressure of 905 hPa around sea west of the Mariana Islands at 12 UTC on 11 September and then it gradually turned west-northwestward. MANGKHUT hit the Philippines with TY intensity after 12 UTC on 14 September and hit the southern coast of China with TY intensity before 12 UTC on 16 September. MANGKHUT rapidly weakened to TD intensity in the southern part of China at 06UTC the next day and dissipated there 18 hours later.



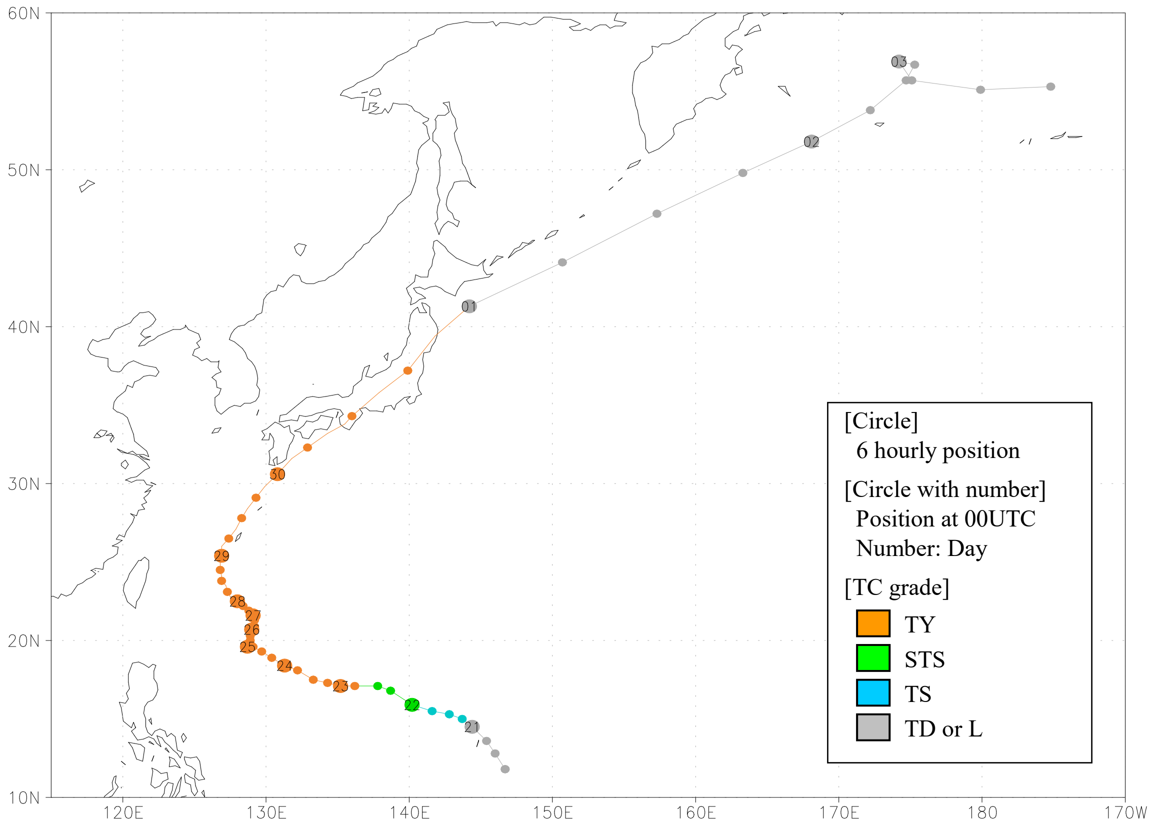
BARIJAT (1823)

BARIJAT formed as a tropical depression (TD) around the Luzon Strait at 06 UTC on 8 September 2018 and moved northeastward. After turning westward sharply, it was upgraded to tropical storm (TS) intensity over the South China Sea at 00 UTC on 11 September and reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 998 hPa 6 hours later. Keeping its westward track, BARIJAT hit the coast of southern China with TS intensity after 18 UTC on 12 September. It weakened to TD intensity in southern China at 06 UTC on 13 September and dissipated there 6 hours later.



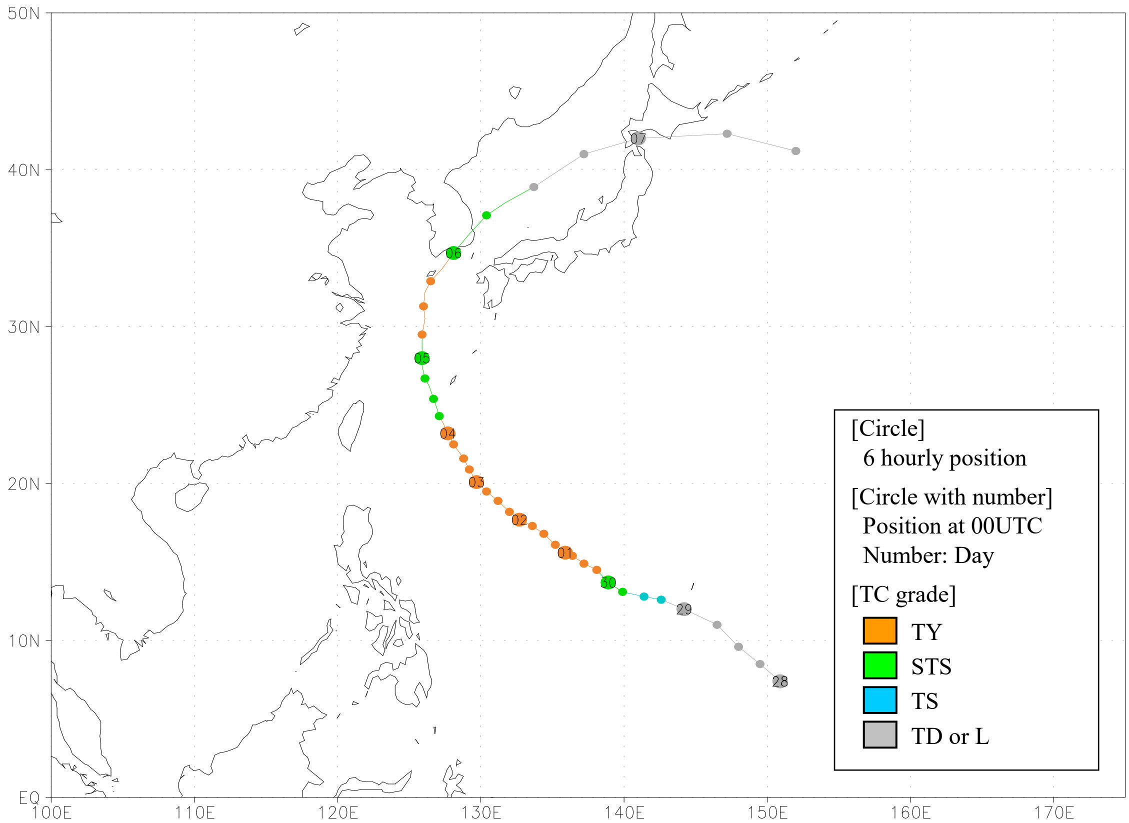
TRAMI (1824)

TRAMI formed as a tropical depression (TD) over the sea near the Mariana Islands at 06 UTC on 20 September 2018 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 06 UTC the next day. After moving west-northwestward, TRAMI was upgraded to typhoon (TY) intensity south of Okinotorishima Island at 18 UTC on 22 September. After reaching its peak intensity with maximum sustained winds of 105 kt and a central pressure of 915 hPa over the sea east of the Philippines at 18 UTC on 24 September, TRAMI decelerated northward over the sea south of the Okinawa Islands and then gradually accelerated northeastward. It made landfall on Tanabe City, Wakayama Prefecture with TY intensity around 11 UTC on 30 September. TRAMI transformed into an extratropical cyclone over the sea east of Japan at 00 UTC on 1 October. It crossed longitude 180 degrees east over the Bering Sea before 18 UTC on 3 October.



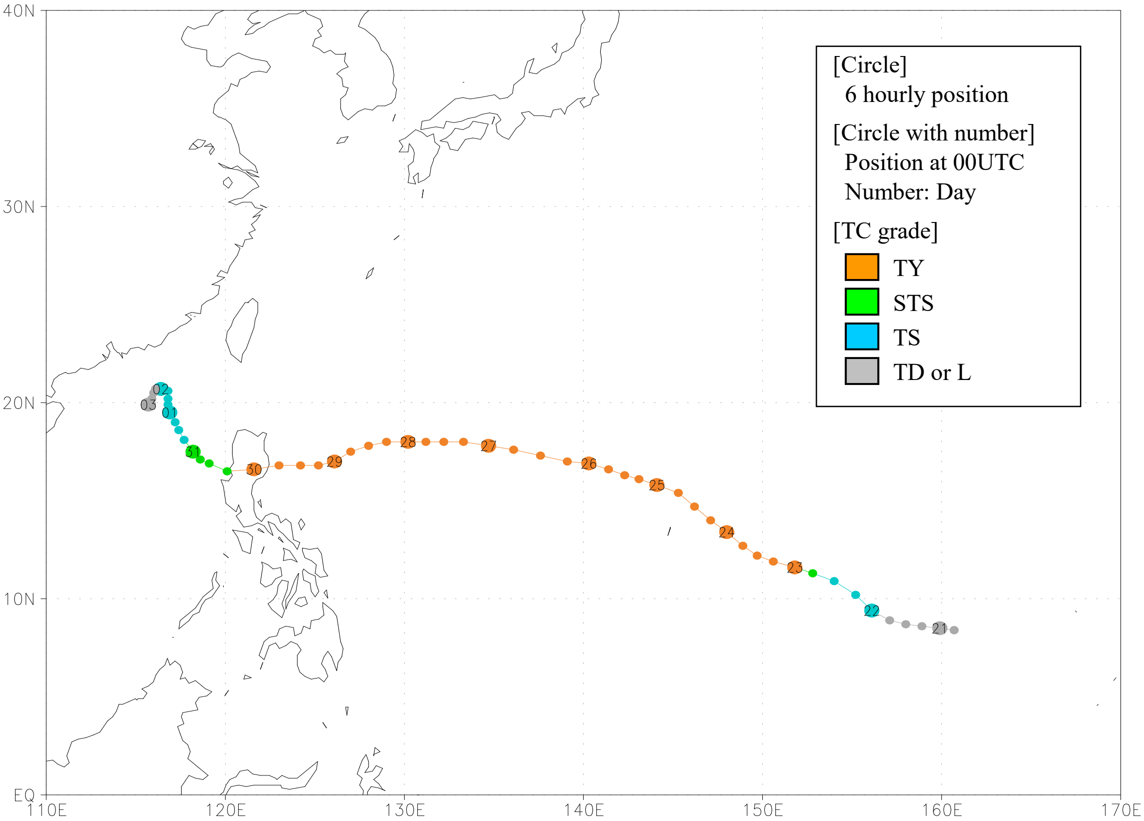
KONG-REY (1825)

KONG-REY formed as a tropical depression (TD) over the sea to the west of the Chuuk Lagoon at 00 UTC on 28 September 2018. It moved northwestward and was upgraded to tropical storm (TS) intensity over the sea to the southwest of the island of Guam at 06 UTC on 29 September. KONG-REY reached its peak intensity with maximum sustained winds of 115 kt and a central pressure of 900 hPa over the sea far east of the Philippines at 12 UTC on 1 October. It continued to head northwestward and passed through the channel between Okinawa Island and Miyakojima Island. KONG-REY turned northward and northeastward subsequently over the East China Sea, crossed the Korean Peninsula with severe tropical storm (STS) intensity early on 6 October and entered the Sea of Japan. It transformed into an extratropical cyclone at 12 UTC on 6 October over the same waters, moved eastward and dissipated over the Pacific far east of northern Japan at 18 UTC on 7 October.



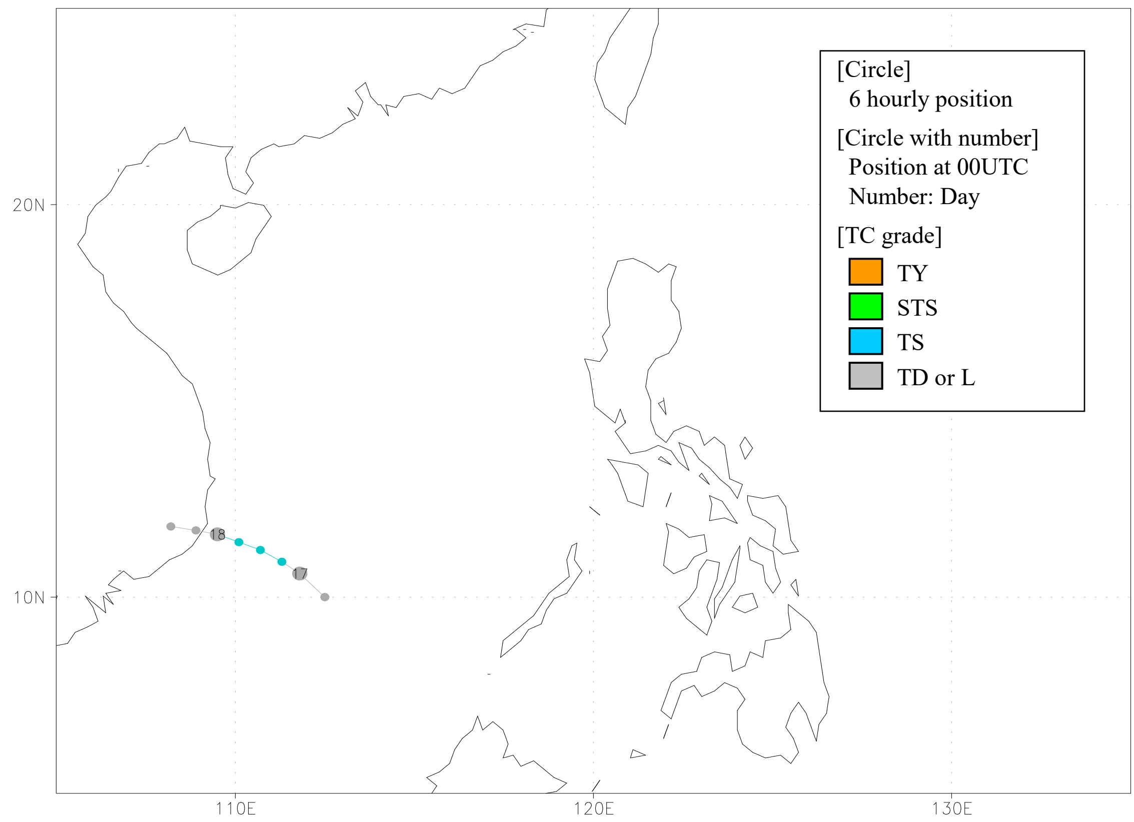
YUTU (1826)

YUTU formed as a tropical depression (TD) over the sea around the Marshall Islands at 18 UTC on 20 October and was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 22 October. Moving west-northwestward, it was upgraded to typhoon (TY) intensity over the sea around the Chuuk Islands at 00 UTC on 23 October. It reached its peak intensity with maximum sustained winds of 115 kt and a central pressure of 900 hPa over the sea around the Mariana Islands at 12 UTC on 24 October. Moving westward, YUTU crossed Luzon Island with TY intensity from the late hours of 29 October to the next day. Turning northwestward, it was downgraded to TS intensity in the South China Sea at 06 UTC on 31 October. After remaining almost stationary over the same waters, it weakened to TD intensity at 06 UTC on 2 November and dissipated there 24 hours later.



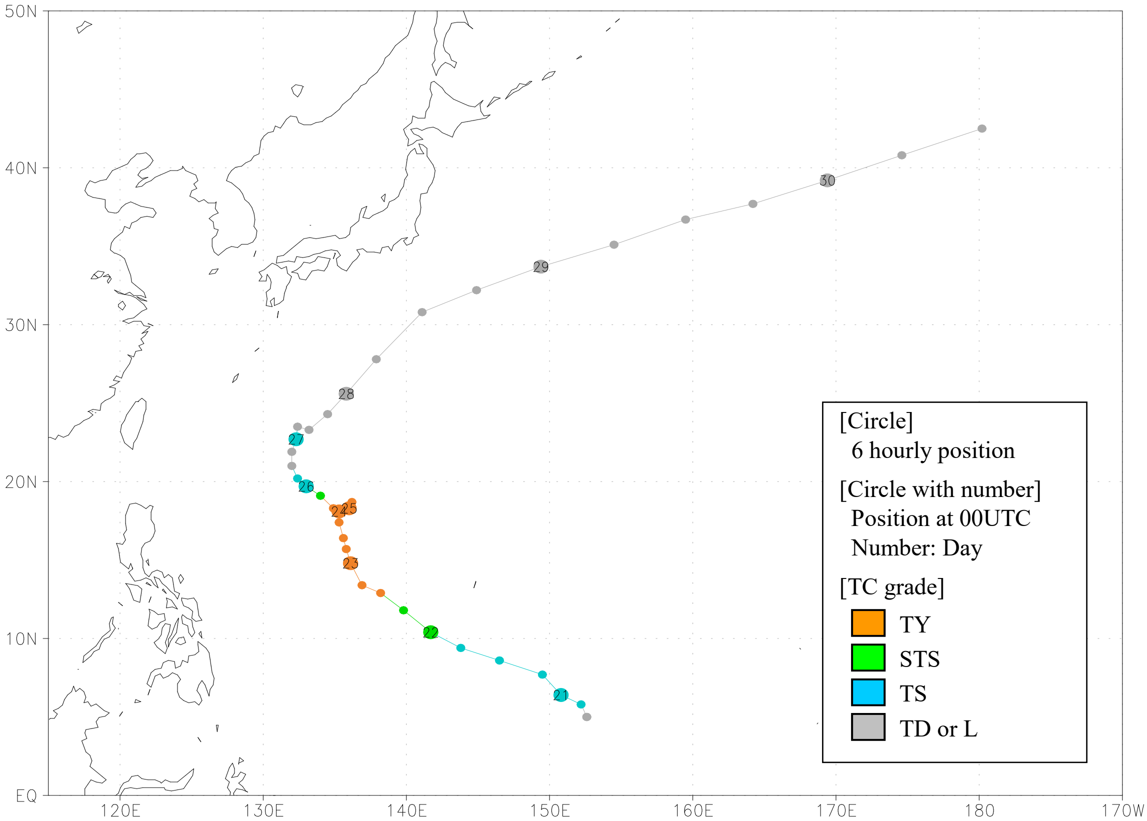
TORAJI (1827)

TORAJI formed as a tropical depression (TD) over the South China Sea at 18 UTC on 16 November 2018, and moved northwestward. With turning west-northwestward gradually, it was upgraded to tropical storm (TS) intensity, and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 1004 hPa over the same waters at 06 UTC the next day. Keeping its west-northwestward track, TORAJI weakened to TD intensity offshore of the southern part of Viet Nam at 00 UTC on 18 November. After crossing the coast of Viet Nam, it dissipated in the country at 18 UTC the same day.



MAN-YI (1828)

MAN-YI formed as a tropical depression (TD) around the Chuuk Islands at 12 UTC on 20 November 2018 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters six hours later. Gradually accelerating west-northwestward, MAN-YI was upgraded to typhoon (TY) intensity around the sea west of the Mariana Islands at 12 UTC on 22 November. After decelerating northward, MAN-YI remained almost stationary and reached its peak intensity with maximum sustained winds of 80 kt and a central pressure of 960 hPa around Okinotorishima Island at 12 UTC on 24 November. After maintaining its peak intensity for 12 hours over the same waters, it started to move northwestward and weakened rapidly. MAN-YI was downgraded to TD intensity around the sea south of Minamidaitojima Island at 12 UTC on 26 November, and then moving northward. It was upgraded to TS intensity again at 00 UTC on 27 November and re-downgraded to TD intensity six hours later over the same waters. Accelerating northeastward, MAN-YI transformed into an extratropical cyclone around the sea west of Chichijima Island at 06 UTC on 28 November. Keeping its northeastward track, it crossed longitude 180 degrees east at 12 UTC on 30 November.



USAGI (1829)

USAGI formed as a tropical depression (TD) over the sea around the Marshall Islands at 00 UTC on 13 November 2018 and moved westward. After hitting the Philippines with TD intensity, it was upgraded to tropical storm (TS) intensity over the South China Sea at 00 UTC on 22 November. USAGI was upgraded to severe tropical storm (STS) intensity over the same waters at 06 UTC on 23 November and reached its peak intensity with maximum sustained winds of 60 kt and a central pressure of 990 hPa over the sea east of Viet Nam at 00 UTC the next day. After crossing the coast of Viet Nam, USAGI weakened to TD intensity at 00 UTC on 26 November and dissipated around Cambodia 24 hours later.