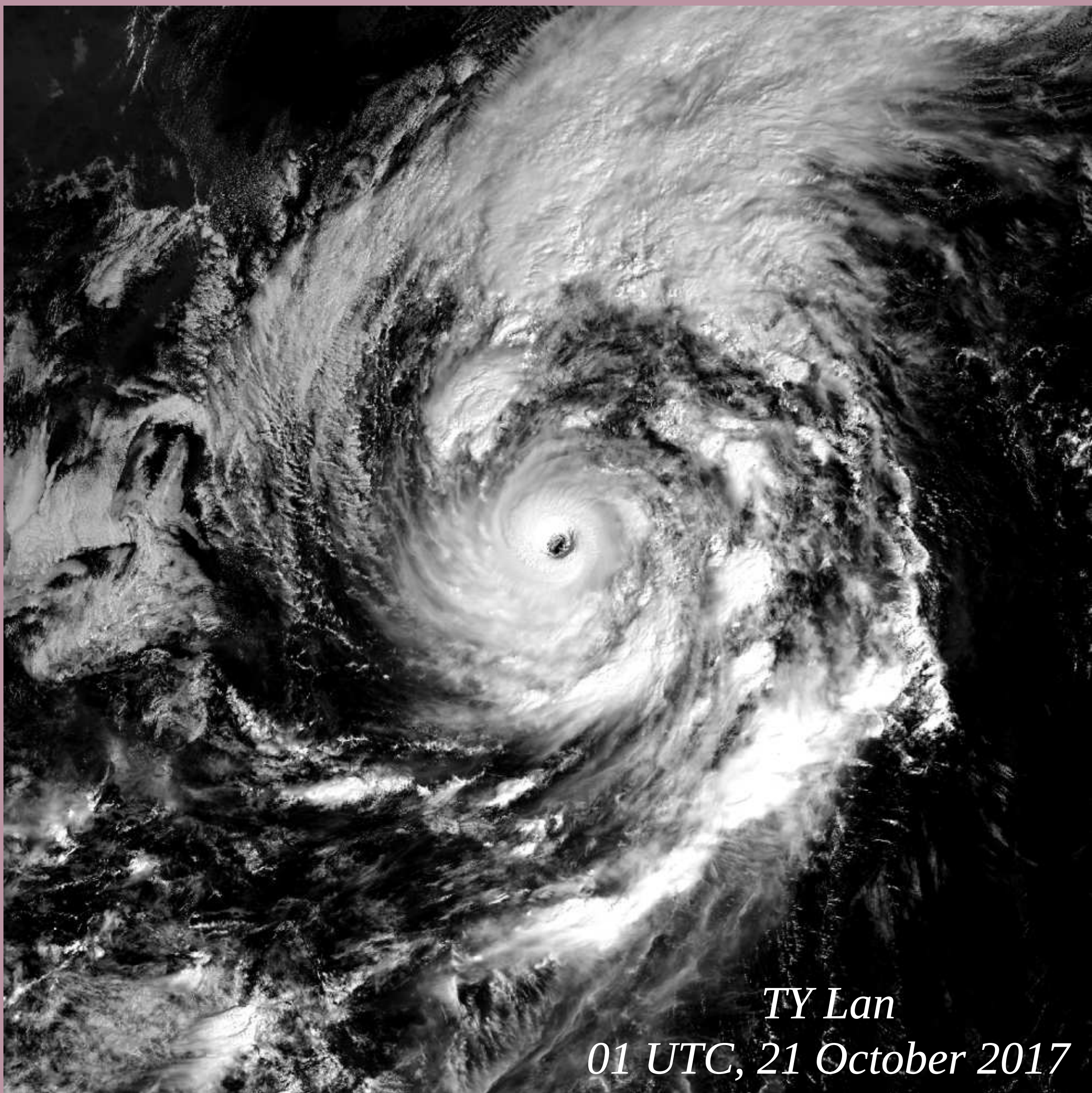
Annual Report
on the Activities of
the RSMC Tokyo - Typhoon Center
2017



Japan Meteorological Agency

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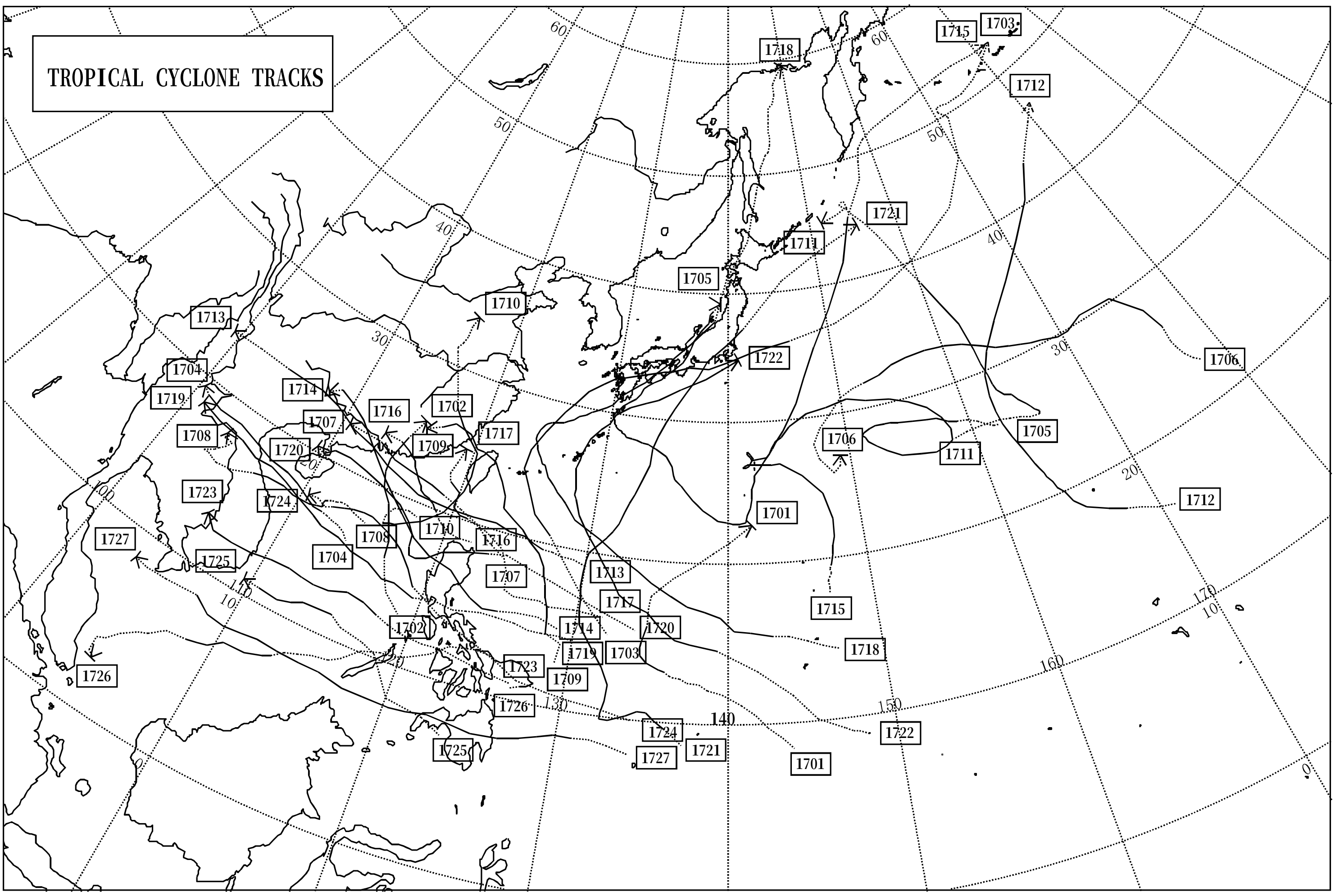


Japan Meteorological Agency

Table of Contents

Appendices

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 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 2017, Chapter 1 outlines routine operations performed at the Center and its operational products, while Chapter 2 reports on its major activities in 2017. Chapter 3 describes atmospheric and oceanic conditions in the tropics and notes the highlights of TC activity in 2017. Chapter 4 presents verification statistics relating to operational forecasts, results from JMA's numerical weather prediction (NWP) models and other guidance models, and storm surge prediction. Best track data for 2017 TCs 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 2017 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 2017

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 tropical cyclones (TCs) in the area and also provides the relevant National Meteorological Services (NMSs) with RSMC products via the Global Telecommunication System (GTS), the Aeronautical Fixed Telecommunication Network (AFTN), the Internet and other media.

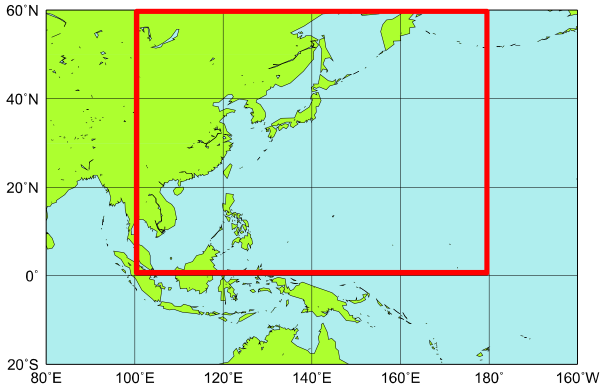


Figure 1.1
Area of responsibility of the RSMC Tokyo - Typhoon Center

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 images from the Himawari-8 are the principal source 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 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, ASCAT observation and *Atmospheric Motion Vector (AMV) based Sea surface Wind (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, JMA extended its TC track forecast up to five days 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 will extend the lead time of TC intensity forecasts up to 120 hours in March 2019 using the prediction scheme being 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.

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 tropical storm (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 (FXPQ20-25 RJTD: via GTS)

The RSMC Guidance for Forecast 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 84 hours ahead and GEPS mean six-hourly predictions up to 132 hours ahead, and reports the following elements:

NWP prediction (T = 06 to 84 or 132)
Center position
Central pressure*
Maximum sustained wind speed*

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

(4) SAREP (IUCC10 RJTD: via GTS)

The SAREP in BUFR format reports 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).

(5) RSMC Prognostic Reasoning (WTPQ30-35 RJTD: via GTS)

The RSMC Prognostic Reasoning report provides brief reasoning for TC forecasts, and is issued at 00 and 06 UTC following the issuance of the RSMC Tropical Cyclone Advisory. In the bulletin, general comments on the forecasting method, the synoptic situation such as the subtropical ridge, the movement and intensity of the TC as well as relevant remarks are given in plain language.

(6) RSMC Tropical Cyclone Best Track (AXPQ20 RJTD: via GTS)

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

(7) 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 Tropical Cyclone Advisory (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 Center (DCPC) service under the Global Information System Center (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 (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 NWP models from nine centers (BoM (Australia), CMA (China), CMC (Canada), DWD (Germany), ECMWF, KMA (Republic of Korea), NCEP (USA), UKMO (UK) and JMA), ensemble TC track predictions of ensemble NWP models 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 2017

2.1 Provision of RSMC Products

The Center provides operational products for tropical cyclone (TC) forecasting to NMSs via the GTS, the AFTN and other networks. Monthly and annual totals of products issued in 2017 are listed in Table 2.1.

Table 2.1 Monthly and annual totals of products issued by the RSMC Tokyo - Typhoon Center in 2017

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
IUCC10	0	11	0	16	0	15	268	249	168	153	60	115	1055
WTPQ20-25	0	22	0	21	0	17	306	275	189	176	73	126	1205
WTPQ30-35	0	5	0	6	0	4	72	67	48	42	18	30	292
WTPQ50-55	0	0	0	0	0	0	64	64	35	47	5	28	243
FXPQ20-25	0	22	0	20	0	16	300	270	184	174	70	124	1180
FKPQ30-35	0	11	0	10	0	8	150	135	92	87	35	62	590
AXPQ20	1	0	0	0	0	1	1	2	8	4	3	6	26

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
FKPQ30-35 RJTD	Tropical Cyclone Advisory for SIGMET
AXPQ20 RJTD	RSMC Tropical Cyclone Best Track

2.2 Publications

In March 2017, the 19th issue of the *RSMC Technical Review* was issued with the following areas of focus:

1. Comparative Study of Dvorak Analysis in the western North Pacific
2. Upgrade of JMA’s Storm Surge Prediction for the WMO Storm Surge Watch Scheme (SSWS)

In December 2017, the Center published the *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2016*. 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 17th Typhoon Committee Attachment Training 2017 course was held at JMA Headquarters from 11 to 21 December 2017.

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 tropical cyclone 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 2017 attendees were Ms. Sze-ning Chong from Hong Kong, Ms. Junjuda Pornsri from Thailand, Ms. Trang Quynh Tran from Viet Nam, Mr. Md Omar Faruq from Bangladesh, Mr. Abdulla Hafiz Abdul Sattar Ali from Maldives, and Dr. Tin Mar Htay from Myanmar.

The training focused on practical knowledge and skills related to operational tropical cyclone analysis and forecasting via lectures and exercises using the Satellite Analysis and Viewer Program (SATAID). The course covered a range of subjects including Dvorak analysis, interpretation of microwave imagery, and storm surge forecasting. Presentations and exercises were also provided on public weather services, including the setting of warning criteria based on quantitative precipitation estimation and forecasting techniques, and forecast skill evaluation, to enhance capacity in the development and implementation of effective warning systems in collaboration with disaster risk reduction operators. All attendees gave presentations to help JMA staff understand the current status of their meteorological and hydrological services including tropical cyclone forecasting and warning services.

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 November, 2016, to 31 October, 2017, was conducted for two tropical cyclones:

1. TY Hato (1713), from 21UTC 20 August to 15UTC 24 August 2017
2. TY Doksuri (1719), from 00UTC 11 September to 00UTC 16 September 2017

The results were distributed to all Typhoon Committee Members in March 2018, 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 2017

2.5.1 Update of Numerical Typhoon Prediction Website

In 2017, the changes outlined below were made to the NTP website.

(1) New Stations for Storm Surge Time Series Charts (30 March)

The Center added ten stations for storm surge time series charts – four in Cambodia (Kampot, Keb, Kohkong and Sihanoukvile) and six in Singapore (Pasirris, Sembawang, Tanjongchangi, Tanahmerah, Tanjongpagar and Westcoast).

(2) Vorticity and Divergence of Wind Fields (30 March)

The Center began to provide maps of vorticity at the 850-hPa level and wind field divergence at the 200-hPa level. These products are useful for identifying wind circulation in lower layers that could develop into tropical cyclones and identifying areas with divergence in upper layers.

(3) Expansion of Chart Areas (30 March)

Chart areas showing stream line content at 850 and 200 hPa, vertical wind shear, sea surface temperature (SST) and tropical cyclone heat potential (TCHP) were expanded to provide useful information over a larger area.

(4) Expansion of the Ensemble Ocean Wave Forecast Map Area (28 September)

The ensemble ocean wave forecast map area was expanded to cover more basins of the Pacific and Indian Oceans. This improvement made the product more relevant and useful for addressing maritime/coastal risks related to ocean waves caused by tropical cyclones.

(5) Radar Composite Imagery (25 October)

Malaysia, Thailand and Japan began to provide hourly radar composite imagery using data shared through an experimental exchange initiated in 2016. The imagery is produced as part of a Typhoon Committee Working Group on Meteorology project titled *Development of Regional Radar Network*.

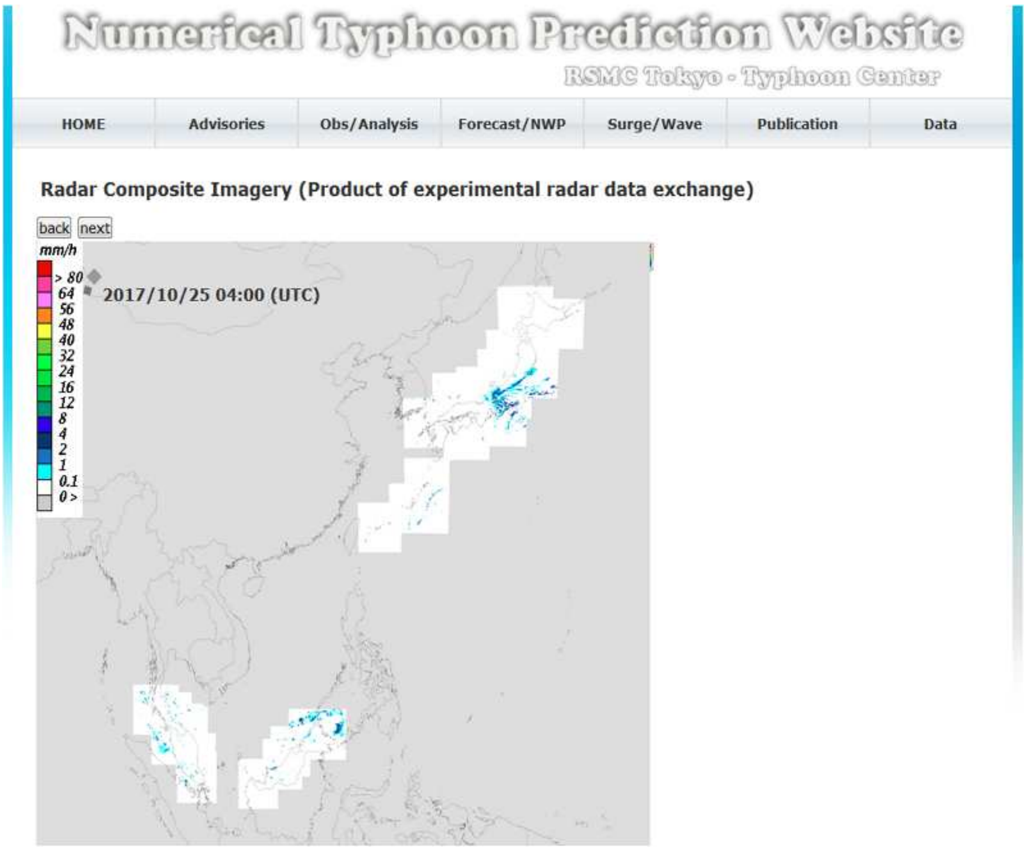


Figure 2.1 Radar composite imagery provided by the NTP website
(URL: https://tynwp-web.kishou.go.jp/Analysis/Radar/index.html)

2.5.2 Update of Forecast Circle Radii based on GEPS

In January 2017 JMA began to operate the Global Ensemble Prediction System (GEPS), which replaced the Typhoon Ensemble Prediction System (TEPS) along with the introduction of an upgraded forecast model, a revision of the initial perturbation production method and other updates. Verification results showed a consequent positive impact on TC track forecasts, including a reduction of track forecast errors for 24- to 120-hour forecasts and a mitigation of spread deficiencies for 96- to 120-hour forecasts.

Based on recent forecast results obtained using GEPS, the forecast circle radius for 96- to 120-hour forecasts was updated in June 2017, starting with STS Nanmadol (1703). Changes in the radius calculated using GEPS for forecast times were smoother than those of TEPS, reflecting changes in model characteristics. As a result, the issue of rapid radius expansion in 72- to 96-hour forecasts was mitigated as shown in Figure 2.2.

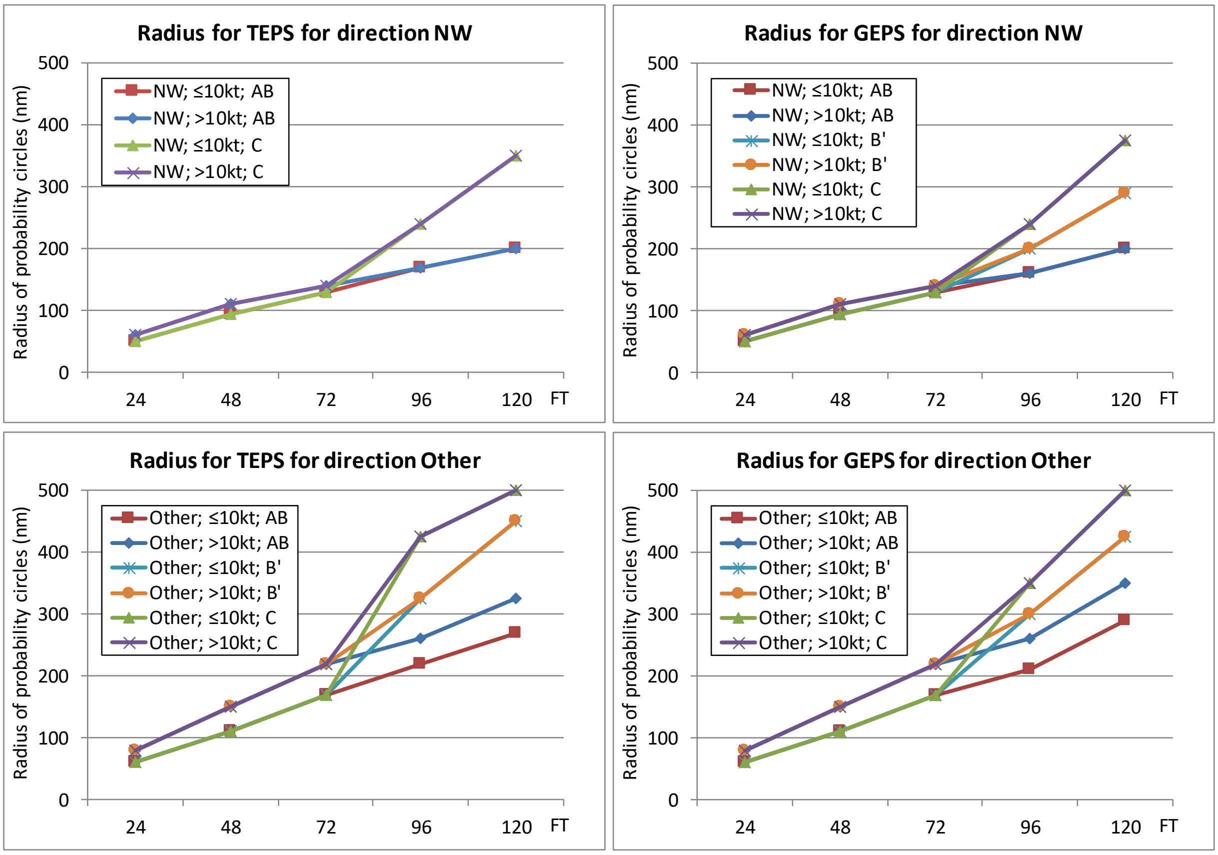


Figure 2.2 Changes in radius for forecast times with TEPS (left) and GEPS (right) (top: NW; bottom: Other in the direction of TC movement)

Chapter 3

Summary of the 2017 Typhoon Season

In 2017, 27 TCs of tropical storm (TS) intensity or higher formed over the western North Pacific and the South China Sea. This is close to the climatological normal* frequency of 25.6. Among these 27 TCs, 11 reached typhoon (TY) intensity, 6 reached severe tropical storm (STS) intensity and 10 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 2017

Tropical Cyclone			Duration (UTC) (TS or higher)					Minimum Central Pressure				Max Wind
								(UTC)	lat (N)	long (E)	(hPa)	(kt)
TS	Muifa	(1701)	251800	Apr	-	270600	Apr	251800	13.1	136.0	1002	35
STS	Merbok	(1702)	110000	Jun	-	130000	Jun	121200	22.0	114.4	985	55
STS	Nanmadol	(1703)	020000	Jul	-	050000	Jul	030600	27.7	125.0	985	55
STS	Talas	(1704)	150600	Jul	-	171200	Jul	161800	18.5	105.6	985	50
TY	Noru	(1705)	201200	Jul	-	081200	Aug	310000	22.8	140.4	935	95
TS	Kulap	(1706)	210600	Jul	-	251800	Jul	230600	30.8	166.5	1002	40
TS	Roke	(1707)	220600	Jul	-	230600	Jul	221200	21.6	117.9	1002	35
TS	Sonca	(1708)	230000	Jul	-	251200	Jul	241800	16.9	109.5	994	35
TY	Nesat	(1709)	251800	Jul	-	301200	Jul	281800	21.7	123.5	960	80
TS	Haitang	(1710)	281800	Jul	-	310600	Jul	300600	21.9	120.3	985	45
TS	Nalgae	(1711)	020000	Aug	-	051800	Aug	050600	34.2	162.1	990	45
TY	Banyan	(1712)	111200	Aug	-	170600	Aug	130000	21.0	164.1	955	80
TY	Hato	(1713)	201200	Aug	-	241200	Aug	230000	21.6	114.4	965	75
STS	Pakhar	(1714)	241800	Aug	-	271800	Aug	270000	21.8	113.4	985	55
TY	Sanvu	(1715)	280600	Aug	-	031200	Sep	312100	27.5	141.8	955	80
STS	Mawar	(1716)	311800	Aug	-	040000	Sep	020000	21.0	117.4	990	50
TS	Guchol	(1717)	051800	Sep	-	061800	Sep	051800	20.3	121.1	1000	35
TY	Talim	(1718)	091200	Sep	-	171800	Sep	140000	26.6	124.6	935	95
TY	Doksuri	(1719)	121200	Sep	-	160000	Sep	141200	17.0	109.8	955	80
TY	Khanun	(1720)	121200	Oct	-	160000	Oct	150000	20.2	114.7	955	75
TY	Lan	(1721)	151800	Oct	-	230000	Oct	211800	25.6	133.3	915	100
STS	Saola	(1722)	241200	Oct	-	291200	Oct	271800	24.2	128.3	975	60
TY	Damrey	(1723)	020000	Nov	-	041800	Nov	030600	12.7	112.6	970	70
TS	Haikui	(1724)	100000	Nov	-	120600	Nov	110000	17.6	116.2	998	40
TS	Kirogi	(1725)	180000	Nov	-	190000	Nov	180000	11.5	115.2	1000	35
TS	Kai-tak	(1726)	140000	Dec	-	211200	Dec	150600	11.7	127.8	994	40
TY	Tembin	(1727)	201800	Dec	-	251200	Dec	240000	8.1	114.7	970	70

3.1 Atmospheric and Oceanographic Conditions in the Tropics

In the western equatorial Pacific, positive sea surface temperature (SST) anomalies continued in areas other than near the date line in 2017. In association with these anomalies, tropical convective activity was enhanced around the Maritime Continent and suppressed over the central equatorial Pacific. Negative SST anomalies over the central equatorial Pacific were strengthened, indicating the occurrence of La Niña conditions from autumn onward.

Corresponding to the positive SST anomalies and associated enhanced convective activity, lower-level cyclonic circulation anomalies were seen from the eastern Indian Ocean to the Maritime Continent in winter 2016/2017 and from autumn 2017. Suppression of convective activity and related lower-level anti-cyclonic circulation anomalies were observed from the southern part of the East China Sea to the seas east of the Philippines in June and August. Asian summer monsoon activity was enhanced and a deep monsoon trough was clearly observed from the South China Sea to the seas east of the Philippines in July. These conditions are considered to have been associated with an increased incidence of temporally coinciding TCs.

Figure 3.1 shows monthly mean streamlines and related anomalies at 850 hPa, Outgoing Longwave Radiation (OLR) and related anomalies (with lower OLR values corresponding to stronger convective activity) in July 2017 and the tracks of TCs forming during the month, when convective activity was enhanced from the South China Sea to the seas east of the Philippines. It can be seen that six named TCs formed in the area of 100 – 130˚E in association with strong convective activity.

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 and related anomalies for the months from January to December are included on the DVD provided with this report.

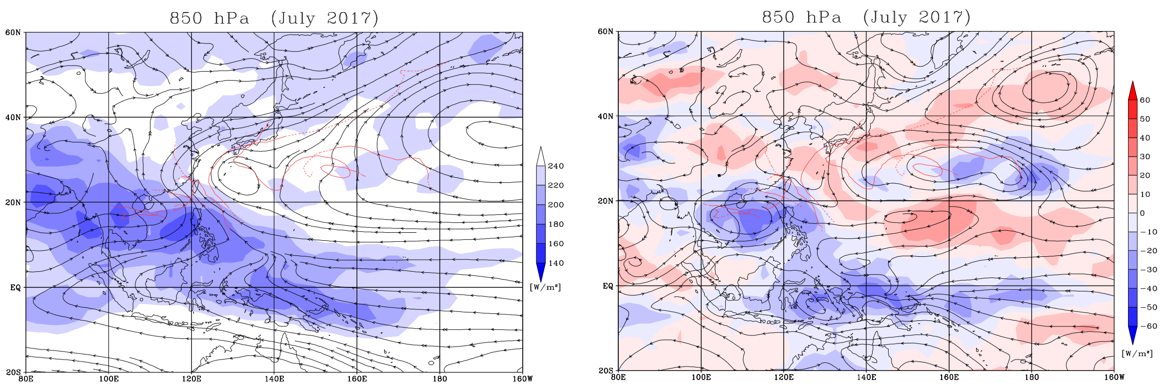


Figure 3.1 Monthly mean streamlines (lines with arrows) and OLR (shading) (left) and related anomalies (right) at 850 hPa for July 2017. The tracks of the eight named TCs forming in July are superimposed in red onto both figures.

3.2 Tropical Cyclones in 2017

A total of 27 named TCs formed over the western North Pacific and the South China Sea in 2017. Monthly and the climatological normal numbers of TC formations are shown in Figure 3.2, and the tracks of the 27 TCs are shown in Figure 3.3. Figure 3.4 shows the genesis points of the 27 TCs (dots) and related frequency distribution for past years (1951 – 2016).

As many as eight named TCs formed in July, which was a joint-record high (along with July 1971) since the Center began keeping TC statistics in 1951. Four of these formed over the South China Sea, two east of the Philippines and two east of Minamitorishima Island. During the month, SSTs were high in these areas and convection was active, partly because of the phase of the Madden-Julian Oscillation (MJO), to which the large number of TC formation could be attributed. The monthly and annual frequencies of named TCs forming since 1951 are detailed in Appendix 4.

The mean genesis point of the named TCs forming in summer (June to August) was at 19.7˚N and 134.5˚E, with almost no deviation from the 30-year summer average** (18.4˚N and 135.9˚E). That of named TCs forming in autumn (September to November) was 14.6˚N and 126.0˚E, representing a significant westward deviation from the 30-year autumn average** (15.9˚N and 137.8˚E), which contributed to a westward deviation of the annual average. The autumn deviation can be attributed to the incidence of higher sea surface temperatures east of the Philippines throughout autumn in association with the La Niña event that started in early autumn and active convection caused by warm seas. In contrast, convection was inactive in the middle of the Pacific Ocean, contributing to the lower number of TC formations in the area. As a result, more TCs formed around the Philippines and contributed to the westward deviation of the mean genesis point for named TCs forming in 2017.

The mean duration of TCs sustaining TS intensity or higher was 4.3 days, which was shorter than the 30-year average** (5.3 days). As TCs forming near and moving toward land are considered unlikely to maintain their intensity for a long time, the westward deviation of the mean genesis point for named TCs may have contributed to the short mean duration over the Center's area of responsibility, which covers the continent in the western part of the area.

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

Detailed descriptions of each TC forming in 2017 are included on the DVD provided with this report.

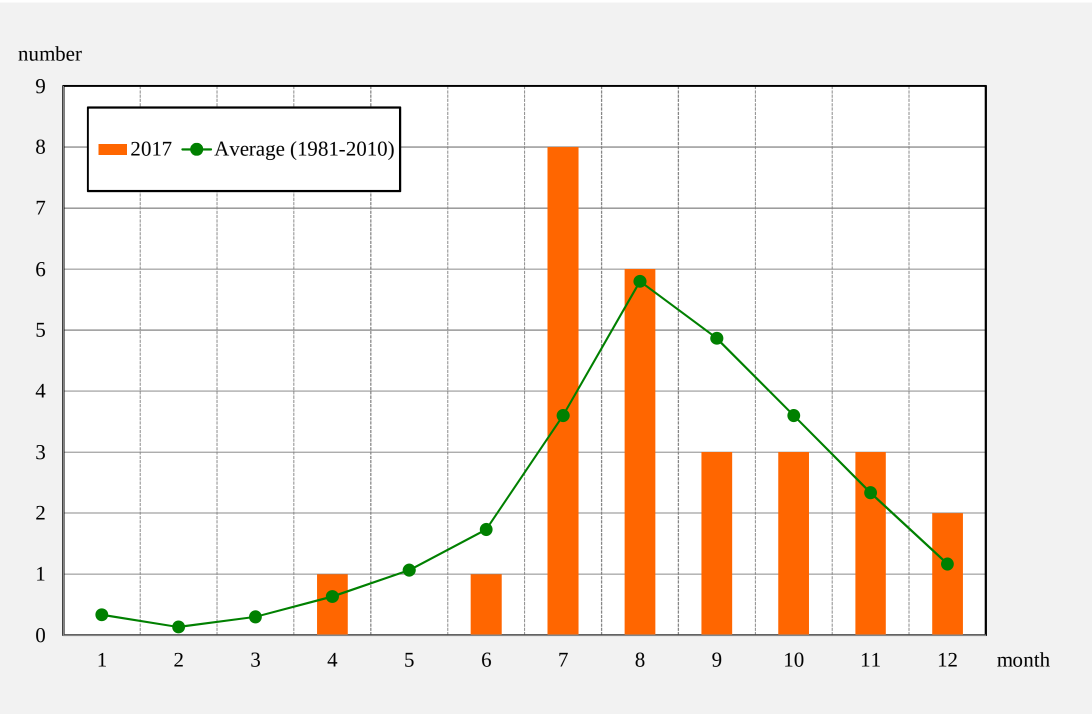


Figure 3.2 Monthly number of TC formations for 2017 compared to the climatological normal

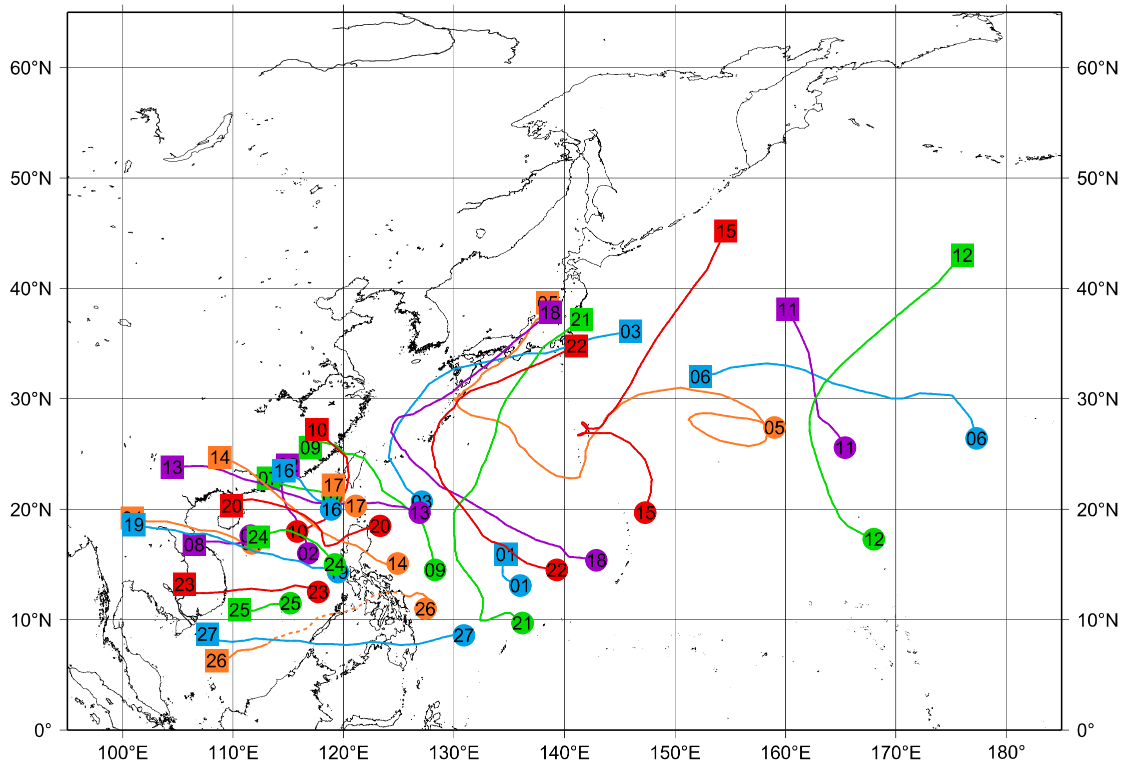


Figure 3.3 Tracks of the 27 named TCs forming in 2017. TC tracks for those with an intensity of TS or higher are shown.

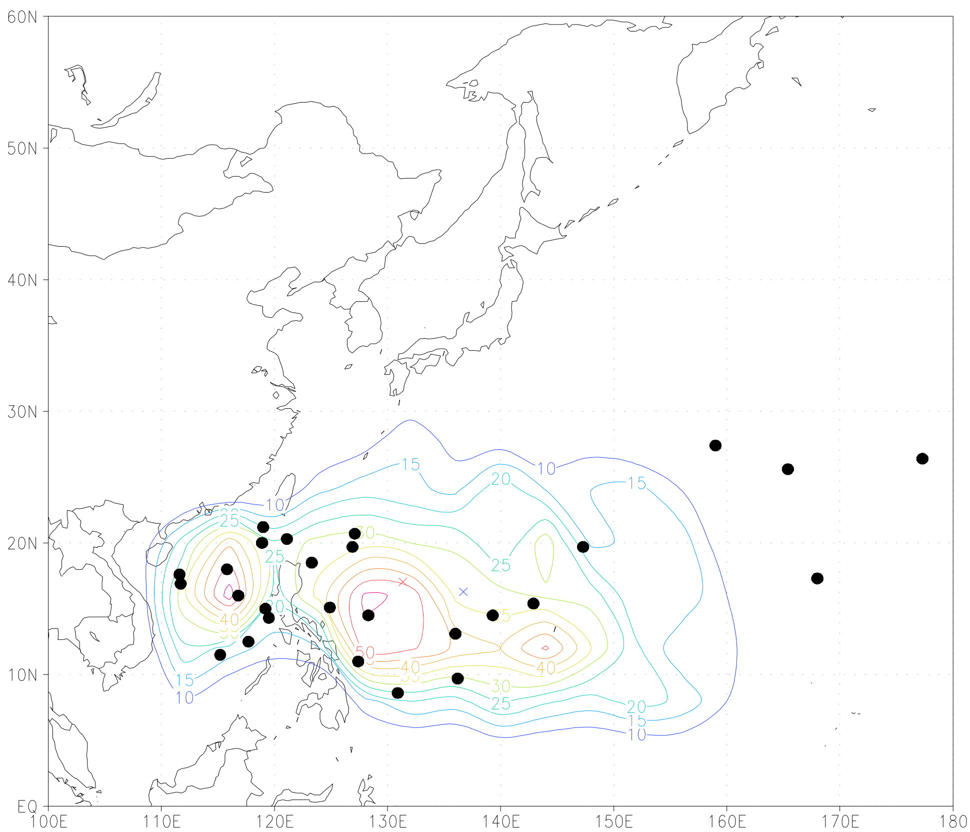


Figure 3.4 Genesis points of the 27 TCs forming in 2017 (dots) and related frequency distribution for 1951 – 2016 (lines). Red and blue crosses show the mean genesis points of TCs forming in 2017 and the 30-year average period (1981 – 2010), respectively.

Chapter 4

Verification of Forecasts in 2017

4.1 Verification of Operational Forecasts

Operational forecasts for the 27 TCs of TS intensity or higher that formed in 2017 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 TC forming in 2017 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 2017 were 82, 151, 248, 335 and 420 km for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively.

The details of errors for each TC forming in 2017 are summarized in Table 4.1. For TCs with mean position errors up to 72 hours ahead, the 24-, 48- and 72-hour forecasts for Kulap (1706), which moved from west of the Midway Islands to east of Japan, and Banyan (1712), which moved from southeast of Wake Island to south of the Aleutian Islands, were characterized by large errors. Meanwhile, forecasts for Nalgae (1711) and Mawar (1716) showed relatively small errors. The 96- and/or 120-hour forecasts for Nesat (1709), which moved from east of the Philippines to southeastern China across Taiwan Island, and Talim (1718), which moved northwestward east of the Philippines and then northeastward, causing damage to Japan, showed large errors, while forecasts for Saola (1722) and Kai-tak (1726) exhibited relatively small errors.

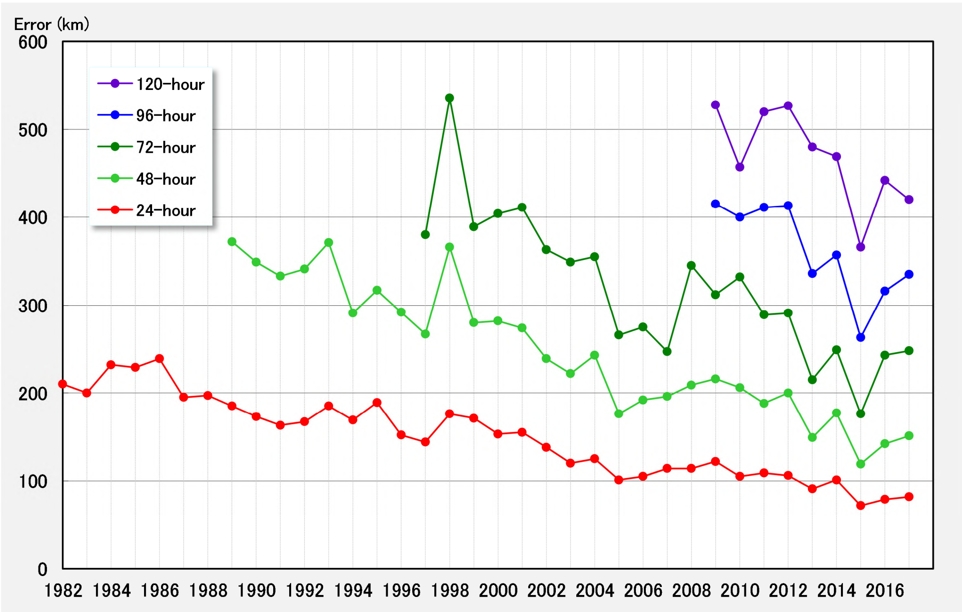


Figure 4.1 Annual mean position errors in 24-, 48-, 72-, 96- and 120-hour operational track forecasts

The position errors were also compared with those determined using the persistency (PER) method*. The ratios of EO (i.e., the position errors of operational forecasts) to EP (the position errors of PER method forecasts) as percentages are also shown in Table 4.1. An EO/EP value smaller/greater than 100% indicates that the operational forecast was better/worse than the PER method forecast. The annual mean EO/EP ratios for 24-, 48-, 72-, 96- and 120-hour forecasts in 2017 were 30% (32% in 2016), 24% (26%), 22% (26%), 22% (23%) and 24% (24%), respectively. Figure 4.2 shows a histogram of 24-hour forecast position errors. About 91% (89% in 2016) of 24-hour forecasts, 92% (92%) of 48-hour forecasts, 91% (91%) of 72-hour forecasts, 80% (86%) of 96-hour forecasts and 81% (72%) of 120-hour forecasts had errors of less than 150, 300, 450, 500 and 600 km, respectively.

** 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 4.1 Mean position errors of 24-, 48-, 72-, 96- and 120-hour operational forecasts for each TC forming in 2017. S.D., EO, EP, and EO/EP represent the standard deviation of operational forecast position error, the operational forecast position error, the position error with the PER method and the ratio of EO to EP, respectively.

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
			Mean (km)	S.D. (km)	Num.	EO/EP (%)	Mean (km)	S.D. (km)	Num.	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)
TS	Muifa	(1701)	101	22	2	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Merbok	(1702)	116	59	4	53	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Nanmadol	(1703)	109	17	8	16	470	153	4	28	-	-	0	-	-	-	0	-	-	-	0	-
STS	Talas	(1704)	66	30	5	38	182	0	1	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Noru	(1705)	71	42	72	30	113	50	67	17	196	73	62	18	316	129	58	21	426	167	54	24
TS	Kulap	(1706)	127	101	14	34	231	111	10	34	430	132	6	31	651	119	2	-	-	-	0	-
TS	Roke	(1707)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Sonca	(1708)	107	17	6	53	145	23	2	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Nesat	(1709)	90	54	15	49	173	69	10	53	367	96	5	63	1038	0	1	148	-	-	0	-
TS	Haitang	(1710)	183	79	4	41	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Nalgae	(1711)	38	22	11	23	104	81	7	41	128	44	3	17	-	-	0	-	-	-	0	-
TY	Banyan	(1712)	99	45	19	31	221	137	15	30	424	304	11	32	242	66	3	18	-	-	0	-
TY	Hato	(1713)	69	44	12	41	125	71	8	21	144	39	4	11	-	-	0	-	-	-	0	-
STS	Pakhar	(1714)	110	85	8	49	211	103	4	35	-	-	0	-	-	-	0	-	-	-	0	-
TY	Sanvu	(1715)	99	43	21	21	170	82	17	15	248	67	13	15	306	136	9	15	303	64	5	53
STS	Mawar	(1716)	45	15	9	29	42	26	5	22	54	0	1	-	-	-	0	-	-	-	0	-
TS	Guchol	(1717)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Talim	(1718)	73	25	29	35	152	72	25	32	305	140	21	34	464	205	17	33	610	284	13	31
TY	Doksuri	(1719)	76	50	10	40	200	54	6	52	403	128	2	-	-	-	0	-	-	-	0	-
TY	Khanun	(1720)	91	38	10	20	149	37	6	14	198	47	2	-	-	-	0	-	-	-	0	-
TY	Lan	(1721)	85	32	25	27	121	58	21	20	193	112	17	21	276	237	13	23	285	258	9	16
STS	Saola	(1722)	74	32	16	22	188	130	12	28	269	146	8	23	168	112	4	3	-	-	0	-
TY	Damrey	(1723)	40	23	7	33	105	44	3	15	-	-	0	-	-	-	0	-	-	-	0	-
TS	Haikui	(1724)	65	16	5	21	46	0	1	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Kirogi	(1725)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Kai-tak	(1726)	67	51	8	23	67	11	2	-	-	-	0	-	186	17	2	19	254	44	6	15
TY	Tembin	(1727)	94	30	15	59	148	50	11	53	236	78	7	35	287	92	3	22	-	-	0	-
Annual Mean (Total)			82	50	335	30	151	98	237	24	248	148	162	22	335	187	112	22	420	216	87	24

Table 4.2 presents the mean hitting ratios and radii of 70% probability circles** provided in operational forecasts for each TC forming in 2017. 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 112 km (112 km in 2016), and their hitting ratio was 78% (78%). The corresponding values for 48-hour forecasts were 206 km (207 km in 2016) and 79% (79%), those for 72-hour forecasts were 299 km (290 km in 2016) and 75% (79%), those for 96-hour forecasts were 418 km (409 km in 2016) and 68% (78%), and those for 120-hour forecasts were 552 km (510 km in 2016) and 75% (69%).

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

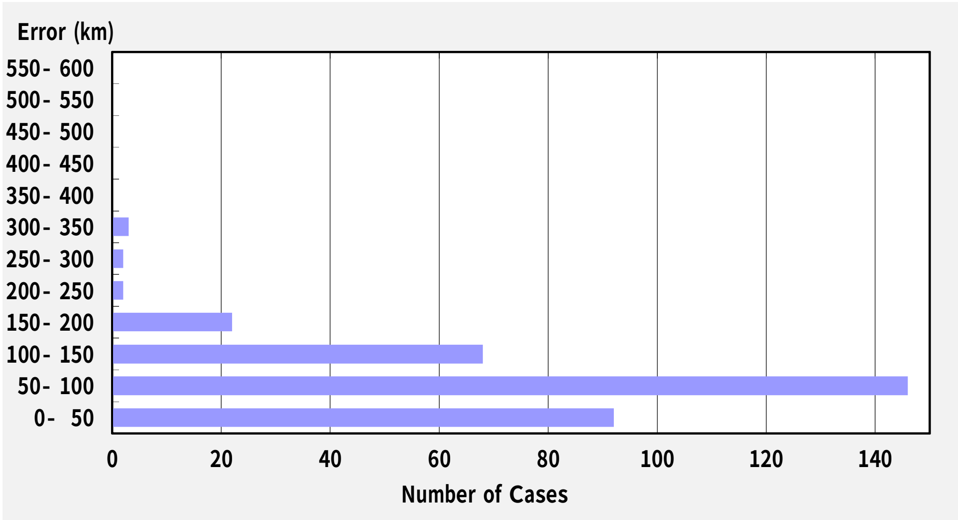


Figure 4.2 Histogram of 24-hour forecast position errors in 2017
(Histograms for 48-, 72-, 96- and 120-hour forecasts are included on the DVD provided with this report).

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 TC forming in 2017

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	Muifa	(1701)	100	2	148	-	0	-	-	0	-	-	0	-	-	0	-
STS	Merbok	(1702)	75	4	130	-	0	-	-	0	-	-	0	-	-	0	-
STS	Nanmadol	(1703)	100	8	162	25	4	315	-	0	-	-	0	-	-	0	-
STS	Talas	(1704)	100	5	104	100	1	204	-	0	-	-	0	-	-	0	-
TY	Noru	(1705)	88	72	111	94	67	196	90	62	288	71	58	404	78	54	551
TS	Kulap	(1706)	57	14	105	30	10	176	17	6	241	0	2	296	-	0	-
TS	Roke	(1707)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TS	Sonca	(1708)	50	6	111	100	2	264	-	0	-	-	0	-	-	0	-
TY	Nesat	(1709)	73	15	114	60	10	194	0	5	241	0	1	444	-	0	-
TS	Haitang	(1710)	25	4	148	-	0	-	-	0	-	-	0	-	-	0	-
TS	Nalgae	(1711)	100	11	101	86	7	188	100	3	247	-	0	-	-	0	-
TY	Banyan	(1712)	68	19	117	73	15	257	55	11	407	100	3	556	-	0	-
TY	Hato	(1713)	83	12	108	88	8	204	100	4	259	-	0	-	-	0	-
STS	Pakhar	(1714)	50	8	111	50	4	204	-	0	-	-	0	-	-	0	-
TY	Sanvu	(1715)	62	21	114	76	17	217	85	13	339	78	9	430	100	5	604
STS	Mawar	(1716)	100	9	95	100	5	176	100	1	241	-	0	-	-	0	-
TS	Guchol	(1717)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TY	Talim	(1718)	90	29	115	72	25	214	52	21	300	41	17	411	38	13	554
TY	Doksuri	(1719)	70	10	104	83	6	199	0	2	250	-	0	-	-	0	-
TY	Khanun	(1720)	60	10	100	83	6	185	50	2	241	-	0	-	-	0	-
TY	Lan	(1721)	80	25	113	90	21	205	94	17	305	77	13	412	78	9	537
STS	Saola	(1722)	88	16	122	58	12	211	75	8	347	100	4	648	-	0	-
TY	Damrey	(1723)	100	7	103	100	3	185	-	0	-	-	0	-	-	0	-
TS	Haikui	(1724)	80	5	93	100	1	176	-	0	-	-	0	-	-	0	-
TS	Kirogi	(1725)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TS	Kai-tak	(1726)	63	8	100	100	2	176	-	0	-	100	2	389	100	6	537
TY	Tembin	(1727)	60	15	106	73	11	201	86	7	257	67	3	370	-	0	-
Annual Mean (Total)			78	335	112	79	237	206	75	162	299	68	112	418	75	87	552

4.1.2 Central Pressure and Maximum Wind Speed

Figure 4.3 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. They both show long-awaited improvements in operational TC intensity forecasts for 2017. This is partially attributed to the experimental use of the statistical intensity prediction scheme (TIFS).

Table 4.3 gives the RMSEs of 24-, 48- and 72-hour operational central pressure forecasts for each TC forming in 2017. RMSE data for maximum wind speed forecasts are included on the DVD provided with this report. The annual mean RMSEs of central pressure and maximum wind speed for 24-hour forecasts were 10.1 hPa (14.6 hPa in 2016) and 5.0 m/s (6.5 m/s). For 48-hour forecasts, the corresponding values were 14.9 hPa (21.5 hPa in 2016) and 6.8 m/s (8.9 m/s), while those for 72-hour forecasts were 16.9 hPa (23.4 hPa in 2016) and 7.8 m/s (10.0 m/s).

Figure 4.4 shows a histogram of maximum wind speed errors for 24-hour forecasts. Approximately 56% (46% in 2016) of 24-hour forecasts had errors of less than ±3.75 m/s, with figures of ±6.25 m/s for 68% (51%) of 48-hour forecasts and ±6.25 m/s for 60% (52%) of 72-hour forecasts.

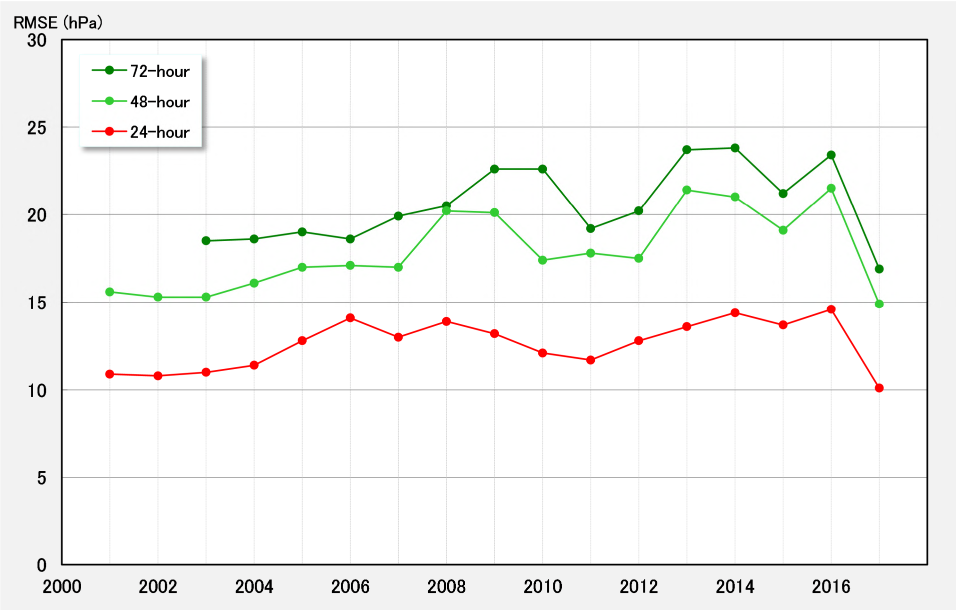


Figure 4.3 Annual RMSEs in 24-, 48- and 72-hour operational central pressure forecasts

Table 4.3 Mean intensity errors of 24-, 48- and 72-hour operational central pressure forecasts for each TC forming in 2017

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast		
			Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.
TS	Muifa	(1701)	-2.0	2.0	2	-	-	0	-	-	0
STS	Merbok	(1702)	9.3	9.6	4	-	-	0	-	-	0
STS	Nanmadol	(1703)	5.1	5.9	8	8.0	8.0	4	-	-	0
STS	Talas	(1704)	2.6	3.4	5	4.0	4.0	1	-	-	0
TY	Noru	(1705)	-1.9	11.0	72	-4.1	16.2	67	-5.4	18.5	62
TS	Kulap	(1706)	-0.6	3.6	14	-0.4	3.5	10	-1.3	5.2	6
TS	Roke	(1707)	-	-	0	-	-	0	-	-	0
TS	Sonca	(1708)	3.0	3.2	6	6.0	6.0	2	-	-	0
TY	Nesat	(1709)	5.5	9.6	15	9.1	11.3	10	-2.0	11.4	5
TS	Haitang	(1710)	6.8	7.0	4	-	-	0	-	-	0
TS	Nalgae	(1711)	0.4	2.3	11	-2.1	4.1	7	2.0	2.6	3
TY	Banyan	(1712)	6.5	15.8	19	5.1	17.8	15	6.6	22.0	11
TY	Hato	(1713)	0.3	6.9	12	8.1	11.6	8	6.3	6.9	4
STS	Pakhar	(1714)	-3.6	6.6	8	-8.0	10.7	4	-	-	0
TY	Sanvu	(1715)	-4.0	9.0	21	-5.3	9.5	17	-4.2	6.9	13
STS	Mawar	(1716)	-3.1	4.0	9	-6.4	6.7	5	-15.0	15.0	1
TS	Guchol	(1717)	-	-	0	-	-	0	-	-	0
TY	Talim	(1718)	-3.1	11.9	29	-4.8	17.9	25	8.3	16.0	21
TY	Doksuri	(1719)	12.1	16.5	10	16.7	20.4	6	-15.5	16.4	2
TY	Khanun	(1720)	4.2	10.1	10	4.2	13.4	6	-12.5	14.6	2
TY	Lan	(1721)	-3.7	12.9	25	-8.3	22.5	21	-14.1	23.9	17
STS	Saola	(1722)	1.9	7.9	16	1.8	9.2	12	-0.6	4.0	8
TY	Damrey	(1723)	6.6	8.4	7	-1.0	6.6	3	-	-	0
TS	Haikui	(1724)	-6.8	6.9	5	-17.0	17.0	1	-	-	0
TS	Kirogi	(1725)	-	-	0	-	-	0	-	-	0
TS	Kai-tak	(1726)	-0.5	2.6	8	-4.0	4.5	2	-	-	0
TY	Tembin	(1727)	5.3	9.8	15	8.2	12.1	11	8.9	15.7	7
Annual Mean (Total)			0.5	10.1	335	-1.1	14.9	237	-2.4	16.9	162

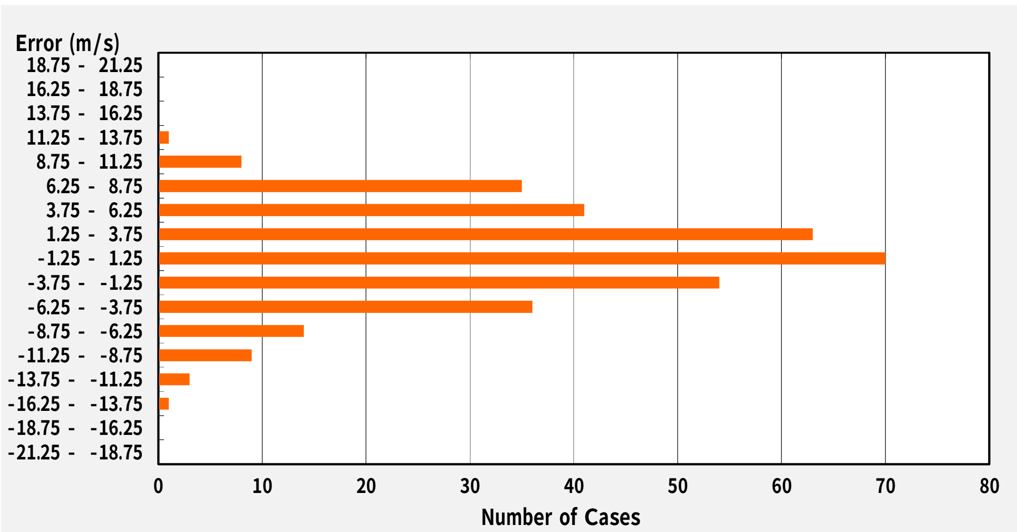


Figure 4.4 Histogram of 24-hour forecast maximum wind speed errors in 2017 (Histograms for 48- and 72-hour forecasts are included on the DVD provided with this report).

4.2 Verification of Numerical Models (GSM, GEPS)

The Global Spectral Model (GSM) and the Global Ensemble Prediction System (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 4.5. In 2017, the annual mean errors for 30-, 54- and 78-hour* predictions were 106 km (107 km in 2016), 182 km (190 km) and 300 km (301 km), respectively. The mean position errors of 18-, 30-, 42-, 54-, 66- and 78-hour predictions for each 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.*

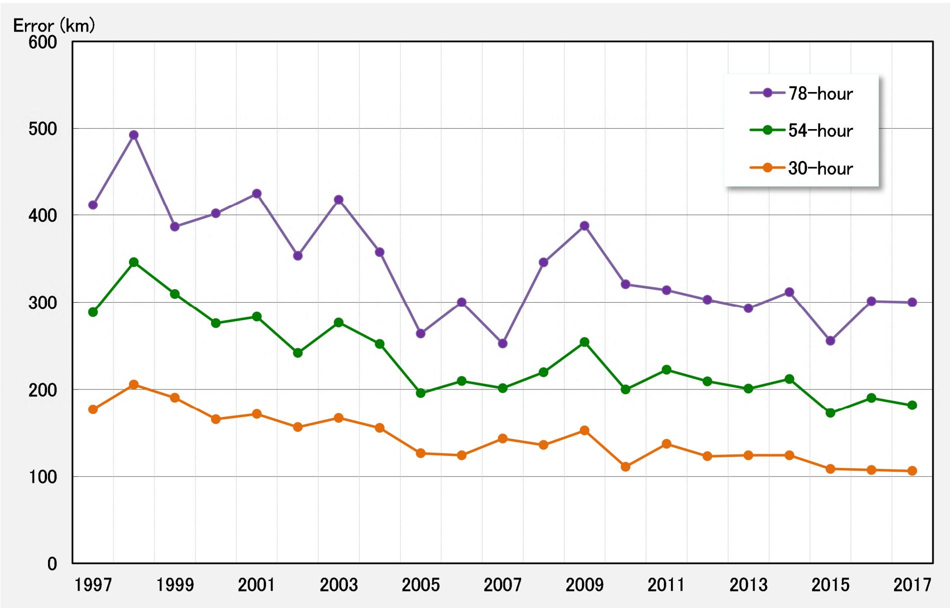


Figure 4.5 GSM annual mean position errors since 1997

Table 4.4 GSM mean position errors (km) for each TC forming in 2017. The number of samples is given in parentheses.

Tropical Cyclone			T=18		T=30		T=42		T=54		T=66		T=78	
TS	MUIFA	(1701)	125.1	(11)	185.6	(9)	277.0	(7)	325.7	(5)	347.7	(3)	342.6	(1)
STS	MERBOK	(1702)	56.2	(5)	85.4	(3)	-	(-)	-	(-)	-	(-)	-	(-)
STS	NANMADOL	(1703)	78.6	(10)	137.9	(8)	238.0	(5)	367.1	(2)	-	(-)	-	(-)
STS	TALAS	(1704)	63.9	(9)	93.3	(7)	145.8	(5)	203.3	(2)	275.3	(1)	-	(-)
TY	NORU	(1705)	60.2	(78)	86.5	(76)	105.8	(74)	129.2	(72)	172.1	(70)	230.0	(68)
TS	KULAP	(1706)	82.6	(17)	87.5	(12)	118.7	(9)	207.4	(7)	299.7	(5)	427.3	(4)
TS	ROKE	(1707)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	SONCA	(1708)	69.0	(13)	116.2	(11)	193.2	(8)	243.6	(4)	213.6	(1)	-	(-)
TY	NESAT	(1709)	87.1	(18)	120.9	(16)	171.2	(14)	241.9	(12)	349.9	(10)	495.1	(8)
TS	HAITANG	(1710)	64.8	(4)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	NALGAE	(1711)	62.9	(20)	73.4	(18)	98.8	(16)	126.8	(14)	163.1	(12)	182.7	(10)
TY	BANYAN	(1712)	61.1	(21)	86.6	(19)	113.3	(17)	160.7	(15)	197.5	(11)	271.0	(9)
TY	HATO	(1713)	53.9	(15)	85.7	(13)	131.0	(11)	179.6	(9)	152.5	(5)	119.9	(2)
STS	PAKHAR	(1714)	133.7	(10)	214.6	(8)	317.6	(6)	433.3	(4)	615.3	(2)	-	(-)
TY	SANVU	(1715)	78.5	(26)	109.1	(24)	135.3	(22)	171.2	(20)	213.8	(18)	265.9	(16)
STS	MAWAR	(1716)	82.8	(13)	88.3	(11)	94.2	(9)	83.6	(7)	96.3	(5)	125.9	(3)
TS	GUCHOL	(1717)	89.6	(7)	115.7	(5)	147.8	(4)	94.5	(1)	-	(-)	-	(-)
TY	TALIM	(1718)	44.5	(34)	67.9	(33)	104.9	(31)	164.5	(29)	243.4	(27)	331.6	(25)
TY	DOKSURI	(1719)	105.2	(16)	108.1	(11)	172.9	(9)	270.4	(7)	381.2	(5)	574.8	(3)
TY	KHANUN	(1720)	95.1	(15)	109.9	(13)	116.5	(11)	143.3	(9)	204.5	(7)	256.7	(5)
TY	LAN	(1721)	74.1	(29)	116.6	(27)	152.4	(25)	179.1	(23)	187.2	(21)	235.8	(19)
STS	SAOLA	(1722)	111.1	(27)	187.2	(25)	275.8	(23)	411.3	(21)	558.8	(19)	768.8	(17)
TY	DAMREY	(1723)	51.5	(11)	83.5	(9)	116.0	(7)	182.6	(5)	253.3	(3)	323.1	(1)
TS	HAIKUI	(1724)	88.0	(9)	108.5	(7)	116.4	(5)	124.6	(3)	164.1	(1)	-	(-)
TS	KIROGI	(1725)	103.1	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	KAI-TAK	(1726)	87.4	(30)	96.9	(28)	103.4	(26)	104.0	(24)	114.4	(22)	151.9	(20)
TY	TEMBIN	(1727)	101.4	(19)	128.9	(17)	143.3	(15)	184.9	(13)	241.3	(11)	333.5	(9)
Annual Mean (Total)			77.1	(469)	106.3	(410)	140.5	(359)	181.6	(308)	230.1	(259)	300.0	(220)

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 4.6). 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 58% (55% in 2016), 67% (64%), 72% (68%) and 70% (69%) for 18-, 30-, 54- and 78-hour predictions, respectively.

About 80% (78% in 2016) of 30-hour predictions had errors of less than 150 km, while 88% (83%) of 54-hour predictions had errors of less than 300 km, and 82% (85%) 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.

Table 4.5　Mean position errors (km) of GSM and PER method predictions for the 27 TCs forming in 2017 in the stages before, during and after recurvature. The number of samples is given in parentheses. IMPROV is the ratio of error reductions in GSM results to those observed using the PER method.

TIME	MODEL	Before		During		After		All	
T=18	GSM	84.0	(280)	66.2	(96)	67.6	(93)	77.1	(469)
	PER	169.6	(280)	155.7	(96)	242.9	(93)	181.3	(469)
	IMPROV	50.5 %		57.5 %		72.2 %		57.5 %	
T=30	GSM	109.5	(237)	96.9	(85)	106.7	(88)	106.3	(410)
	PER	290.2	(237)	290.8	(85)	433.9	(88)	321.2	(410)
	IMPROV	62.3 %		66.7 %		75.4 %		66.9 %	
T=42	GSM	143.5	(202)	134.3	(75)	138.8	(82)	140.5	(359)
	PER	437.5	(202)	426.3	(75)	630.2	(82)	479.2	(359)
	IMPROV	67.2 %		68.5 %		78.0 %		70.7 %	
T=54	GSM	183.9	(164)	177.8	(67)	180.1	(77)	181.6	(308)
	PER	610.0	(164)	526.8	(67)	806.1	(77)	640.9	(308)
	IMPROV	69.9 %		66.2 %		77.7 %		71.7 %	
T=66	GSM	226.0	(131)	242.2	(54)	228.4	(74)	230.1	(259)
	PER	788.6	(131)	687.5	(54)	937.1	(74)	809.9	(259)
	IMPROV	71.3 %		64.8 %		75.6 %		71.6 %	
T=78	GSM	278.0	(101)	349.4	(45)	300.0	(74)	300.0	(220)
	PER	920.7	(101)	959.6	(45)	1126.1	(74)	997.7	(220)
	IMPROV	69.8 %		63.6 %		73.4 %		69.9 %	

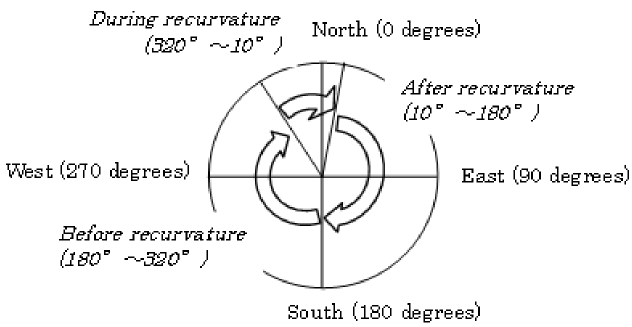


Figure 4.6　Definition of the stages before, during and after recurvature based on the direction of TC movement.

2) Central Pressure and Maximum Wind Speed

The mean errors of 30-, 54- and 78-hour GSM central pressure predictions in 2017 were +5.1 hPa (+14.7 hPa in 2016), +5.0 hPa (+16.5 hPa) and +3.4 hPa (+16.5 hPa), respectively. Their root mean square errors (RMSEs) were 12.8 hPa (24.4 hPa in 2016) for 30-hour predictions, 16.4 hPa (27.6 hPa) for 54-hour predictions and 19.1 hPa (30.6 hPa) for 78-hour predictions. The biases for 30-, 54- and 78-hour maximum wind speed predictions were -5.5 m/s (-8.0 m/s in 2016) with a RMSE of 8.5 m/s (11.5 m/s), -5.8 m/s (-8.4 m/s) with a RMSE of 10.4 m/s (13.2 m/s) and -5.3 m/s (-8.1 m/s) with a RMSE of 11.4 m/s (14.4 m/s), respectively.

Figure 4.7 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. In addition, relative frequencies of large positive central pressure errors and large negative wind speed errors decreased significantly in 2017 compared to those in previous years.

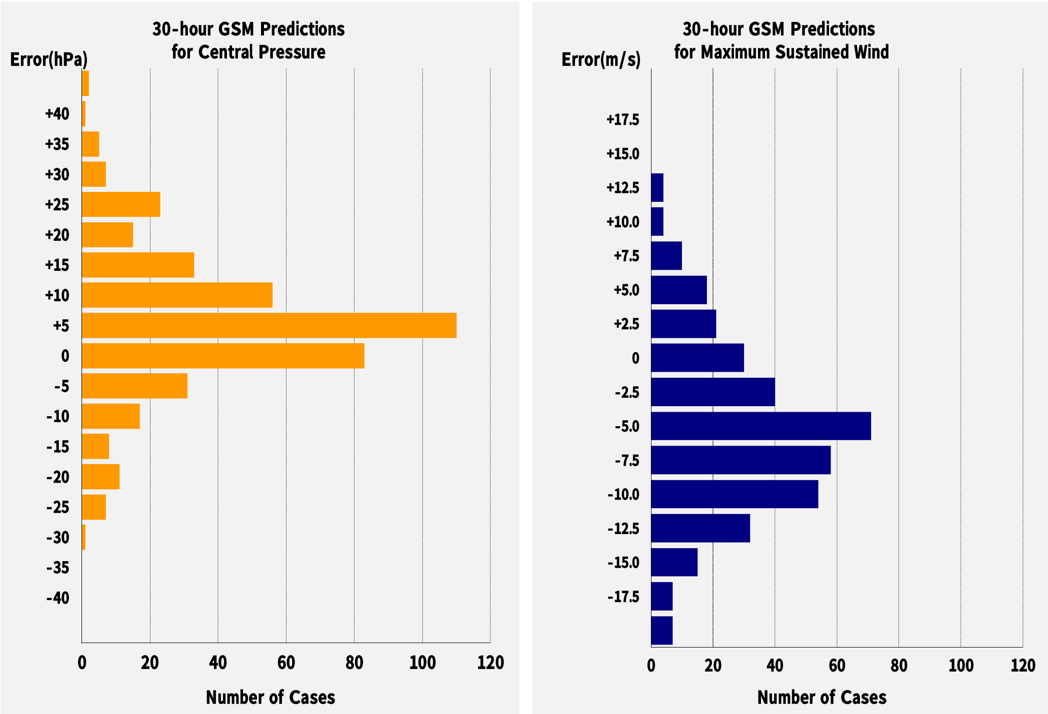


Figure 4.7 Error distribution of GSM 30-hour intensity predictions in 2017.
The figure on the left shows error distribution for central pressure, while the one on the right shows that for maximum wind speed (the error distributions of 54- and 78-hour predictions are included on the DVD provided with 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 4.8. In 2017, the mean position errors of GEPS ensemble mean forecasts for 30-, 54-, 78-, 102- and 126-hour predictions for each 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 114 km (106 km with the GSM), 193 km (182 km), 314 km (300 km), 436 km and 542 km, respectively.

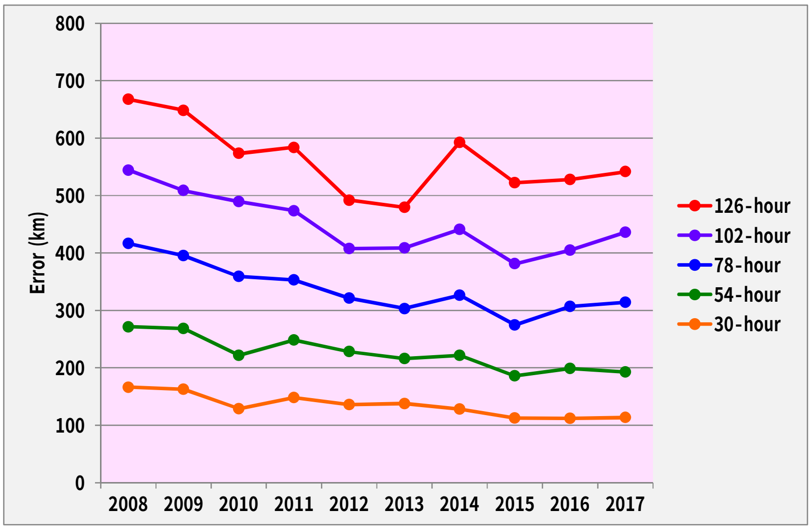


Figure 4.8 GEPS and TEPS annual mean position errors since 2008

Table 4.6 Mean position errors (km) of GEPS ensemble mean forecasts for each TC forming in 2017. The number of samples is given in parentheses.

Tropical Cyclone			T=30		T=54		T=78		T=102		T=126	
TS	MUIFA	(1701)	178.9	(7)	254.8	(3)	-	(-)	-	(-)	-	(-)
STS	MERBOK	(1702)	59.6	(2)	-	(-)	-	(-)	-	(-)	-	(-)
STS	NANMADOL	(1703)	192.5	(3)	-	(-)	-	(-)	-	(-)	-	(-)
STS	TALAS	(1704)	95.0	(7)	249.2	(3)	-	(-)	-	(-)	-	(-)
TY	NORU	(1705)	85.8	(76)	136.0	(72)	238.2	(68)	359.2	(64)	505.8	(59)
TS	KULAP	(1706)	77.1	(12)	205.3	(7)	418.3	(4)	809.5	(1)	-	(-)
TS	ROKE	(1707)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	SONCA	(1708)	158.0	(9)	-	(-)	-	(-)	-	(-)	-	(-)
TY	NESAT	(1709)	148.1	(16)	322.4	(12)	606.7	(8)	929.3	(4)	-	(-)
TS	HAITANG	(1710)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	NALGAE	(1711)	68.8	(18)	101.6	(14)	160.2	(10)	163.1	(6)	448.4	(2)
TY	BANYAN	(1712)	113.8	(19)	183.5	(14)	371.3	(6)	695.8	(3)	-	(-)
TY	HATO	(1713)	81.6	(13)	201.3	(9)	174.1	(1)	-	(-)	-	(-)
STS	PAKHAR	(1714)	225.1	(8)	524.9	(4)	-	(-)	-	(-)	-	(-)
TY	SANVU	(1715)	109.4	(24)	192.5	(20)	253.0	(16)	281.1	(12)	288.4	(8)
STS	MAWAR	(1716)	114.8	(12)	98.2	(8)	140.0	(4)	-	(-)	-	(-)
TS	GUCHOL	(1717)	134.2	(5)	-	(-)	-	(-)	-	(-)	-	(-)
TY	TALIM	(1718)	71.1	(33)	165.2	(28)	326.8	(24)	472.0	(20)	550.0	(16)
TY	DOKSURI	(1719)	120.9	(12)	291.7	(8)	605.8	(4)	-	(-)	-	(-)
TY	KHANUN	(1720)	126.9	(13)	181.9	(9)	293.7	(5)	280.1	(1)	-	(-)
TY	LAN	(1721)	128.9	(27)	211.4	(23)	305.7	(19)	443.4	(15)	560.0	(11)
STS	SAOLA	(1722)	199.4	(25)	403.1	(21)	720.9	(17)	1044.5	(13)	1347.2	(9)
TY	DAMREY	(1723)	78.3	(9)	171.5	(5)	315.2	(1)	-	(-)	-	(-)
TS	HAIKUI	(1724)	129.5	(7)	179.9	(3)	-	(-)	-	(-)	-	(-)
TS	KIROGI	(1725)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	KAI-TAK	(1726)	98.7	(28)	117.0	(24)	175.5	(20)	258.9	(16)	277.2	(12)
TY	TEMBIN	(1727)	150.8	(17)	195.0	(13)	324.5	(9)	347.8	(5)	454.0	(1)
All Mean (Total)			113.5	(402)	192.7	(300)	314.2	(216)	436.2	(160)	541.6	(118)

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 4.9 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 2017 only when GEPS predicted large spreads.

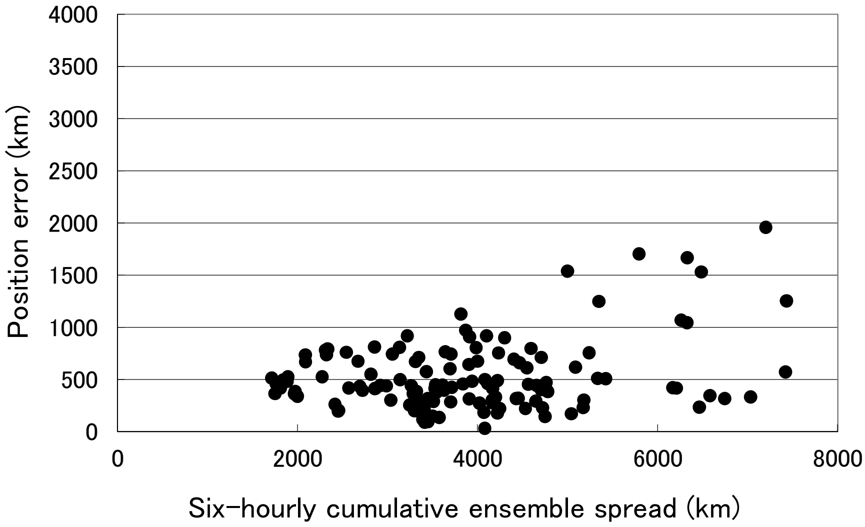


Figure 4.9 Relationship between six-hourly cumulative ensemble spread in TC position forecasts (km) and ensemble mean forecast position errors (km) in 126-hour predictions in 2017.

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 2017 TC track forecasts except for 78-hour predictions.

Table 4.7 Ensemble mean forecast position errors (km) in 2017 classified with six-hourly cumulative ensemble spread at each forecast time. The number of samples is given in parentheses.

Time	Reliability Index					
	A		B		C	
T=30	88.3	(137)	112.1	(136)	129.9	(155)
T=54	152.4	(127)	190.1	(99)	240.4	(96)
T=78	272.6	(96)	271.0	(78)	402.6	(56)
T=102	381.5	(71)	397.9	(68)	639.0	(27)
T=126	471.1	(57)	525.6	(49)	916.1	(14)

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 ensemble NWP models 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 ensemble model 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 and ensemble mean predictions from four global ensemble models. 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 smaller errors than global models for the first half of forecast times. Ensemble mean predictions from ECMWF, NCEP and UKMO ensemble models additionally exhibit smaller errors than the same centers' deterministic models for most forecast times.

Table 4.8 Mean position errors of various guidance models in 2017
As examples of the consensus method with global deterministic models, EN (ECMWF and NCEP), 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		82	335	151	237	248	162	335	112	420	87
Global deterministic model	JMA (GSM)	95	324	174	231	295	158	403	116	478	90
	BoM	142	293	218	210	349	147	476	106	541	84
	CMA	166	313	272	224	442	144	530	16	-	0
	CMC	139	315	223	218	320	152	452	111	622	82
	DWD	141	302	228	208	330	70	-	0	-	0
	ECMWF	89	268	172	183	279	127	366	94	393	75
	KMA	102	315	177	226	266	151	-	0	-	0
	NCEP	104	327	173	233	254	156	358	112	425	22
	UKMO	123	319	176	227	266	159	415	112	-	0
Consensus method with global deterministic models	EN	81	268	151	183	242	126	308	94	327	19
	JENU	85	328	149	234	230	161	317	115	400	78
	All	96	328	167	237	253	163	328	117	414	89
Regional deterministic model	HWRF	92	318	142	224	227	152	379	108	451	85
Ensemble mean of global ensemble model	JMA (GEPS)	105	329	187	232	316	164	425	120	496	91
	ECMWF	86	270	160	184	276	125	328	91	430	77
	NCEP	106	316	166	219	251	149	334	108	424	86
	UKMO	96	276	163	194	258	133	324	96	399	73

4.3.2 Spread-Skill Relationship

In addition to ensemble mean predictions from most ensemble models exhibiting smaller errors than those of the same centers' deterministic models, ensemble models (including multi- and single-ensemble types) provide useful information on the reliability of TC track forecasts with the related ensemble spread. Figure 4.10 shows relationships between the RMSE of the ensemble mean prediction and the spread for forecast times from each single-ensemble model and certain combinations of multi-ensemble models. It can be seen that the spread for all single ensembles 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-ensemble RMSE is smaller than the single-ensemble value, and the multi-ensemble spread is closer to the RMSE value than that of single ensembles.

Figure 4.11 shows scatter diagrams indicating relationships between prediction errors and six-hourly cumulative ensemble spreads for 96-hour forecasts with coloring based on reliability levels A, B and C, which are categorized for identical frequencies based on cumulative ensemble spreads at each forecast time, with lines showing the mean error for each level. Figure 4.12 shows relationships between mean errors and reliability levels for different forecast times. Although all single ensembles and multi-ensemble combinations exhibit a correlation between prediction errors and cumulative ensemble spreads, reverse correlations between mean errors and reliability levels are sometimes seen for the single-ensemble variety, while the same for the multi-ensemble variety is rarely seen. This indicates that multi-ensemble models provide more effective information on track forecast reliability.

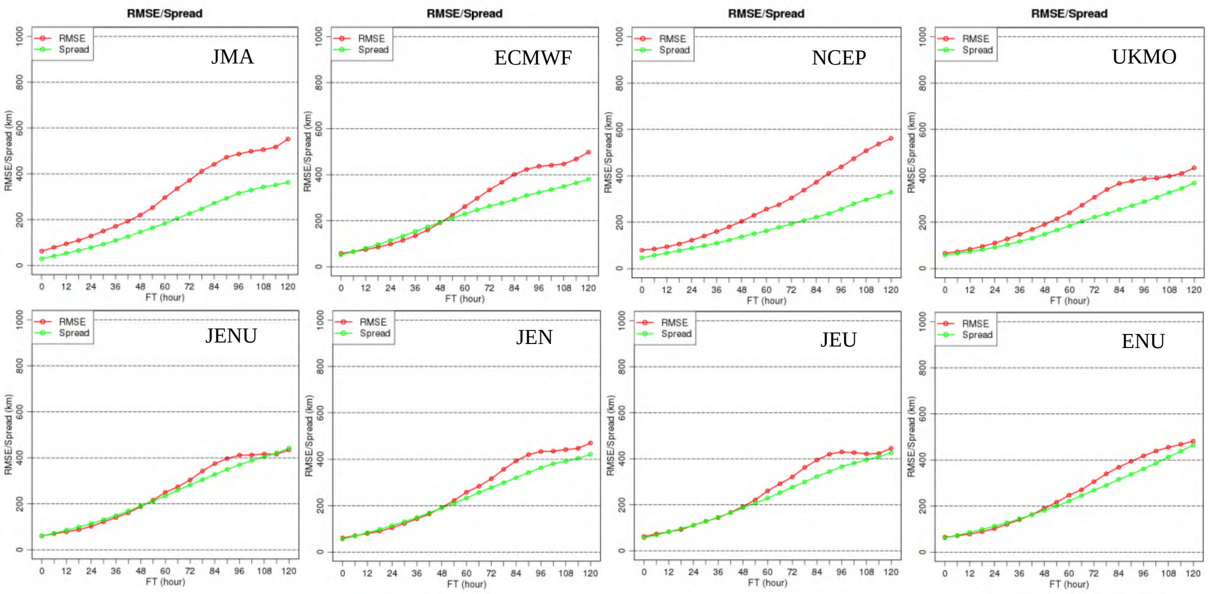


Figure 4.10 Relationships between the RMSE (km) of ensemble mean prediction and spread (km) for forecast times for each single-ensemble model (top) and four combinations of multi-ensemble models (bottom) in 2017. The combinations are represented by the initials of the component models (e.g., JENU represents a multi-ensemble incorporating JMA, ECMWF, NCEP and UKMO).

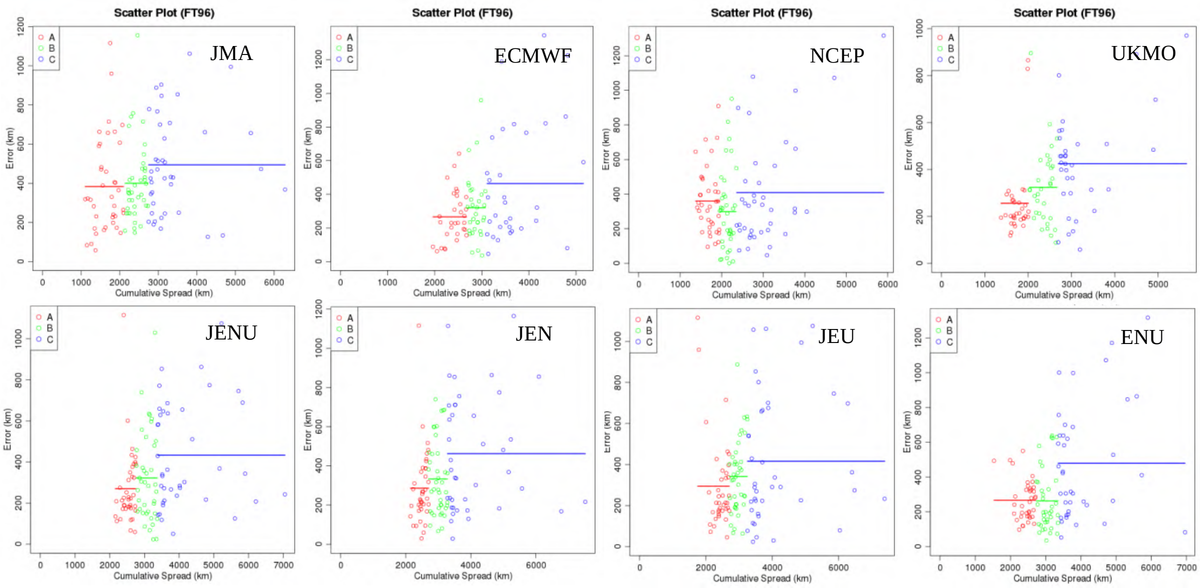


Figure 4.11 Relationships between prediction errors and cumulative ensemble spreads with coloring based on reliability levels A, B and C for 96-hour forecasts with each single-ensemble model (top) and four combinations (bottom) of multi-ensemble models in 2017. Lines show the mean error for each reliability level.

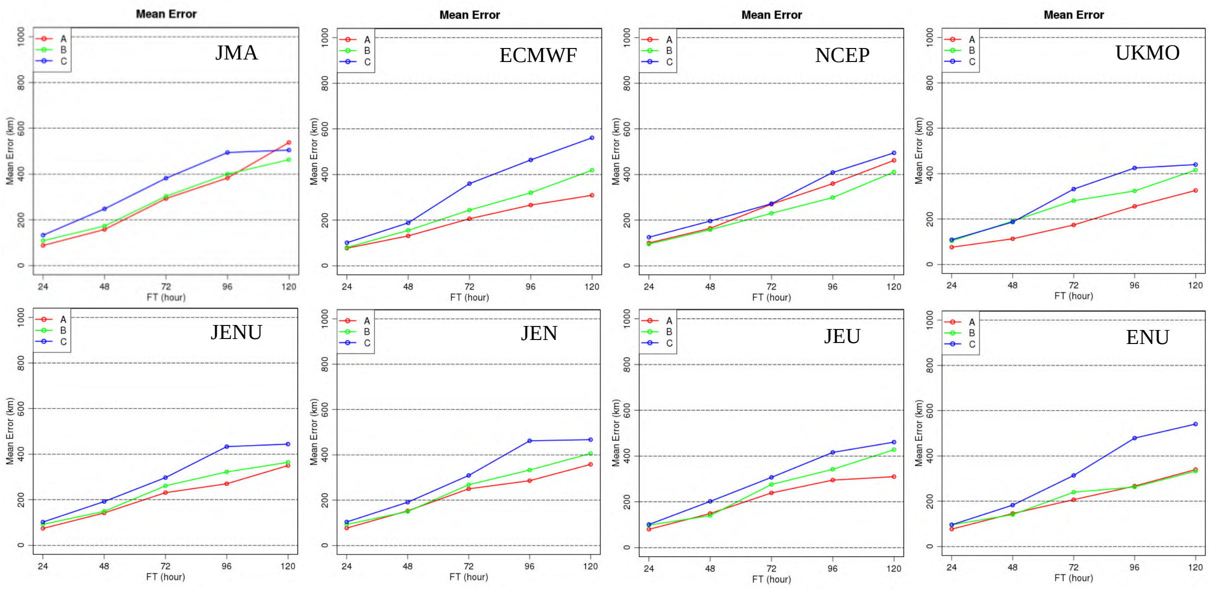


Figure 4.12 Relationships between mean errors and reliability levels for forecast times with each single-ensemble model and four combinations of multi-ensemble models in 2017.

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 (a guidance model based on climatology and persistence) and examples from the consensus method with intensity guidance models, in addition to the same predictions 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 that global deterministic models, the consensus method and global ensemble models still need to improve in resolution for their direct use for TC intensity forecasts. 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 2017
Examples of the consensus method with intensity guidance models are represented by the initials of the components (JMA (GSM), HWRF, TIFS, LGEM).

Prediction		24-hour			48-hour			72-hour		
		Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.
RSMC Operational		0.5	10.1	335	-1.1	14.9	237	-2.4	16.9	162
Global deterministic model	JMA (GSM)	6.2	14.1	324	5.4	17.8	231	2.9	20.9	158
	BoM	16.3	21.7	293	19.1	24.6	210	20.4	27.4	147
	CMA	7.4	14.8	313	6.8	17.8	224	5.8	19.9	144
	CMC	12.1	18.7	315	12.1	19.6	218	11.8	22.3	152
	DWD	9.4	16.0	302	9.3	18.4	208	9.2	21.9	70
	ECMWF	-2.7	15.5	268	-5.5	19.6	183	-8.9	25.9	127
	KMA	5.0	13.8	315	3.5	15.8	226	2.6	20.2	151
	NCEP	-3.1	16.4	327	-9.2	21.4	233	-15.8	27.8	156
	UKMO	4.6	14.0	319	4.3	15.9	227	2.3	19.2	159
Consensus method with global deterministic models	EN	-3.3	15.4	268	-8.6	19.8	183	-13.7	25.2	126
	JENU	1.5	11.9	328	-0.4	15.0	234	-4.1	18.9	161
	All	6.5	13.0	328	5.7	14.9	237	3.3	17.3	163
Regional deterministic model	HWRF	-1.6	12.2	318	-3.0	15.6	224	-3.3	17.0	152
Ensemble mean of global ensemble model	JMA (GEPS)	12.9	18.1	329	14.9	21.1	232	14.9	22.6	164
	ECMWF	5.0	13.4	270	6.5	16.2	184	9.0	19.0	124
	NCEP	15.9	21.0	316	17.3	22.2	219	17.1	22.6	149
	UKMO	5.3	13.3	276	4.0	15.0	194	2.5	18.9	133
Intensity guidance model	TIFS	-0.5	10.4	324	-3.2	13.5	231	-5.4	16.2	158
	LGEM	0.7	11.7	324	-2.4	17.4	231	-5.0	20.2	157
	SHIFOR	-0.9	12.0	333	-0.1	16.4	239	3.7	20.0	164
Consensus method with intensity guidance models	JT	2.8	10.6	324	1.1	13.5	231	-1.2	16.0	158
	JHT	1.4	9.7	324	-0.2	12.4	231	-1.9	14.2	158
	JHTL	1.2	9.8	324	-0.8	12.9	231	-2.7	14.6	158
	HT	-1.0	9.8	307	-3.0	12.9	216	-4.8	14.8	144

4.4 Verification of Storm Surge Prediction

Storm surge predictions have been provided since 2011 via the Numerical Typhoon Prediction website to Typhoon Committee Members within the framework of the Storm Surge Watch Scheme (SSWS) (for details of the storm surge model, refer to Hasegawa et al. (2012) on the RSMC Tokyo - Typhoon Center website). Verification of deterministic storm surge prediction was conducted on data from eight stations (Table 4.10) for which tide observation information is provided on the University of Hawaii Sea Level Center (UHSLC) database website (http://uhslc.soest.hawaii.edu/data/?fd) for all typhoons in 2017. 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 Hato (1713) and TY Khanun (1720).

Table 4.10 Stations used for verification

	Station		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

4.4.1 Deterministic Prediction

Storm surges of nearly a meter in height were observed in Quarry Bay (Hong Kong) in 2017 (Table 4.11). Figure 4.13 shows a scatter diagram of model storm surges (hindcast and forecast) against observation data. The root mean square errors (RMSEs; unit: m) were 0.081 (hindcast) and 0.082 (forecast), and the correlations were 0.35 and 0.34, respectively. Forecast data tended to overestimate storm surges because the typhoon bogus, which expresses wind and pressure fields based on parametric TC modeling, does not incorporate consideration of structural changes and wind reduction caused by land topography.

Table 4.11 Maximum storm surges observed at the eight stations for each TC forming in 2017 (unit: m). Slashes indicate missing observation data.

	T1701	T1702	T1703	T1704	T1705	T1706	T1707	T1708	T1709	T1710
QB	0.07	0.21			0.24	0.16	0.13	0.16	0.24	0.24
LK	0.10	0.07	-0.01	0.09	0.13	0.13	0.11	0.11	0.13	0.11
LG	0.06	0.02	0.09	0.04	0.12	0.07	0.03	0.07	0.10	0.06
ML	0.06	0.04	0.01	0.01	0.22	0.10	0.04	0.08	0.22	0.18
SB	0.01	0.00	0.02	0.05	0.13	0.07	0.02	0.06	0.13	0.13
AP	0.05	0.03	0.05	-0.03	0.15	0.07	0.06	0.07	0.12	0.14
QN	0.03	0.10	0.05	0.15	0.21	0.21	0.19	0.21	0.21	0.17
VT	0.07	0.01	0.13	0.12	0.20	0.19	0.12	0.14	0.20	0.09

	T1711	T1712	T1713	T1714	T1715	T1716	T1717	T1718	T1719	T1720
QB	-0.01	-0.10	0.95	0.64	0.27	0.27	0.01	0.28	0.28	0.90
LK	0.05	0.17	0.15	0.17	0.08	0.04	0.06	0.34	0.34	0.01
LG	0.12	0.08	0.17	0.08	0.11	0.07	0.06	0.15	0.09	0.19
ML	0.07	0.01	0.12	0.07	0.14	0.12	-0.02	0.19	0.12	0.31
SB	0.07	0.06	0.07	0.06	0.10	0.07				0.21
AP	0.12	0.17	0.13	0.12	0.15	0.15	0.10	0.10	0.10	0.14
QN	0.02	-0.08	0.04	0.09	0.06	0.06	0.00	0.15	0.13	0.19
VT	0.13	0.14	0.17	0.18	0.17	0.04	0.07	0.13	0.07	0.21

	T1721	T1722	T1723	T1724	T1725	T1726	T1727
QB	0.30	0.25	0.34	0.20	0.12	0.20	0.18
LK	0.21	0.07	0.11	0.05	0.06	0.06	0.11
LG	0.12	0.13	0.14	0.05	0.08	0.30	0.21
ML	0.19	0.12	0.13	0.13	0.11	0.10	0.14
SB	0.13	0.09	0.14	0.10	0.05	0.07	0.12
AP	0.09	0.09	0.13	0.06		0.15	0.09
QN	0.20	0.14	0.25	0.16	-0.01	0.12	0.12
VT	0.23	0.26	0.31	0.08	-0.02	0.27	0.22

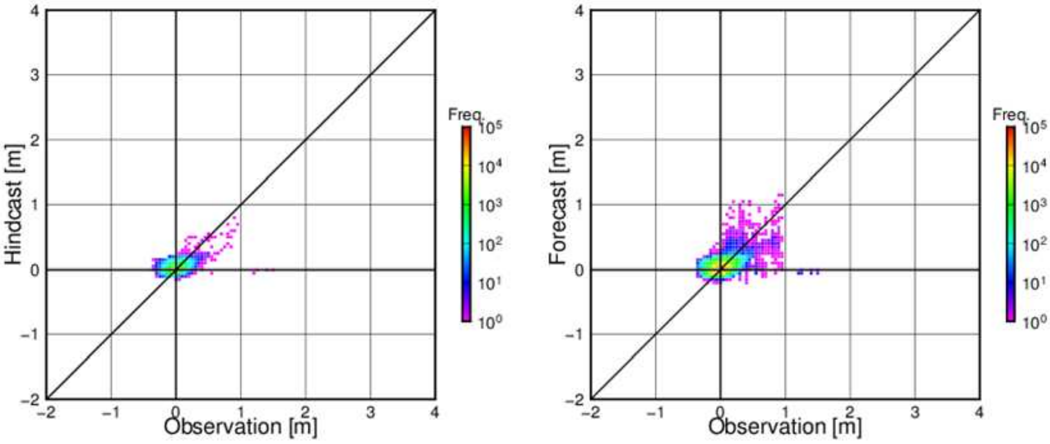


Figure 4.13 Scatter diagram of model storm surges against observation data from the eight stations for all TCs forming in 2017 (left: hindcast; right: forecast)

4.4.2 Multi-Scenario Prediction

TY Hato (1713) hit the southern coast of China in August 2017 with a maximum wind speed of 40 m/s and a minimum pressure of 965 hPa. Storm surges are a concern along the wide, shallow sea area off the Chinese coast because the phenomenon is particularly intensified there. Figure 4.14 shows the analysis track and predicted tracks (the official one and five selected ones) for TY Hato covering the 30 hours before landfall. The official forecast track took the middle course, passing near Hong Kong. In reality, TY Hato passed several ten kilometers west of Hong Kong with a track similar to that of scenario 1, which was slightly different from the official forecast. The maximum storm tide and surge for Quarry Bay in Hong Kong in the official forecast were 3.42 and 1.08 m, respectively, and those of scenario 1 were 3.37 and 1.06 m, respectively (Figure 4.15). The values of scenario 1 correspond closely to the observation (3.38 and 0.95 m).

Figure 4.16 shows another example of multi-scenario prediction. TY Khanun (T1720) passed westward over the South China Sea in October 2017 with a maximum wind speed of 40 m/s and a minimum pressure of 955 hPa. The map of maximum storm surges among all scenarios during the 72-hour forecast period indicates probabilities of high storm surges along the southern coast of China.

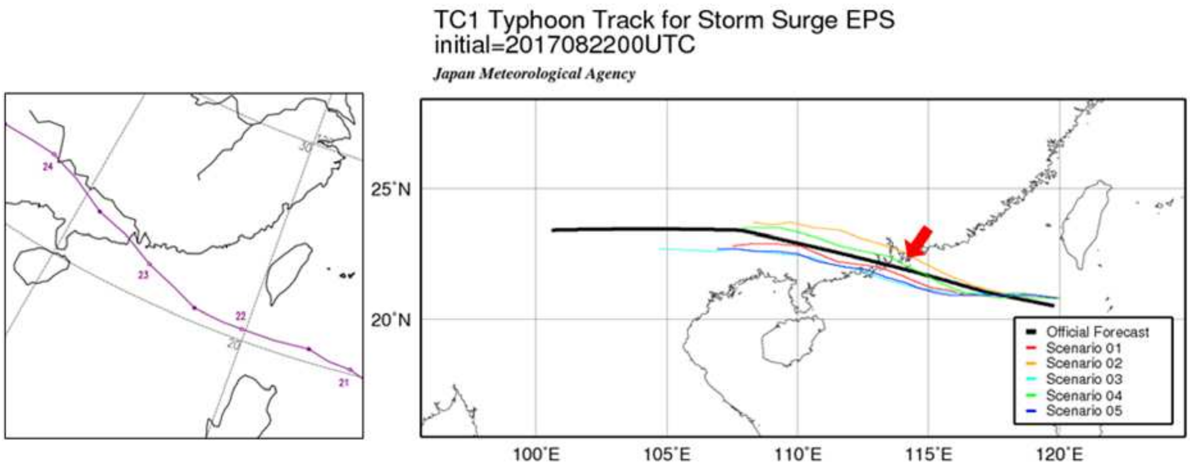


Figure 4.14 Analysis track (left) and predicted tracks (right) for TY Hato.
In the figure on the right, colored lines show the five selected tracks and the bold black line shows the official JMA forecast. The red arrow shows Quarry Bay.

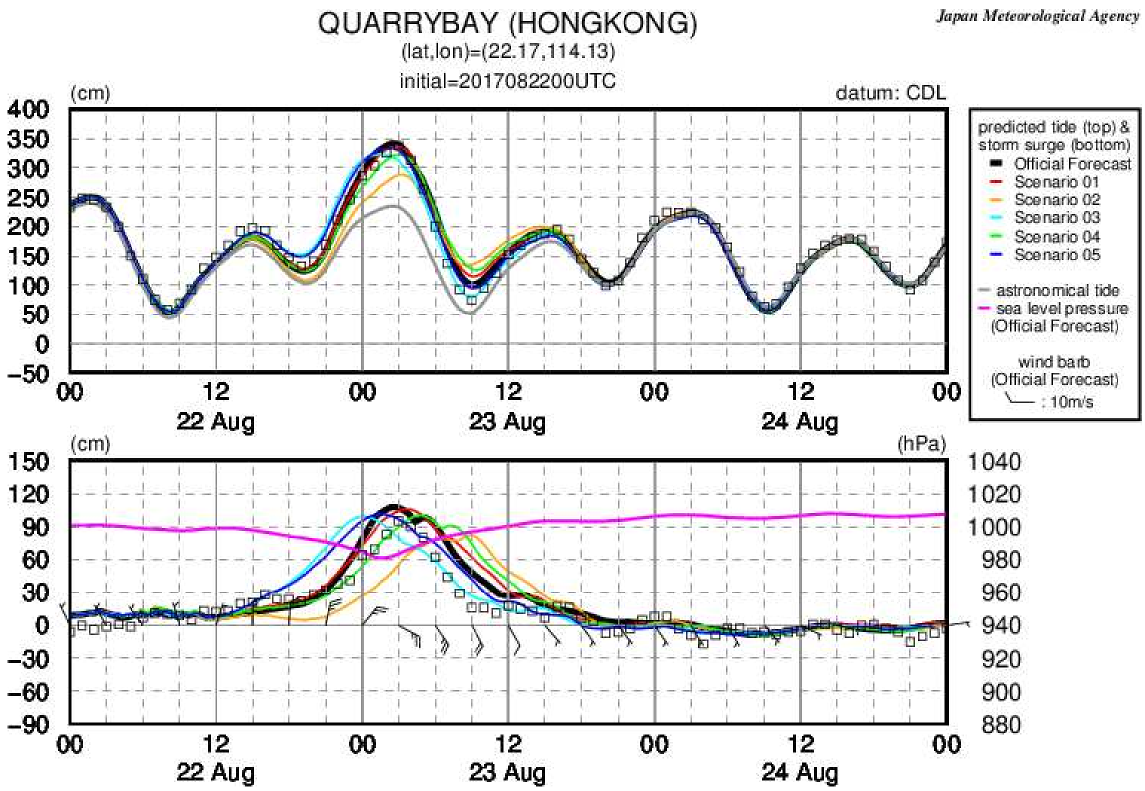


Figure 4.15 Time-series representation of storm tide and astronomical tide (top), storm surge, sea level pressure and surface wind (bottom) for Quarry Bay (Hong Kong). Squares show hourly observation values.

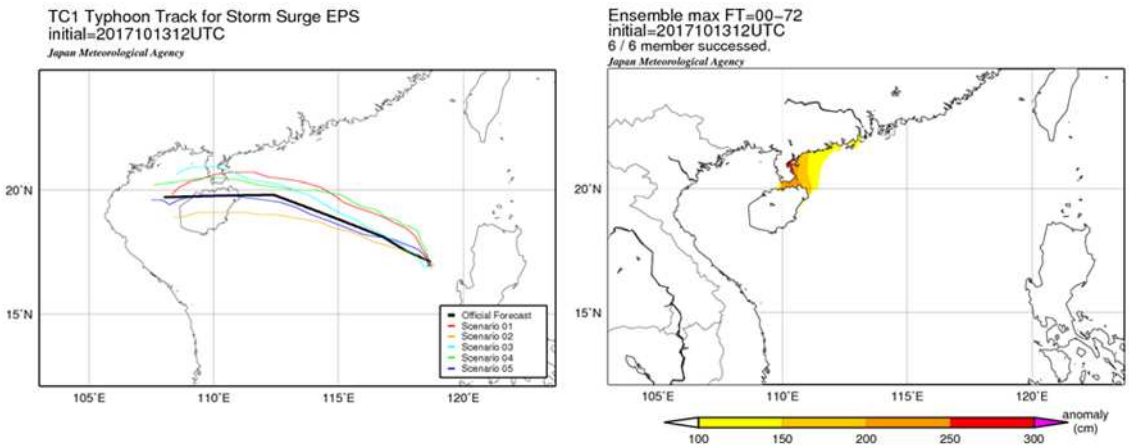


Figure 4.16 Predicted tracks (black line: official forecast; colored lines: five selected tracks). The figure on the right shows storm surge distribution maxima for all scenarios during the forecast time for TY Khanun.

[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 2017

Muifa (1701)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Apr.	22/18	8.6	143.9	1006	-	0.5	TD
	23/00	9.2	143.2	1006	-	0.5	TD
	23/06	9.9	142.4	1006	-	0.5	TD
	23/12	10.6	141.7	1006	-	1.0	TD
	23/18	11.2	140.8	1006	-	1.0	TD
	24/00	11.8	139.7	1006	-	1.0	TD
	24/06	12.1	138.8	1004	-	1.0	TD
	24/12	12.4	138.2	1004	-	1.0	TD
	24/18	12.5	137.5	1004	-	1.5	TD
	25/00	12.7	137.0	1004	-	1.5	TD
	25/06	12.8	136.6	1004	-	2.0	TD
	25/12	12.9	136.4	1004	-	2.0	TD
	25/18	13.1	136.0	1002	35	2.5	TS
	26/00	13.2	135.7	1002	35	2.5	TS
	26/06	13.6	134.8	1002	35	2.5	TS
	26/12	14.0	134.4	1002	35	2.5	TS
	26/18	14.4	134.4	1002	35	2.5	TS
	27/00	14.8	134.4	1002	35	2.5	TS
	27/06	15.9	134.7	1004	-	2.5	TD
	27/12	17.0	134.7	1006	-	2.0	TD
	27/18	17.8	134.8	1006	-	-	TD
	28/00	18.4	135.5	1008	-	-	TD
	28/06	19.0	136.3	1008	-	-	TD
	28/12	19.9	137.7	1008	-	-	TD
	28/18	20.8	139.0	1008	-	-	TD
	29/00	21.5	140.2	1008	-	-	TD
	29/06	22.7	141.8	1008	-	-	TD
	29/12						Dissip.

Merbok (1702)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jun.	10/00	13.0	119.0	1006	-	1.0	TD
	10/06	13.4	118.5	1006	-	0.5	TD
	10/12	14.0	117.8	1006	-	1.0	TD
	10/18	15.0	117.3	1004	-	1.5	TD
	11/00	16.0	116.8	1002	35	2.0	TS
	11/06	17.1	116.6	1002	35	2.5	TS
	11/12	18.1	116.2	1002	35	2.5	TS
	11/18	19.3	115.6	998	40	2.5	TS
	12/00	20.1	114.9	994	45	2.5	TS
	12/06	21.2	114.5	990	50	2.5	STS
	12/12	22.0	114.4	985	55	2.5	STS
	12/18	22.9	114.6	994	45	2.5	TS
	13/00	24.0	115.0	1002	-	2.0	TD
	13/06	25.5	115.7	1004	-	1.5	TD
	13/12						Dissip.

Nanmadol (1703)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	01/06	15.0	132.2	1006	-	0.5	TD
	01/12	16.8	130.5	1006	-	1.0	TD
	01/18	18.8	128.9	1006	-	1.5	TD
	02/00	20.7	127.1	1002	35	2.0	TS
	02/06	21.9	125.7	1002	35	2.0	TS
	02/12	23.5	124.8	998	40	2.5	TS
	02/18	24.7	124.1	990	50	3.0	STS
	03/00	26.2	124.3	990	50	3.0	STS
	03/06	27.7	125.0	985	55	3.0	STS
	03/12	29.4	126.2	985	55	3.5	STS
	03/15	30.2	126.9	985	55	-	STS
	03/18	31.3	127.7	985	55	3.5	STS
	03/21	32.1	128.9	985	55	-	STS
	03/23	32.7	130.0	985	55	-	STS
	04/00	32.8	130.5	990	50	3.5	STS
	04/03	33.2	132.3	990	50	-	STS
	04/06	33.6	134.2	990	50	3.0	STS
	04/07	33.7	134.8	990	50	-	STS
	04/09	34.1	136.5	990	50	-	STS
	04/12	34.1	138.3	990	50	3.0	STS
	04/15	34.7	140.2	990	50	-	STS
	04/18	35.5	142.6	990	50	3.0	STS
	05/00	36.1	146.0	994	-	3.0	L
	05/06	36.9	150.7	994	-	-	L
	05/12	38.2	154.8	994	-	-	L
	05/18	40.3	160.2	994	-	-	L
	06/00	43.0	166.1	992	-	-	L
	06/06	46.4	169.9	988	-	-	L
	06/12	49.8	171.4	988	-	-	L
	06/18	50.6	170.4	990	-	-	L
	07/00	51.0	170.6	990	-	-	L
	07/06	51.0	171.3	988	-	-	L
	07/12	50.9	172.3	988	-	-	L
	07/18	50.9	174.6	990	-	-	L
	08/00	51.4	177.2	992	-	-	L
	08/06	52.1	179.6	992	-	-	L
	08/12	53.1	182.3	994	-	-	Out

Talas (1704)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	14/00	16.0	114.1	1004	-	0.0	TD
	14/06	16.4	113.6	1004	-	0.5	TD
	14/12	16.6	113.1	1002	-	0.5	TD
	14/18	16.7	112.7	1002	-	1.0	TD
	15/00	16.8	112.2	1000	-	1.5	TD
	15/06	16.9	111.7	998	35	1.5	TS
	15/12	16.9	111.1	996	40	2.0	TS
	15/18	17.4	110.1	996	40	2.5	TS
	16/00	17.7	109.4	992	45	3.0	TS
	16/06	18.0	108.5	990	50	3.5	STS
	16/12	18.1	107.0	990	50	3.5	STS
	16/18	18.5	105.6	985	50	3.5	STS
	17/00	18.9	104.0	992	40	3.5	TS
	17/06	18.9	102.2	996	35	3.0	TS
	17/12	19.2	100.9	998	-	-	TD
	17/18	19.5	100.4	1000	-	-	TD
	18/00						Dissip.

Noru (1705)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	19/06	26.1	162.1	1010	-	0.5	TD
	19/12	26.2	161.7	1010	-	1.0	TD
	19/18	26.4	161.2	1008	-	1.5	TD
	20/00	26.9	160.6	1008	-	1.5	TD
	20/06	27.2	159.9	1008	-	1.5	TD
	20/12	27.4	159.0	1006	35	2.0	TS
	20/18	27.6	158.4	1006	35	2.0	TS
	21/00	28.0	157.5	1006	35	2.0	TS
	21/06	28.2	156.6	1006	35	2.0	TS
	21/12	28.3	155.5	1004	35	2.0	TS
	21/18	28.5	154.3	1000	40	2.5	TS
	22/00	28.6	153.7	1000	40	2.5	TS
	22/06	28.7	153.2	998	40	2.5	TS
	22/12	28.7	152.5	994	45	3.0	TS
	22/18	28.6	151.9	990	50	3.5	STS
	23/00	28.3	151.4	985	55	3.5	STS
	23/06	28.1	151.2	980	60	4.0	STS
	23/12	28.0	151.4	975	65	4.5	TY
	23/18	27.6	151.6	975	65	4.5	TY
	24/00	27.2	152.2	970	70	5.0	TY
	24/06	26.7	153.0	970	70	5.0	TY
	24/12	26.2	154.1	970	70	5.0	TY
	24/18	25.9	155.5	970	70	5.0	TY
	25/00	25.7	156.7	970	70	5.0	TY
	25/06	25.9	157.6	970	70	5.0	TY
	25/12	26.2	158.2	975	65	4.5	TY
	25/18	27.0	158.4	975	65	4.5	TY
	26/00	28.0	157.9	975	65	4.5	TY
	26/06	29.0	157.1	975	65	4.5	TY
	26/12	29.8	155.6	975	65	4.5	TY
	26/18	30.4	154.1	975	65	4.5	TY
	27/00	30.7	152.1	975	65	4.5	TY
	27/06	31.0	150.5	975	65	4.5	TY
	27/12	30.7	148.5	975	65	4.5	TY
	27/18	30.4	146.8	975	65	4.5	TY
	28/00	29.6	145.2	975	60	4.0	STS
	28/06	28.9	144.5	975	60	4.0	STS
	28/09	28.6	144.0	975	60	-	STS
	28/12	28.3	143.8	975	60	4.0	STS
	28/15	28.0	143.6	975	60	-	STS
	28/18	27.7	143.5	975	60	4.0	STS
	28/21	27.4	143.2	975	60	-	STS
	29/00	27.1	142.9	975	60	4.0	STS
	29/03	26.6	142.5	975	60	-	STS
	29/06	26.2	142.2	975	60	4.0	STS
	29/09	25.8	142.1	975	60	-	STS
	29/12	25.3	141.9	975	60	4.0	STS
	29/18	24.5	141.9	975	60	4.0	STS
	30/00	23.9	141.7	970	65	4.0	TY
	30/06	23.4	141.5	965	70	4.5	TY
	30/12	22.9	141.4	955	75	5.0	TY
	30/18	22.8	140.9	945	85	6.0	TY
	31/00	22.8	140.4	935	95	6.0	TY
	31/06	22.9	139.9	935	95	6.0	TY
	31/12	23.0	139.3	935	95	6.0	TY
	31/18	23.3	138.8	935	95	6.0	TY
Aug.	01/00	23.7	138.2	935	95	6.0	TY
	01/06	24.1	137.7	940	90	5.5	TY
	01/12	24.4	137.3	940	90	5.0	TY
	01/18	25.0	136.7	940	90	5.0	TY
	02/00	25.4	136.4	940	90	5.0	TY
	02/06	25.8	135.9	940	90	5.0	TY
	02/12	26.1	135.7	940	90	5.0	TY
	02/18	26.7	135.5	940	90	5.0	TY
	03/00	27.4	135.0	945	85	5.0	TY
	03/06	27.9	134.1	945	85	4.5	TY
	03/12	28.1	133.5	950	80	4.0	TY
	03/15	28.2	132.9	950	80	-	TY
	03/18	28.3	132.5	955	75	4.0	TY
	03/21	28.4	132.0	955	75	-	TY
	04/00	28.5	131.6	955	75	4.0	TY
	04/03	28.6	131.4	955	75	-	TY
	04/06	28.7	131.2	960	70	4.0	TY
	04/09	28.8	131.1	960	70	-	TY
	04/12	28.9	130.9	960	70	4.5	TY
	04/15	29.1	130.6	960	70	-	TY
	04/18	29.2	130.5	960	70	4.5	TY
	04/21	29.3	130.4	960	70	-	TY
	05/00	29.6	130.3	965	65	4.5	TY
	05/03	29.8	130.2	965	65	-	TY
	05/06	29.9	130.1	965	65	4.5	TY
	05/09	30.0	130.1	965	65	-	TY
	05/12	30.1	130.1	970	60	4.5	STS
	05/15	29.8	130.2	970	60	-	STS
	05/17	30.3	130.4	970	60	-	STS
	05/18	30.3	130.5	970	60	4.0	STS
	05/21	30.4	130.7	970	60	-	STS
	06/00	30.7	130.9	970	60	4.0	STS
	06/03	30.9	131.2	970	60	-	STS
	06/06	31.1	131.5	970	60	4.0	STS
	06/09	31.4	131.9	970	60	-	STS
	06/12	31.8	132.3	970	60	4.0	STS
	06/15	32.2	132.5	970	60	-	STS
	06/18	32.5	132.9	970	60	4.0	STS
	06/21	32.8	133.4	970	60	-	STS
	07/00	33.1	134.0	970	60	4.0	STS
	07/01	33.3	134.2	970	60	-	STS
	07/03	33.6	134.6	970	60	-	STS
	07/06	34.0	135.1	975	55	4.0	STS
	07/09	34.5	135.7	975	55	-	STS
	07/12	35.2	136.2	980	50	3.5	STS
	07/15	35.6	136.5	985	45	-	TS
	07/18	36.2	136.8	985	40	3.0	TS
	07/21	37.1	137.4	985	40	-	TS
	08/00	37.3	137.7	985	35	2.5	TS
	08/03	37.5	137.8	985	35	-	TS
	08/06	37.7	138.1	988	35	2.0	TS
	08/09	38.4	138.3	990	35	-	TS
	08/12	38.7	138.5	990	-	1.5	L
	08/18	39.0	139.0	992	-	1.0	L
	09/00	39.2	139.2	994	-	-	L
	09/06	39.2	139.3	996	-	-	L
	09/12						Dissip.

Kulap (1706)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	20/00	23.0	178.1	1012	-	1.0	TD
	20/06	23.4	177.7	1012	-	1.0	TD
	20/12	24.0	177.4	1012	-	1.5	TD
	20/18	24.6	177.2	1010	-	1.5	TD
	21/00	25.2	177.1	1010	-	2.0	TD
	21/06	26.4	177.3	1006	35	2.5	TS
	21/12	28.2	176.8	1006	35	2.5	TS
	21/18	30.3	175.1	1004	40	2.5	TS
	22/00	30.5	172.2	1004	40	2.5	TS
	22/06	30.0	170.6	1004	40	2.5	TS
	22/12	30.0	169.6	1004	40	2.5	TS
	22/18	30.4	168.3	1004	40	2.5	TS
	23/00	30.6	167.3	1004	40	2.5	TS
	23/06	30.8	166.5	1002	40	2.5	TS
	23/12	31.1	165.5	1002	40	2.5	TS
	23/18	31.4	164.3	1002	40	2.5	TS
	24/00	31.9	163.3	1002	40	2.5	TS
	24/06	32.6	161.7	1002	40	2.5	TS
	24/12	33.0	160.1	1002	40	2.5	TS
	24/18	33.2	158.3	1002	35	2.5	TS
	25/00	33.0	156.5	1002	35	2.0	TS
	25/06	32.8	155.0	1002	35	2.0	TS
	25/12	32.3	153.7	1002	35	1.5	TS
	25/18	32.0	152.3	1004	-	-	TD
	26/00	31.7	151.1	1004	-	-	TD
	26/06	31.2	149.9	1002	-	-	TD
	26/12	30.2	148.8	1002	-	-	TD
	26/18	29.2	147.8	1002	-	-	TD
	27/00	28.1	147.1	1002	-	-	TD
	27/06	26.9	147.5	1002	-	-	TD
	27/12	25.9	148.5	1002	-	-	TD
	27/18	26.3	149.0	1002	-	-	TD
	28/00	27.1	149.2	1002	-	-	TD
	28/06						Dissip.

Roke (1707)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	21/06	18.6	124.3	1008	-	1.0	TD
	21/12	19.3	123.0	1008	-	1.0	TD
	21/18	20.1	122.0	1006	-	1.0	TD
	22/00	20.7	120.5	1006	-	1.5	TD
	22/06	21.2	119.0	1004	35	1.5	TS
	22/12	21.6	117.9	1002	35	2.0	TS
	22/18	21.9	116.0	1002	35	2.0	TS
	23/00	22.2	114.7	1002	35	2.0	TS
	23/06	22.8	113.2	1004	-	1.5	TD
	23/12	22.9	110.5	1004	-	1.0	TD
	23/18						Dissip.

Sonca (1708)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	21/00	17.5	114.7	1006	-	1.0	TD
	21/06	17.8	113.7	1006	-	1.0	TD
	21/12	18.0	113.1	1006	-	1.5	TD
	21/18	18.0	112.7	1004	-	1.5	TD
	22/00	17.9	112.4	1004	-	2.0	TD
	22/06	17.9	112.1	1002	-	2.0	TD
	22/12	17.8	111.9	1002	-	2.0	TD
	22/18	17.7	111.7	1002	-	2.0	TD
	23/00	17.6	111.6	1000	35	2.0	TS
	23/06	17.5	111.6	1000	35	2.5	TS
	23/12	17.3	111.6	1000	35	2.5	TS
	23/18	17.2	111.6	998	35	2.5	TS
	24/00	17.1	111.2	998	35	2.5	TS
	24/06	17.0	110.8	996	35	2.5	TS
	24/12	16.9	110.3	996	35	2.5	TS
	24/18	16.9	109.5	994	35	2.5	TS
	25/00	17.1	108.7	994	35	2.5	TS
	25/06	17.1	107.5	994	35	2.5	TS
	25/12	16.8	106.5	998	-	2.5	TD
	25/18	16.2	105.2	998	-	2.0	TD
	26/00	16.0	104.1	998	-	-	TD
	26/06	16.1	103.7	998	-	-	TD
	26/12	16.2	103.3	998	-	-	TD
	26/18	16.2	103.0	998	-	-	TD
	27/00	16.4	103.2	998	-	-	TD
	27/06	16.6	103.5	998	-	-	TD
	27/12	16.9	103.7	1000	-	-	TD
	27/18	17.2	104.0	1000	-	-	TD
	28/00	17.4	104.1	1002	-	-	TD
	28/06	17.6	104.2	1002	-	-	TD
	28/12	17.6	103.8	1002	-	-	TD
	28/18	17.6	103.6	1004	-	-	TD
	29/00	17.7	103.6	1004	-	-	TD
	29/06	17.9	103.8	1002	-	-	TD
	29/12	18.0	103.6	1002	-	-	TD
	29/18						Dissip.

Nesat (1709)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	25/06	12.8	129.2	1002	-	0.5	TD
	25/12	14.0	129.3	1002	-	1.0	TD
	25/18	14.5	128.3	1000	35	1.5	TS
	26/00	15.5	128.1	996	40	1.5	TS
	26/06	16.1	128.0	996	40	2.0	TS
	26/12	16.6	127.8	996	40	2.0	TS
	26/18	17.1	127.7	994	45	2.5	TS
	27/00	17.5	127.6	990	50	3.0	STS
	27/06	18.0	127.4	990	50	3.0	STS
	27/12	18.6	127.2	990	50	3.0	STS
	27/18	19.3	126.7	990	50	3.0	STS
	28/00	20.0	125.8	985	55	3.5	STS
	28/06	20.6	125.2	975	65	4.0	TY
	28/12	21.1	124.4	970	70	4.5	TY
	28/18	21.7	123.5	960	80	5.0	TY
	29/00	22.5	123.3	960	80	5.0	TY
	29/06	23.4	122.8	960	80	5.0	TY
	29/09	23.9	122.4	960	80	-	TY
	29/12	24.6	121.9	960	80	5.0	TY
	29/15	25.0	120.8	970	70	-	TY
	29/18	25.0	120.2	970	70	4.5	TY
	30/00	25.8	119.3	985	50	4.0	STS
	30/06	26.1	117.9	990	35	3.5	TS
	30/12	25.6	117.0	992	-	3.0	TD
	30/18	25.0	116.0	992	-	2.5	TD
	31/00						Dissip.

Haitang (1710)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	27/12	19.2	117.8	1000	-	0.0	TD
	27/18	19.4	117.2	1000	-	0.0	TD
	28/00	19.3	116.6	1000	-	0.0	TD
	28/06	19.2	116.1	998	-	0.5	TD
	28/12	18.5	115.8	998	-	1.0	TD
	28/18	18.0	115.8	996	35	1.0	TS
	29/00	18.1	116.2	994	35	1.0	TS
	29/06	18.2	116.6	990	40	1.5	TS
	29/12	18.6	117.3	990	40	1.5	TS
	29/18	19.0	118.2	990	40	1.5	TS
	30/00	20.1	119.4	990	40	2.0	TS
	30/06	21.9	120.3	985	45	2.5	TS
	30/12	23.0	120.5	990	40	2.5	TS
	30/18	24.7	120.3	990	40	2.0	TS
	31/00	26.2	118.6	992	35	2.0	TS
	31/06	27.2	117.6	994	-	1.5	TD
	31/12	28.2	117.1	994	-	1.0	TD
	31/18	29.2	116.6	996	-	0.5	TD
Aug.	01/00	29.8	116.3	996	-	0.5	TD
	01/06	30.4	116.0	996	-	0.0	L
	01/12	31.0	115.7	996	-	-	L
	01/18	31.4	115.5	996	-	-	L
	02/00	31.8	115.8	996	-	-	L
	02/06	32.4	115.9	996	-	-	L
	02/12	33.3	116.0	996	-	-	L
	02/18	34.1	116.2	996	-	-	L
	03/00						Dissip.

Nalgae (1711)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul.	31/06	26.3	158.3	1006	-	0.0	TD
	31/12	26.5	159.5	1006	-	0.0	TD
	31/18	26.5	160.8	1006	-	0.0	TD
Aug.	01/00	26.4	162.3	1006	-	0.0	TD
	01/06	26.2	163.1	1004	-	0.5	TD
	01/12	26.0	163.9	1004	-	0.5	TD
	01/18	25.7	164.6	1000	-	1.0	TD
	02/00	25.6	165.4	998	35	1.5	TS
	02/06	25.8	165.4	996	40	2.0	TS
	02/12	26.1	165.2	996	40	2.0	TS
	02/18	26.4	165.0	992	40	2.5	TS
	03/00	26.7	164.8	992	40	2.5	TS
	03/06	27.3	164.3	992	40	2.5	TS
	03/12	27.7	163.9	992	40	2.5	TS
	03/18	28.0	163.4	992	40	2.5	TS
	04/00	28.4	163.0	992	40	2.0	TS
	04/06	29.0	162.9	992	40	2.0	TS
	04/12	29.7	162.8	992	40	2.0	TS
	04/18	30.7	162.6	992	40	2.0	TS
	05/00	32.0	162.5	992	40	2.0	TS
	05/06	34.2	162.1	990	45	2.0	TS
	05/12	36.2	161.2	990	45	2.0	TS
	05/18	38.1	160.2	990	-	1.5	L
	06/00	40.0	159.0	990	-	1.5	L
	06/06	41.6	158.3	990	-	-	L
	06/12	43.1	157.4	992	-	-	L
	06/18	44.5	156.1	994	-	-	L
	07/00	45.3	155.2	994	-	-	L
	07/06	45.7	154.8	996	-	-	L
	07/12	45.9	154.7	998	-	-	L
	07/18	46.1	154.7	998	-	-	L
	08/00	46.6	154.6	998	-	-	L
	08/06	46.5	154.2	1000	-	-	L
	08/12	46.4	153.9	1000	-	-	L
	08/18	46.0	154.6	1000	-	-	L
	09/00	45.6	153.0	1002	-	-	L
	09/06	45.2	151.3	1002	-	-	L
	09/12						Dissip.

Banyan (1712)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	10/18	16.0	170.9	1008	-	1.0	TD
	11/00	16.4	169.9	1008	-	1.5	TD
	11/06	16.9	168.9	1006	-	2.0	TD
	11/12	17.3	168.0	1002	35	2.5	TS
	11/18	17.8	166.9	996	45	3.0	TS
	12/00	18.5	165.6	990	50	3.5	STS
	12/06	19.3	164.9	980	60	4.0	STS
	12/12	20.0	164.6	975	65	5.0	TY
	12/18	20.5	164.3	965	70	5.5	TY
	13/00	21.0	164.1	955	80	5.5	TY
	13/06	21.4	163.9	955	80	5.5	TY
	13/12	21.8	163.8	955	80	5.5	TY
	13/18	22.2	163.7	960	75	5.5	TY
	14/00	22.6	163.5	965	70	5.0	TY
	14/06	23.2	163.3	965	70	5.0	TY
	14/12	24.0	163.0	965	70	5.0	TY
	14/18	25.0	162.7	965	70	5.0	TY
	15/00	26.0	162.4	965	70	5.0	TY
	15/06	27.1	162.2	975	65	4.5	TY
	15/12	28.3	162.2	980	60	4.0	STS
	15/18	29.8	162.6	980	60	4.0	STS
	16/00	31.4	163.5	980	60	4.0	STS
	16/06	33.3	165.3	980	60	4.0	STS
	16/12	35.6	167.9	985	55	3.5	STS
	16/18	38.0	170.7	990	50	3.5	STS
	17/00	40.5	173.8	994	45	3.0	TS
	17/06	43.0	176.0	996	-	2.5	L
	17/12	44.1	177.4	996	-	-	L
	17/18	45.5	179.4	998	-	-	L
	18/00	46.7	181.0	1000	-	-	Out

Hato (1713)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	19/12	19.1	130.1	1006	-	0.5	TD
	19/18	19.4	129.1	1004	-	1.0	TD
	20/00	19.5	128.3	1004	-	1.5	TD
	20/06	19.6	127.6	1002	-	1.5	TD
	20/12	19.7	126.9	998	35	2.0	TS
	20/18	19.9	126.2	996	35	2.0	TS
	21/00	20.2	125.4	994	35	2.0	TS
	21/06	20.3	124.3	994	35	2.0	TS
	21/12	20.6	123.2	990	40	2.5	TS
	21/18	20.5	121.5	990	40	3.0	TS
	22/00	20.5	119.8	985	45	3.0	TS
	22/06	20.5	118.8	975	60	3.5	STS
	22/12	20.6	117.3	975	60	3.5	STS
	22/18	21.1	116.0	970	65	4.0	TY
	23/00	21.6	114.4	965	75	4.5	TY
	23/06	22.3	112.8	965	75	4.5	TY
	23/12	22.7	111.0	985	50	4.0	STS
	23/18	23.5	109.1	994	40	3.5	TS
	24/00	23.9	107.5	996	35	3.0	TS
	24/06	23.9	106.1	996	35	2.5	TS
	24/12	23.8	104.5	998	-	2.0	TD
	24/18	23.8	101.9	1000	-	1.5	TD
	25/00	23.6	99.5	1002	-	-	Out

Pakhar (1714)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	24/00	14.9	128.9	1010	-	1.0	TD
	24/06	15.4	127.6	1008	-	1.0	TD
	24/12	15.3	126.0	1006	-	1.5	TD
	24/18	15.1	124.9	1000	35	2.0	TS
	25/00	15.0	123.9	996	40	2.5	TS
	25/06	15.4	123.0	996	40	3.0	TS
	25/12	16.0	122.2	994	45	3.0	TS
	25/18	16.7	121.2	998	40	2.5	TS
	26/00	17.2	119.5	996	40	3.0	TS
	26/06	17.9	118.1	994	40	3.0	TS
	26/12	19.0	116.8	992	45	3.0	TS
	26/18	20.6	114.8	990	50	3.0	STS
	27/00	21.8	113.4	985	55	3.0	STS
	27/06	23.6	111.3	996	40	2.5	TS
	27/12	24.3	110.0	998	35	2.0	TS
	27/18	24.7	108.8	1002	-	-	TD
	28/00	24.1	108.0	1004	-	-	TD
	28/06						Dissip.

Sanvu (1715)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	26/18	17.8	147.0	1004	-	0.0	TD
	27/00	18.2	147.0	1004	-	0.0	TD
	27/06	18.6	147.0	1004	-	0.5	TD
	27/12	18.9	147.1	1004	-	1.0	TD
	27/18	19.1	147.2	1002	-	1.5	TD
	28/00	19.4	147.2	1000	-	2.0	TD
	28/06	19.7	147.3	994	35	2.0	TS
	28/12	20.3	147.5	994	35	2.5	TS
	28/18	20.9	147.6	992	40	2.5	TS
	29/00	21.5	147.8	992	40	3.0	TS
	29/06	22.7	147.9	992	40	3.0	TS
	29/12	24.5	147.3	992	40	3.0	TS
	29/18	26.0	145.9	985	45	3.0	TS
	30/00	26.9	144.2	980	50	3.0	STS
	30/03	26.9	143.5	975	55	-	STS
	30/06	26.9	142.7	970	55	3.0	STS
	30/09	26.9	142.2	970	55	-	STS
	30/12	26.9	141.6	970	55	3.0	STS
	30/15	26.8	141.4	970	55	-	STS
	30/18	26.7	141.2	970	55	3.5	STS
	30/21	26.7	141.5	970	55	-	STS
	31/00	26.8	141.7	970	55	3.5	STS
	31/03	27.0	141.9	970	55	-	STS
	31/06	27.2	142.0	965	60	4.5	STS
	31/09	27.4	142.1	965	60	-	STS
	31/12	27.7	141.9	965	65	4.5	TY
	31/15	27.9	141.6	965	65	-	TY
	31/18	27.7	141.6	960	70	4.5	TY
	31/21	27.5	141.8	955	75	-	TY
Sep.	01/00	27.3	142.0	955	80	5.0	TY
	01/03	27.3	142.6	955	80	-	TY
	01/06	27.4	143.2	955	80	5.0	TY
	01/09	27.7	143.5	955	80	-	TY
	01/12	28.0	143.7	955	80	5.0	TY
	01/18	28.5	144.0	960	70	4.0	TY
	02/00	29.3	144.7	965	65	4.0	TY
	02/06	31.3	146.0	965	65	4.0	TY
	02/12	33.1	146.9	965	65	4.0	TY
	02/18	35.4	148.3	965	65	3.5	TY
	03/00	38.2	150.3	965	65	3.5	TY
	03/06	41.7	152.9	965	65	3.5	TY
	03/12	45.2	154.6	964	-	3.5	L
	03/18	48.1	157.3	964	-	-	L
	04/00	49.6	157.8	960	-	-	L
	04/06	50.7	158.4	960	-	-	L
	04/12	51.3	159.3	966	-	-	L
	04/18	51.9	161.0	972	-	-	L
	05/00	52.4	164.0	972	-	-	L
	05/06	52.8	167.2	972	-	-	L
	05/12	53.2	170.0	974	-	-	L
	05/18	53.4	172.8	974	-	-	L
	06/00	53.4	175.8	976	-	-	L
	06/06	53.2	179.0	978	-	-	L
	06/12	53.0	181.7	982	-	-	Out

Mawar (1716)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	30/06	18.9	122.0	1002	-	-	TD
	30/12	18.9	120.9	1004	-	0.5	TD
	30/18	19.0	120.2	1002	-	0.5	TD
	31/00	19.3	119.6	1002	-	0.5	TD
	31/06	19.6	119.3	1002	-	1.0	TD
	31/12	19.8	119.1	1000	-	1.5	TD
	31/18	20.0	118.9	998	35	2.0	TS
Sep.	01/00	20.2	118.7	998	35	2.0	TS
	01/06	20.4	118.5	998	35	2.0	TS
	01/12	20.7	118.1	996	40	2.0	TS
	01/18	20.8	117.7	994	45	2.5	TS
	02/00	21.0	117.4	990	50	3.0	STS
	02/06	21.2	117.2	990	50	3.0	STS
	02/12	21.4	117.0	990	50	3.0	STS
	02/18	21.6	116.8	990	50	3.0	STS
	03/00	22.0	116.5	990	50	3.0	STS
	03/06	22.3	116.3	990	50	3.0	STS
	03/12	22.6	116.1	992	45	3.0	TS
	03/18	23.1	115.4	1000	35	2.5	TS
	04/00	23.5	114.6	1004	-	2.0	TD
	04/06	23.5	113.2	1004	-	1.5	TD
	04/12						Dissip.

Guchol (1717)

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep.	03/12	16.1	131.8	1010	-	1.0	TD
	03/18	16.3	129.8	1008	-	1.0	TD
	04/00	16.1	128.1	1006	-	1.5	TD
	04/06	16.4	127.4	1006	-	1.5	TD
	04/12	16.3	125.7	1004	-	1.5	TD
	04/18	16.6	125.0	1004	-	1.5	TD
	05/00	17.5	124.9	1004	-	1.5	TD
	05/06	19.0	124.2	1004	-	1.5	TD
	05/12	19.8	122.7	1004	-	1.5	TD
	05/18	20.3	121.1	1000	35	2.0	TS
	06/00	20.3	120.6	1000	35	2.0	TS
	06/06	20.7	120.0	1000	35	2.0	TS
	06/12	21.7	120.0	1004	35	2.0	TS
	06/18	22.2	119.1	1006	-	1.5	TD
	07/00	22.8	118.9	1008	-	1.5	TD
	07/06	23.7	119.1	1008	-	1.0	TD
	07/12	24.7	119.4	1008	-	0.5	TD
	07/18						Dissip.

Talim (1718)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep.	08/12	14.3	147.1	1008	-	1.0	TD
	08/18	14.6	146.1	1006	-	1.5	TD
	09/00	14.9	145.2	1006	-	1.5	TD
	09/06	15.3	144.0	1004	-	1.5	TD
	09/12	15.4	142.9	1000	35	1.5	TS
	09/18	15.6	141.5	996	40	2.0	TS
	10/00	15.7	140.4	990	45	2.5	TS
	10/06	16.6	139.6	990	45	2.5	TS
	10/12	16.9	138.5	990	45	2.5	TS
	10/18	17.3	137.3	985	50	3.0	STS
	11/00	17.9	136.1	980	55	3.5	STS
	11/06	18.6	134.7	975	60	3.5	STS
	11/12	19.3	133.8	975	60	3.5	STS
	11/18	20.2	132.2	965	65	4.0	TY
	12/00	21.1	130.7	960	70	4.0	TY
	12/06	22.1	128.7	955	80	5.0	TY
	12/12	23.0	127.8	955	80	5.0	TY
	12/15	23.4	127.4	955	80	-	TY
	12/18	23.7	127.0	955	80	5.0	TY
	12/21	24.0	126.6	955	80	-	TY
	13/00	24.3	126.3	955	80	5.0	TY
	13/03	24.6	126.0	955	80	-	TY
	13/06	24.9	125.8	955	80	5.0	TY
	13/09	25.3	125.6	950	80	-	TY
	13/12	25.4	125.3	945	85	5.5	TY
	13/15	25.7	125.1	945	85	-	TY
	13/18	26.0	124.9	940	90	5.5	TY
	13/21	26.3	124.7	940	90	-	TY
	14/00	26.6	124.6	935	95	6.5	TY
	14/06	27.0	124.3	935	95	6.5	TY
	14/12	27.3	124.4	935	95	6.5	TY
	14/18	27.7	124.5	935	95	6.5	TY
	15/00	28.1	124.8	940	85	5.5	TY
	15/06	28.3	125.0	950	80	5.0	TY
	15/12	28.4	125.3	950	80	5.0	TY
	15/18	28.5	125.7	955	75	4.5	TY
	16/00	28.6	126.3	960	70	4.0	TY
	16/03	28.8	126.6	965	65	-	TY
	16/06	29.0	127.0	965	65	4.0	TY
	16/09	29.3	127.4	965	65	-	TY
	16/12	29.5	127.9	965	65	4.0	TY
	16/15	29.8	128.4	965	65	-	TY
	16/18	30.0	128.9	965	65	4.0	TY
	16/21	30.4	129.5	970	60	-	STS
	17/00	30.7	130.0	970	60	4.0	STS
	17/02	31.0	130.3	975	55	-	STS
	17/03	31.4	130.7	975	55	-	STS
	17/06	32.4	132.1	975	55	4.0	STS
	17/07	32.7	132.5	975	55	-	STS
	17/09	33.3	133.3	975	55	-	STS
	17/12	34.4	134.6	975	55	4.0	STS
	17/13	34.7	134.9	975	55	-	STS
	17/15	36.0	136.5	975	55	-	STS
	17/18	37.8	138.7	980	-	3.5	L
	18/00	41.3	139.9	976	-	-	L
	18/06	44.3	142.3	976	-	-	L
	18/12	46.6	143.1	976	-	-	L
	18/18	48.4	143.7	976	-	-	L
	19/00	49.8	144.3	980	-	-	L
	19/06	50.7	144.6	982	-	-	L
	19/12	51.3	145.0	982	-	-	L
	19/18	51.7	145.4	984	-	-	L
	20/00	52.0	145.9	988	-	-	L
	20/06	52.6	146.1	988	-	-	L
	20/12	53.3	146.2	992	-	-	L
	20/18	53.8	146.2	994	-	-	L
	21/00	54.6	146.4	994	-	-	L
	21/06	55.3	146.5	996	-	-	L
	21/12	55.9	146.6	998	-	-	L
	21/18	56.3	147.3	1000	-	-	L
	22/00	57.0	147.8	1000	-	-	L
	22/06	58.0	147.8	1002	-	-	L
	22/12	58.9	148.7	1006	-	-	L
	22/18	59.5	149.8	1006	-	-	L
	23/00						Dissip.

Doksuri (1719)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep.	10/00	14.3	130.0	1004	-	0.0	TD
	10/06	14.4	129.1	1004	-	0.0	TD
	10/12	14.4	128.0	1004	-	0.5	TD
	10/18	14.4	127.1	1004	-	0.5	TD
	11/00	14.7	126.2	1004	-	1.0	TD
	11/06	14.7	124.9	1002	-	1.5	TD
	11/12	14.7	123.9	1002	-	1.5	TD
	11/18	14.6	123.0	1002	-	1.5	TD
	12/00	14.4	122.1	1002	-	2.0	TD
	12/06	14.6	120.7	1000	-	1.5	TD
	12/12	14.3	119.5	998	35	2.0	TS
	12/18	14.7	118.1	998	40	2.5	TS
	13/00	14.7	117.2	996	40	2.5	TS
	13/06	15.3	116.0	996	40	2.5	TS
	13/12	15.5	114.6	996	40	2.5	TS
	13/18	15.9	113.6	990	50	3.0	STS
	14/00	16.1	112.2	980	55	3.5	STS
	14/06	16.4	111.4	970	65	4.0	TY
	14/12	17.0	109.8	955	80	5.0	TY
	14/18	17.4	108.7	955	80	5.0	TY
	15/00	17.8	107.4	955	80	5.0	TY
	15/06	17.7	106.1	955	80	5.0	TY
	15/12	18.1	104.7	980	60	4.0	STS
	15/18	18.3	102.7	996	40	3.5	TS
	16/00	18.6	101.0	1002	-	3.0	TD
	16/06						Dissip.

Khanun (1720)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Oct.	11/00	15.5	134.0	1002	-	0.5	TD
	11/06	16.2	132.1	1002	-	1.0	TD
	11/12	17.0	130.1	1002	-	1.0	TD
	11/18	17.7	128.2	1000	-	1.0	TD
	12/00	18.3	126.1	1000	-	1.5	TD
	12/06	18.7	124.6	998	-	1.5	TD
	12/12	18.5	123.3	996	35	2.0	TS
	12/18	18.2	121.9	994	35	2.0	TS
	13/00	17.6	120.3	992	35	2.5	TS
	13/06	16.9	119.4	985	45	2.5	TS
	13/12	16.7	118.7	985	45	3.0	TS
	13/18	16.7	118.3	980	50	3.5	STS
	14/00	17.3	118.1	980	50	4.0	STS
	14/06	18.0	118.0	975	55	4.5	STS
	14/12	18.7	117.5	970	60	4.5	STS
	14/18	19.5	116.4	960	70	5.0	TY
	15/00	20.2	114.7	955	75	5.0	TY
	15/06	20.6	113.2	960	70	5.0	TY
	15/12	20.9	111.7	975	50	5.0	STS
	15/18	20.8	110.6	990	40	4.5	TS
	16/00	20.3	109.9	1004	-	4.0	TD
	16/06	20.5	109.3	1004	-	3.5	TD
	16/12						Dissip.

Lan (1721)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Oct.	15/06	8.8	137.3	1002	-	0.5	TD
	15/12	9.3	136.8	1002	-	1.0	TD
	15/18	9.7	136.2	1000	35	1.5	TS
	16/00	10.2	135.6	1000	35	2.0	TS
	16/06	10.6	135.1	996	40	2.0	TS
	16/12	10.6	134.6	996	40	2.0	TS
	16/18	10.3	133.9	992	45	2.0	TS
	17/00	9.9	132.9	992	45	2.0	TS
	17/06	9.9	132.4	985	50	2.5	STS
	17/12	10.3	132.4	980	55	2.5	STS
	17/18	11.0	132.6	970	65	3.0	TY
	18/00	12.0	132.6	970	65	3.0	TY
	18/06	13.0	132.1	970	65	3.0	TY
	18/12	13.9	131.4	970	65	3.0	TY
	18/18	14.7	130.8	970	65	3.5	TY
	19/00	15.4	130.3	965	70	3.5	TY
	19/06	16.3	130.1	965	70	4.0	TY
	19/12	17.0	130.1	965	70	4.0	TY
	19/18	17.9	130.0	965	70	4.0	TY
	20/00	18.8	130.0	965	70	4.0	TY
	20/06	19.6	130.0	950	80	4.5	TY
	20/12	20.1	130.2	945	85	5.5	TY
	20/18	20.7	130.7	935	90	6.0	TY
	21/00	21.3	131.2	935	90	6.0	TY
	21/03	21.7	131.6	935	90	-	TY
	21/06	22.3	132.0	935	90	6.0	TY
	21/09	23.2	132.3	935	90	-	TY
	21/12	23.8	132.5	935	90	6.0	TY
	21/15	24.5	132.9	925	95	-	TY
	21/18	25.6	133.3	915	100	7.0	TY
	21/21	26.7	133.7	915	100	-	TY
	22/00	27.8	133.9	915	100	7.0	TY
	22/03	28.9	134.2	915	100	-	TY
	22/06	29.9	134.7	915	100	7.0	TY
	22/09	30.9	135.4	925	95	-	TY
	22/12	32.2	136.3	935	90	6.0	TY
	22/15	33.5	137.3	945	85	-	TY
	22/18	34.7	138.1	950	80	6.0	TY
	22/21	36.1	140.1	965	65	-	TY
	23/00	37.2	141.5	970	-	5.0	L
	23/06	41.0	145.9	970	-	5.0	L
	23/12	42.9	150.3	972	-	-	L
	23/18	44.4	155.4	978	-	-	L
	24/00						Dissip.

Saola (1722)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Oct.	22/06	9.1	148.3	1004	-	0.5	TD
	22/12	9.0	148.3	1006	-	0.5	TD
	22/18	9.1	148.0	1004	-	0.0	TD
	23/00	9.2	147.7	1006	-	0.5	TD
	23/06	9.3	147.4	1004	-	0.5	TD
	23/12	9.5	147.0	1006	-	0.5	TD
	23/18	10.2	145.4	1002	-	1.0	TD
	24/00	11.7	144.0	1004	-	1.0	TD
	24/06	13.2	141.9	1002	-	1.5	TD
	24/12	14.5	139.3	1000	35	2.0	TS
	24/18	14.8	137.6	1000	35	2.0	TS
	25/00	15.1	136.6	998	40	2.5	TS
	25/06	15.7	135.7	998	40	2.5	TS
	25/12	16.7	134.6	998	40	2.5	TS
	25/18	17.1	133.4	996	40	2.5	TS
	26/00	17.6	132.6	992	45	3.0	TS
	26/06	18.4	132.1	992	45	3.0	TS
	26/12	19.6	131.2	992	45	3.0	TS
	26/18	20.5	130.5	992	45	3.0	TS
	27/00	21.3	129.8	990	50	3.0	STS
	27/06	22.4	128.9	990	50	3.0	STS
	27/12	23.5	128.5	985	55	3.5	STS
	27/15	23.8	128.3	985	55	-	STS
	27/18	24.2	128.3	975	60	3.5	STS
	27/21	25.0	128.1	975	60	-	STS
	28/00	25.6	128.0	975	60	3.5	STS
	28/03	26.3	128.2	975	60	-	STS
	28/04	26.6	128.2	975	60	-	STS
	28/06	27.1	128.4	975	60	3.5	STS
	28/09	27.9	128.7	975	60	-	STS
	28/12	28.7	129.4	975	60	3.5	STS
	28/15	29.2	130.0	975	60	-	STS
	28/18	29.9	130.4	975	60	3.5	STS
	28/21	30.7	131.5	975	60	-	STS
	29/00	31.2	132.9	975	60	3.5	STS
	29/03	31.5	133.9	975	60	-	STS
	29/06	32.4	135.8	975	60	3.5	STS
	29/09	33.3	138.0	975	60	-	STS
	29/12	34.8	141.1	988	-	3.0	L
	29/18						Dissip.

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Damrey (1723)							
Oct.	31/00	11.0	126.8	1008	-	0.5	TD
	31/06	11.2	125.9	1006	-	0.5	TD
	31/12	11.4	124.7	1008	-	0.5	TD
	31/18	11.7	123.2	1006	-	0.5	TD
Nov.	01/00	11.9	122.3	1008	-	0.5	TD
	01/06	11.9	121.0	1006	-	1.0	TD
	01/12	12.0	119.5	1004	-	1.5	TD
	01/18	12.2	118.6	1002	-	1.5	TD
	02/00	12.5	117.7	1000	35	2.0	TS
	02/06	12.9	116.8	996	40	2.5	TS
	02/12	13.1	115.6	994	40	3.0	TS
	02/18	12.7	114.4	985	55	3.5	STS
	03/00	12.6	113.5	975	65	4.0	TY
	03/06	12.7	112.6	970	70	4.5	TY
	03/12	12.8	111.7	970	70	4.5	TY
	03/18	12.7	110.4	970	70	4.5	TY
	04/00	12.5	109.1	970	70	4.5	TY
	04/06	12.4	107.7	985	55	4.0	STS
	04/12	12.4	106.4	1000	35	3.5	TS
	04/18	13.2	105.6	1004	-	-	TD
	05/00						Dissip.

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Haikui (1724)							
Nov.	07/12	10.1	134.2	1008	-	-	TD
	07/18	10.5	132.2	1006	-	0.0	TD
	08/00	10.7	130.6	1006	-	0.5	TD
	08/06	11.0	129.0	1004	-	0.5	TD
	08/12	11.3	127.1	1006	-	0.5	TD
	08/18	12.1	125.6	1004	-	1.0	TD
	09/00	12.7	124.3	1006	-	1.5	TD
	09/06	13.3	122.8	1004	-	2.0	TD
	09/12	13.8	121.5	1004	-	2.0	TD
	09/18	14.4	120.3	1004	-	2.0	TD
	10/00	15.0	119.2	1002	35	2.0	TS
	10/06	15.9	118.5	1002	35	2.0	TS
	10/12	16.9	117.6	1002	35	2.0	TS
	10/18	17.2	117.0	1000	35	2.0	TS
	11/00	17.6	116.2	998	40	2.5	TS
	11/06	18.1	115.0	998	40	2.5	TS
	11/12	18.1	114.3	998	40	2.5	TS
	11/18	17.9	113.6	1000	35	2.5	TS
	12/00	17.8	113.0	1002	35	2.0	TS
	12/06	17.5	112.3	1006	-	2.0	TD
	12/12	17.3	111.8	1008	-	1.5	TD
	12/18	17.5	111.1	1008	-	-	TD
	13/00	17.5	110.5	1008	-	-	TD
	13/06						Dissip.

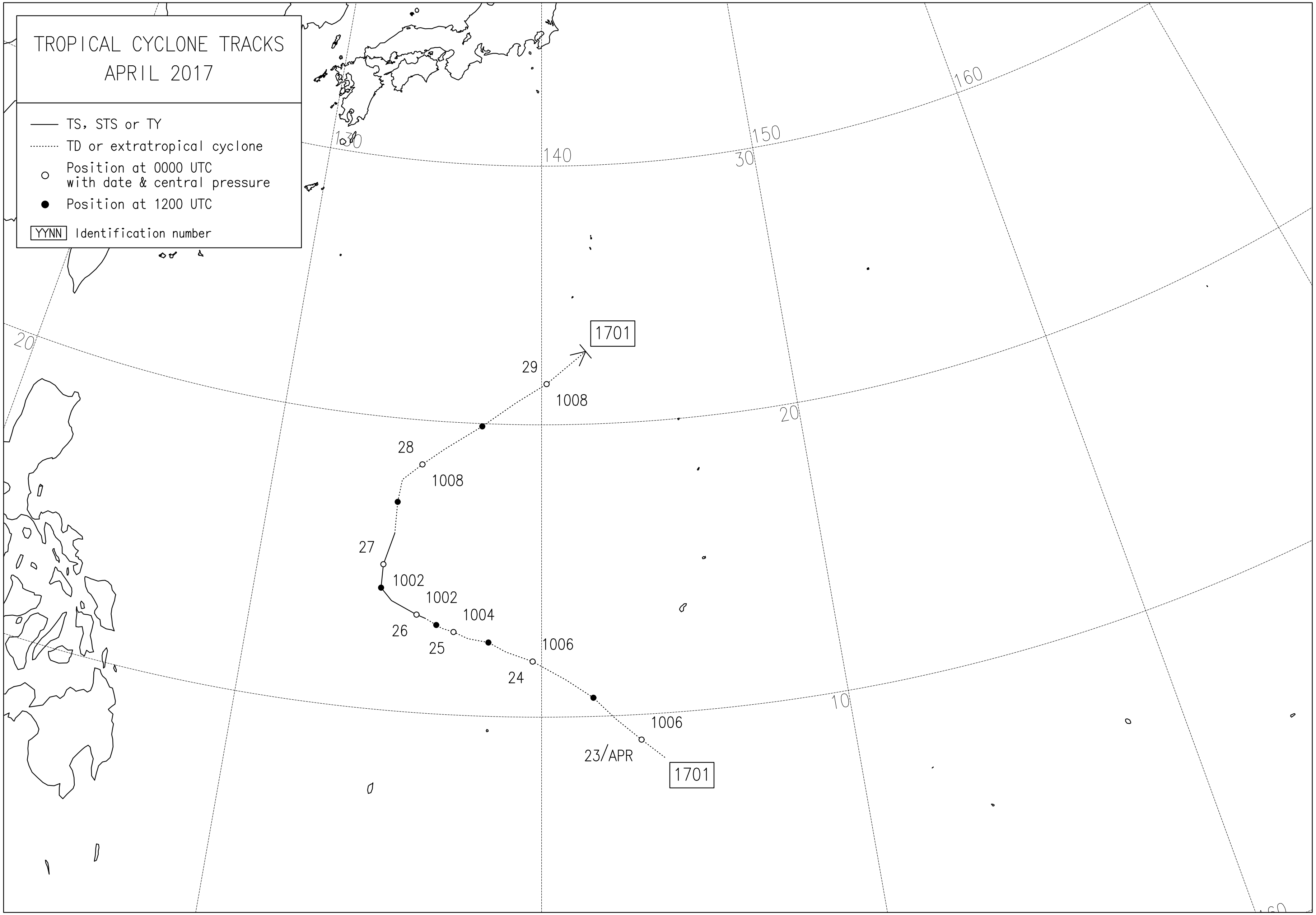
Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Kirogi (1725)							
Nov.	16/12	7.1	123.6	1006	-	0.0	TD
	16/18	7.8	122.3	1006	-	0.5	TD
	17/00	8.2	120.1	1006	-	1.0	TD
	17/06	10.3	118.5	1004	-	1.0	TD
	17/12	10.7	117.6	1004	-	1.5	TD
	17/18	11.0	116.0	1002	-	2.0	TD
	18/00	11.5	115.2	1000	35	2.5	TS
	18/06	11.4	113.4	1000	35	2.5	TS
	18/12	11.1	112.7	1000	35	2.5	TS
	18/18	10.8	111.9	1000	35	2.5	TS
	19/00	10.9	110.6	1002	-	2.5	TD
	19/06	11.0	109.6	1004	-	2.5	TD
	19/12						Dissip.

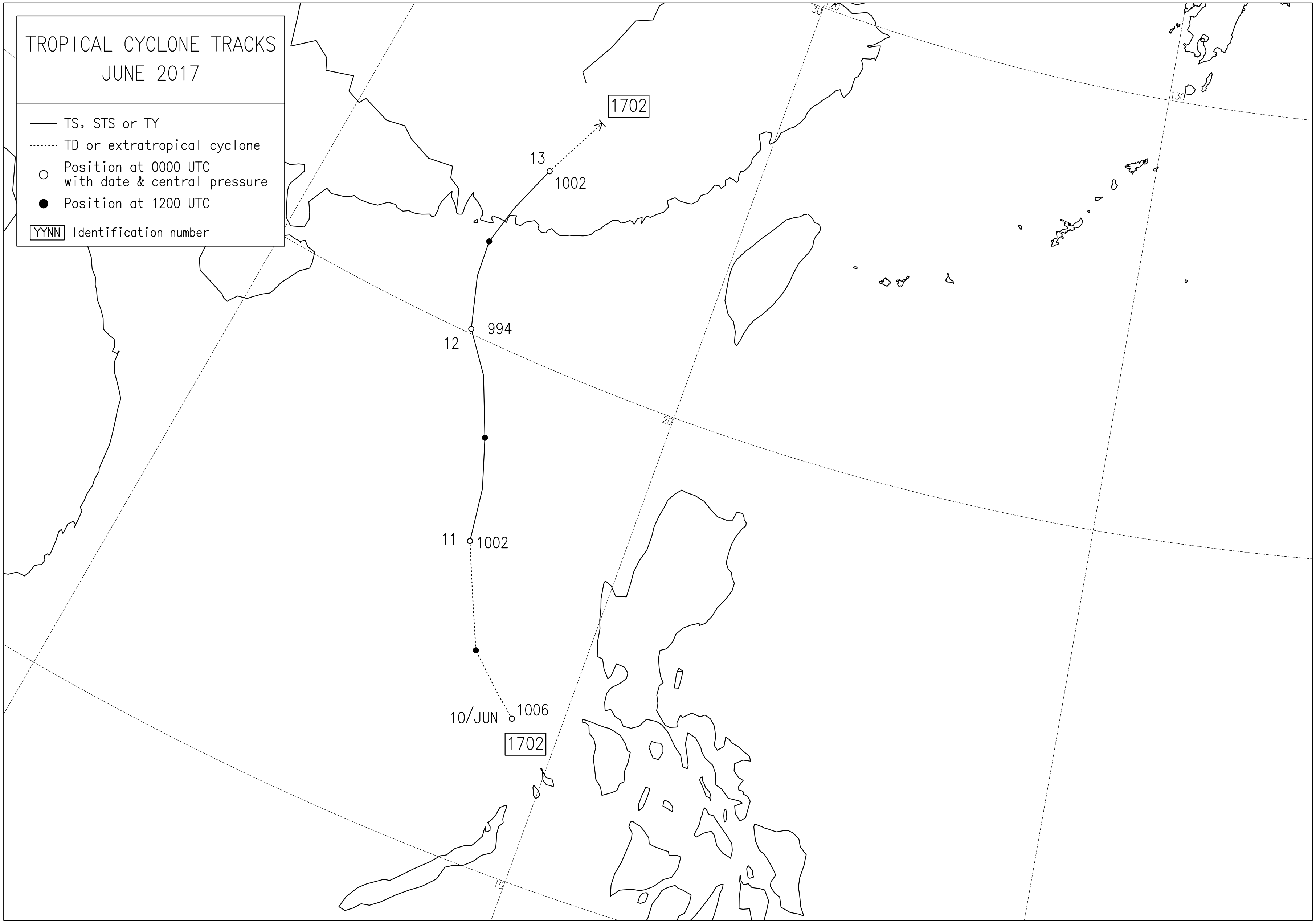
Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Kai-tak (1726)							
Dec.	13/18	10.8	126.8	1002	-	0.5	TD
	14/00	11.0	127.4	1000	35	1.0	TS
	14/06	11.1	127.8	1000	35	1.5	TS
	14/12	11.3	128.2	998	40	2.0	TS
	14/18	11.4	128.0	998	40	2.0	TS
	15/00	11.5	127.8	996	40	2.0	TS
	15/06	11.7	127.8	994	40	2.0	TS
	15/12	11.9	127.7	996	35	2.5	TS
	15/18	12.3	127.2	996	35	2.5	TS
	16/00	12.4	126.6	998	35	2.5	TS
	16/06	12.1	126.0	998	35	2.5	TS
	16/12	12.2	125.6	1002	-	2.5	TD
	16/18	12.4	125.2	1002	-	2.0	TD
	17/00	12.5	124.2	1004	-	2.0	TD
	17/06	12.2	122.7	1004	-	2.0	TD
	17/12	11.4	121.7	1004	-	2.0	TD
	17/18	10.8	120.4	1004	-	2.0	TD
	18/00	10.6	119.7	1004	-	2.0	TD
	18/06	10.5	118.8	1004	-	2.0	TD
	18/12	10.2	117.7	1004	-	2.0	TD
	18/18	9.3	116.8	1004	-	2.0	TD
	19/00	9.0	116.2	1004	-	2.0	TD
	19/06	8.8	115.2	1002	-	2.0	TD
	19/12	8.5	114.4	1002	-	2.0	TD
	19/18	8.3	113.7	1002	-	2.0	TD
	20/00	7.8	113.1	1000	35	2.0	TS
	20/06	7.6	112.6	1000	35	2.0	TS
	20/12	7.3	111.7	996	40	2.0	TS
	20/18	7.2	110.4	996	40	2.0	TS
	21/00	6.6	109.7	1000	35	2.0	TS
	21/06	6.5	109.1	1000	35	2.0	TS
	21/12	6.3	108.5	1002	-	1.5	TD
	21/18	6.1	107.3	1004	-	1.5	TD
	22/00	5.5	106.6	1004	-	1.0	TD
	22/06	5.2	106.1	1004	-	1.0	TD
	22/12	4.6	105.3	1004	-	1.0	TD
	22/18	4.0	104.8	1004	-	1.0	TD
	23/00	3.8	104.4	1004	-	1.0	TD
	23/06	3.0	104.5	1004	-	1.0	TD
	23/12	2.8	104.8	1004	-	-	TD
	23/18	2.7	104.8	1006	-	-	TD
	24/00						Dissip.

Date/Time (UTC)		Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Tembin (1727)							
Dec.	20/00	8.1	134.2	1006	-	0.5	TD
	20/06	8.5	133.0	1004	-	1.0	TD
	20/12	8.7	131.9	1002	-	1.5	TD
	20/18	8.6	130.9	998	35	2.0	TS
	21/00	8.6	129.9	996	40	2.5	TS
	21/06	8.4	129.0	994	45	3.0	TS
	21/12	8.1	128.0	992	45	3.0	TS
	21/18	7.8	126.8	990	50	3.5	STS
	22/00	7.7	125.2	992	45	3.0	TS
	22/06	7.9	123.6	994	40	2.5	TS
	22/12	8.0	122.5	992	45	3.0	TS
	22/18	7.8	121.4	990	50	3.5	STS
	23/00	7.7	120.3	985	55	3.5	STS
	23/06	7.8	118.8	980	60	4.0	STS
	23/12	7.8	117.5	975	65	4.5	TY
	23/18	8.1	115.9	975	65	4.5	TY
	24/00	8.1	114.7	970	70	5.0	TY
	24/06	8.2	113.3	970	70	5.0	TY
	24/12	8.3	112.0	975	65	5.0	TY
	24/18	8.1	111.0	980	55	4.5	STS
	25/00	8.0	109.9	992	45	4.0	TS
	25/06	8.1	108.8	996	40	4.0	TS
	25/12	8.7	107.7	1004	-	3.5	TD
	25/18	8.5	105.7	1006	-	3.0	TD
	26/00	8.4	104.4	1008	-	3.0	TD
	26/06	8.6	103.6	1008	-	-	TD
	26/12						Dissip.

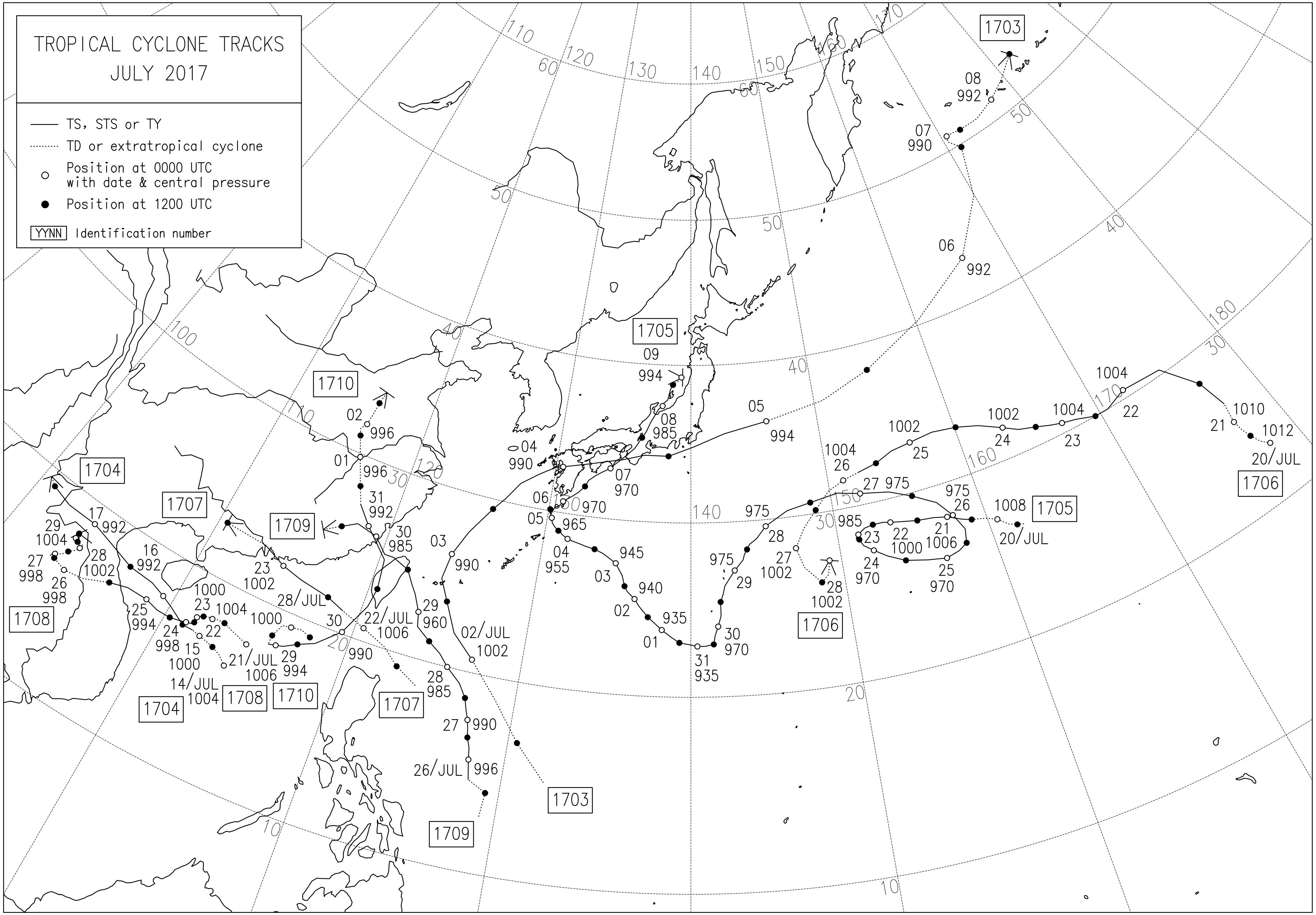
Appendix 2

Monthly Tracks of Tropical Cyclones in 2017

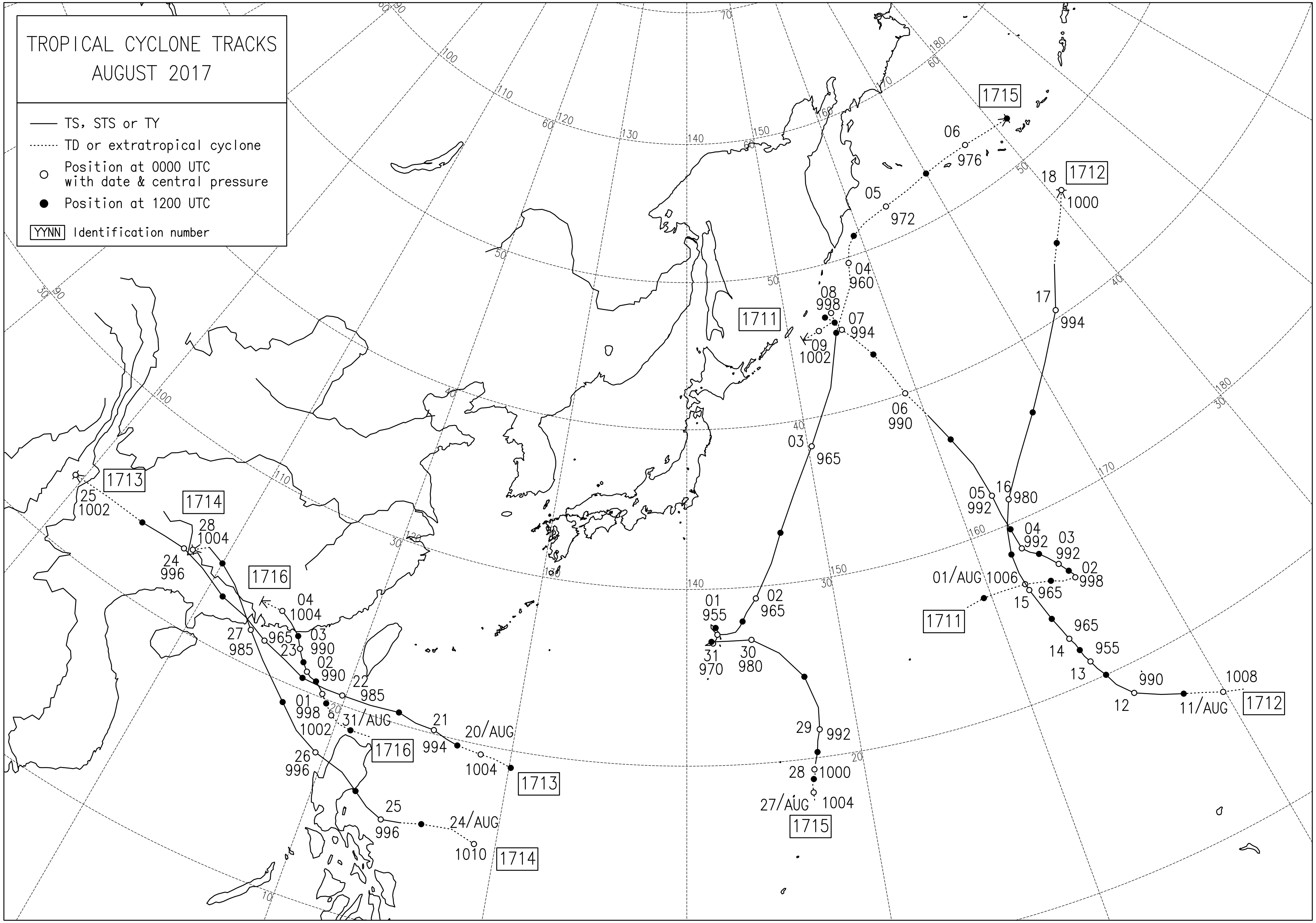

TROPICAL CYCLONE TRACKS
APRIL 2017
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
130
140
150
160
30
20
10
1701
29
1008
28
1008
27
1002
1002
1004
26
25
1006
24
1006
23/APR
1701

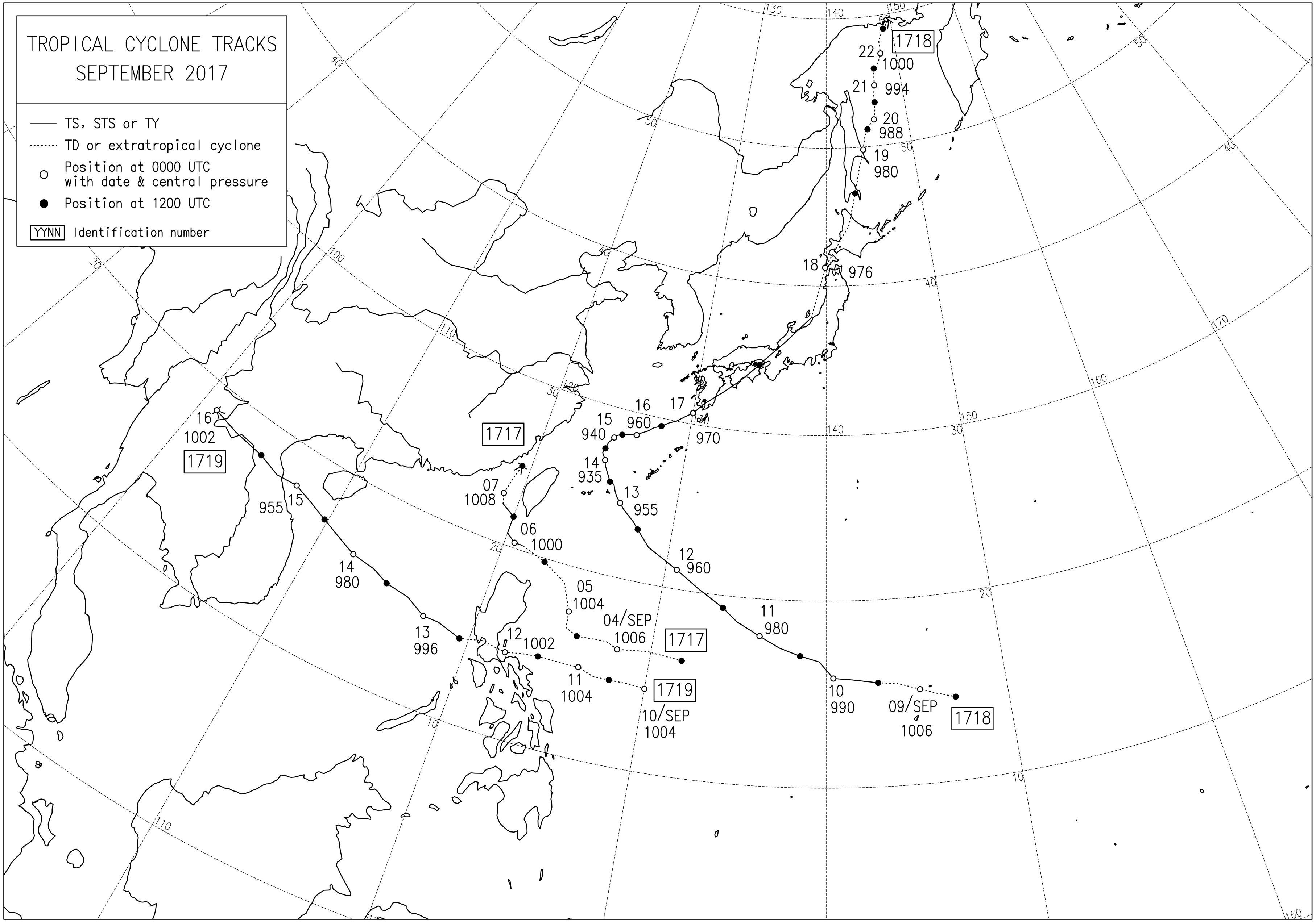


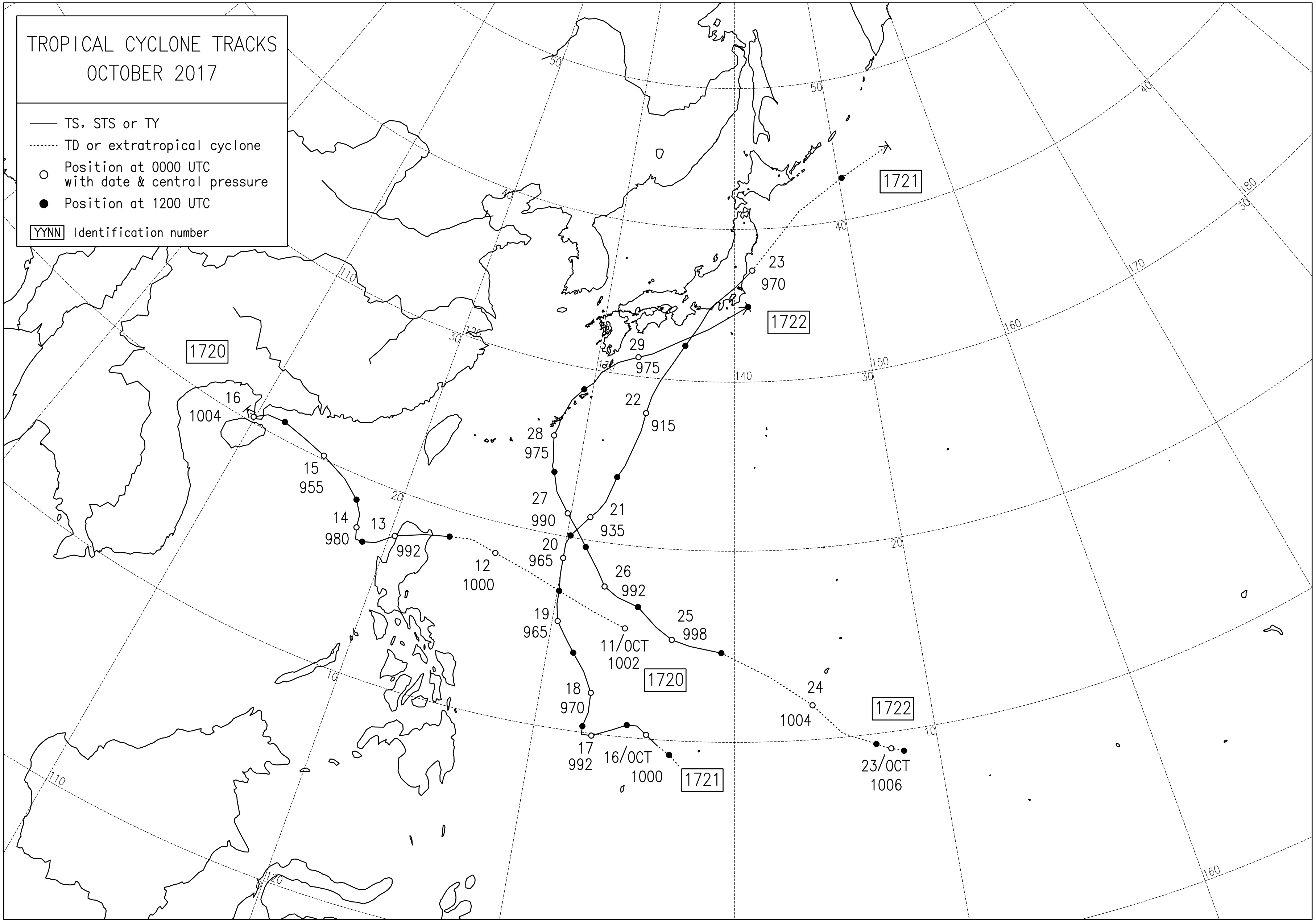
TROPICAL CYCLONE TRACKS
JUNE 2017
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1702
13
1002
994
12
11
1002
10/JUN
1006
1702
30
120
130
20
10



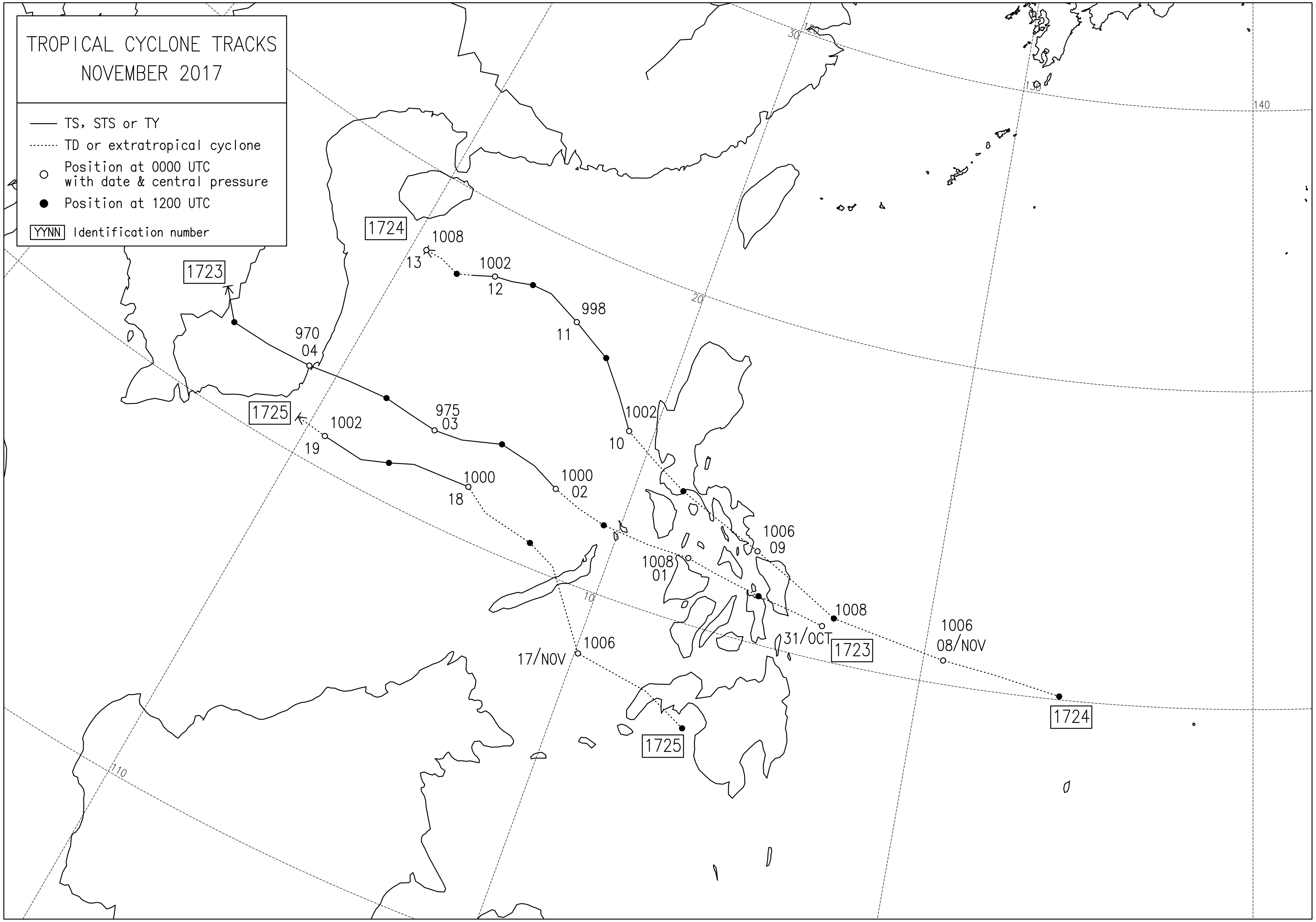
TROPICAL CYCLONE TRACKS
JULY 2017
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1703
1704
1705
1706
1707
1708
1709
1710

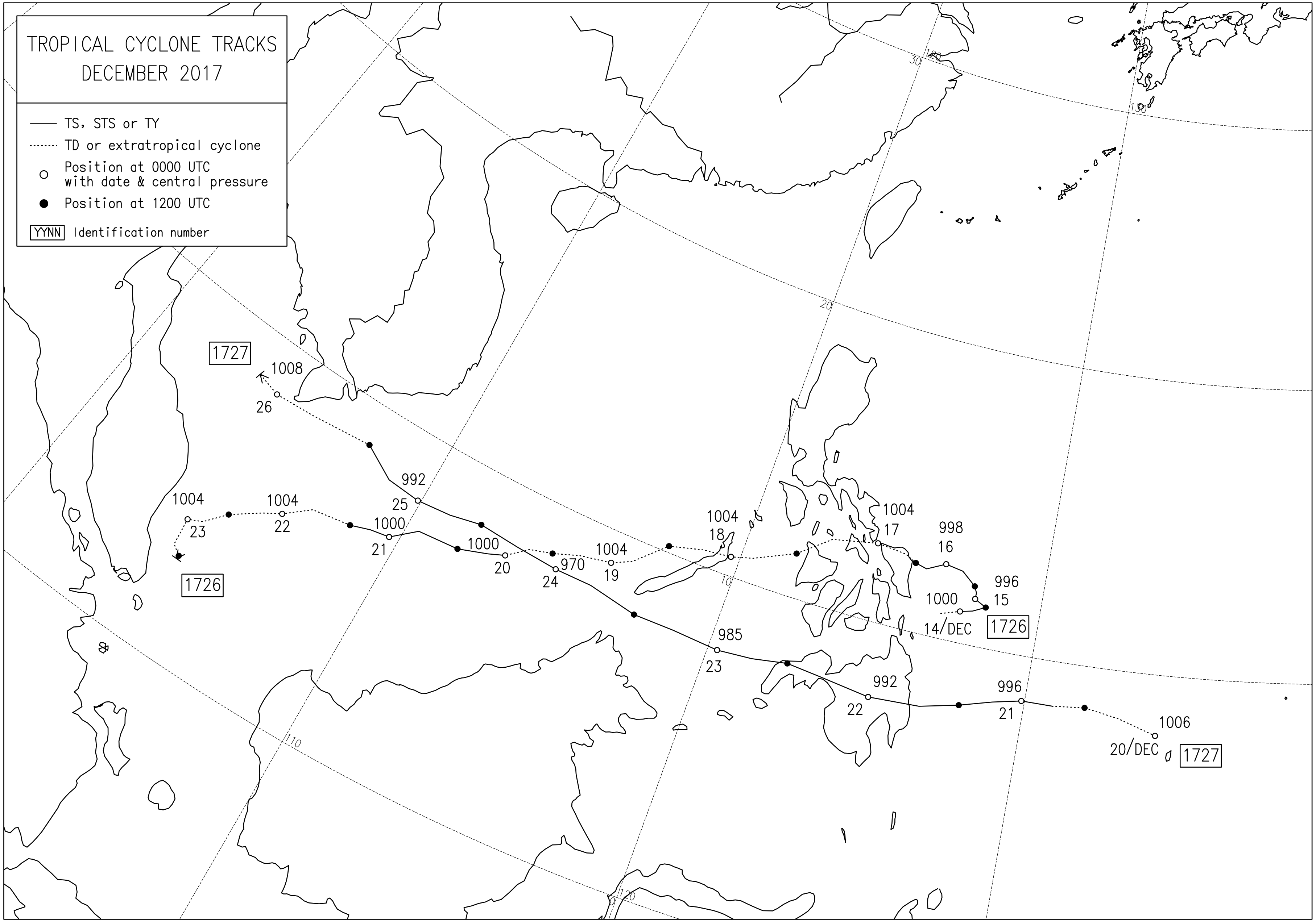

TROPICAL CYCLONE TRACKS
AUGUST 2017
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1711
1712
1713
1714
1715
1716
01/AUG 1006
11/AUG
20/AUG
24/AUG
27/AUG
31/AUG


TROPICAL CYCLONE TRACKS
SEPTEMBER 2017
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
1717
04/SEP 1006
05 1004
06 1000
07 1008
1718
09/SEP 1006
10 990
11 980
12 960
13 955
14 935
15 940
16 960
17 970
18 976
19 980
20 988
21 994
22 1000
1719
10/SEP 1004
11 1004
12 1002
13 996
14 980
15 955
16 1002



TROPICAL CYCLONE TRACKS
OCTOBER 2017
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1720
1721
1722
16
1004
15
955
14
980
13
992
12
1000
11/OCT
1002
20
965
19
965
18
970
17
992
16/OCT
1000
28
975
27
990
29
975
22
915
21
935
26
992
25
998
24
1004
23/OCT
1006
23
970


TROPICAL CYCLONE TRACKS
NOVEMBER 2017
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
1723
1724
1725
1008
13
1002
12
998
11
1002
10
970
04
975
03
1000
02
1008
01
1006
09
1008
31/OCT
1006
08/NOV
1002
19
1000
18
1006
17/NOV
10
20
30
110
120
130
140


TROPICAL CYCLONE TRACKS
DECEMBER 2017
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1727
1008
26
992
25
1004
23
1004
22
1000
21
1000
20
970
24
1004
19
1004
18
1004
17
998
16
996
15
1000
14/DEC
1726
1726
985
23
992
22
996
21
1006
20/DEC
1727
30
20
10
110
120
130

Appendix 3

Errors of Track and Intensity Forecasts for Each Tropical Cyclone in 2017

TS Muifa (1701)

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
Apr. 25/18	22	123					-2			0		
26/00	40	78					-2			0		
26/06	65											
26/12	79											
26/18	66											
27/00	31											
mean	50	101	--	--	--	--	-2	--	--	0	--	--
sample	6	2	0	0	0	0	2	0	0	2	0	0

STS Merbok (1702)

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
Jun. 11/00	0	194					6			-10		
11/06	0	152					10			-15		
11/12	21	73					13			-15		
11/18	21	47					8			-10		
12/00	0											
12/06	0											
12/12	0											
12/18	0											
mean	5	116	--	--	--	--	9	--	--	-12	--	--
sample	8	4	0	0	0	0	4	0	0	4	0	0

STS Nanmadol (1703)

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
Jul. 02/00	0	102	234				4	8		-5	-10	
02/06	0	96	447				9	8		-10	-10	
02/12	0	147	555				9	8		-10	-10	
02/18	0	109	643				5	8		-5	-15	
03/00	0	113					0			0		
03/06	0	107					2			-5		
03/12	0	84					6			-10		
03/18	0	114					6			-10		
04/00	9											
04/06	0											
04/12	0											
04/18	0											
mean	1	109	470	--	--	--	5	8	--	-7	-11	--
sample	12	8	4	0	0	0	8	4	0	8	4	0

STS Talas (1704)

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
Jul. 15/06	15	11	182				4	4		-10	-10	
15/12	11	77					0			-5		
15/18	40	62					5			-5		
16/00	0	95					4			0		
16/06	31	85					0			0		
16/12	49											
16/18	34											
17/00	11											
17/06	15											
mean	23	66	182	--	--	--	3	4	--	-4	-10	--
sample	9	5	1	0	0	0	5	1	0	5	1	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 Noru (1705)												
Jul. 20/12	89	76	163				2	2		0	5	
20/18	51	129					6			-5		
21/00	126	157	236	194	502	508	4	7	20	0	-10	-20
21/06	59	185	245	167	522	419	2	12	20	0	-15	-20
21/12	79	200	149	232	473	343	6	17	20	5	-5	0
21/18	50	185	118	186	446	399	6	10	0	-5	-10	0
22/00	60	137	86	182	230	645	9	10	-15	-5	-10	10
22/06	79	170	86	214	245	772	14	5	-15	-10	-5	10
22/12	89	157	122	160	241	710	15	0	-20	-10	0	15
22/18	29	132	49	170	164	623	10	0	-20	-5	0	15
23/00	11	69	104	176	194	494	10	-5	-20	-10	5	15
23/06	0	70	80	131	123	318	5	-10	-20	0	10	20
23/12	11	30	59	109	208	256	0	-20	-20	5	20	20
23/18	0	20	134	124	209	164	-15	-25	-25	10	20	20
24/00	0	51	109	112	165	30	-15	-25	-25	10	20	15
24/06	10	70	76	97	116	170	-15	-25	-20	10	20	15
24/12	0	100	68	150	176	284	-20	-25	-25	15	20	20
24/18	10	52	11	178	209	386	-20	-25	-20	15	20	15
25/00	10	76	44	182	157	400	-20	-20	-20	15	15	20
25/06	10	85	73	175	260	424	-20	-15	-15	15	10	15
25/12	10	31	77	190	356	555	-20	-15	-15	15	10	15
25/18	0	0	129	212	403	510	-10	-5	-10	10	5	10
26/00	10	40	161	200	397	457	-10	-10	-10	10	10	10
26/06	0	22	150	268	496	490	-5	-5	-5	5	10	10
26/12	10	53	166	295	489	403	-5	-5	-5	5	10	10
26/18	0	68	112	284	381	275	-5	-5	-5	5	10	10
27/00	0	80	126	303	345	227	-5	-5	0	10	10	5
27/06	0	45	153	313	304	212	-5	-5	5	10	10	0
27/12	11	46	145	259	210	254	-5	-5	15	10	10	-5
27/18	0	59	129	201	173	298	0	-5	20	5	10	-10
28/00	0	41	98	147	236	387	0	0	30	5	5	-20
28/06	35	11	80	123	244	404	-5	-10	20	5	0	-15
28/12	11	44	113	128	230	376	0	10	20	5	0	-15
28/18	0	63	78	107	251	457	-5	20	20	10	-10	-15
29/00	0	56	35	23	105	337	5	35	30	0	-25	-20
29/06	11	35	0	52	158	422	10	30	15	-5	-20	-10
29/12	10	60	24	70	195	477	20	30	15	-10	-20	-10
29/18	30	35	30	90	231	519	20	20	15	-10	-15	-10
30/00	10	56	79	188	395	706	30	20	15	-20	-15	-10
30/06	0	76	114	284	548	771	30	15	15	-20	-10	-10
30/12	0	84	143	350	591	752	5	0	0	-5	0	0
30/18	0	56	132	318	568	589	5	0	10	-5	0	-5
31/00	0	81	164	345	577	579	5	10	5	-5	-5	-5
31/06	0	72	196	371	560	526	-5	0	0	5	0	0
31/12	0	38	143	279	398	397	-5	5	-5	5	-5	5
31/18	0	78	134	275	398	322	-5	-5	-10	0	0	10
Aug. 01/00	11	63	122	229	303	97	-5	-10	-10	0	5	10
01/06	0	82	155	216	249	118	0	-5	-20	0	5	20
01/12	0	56	133	174	295	504	0	-10	-20	0	10	20
01/18	0	56	102	139	248	436	0	-15	-20	0	15	20
02/00	15	74	87	162	327	526	-5	-15	-30	5	15	30
02/06	11	56	70	220	386	525	0	-20	-30	0	20	30
02/12	0	44	73	221	412	536	-10	-25	-35	10	25	35
02/18	0	37	69	209	372	485	-15	-25	-35	15	25	35
03/00	15	39	73	133	291	355	-10	-25	-30	10	25	30
03/06	0	15	80	194	326	349	-15	-25	-30	15	25	30
03/12	11	44	112	225	333		-15	-30	-30	15	30	30
03/18	0	59	146	243	341		-10	-25	-20	10	25	20
04/00	10	87	160	228	312		-15	-25	0	15	25	5
04/06	24	53	141	241	242		-15	-25	-5	15	25	10
04/12	24	44	144	246			-10	-20	5	15	20	0
04/18	0	36	103	176			-10	15	5	15	-10	0
05/00	0	53	116	134			-10	15	5	15	-10	5
05/06	15	70	142	125			-5	10	2	10	-5	5
05/12	0	118	173				0	5		5	0	
05/18	0	109	225				0	0		5	5	
06/00	0	93	168				5	0		0	10	
06/06	11	73	38				5	-3		0	10	
06/12	0	35					5			0		
06/18	0	35					0			5		
07/00	0	96					0			5		
07/06	9	97					-3			0		
07/12	0											
07/18	0											
08/00	0											
08/06	0											
mean	14	71	113	196	316	426	-2	-4	-5	4	6	7
sample	76	72	67	62	58	54	72	67	62	72	67	62

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 Kulap (1706)												
Jul. 21/06	30	73	44	172	533		-4	-10	-12	0	5	10
21/12	0	347	340	531	770		-6	-2	-2	5	0	-5
21/18	40	146	168	364			-6	0	0	5	-5	0
22/00	0	58	78	440			-6	0	2	5	0	0
22/06	0	73	190	543			-4	0	2	5	0	0
22/12	0	56	208	529			0	0	2	0	0	0
22/18	0	35	246				2	2		0	0	
23/00	0	61	281				2	2		0	0	
23/06	0	48	338				2	2		-5	0	
23/12	0	122	414				2	2		-5	0	
23/18	29	254					2			0		
24/00	29	321					2			0		
24/06	0	44					2			0		
24/12	0	134					4			-10		
24/18	0											
25/00	0											
25/06	0											
25/12	44											
mean	10	127	231	430	651	--	-1	0	-1	0	0	1
sample	18	14	10	6	2	0	14	10	6	14	10	6

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 Roke (1707)												
Jul. 22/06	70											
22/12	10											
22/18	126											
23/00	38											
mean	61	--	--	--	--	--	--	--	--	--	--	--
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 Sonca (1708)												
Jul. 23/00	34	108	122				2	6		0	0	
23/06	54	94	168				4	6		0	0	
23/12	39	135					2			0		
23/18	32	123					4			0		
24/00	15	91					4			0		
24/06	34	89					2			0		
24/12	25											
24/18	0											
25/00	78											
25/06	21											
mean	33	107	145	--	--	--	3	6	--	0	0	--
sample	10	6	2	0	0	0	6	2	0	6	2	0

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TY Nesat (1709)												
Jul. 25/18	60	164					4			-10		
26/00	11	130	242				8	11		-15	-15	
26/06	15	123	294	542	1038		0	5	10	0	-5	-10
26/12	11	39	209	354			0	10	10	0	-10	-10
26/18	11	44	109	271			-5	20	0	5	-20	0
27/00	25	38	54	287			0	20	-15	0	-20	20
27/06	0	30	115	381			5	10	-15	-5	-10	30
27/12	0	25	211				5	10		-5	-10	
27/18	79	23	213				15	5		-15	-5	
28/00	0	68	157				15	0		-15	5	
28/06	54	152	122				5	0		-5	10	
28/12	0	195					25			-30		
28/18	23	102					10			-15		
29/00	0	104					-5			5		
29/06	0	108					0			10		
29/12	0											
29/18	0											
30/00	0											
30/06	35											
mean	17	90	173	367	1038	--	5	9	-2	-6	-8	6
sample	19	15	10	5	1	0	15	10	5	15	10	5

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 Haitang (1710)												
Jul. 28/18	15											
29/00	25											
29/06	21	106					9			-10		
29/12	34	149					6			-15		
29/18	79	163					8			-15		
30/00	15	315					4			-10		
30/06	0											
30/12	15											
30/18	0											
31/00	23											
mean	23	183	--	--	--	--	7	--	--	-12	--	--
sample	10	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
TS Nalgae (1711)												
Aug. 02/00	37	23	31	67			6	4	0	-5	0	5
02/06	15	23	30	172			2	0	2	0	5	0
02/12	24	23	29	144			2	0	4	0	5	-5
02/18	33	15	63				0	-2		0	5	
03/00	24	46	147				-2	-7		5	10	
03/06	15	80	235				-2	-5		5	5	
03/12	15	69	196				-2	-5		5	5	
03/18	22	35					0			0		
04/00	10	22					0			0		
04/06	35	62					0			0		
04/12	45	21					0			-5		
04/18	29											
05/00	19											
05/06	24											
05/12	66											
mean	28	38	104	128	--	--	0	-2	2	0	5	0
sample	15	11	7	3	0	0	11	7	3	11	7	3

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 Banyan (1712)												
Aug. 11/12	15	164	481	998			25	43	41	-25	-35	-45
11/18	35	172	479	893			33	38	41	-25	-30	-45
12/00	15	133	355	638			35	25	33	-20	-10	-25
12/06	35	137	284	502			25	15	17	-15	-5	-15
12/12	21	56	80	142	175		25	5	-10	-15	5	15
12/18	0	69	113	179	218		10	5	-5	0	5	10
13/00	0	69	77	114	332		-5	5	-5	10	5	5
13/06	0	68	60	140			-5	-5	-5	10	10	5
13/12	0	62	69	225			-5	-10	-10	10	15	10
13/18	15	61	80	246			10	-5	-10	0	5	10
14/00	15	135	268	587			10	-5	-14	0	5	15
14/06	0	74	259				0	-5		5	5	
14/12	32	54	241				-5	-5		5	5	
14/18	15	40	202				-5	-10		5	10	
15/00	0	61	258				-5	-14		5	15	
15/06	0	99					0			0		
15/12	0	192					-5			5		
15/18	0	140					-5			10		
16/00	15	96					-9			15		
16/06	14											
16/12	70											
16/18	97											
17/00	48											
mean	19	99	221	424	242	--	7	5	7	-1	0	-5
sample	23	19	15	11	3	0	19	15	11	19	15	11

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 Hato (1713)												
Aug. 20/12	67	25	279	198			0	10	11	5	-10	-15
20/18	127	39	143	128			-5	10	6	10	-10	-15
21/00	74	100	142	93			0	15	4	5	-20	-10
21/06	0	160	166	159			10	25	4	-10	-30	-10
21/12	53	102	88				5	5		-10	-10	
21/18	0	112	56				10	0		-15	-5	
22/00	0	25	63				10	-2		-20	0	
22/06	0	15	59				0	2		0	0	
22/12	0	30					-10			15		
22/18	0	73					-9			15		
23/00	0	101					-6			15		
23/06	41	45					-2			5		
23/12	0											
23/18	0											
24/00	0											
24/06	15											
mean	24	69	125	144	--	--	0	8	6	1	-11	-12
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
STS Pakhar (1714)												
Aug. 24/18	25	65	94				0	2		0	0	
25/00	11	11	123				0	-5		0	0	
25/06	0	15	299				-2	-16		5	20	
25/12	11	154	327				2	-13		0	25	
25/18	0	46					0			5		
26/00	11	126					-5			5		
26/06	11	255					-16			20		
26/12	24	209					-8			15		
26/18	38											
27/00	0											
27/06	108											
27/12	78											
mean	26	110	211	--	--	--	-4	-8	--	6	11	--
sample	12	8	4	0	0	0	8	4	0	8	4	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 Sanvu (1715)												
Aug. 28/06	42	105	319	297	419	392	-12	5	5	10	0	0
28/12	21	94	319	262	499	242	-12	0	-10	10	5	5
28/18	15	182	289	276	363	258	-5	0	0	10	10	5
29/00	11	167	179	272	323	368	0	-5	-5	5	15	0
29/06	31	134	82	191	111	254	10	0	-5	0	10	0
29/12	30	97	59	174	122		5	0	-5	5	5	0
29/18	15	51	92	123	143		5	5	0	5	0	5
30/00	10	15	160	281	350		0	5	-5	10	-5	10
30/06	11	56	178	256	422		-5	-5	-15	5	-5	10
30/12	0	30	136	184			-10	-5	-10	5	-5	5
30/18	0	68	171	229			-5	-10	-5	0	5	0
31/00	0	118	179	280			0	-10	-5	-10	5	0
31/06	15	128	111	403			0	-10	5	-10	5	-5
31/12	20	83	69				-5	-15		-5	10	
31/18	0	63	91				-20	-25		10	15	
Sep. 01/00	0	87	195				-20	-15		20	15	
01/06	54	160	261				-10	-5		15	10	
01/12	15	129					-10			15		
01/18	29	97					0			5		
02/00	56	91					5			0		
02/06	77	122					5			0		
02/12	36											
02/18	0											
03/00	14											
03/06	20											
mean	21	99	170	248	306	303	-4	-5	-4	5	6	3
sample	25	21	17	13	9	5	21	17	13	21	17	13

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 Mawar (1716)												
Aug. 31/18	103	57	15	54			-2	-5	-15	0	5	20
Sep. 01/00	69	35	23				0	-5		0	5	
01/06	38	38	25				0	-5		0	5	
01/12	35	43	80				0	-7		0	10	
01/18	30	35	67				-5	-10		5	15	
02/00	42	38					-5			5		
02/06	30	83					-5			5		
02/12	22	47					-7			10		
02/18	21	31					-4			5		
03/00	23											
03/06	22											
03/12	21											
03/18	42											
mean	38	45	42	54	--	--	-3	-6	-15	3	8	20
sample	13	9	5	1	0	0	9	5	1	9	5	1

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TS Guchol (1717)												
Sep. 05/18	0											
06/00	33											
06/06	0											
06/12	21											
mean	13	--	--	--	--	--	--	--	--	--	--	--
sample	4	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 Talim (1718)												
Sep. 09/12	32	69	120	276	504	658	10	15	15	-5	-5	-5
09/18	32	40	100	337	578	738	11	20	5	-5	-5	0
10/00	22	61	137	381	622	804	14	25	5	-10	-10	0
10/06	40	55	137	437	672	890	10	15	-5	-5	-10	5
10/12	39	74	210	471	717	929	10	10	-5	-5	-5	5
10/18	25	104	270	510	686	887	10	-5	0	0	5	0
11/00	22	90	256	528	681	829	-5	-20	35	10	15	-25
11/06	11	78	308	529	711	807	0	-20	35	0	15	-25
11/12	33	103	266	438	577	463	-5	-10	20	5	10	-15
11/18	54	128	272	433	525	420	-5	-5	20	5	5	-15
12/00	0	120	220	289	308	135	-15	0	30	10	0	-15
12/06	0	87	140	191	208	258	-20	5	15	15	-5	-5
12/12	11	96	150	184	174	115	-10	15	15	10	-10	-10
12/18	23	90	127	150	218		5	15	10	-5	-10	-5
13/00	11	51	90	123	246		10	15	5	-10	-5	0
13/06	11	40	59	118	243		15	0	0	-10	5	10
13/12	23	37	67	150	215		5	-10	-5	-5	10	15
13/18	11	45	67	150			5	-15	-5	-5	15	15
14/00	15	35	118	216			-5	-25	-15	10	25	20
14/06	15	44	135	267			-15	-30	-5	15	30	15
14/12	0	44	116	228			-15	-30	5	15	30	5
14/18	0	67	113				-15	-25		15	25	
15/00	0	89	152				-20	-30		20	30	
15/06	20	67	102				-15	-20		20	25	
15/12	44	51	77				-15	-10		20	20	
15/18	78	80					-15			20		
16/00	77	100					-20			25		
16/06	37	89					0			5		
16/12	40	78					0			5		
16/18	11											
17/00	15											
17/06	11											
17/12	0											
mean	23	73	152	305	464	610	-3	-5	8	6	8	-1
sample	33	29	25	21	17	13	29	25	21	29	25	21

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 Doksuri (1719)												
Sep. 12/12	70	177	319	531			-6	25	-10	10	-20	10
12/18	54	86	161	275			0	25	-21	0	-20	25
13/00	22	129	181				10	25		-5	-20	
13/06	0	86	181				15	25		-10	-20	
13/12	34	107	180				30	0		-25	0	
13/18	72	75	179				25	0		-20	0	
14/00	0	46					20			-20		
14/06	32	11					15			-15		
14/12	11	11					14			-20		
14/18	15	35					-2			-5		
15/00	11											
15/06	22											
15/12	0											
15/18	0											
mean	24	76	200	403	--	--	12	17	-15	-11	-13	18
sample	14	10	6	2	0	0	10	6	2	10	6	2

Date/Time (UTC)	Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
TY Khanun (1720)												
Oct. 12/12	89	78	224	245			7	10	-5	-5	-5	15
12/18	77	49	160	150			10	15	-20	-5	-10	25
13/00	25	39	137				5	15		0	-10	
13/06	64	88	113				5	10		-5	-5	
13/12	44	100	142				5	-5		-5	15	
13/18	24	88	118				15	-20		-10	25	
14/00	46	116					15			-10		
14/06	25	145					5			-5		
14/12	0	160					-10			15		
14/18	33	53					-15			20		
15/00	15											
15/06	21											
15/12	25											
15/18	11											
mean	36	91	149	198	--	--	4	4	-12	-1	2	20
sample	14	10	6	2	0	0	10	6	2	10	6	2

Date/Time (UTC)	Center Position (km) T=00	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	Max. Wind (kt) T=24	=48	=72
TY Lan (1721)												
Oct. 15/18	0	57	89	101	109	107	4	15	5	-5	-10	0
16/00	35	105	56	129	108	25	-12	-20	-30	15	20	25
16/06	55	140	11	162	138	68	-15	-20	-30	15	20	25
16/12	40	99	89	192	201	151	-15	-25	-40	15	20	30
16/18	40	60	151	175	208	112	0	-20	-30	0	15	25
17/00	33	45	198	158	161	252	-5	-20	-45	5	15	30
17/06	95	100	207	147	73	416	-20	-30	-30	15	20	20
17/12	79	100	91	66	122	647	-5	-30	-25	5	20	15
17/18	25	87	48	21	198	790	-20	-30	-15	15	20	10
18/00	68	131	87	49	245		-20	-40	-15	15	25	10
18/06	22	58	22	155	482		-20	-25	-15	15	15	10
18/12	15	15	57	189	658		-20	-20	-15	15	10	10
18/18	31	81	146	298	887		-15	-10	10	10	5	-5
19/00	15	54	129	401			-15	0	20	10	0	-10
19/06	0	57	168	405			-5	0	20	5	0	-10
19/12	15	38	134	318			0	0	0	5	0	0
19/18	0	80	160	313			10	20	-5	-5	-10	5
20/00	0	85	190				15	30		-10	-15	
20/06	15	113	177				15	35		-10	-20	
20/12	15	144	159				10	15		-5	-10	
20/18	0	125	165				10	0		-5	0	
21/00	0	99					10			-5		
21/06	0	73					10			-5		
21/12	0	94					10			-5		
21/18	22	86					0			-5		
22/00	15											
22/06	31											
22/12	15											
22/18	0											
mean	23	85	121	193	276	285	-4	-8	-14	4	7	11
sample	29	25	21	17	13	9	25	21	17	25	21	17

STS Saola (1722)

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
Oct. 24/12	112	149	239	364	352		0	-2	-10	0	5	10
24/18	169	78	117	211	164		-6	-12	0	10	15	5
25/00	203	72	64	93	70		-2	-10	0	5	10	5
25/06	134	39	103	116	86		-7	-10	0	10	10	5
25/12	0	43	88	190			-7	-5	0	10	5	5
25/18	0	22	24	237			-7	5	0	10	0	5
26/00	0	46	78	381			-5	5	0	5	0	5
26/06	0	49	112	558			-5	5	5	5	0	0
26/12	0	90	335				0	5		0	0	
26/18	0	69	370				15	10		-10	-5	
27/00	0	93	359				10	15		-5	-10	
27/06	0	104	373				10	15		-5	-10	
27/12	0	125					10			-5		
27/18	0	59					10			-5		
28/00	0	66					10			-5		
28/06	0	75					5			-5		
28/12	0											
28/18	0											
29/00	0											
29/06	0											
mean	31	74	188	269	168	--	2	2	-1	1	2	5
sample	20	16	12	8	4	0	16	12	8	16	12	8

TY Damrey (1723)

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
Nov. 02/00	24	60	110				17	5		-20	-10	
02/06	11	71	156				10	-10		-10	10	
02/12	31	57	49				5	2		-5	-10	
02/18	55	46					5			-5		
03/00	25	11					0			0		
03/06	0	11					7			-10		
03/12	11	24					2			-10		
03/18	0											
04/00	0											
04/06	43											
04/12	80											
mean	25	40	105	--	--	--	7	-1	--	-9	-3	--
sample	11	7	3	0	0	0	7	3	0	7	3	0

TS Haikui (1724)

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
Nov. 10/00	31	93	46				-6	-17		5	20	
10/06	15	70					-6			5		
10/12	31	46					-6			5		
10/18	15	57					-8			10		
11/00	24	57					-8			10		
11/06	86											
11/12	141											
11/18	42											
12/00	15											
mean	45	65	46	--	--	--	-7	-17	--	7	20	--
sample	9	5	1	0	0	0	5	1	0	5	1	0

TS Kirogi (1725)

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
Nov. 18/00	70											
18/06	103											
18/12	103											
18/18	25											
mean	75	--	--	--	--	--	--	--	--	--	--	--
sample	4	0	0	0	0	0	0	0	0	0	0	0

TS Kai-tak (1726)

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
Dec. 14/00	86	158	78				4	-2		-5	5	
14/06	24	120	57				2	-6		0	10	
14/12	101	109					0			5		
14/18	77	55					-2			10		
15/00	33	11				297	-4			10		
15/06	16	33				219	-4			10		
15/12	60					261						
15/18	25					254						
16/00	47				203	310						
16/06	55				169	180						
16/12												
16/18												
17/00												
17/06												
17/12												
17/18												
18/00												
18/06												
18/12												
18/18												
19/00												
19/06												
19/12												
19/18												
20/00	46	40					0			0		
20/06	11	11					0			0		
20/12	81											
20/18	47											
21/00	40											
21/06	16											
mean	48	67	67	--	186	254	0	-4	--	4	8	--
sample	16	8	2	0	2	6	8	2	0	8	2	0

TY Tembin (1727)

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
Dec. 20/18	50	149	205	419	415		8	8	19	-10	-10	-20
21/00	66	123	102	237	242		6	13	24	-5	-15	-25
21/06	47	118	86	212	203		0	12	22	5	-10	-20
21/12	40	55	110	172			4	10	10	0	-10	-10
21/18	0	78	220	227			4	15	5	-10	-15	0
22/00	44	74	206	205			9	20	-7	-10	-20	10
22/06	22	105	198	181			12	15	-11	-15	-15	15
22/12	11	133	174				17	10		-20	-10	
22/18	11	115	120				17	5		-15	5	
23/00	11	86	113				15	-7		-10	15	
23/06	0	86	89				10	-11		-5	20	
23/12	0	55					0			5		
23/18	22	40					-5			15		
24/00	56	80					-7			15		
24/06	0	110					-11			20		
24/12	11											
24/18	11											
25/00	25											
25/06	0											
mean	22	94	148	236	287	--	5	8	9	-3	-6	-7
sample	19	15	11	7	3	0	15	11	7	15	11	7

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 - 2017

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
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 YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
120HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ 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 (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=06 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=12 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=18 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
:
T=84 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=06 15.4N 125.8E +018HPA -008KT
T=12 15.5N 125.6E +011HPA -011KT
T=18 15.8N 125.7E +027HPA -028KT
                  :
                  :
T=84 20.7N 128.8E +021HPA -022KT=
```

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

Example:

```
WTPQ30 RJTD 180000

RSMC TROPICAL CYCLONE PROGNOSTIC REASONING
REASONING NO. 9 FOR TY 0001 DAMREY (0001)
        1.GENERAL COMMENTS
REASONING OF PROGNOSIS THIS TIME IS SIMILAR TO PREVIOUS ONE.
POSITION FORECAST IS MAINLY BASED ON NWP AND PERSISTENCY.
        2.SYNOPTIC SITUATION
SUBTROPICAL RIDGE WILL NOT CHANGE ITS LOCATION AND STRENGTH FOR THE NEXT 24 HOURS.
        3.MOTION FORECAST
POSITION ACCURACY AT 180000 UTC IS GOOD.
TY WILL DECELERATE FOR THE NEXT 12 HOURS.
TY WILL RECURVE WITHIN 60 HOURS FROM 180000 UTC.
TY WILL MOVE WEST FOR THE NEXT 12 HOURS THEN MOVE GRADUALLY TO WEST-NORTHWEST.
        4.INTENSITY FORECAST
TY WILL KEEP PRESENT INTENSITY FOR NEXT 24 HOURS.
FI-NUMBER WILL BE 7.0 AFTER 24 HOURS.=
```

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

AXPQ20 RJTD YYGGgg
RSMC TROPICAL CYCLONE BEST TRACK
NAME ty-No. name (common-No.)
PERIOD FROM MMMDDTTUTC TO MMMDDTTUTC
DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT
DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT
:
:
DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT
REMARKS[1]
TD FORMATION AT MMMDDTTUTC
FROM TD TO TS AT MMMDDTTUTC
:
:
DISSIPATION AT MMMDDTTUTC=

Notes:

a. Underlined parts are fixed.

b. [1] REMARKS is given optionally.

c. Symbolic letters

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

Example:

```
AXPQ20 RJTD 020600

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

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

FKPQ i i RJTD YYGGgg
TC ADVISORY

DTG:	yyyymmdd/time Z
TCAC:	TOKYO
TC:	name
NR:	number
PSN:	N LaLa.LaLa E LoLoLo.LoLo

MOV:	direction SpSpSp KT
C:	PPPP HPA
MAX WIND:	WWW KT
FCST PSN +6HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo*
FCST MAX WIND +6HR:	WWW KT*
FCST PSN +12HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo
FCST MAX WIND +12HR:	WWW KT
FCST PSN +18HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo*
FCST MAX WIND +18HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo*
FCST PSN +24HR:	YY/GGgg Z N LaLa.LaLa E LoLoLo.LoLo
FCST MAX WIND +24HR:	WWW KT
RMK:	NIL =
NXT MSG:	yyyymmdd/time Z

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

Notes:

a. Underlined parts are fixed.

b. Abbreviations

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

c. Symbolic letters

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

Example:

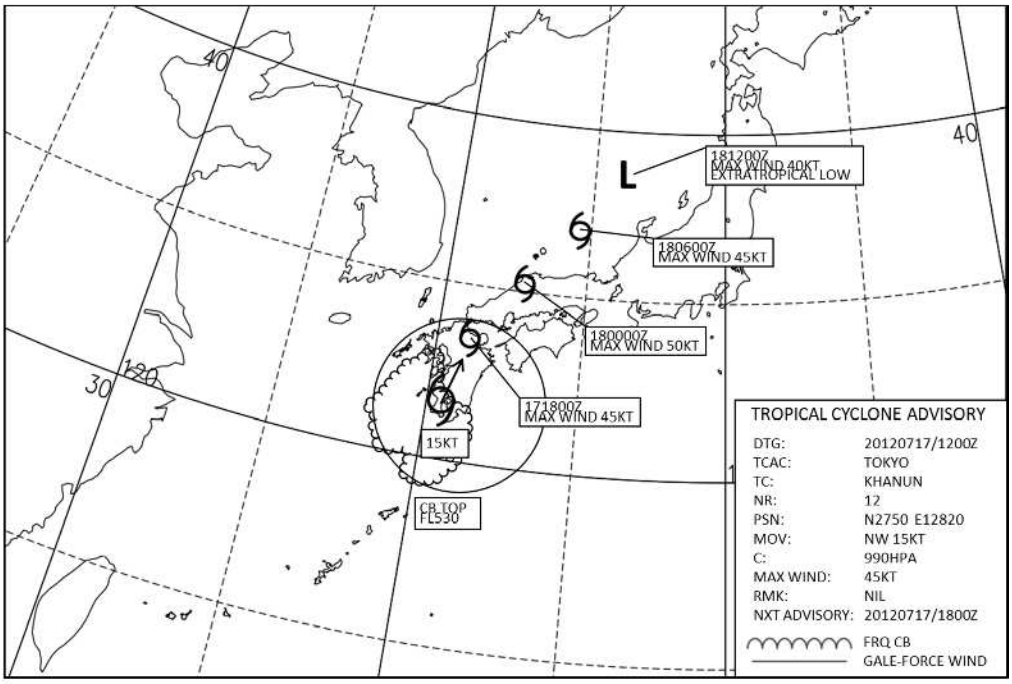
FKPQ30 RJTD 271200
TC ADVISORY

DTG:	20080927/1200Z
TCAC:	TOKYO
TC:	JANGMI
NR:	15
PSN:	N2120 E12425
MOV:	NW 13KT
C:	910HPA
MAX WIND:	115KT
FCST PSN +6HR:	27/1800Z N2200 E12330
FCST MAX WIND +6HR:	115KT
FCST PSN +12HR:	28/0000Z N2240 E12250
FCST MAX WIND +12HR:	115KT
FCST PSN +18HR:	28/0600Z N2340 E12205
FCST MAX WIND +18HR:	95KT

FCST PSN +24HR:	28/1200Z N2440 E12105
FCST MAX WIND +24HR:	80KT
RMK:	NIL
NXT MSG:	20080927/1800Z =

(7) Graphical Tropical Cyclone Advisory for SIGMET

Example:



TROPICAL CYCLONE ADVISORY CENTER TOKYO

Appendix 6

Specifications of JMA’s NWP Models (GSM, GEPS)

The Global Spectral Model (GSM) and the Global Ensemble Prediction System (GEPS) are used in JMA as a primary basis for TC forecasts. The general specifications of GSM and GEPS are summarized in Table 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)	84h (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 and GEPS]

GSM:

- Parameterization schemes including deep convection, cloud, radiation, land surface and sea surface were revised (May 2017).
- A stratospheric methane oxidation parameterization scheme was implemented (May 2017).
- Discretization in calculation of pressure gradient force terms was revised (May 2017).

Global Data Assimilation System:

- Usage of GNSS radio occultation data was revised. (July 2017).
- Background error statistics in the data assimilation system were revised (May 2017).
- Assimilation of Suomi-NPP/ATMS, Suomi-NPP/CrIS and DMSP-F17 and 18/SSMIS (183 GHz) was commenced (March 2017).
- Transition of AMV and CSR from Meteosat-7 to Meteosat-8 was completed (March 2017).

GEPS:

- GEPS was put into operation (January 2017), replacing the Typhoon Ensemble Prediction System (TEPS).

[References]

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

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

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Products on WIS GISC Tokyo Server

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

NWP products (GSM and EPS)

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 † 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	Global EPS
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/)

Appendix 8

Products on NTP Website

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

Products	Frequency	Details
Observation/Analysis		
TC 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 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
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 difference from 24 hours ago • Tropical cyclone heat potential and difference 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 ensemble NWP models from four centers (ECMWF, NCEP, UKMO and JMA)
NWP Weather Maps	Twice/day	• Mean sea level pressure and 500 hPa Geopotential height (up to 72 hours at 00 UTC, up to 168 hours at 12 UTC) 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 ensemble NWP models from two centers (ECMWF and UKMO) 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)
Wave Height Forecasts	Twice/day	• Distribution maps of ensemble mean wave height, maximum wave height, probability of exceeding various wave heights and ensemble spread based on Wave Ensemble System (WENS) (up to 264 hours ahead) • Time-series charts of ensemble mean wave height with ensemble spread information and probability of exceeding various wave heights based on Wave Ensemble System (WENS) (up to 264 hours ahead)

Appendix 9

User's Guide to the DVD

Preface

This DVD contains all the texts, tables and charts of the RSMC Annual Report 2017 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 2017. 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 2017 in PDF)
        |---Figure (figures in PDF)
        |---Table (tables in PDF)
        |---Appendix (appendices for MS Word, Excel and PDF)
|------Best_Track
        |---E_BST_2017.txt (best track data for 2017)
        |---E_BST_201704.txt (best track data for TCs generated in April 2017)
                :
        |---E_BST_201712.txt (best track data for TCs generated in December 2017)
|------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
        |---T1701 (hourly satellite image data for T1701)
        |---T1702 (hourly satellite image data for T1702)
            :
        |---T1727 (hourly satellite image data for T1727)
```

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 2017, 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 2017>

Annual Report 2017 is provided in two formats as PDF files and MS Word/Excel files.

- PDF files:

Click *Annual Report 2017* 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 2017 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.

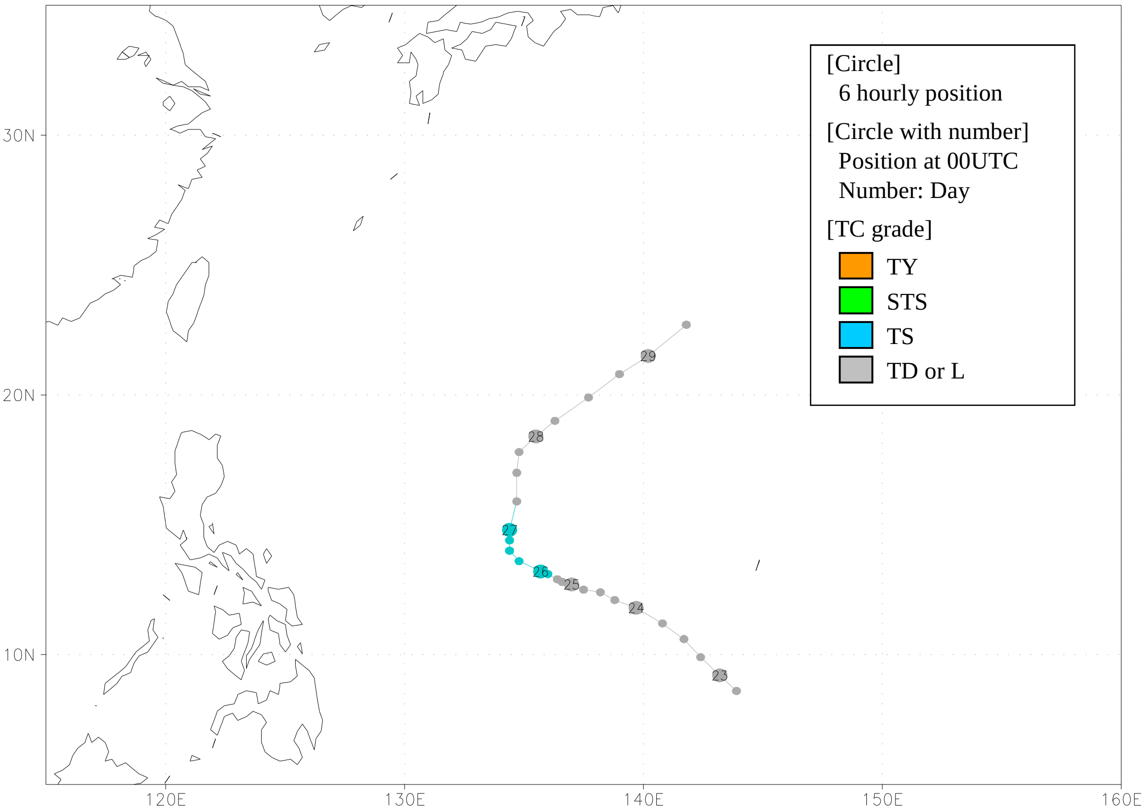
For further information, please contact:

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 2017

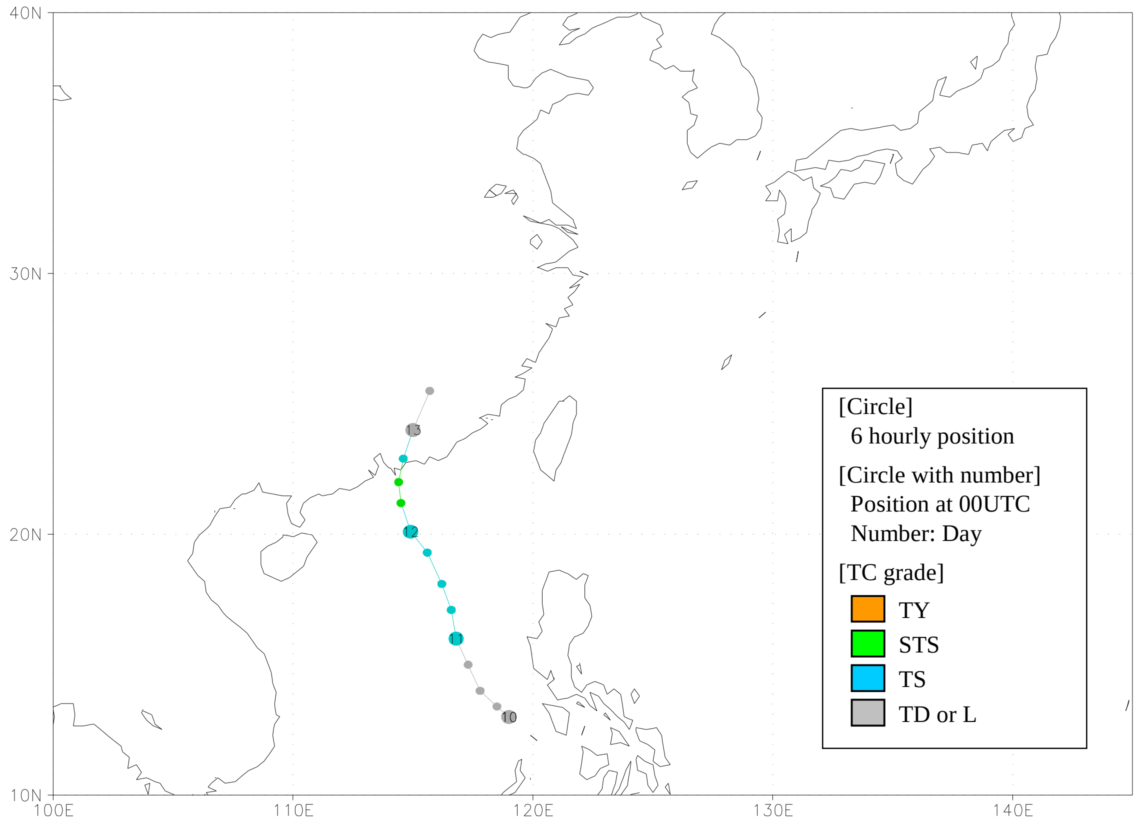
MUIFA (1701)

MUIFA formed as a tropical depression (TD) around the Caroline Islands at 18 UTC on 22 April 2017 and moved west-northwestward. 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 around the sea east of the Philippines at 18 UTC on 25 April. After turning northward, MUIFA weakened to TD intensity over the same waters at 06 UTC on 27 April. It turned northeastward and dissipated south of the Ogasawara Islands at 12 UTC on 29 April.



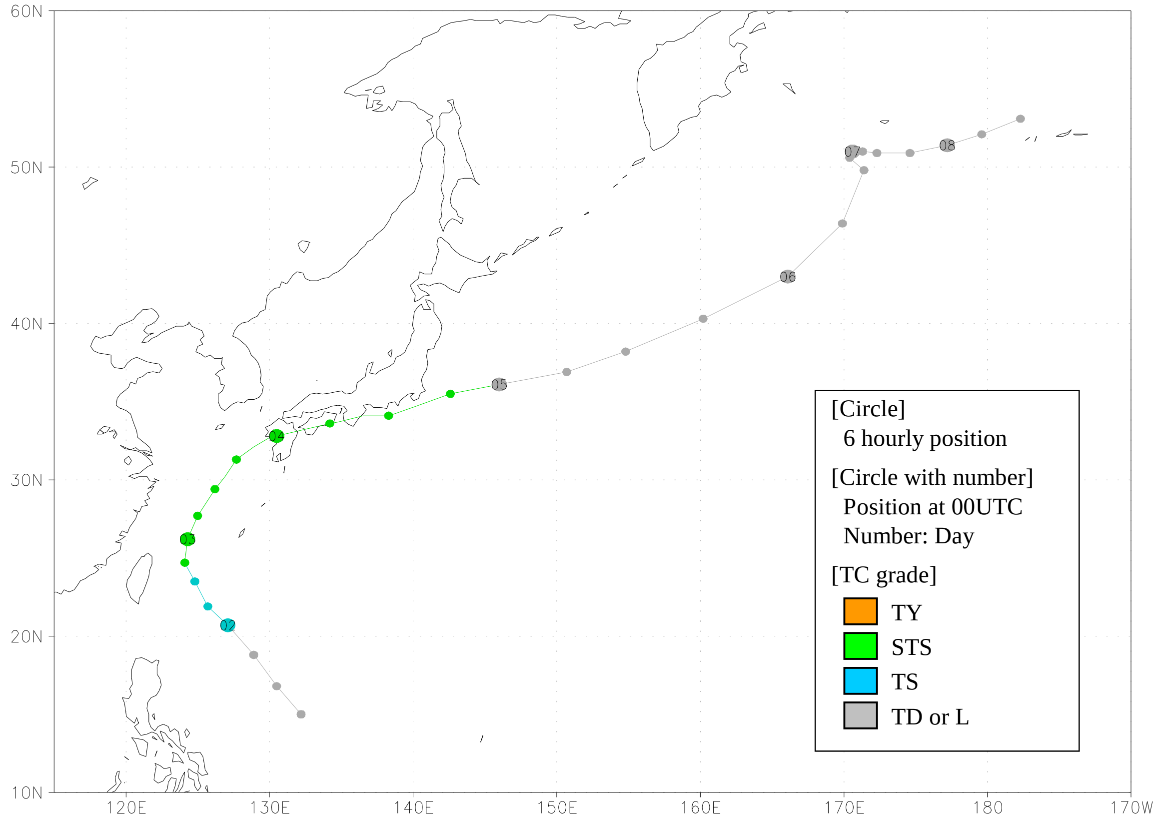
MERBOK (1702)

MERBOK formed as a tropical depression (TD) over the South China Sea at 00 UTC on 10 June 2017. After moving north-northwestward, it was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on the next day. Keeping its north-northwestward track, MERBOK reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 985 hPa southeast of Hong Kong at 12 UTC on 12 June. After turning north-northeastward and crossing the coast line of the southern part of China with STS intensity, it downgraded to TS intensity on 18 UTC the same day and weakened to TD intensity in the same area 6 hours later. MERBOK dissipated there at 12 UTC on 13 June.



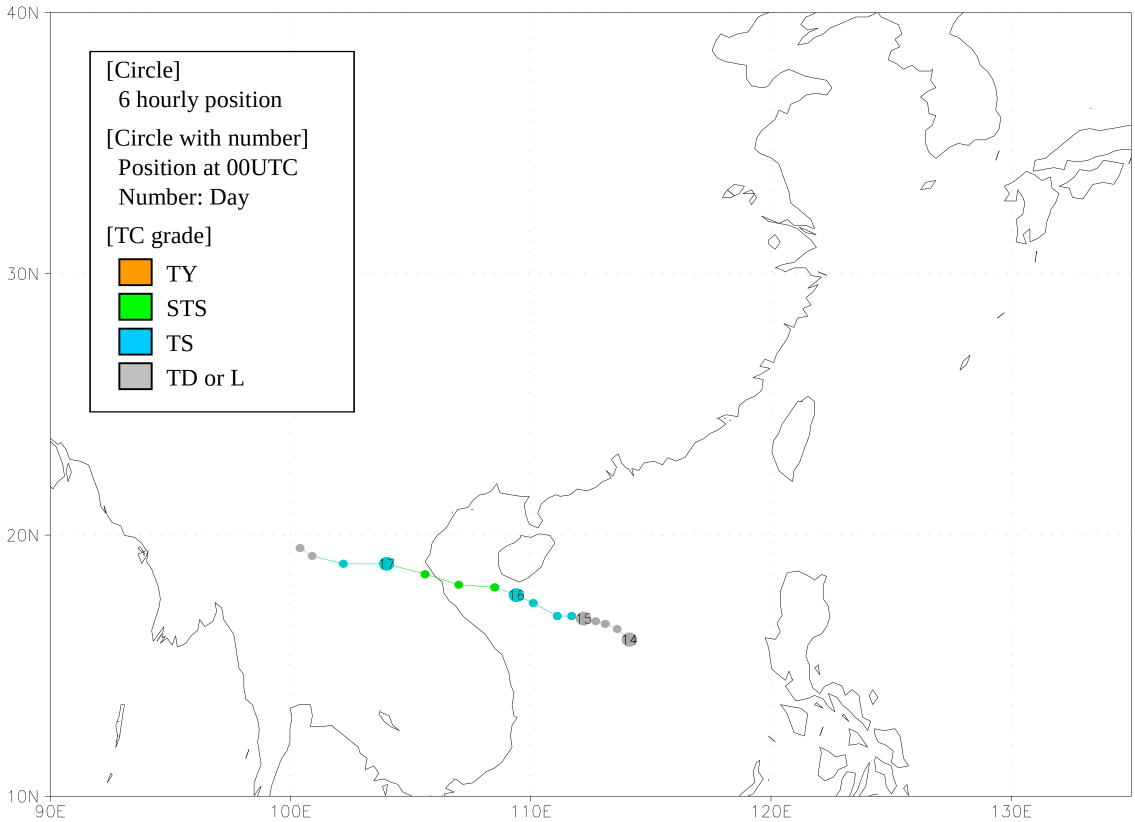
NANMADOL (1703)

NANMADOL formed as a tropical depression (TD) around the sea east of the Philippines at 06 UTC on 1 July 2017. Moving northwestward, it was upgraded to tropical storm (TS) intensity around the sea south of Okinawa Island at 00 UTC on 02 July. NANMADOL gradually turned northeastward and reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 985 hPa over the East China Sea at 06 UTC on 03 July. NANMADOL made a landfall on Nagasaki City, Nagasaki Prefecture around 2300 UTC on 3 July and made landfall on Uwajima City, Ehime Prefecture after 0300 UTC the next day. After making landfall on Tanabe City, Wakayama Prefecture before 0800 UTC on 4 July, NANMADOL transformed into an extratropical cyclone around the sea east of Japan at 00 UTC on 5 July. It moved northeastward and crossed longitude 180 degrees east at 12 UTC on 8 July.



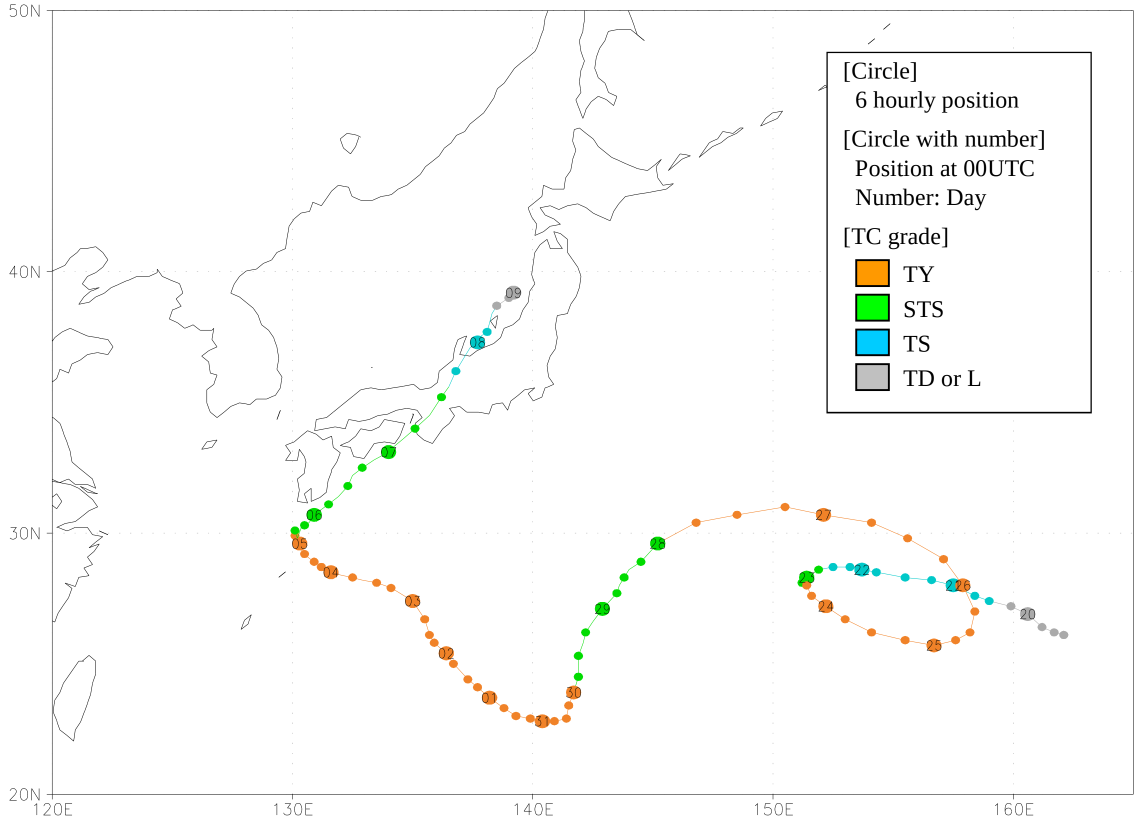
TALAS (1704)

TALAS formed as a tropical depression (TD) over the South China Sea at 00 UTC on 14 July 2017. Moving west-northwestward, it was upgraded to tropical storm (TS) intensity over the same waters at 06 UTC on 15 July. Shortly after hitting the northern part of Viet Nam, TALAS reached its peak intensity as a severe tropical storm (STS) with maximum sustained winds of 50 kt and a central pressure of 985 hPa on 18 UTC on 16 July. TALAS weakened to TD intensity in Thailand at 12 UTC on 17 July and dissipated 12 hours later.



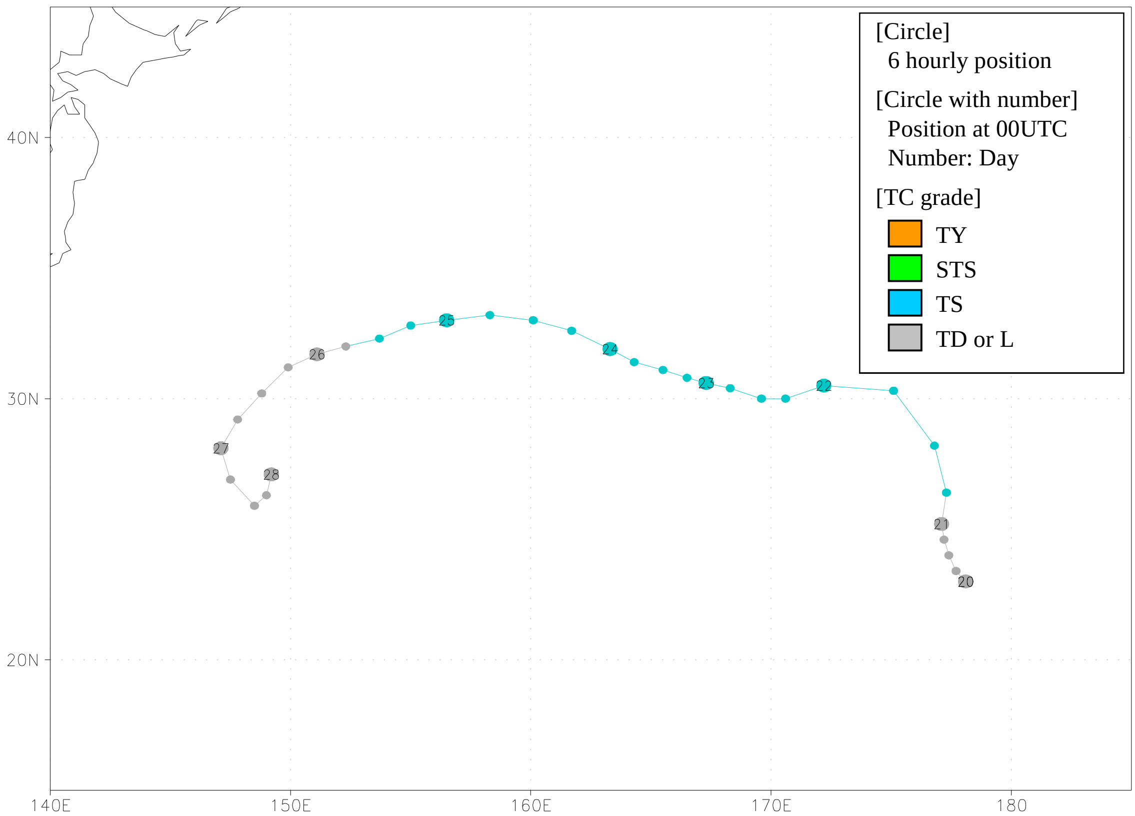
NORU (1705)

NORU formed as a tropical depression (TD) over the sea east of Minamitorishima Island at 06 UTC on 19 July 2017. Moving westward, it was upgraded to tropical storm (TS) intensity northeast of the same island at 12 UTC on the next day. Shortly after turning in a counterclockwise direction, NORU was upgraded to typhoon (TY) intensity northwest of Minamitorishima Island at 12 UTC on 23 July. Gradually turning southwestward, it weakened to severe tropical storm (STS) intensity northeast of Chichijima Island.at 00 UTC on 28 July. Keeping its southwestward track, NORU gradually developed and was upgraded to TY intensity again at 00 UTC on 30 July. Gradually turning northwestward, it reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 935 hPa south-southwest of Chichijima Island at 00 UTC on 31 July. After that NORU remained almost stationary over the sea west of Yakushima Island on 5 August and weakened to STS intensity at 12 UTC on the same day. After moving northeastward, it passed over Yakushima Island with STS intensity after 17 UTC on 5 August, and passed over Tanegashima Island with STS intensity around 0030 UTC on the next day. After passing around Cape Muroto before 01 UTC on 7 August, Noru made landfall in the northern part of Wakayama Prefecture with STS intensity after 06 UTC on the same day. Keeping its northeastward track, NORU crossed the central Honshu Island and entered the Sea of Japan on 8 August. It transformed into an extratropical cyclone over the same waters at 12 UTC on the same day. Noru dissipated over the Sea of Japan at 12 UTC on 9 August.



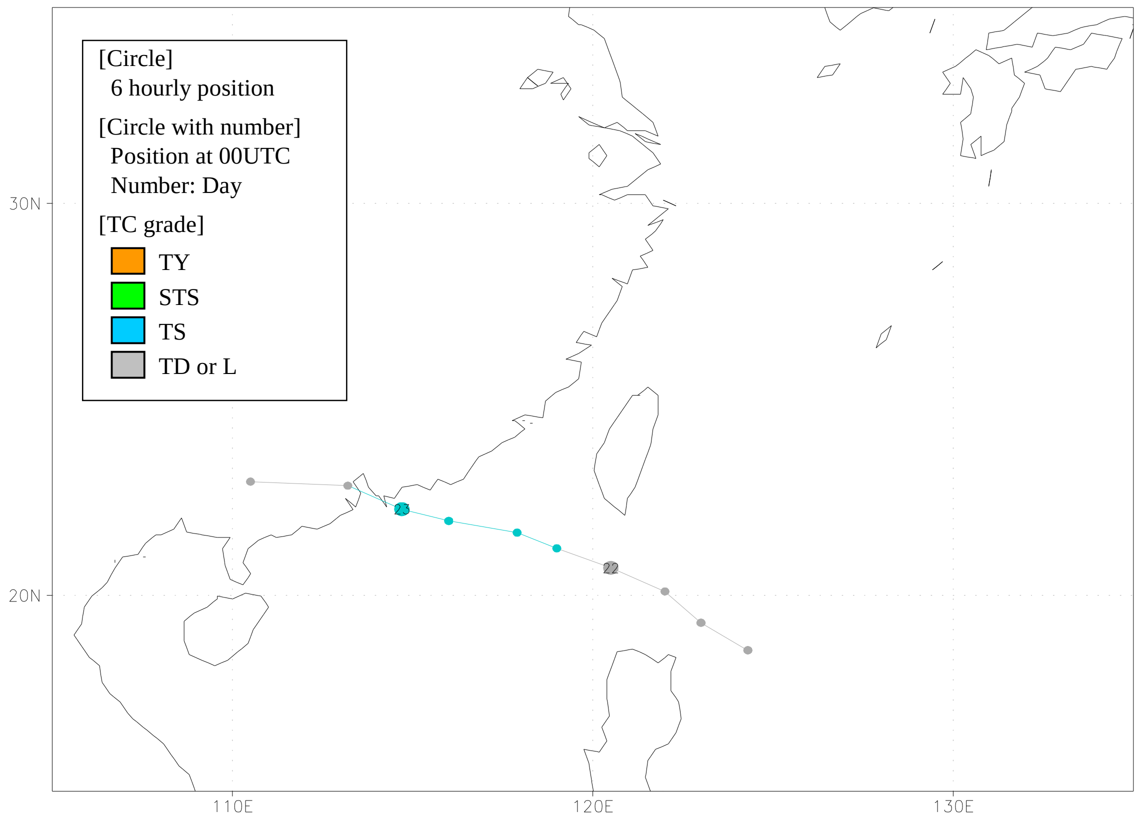
KULAP (1706)

KULAP formed as a tropical depression (TD) over the sea southwest of the Midway Islands at 00 UTC on 20 July 2017. Moving northward, it was upgraded to tropical storm (TS) intensity over the sea west of the Midway Islands at 06 UTC the next day. Turning westward, KULAP reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 1002 hPa far east of Japan at 18 UTC on 06 UTC on 23 July. Keeping its westward track, KULAP was downgraded to TD intensity over the sea east of Japan at 18 UTC on 25 July. It dissipated over the sea east of the Ogasawara Islands at 06UTC on 28 July.



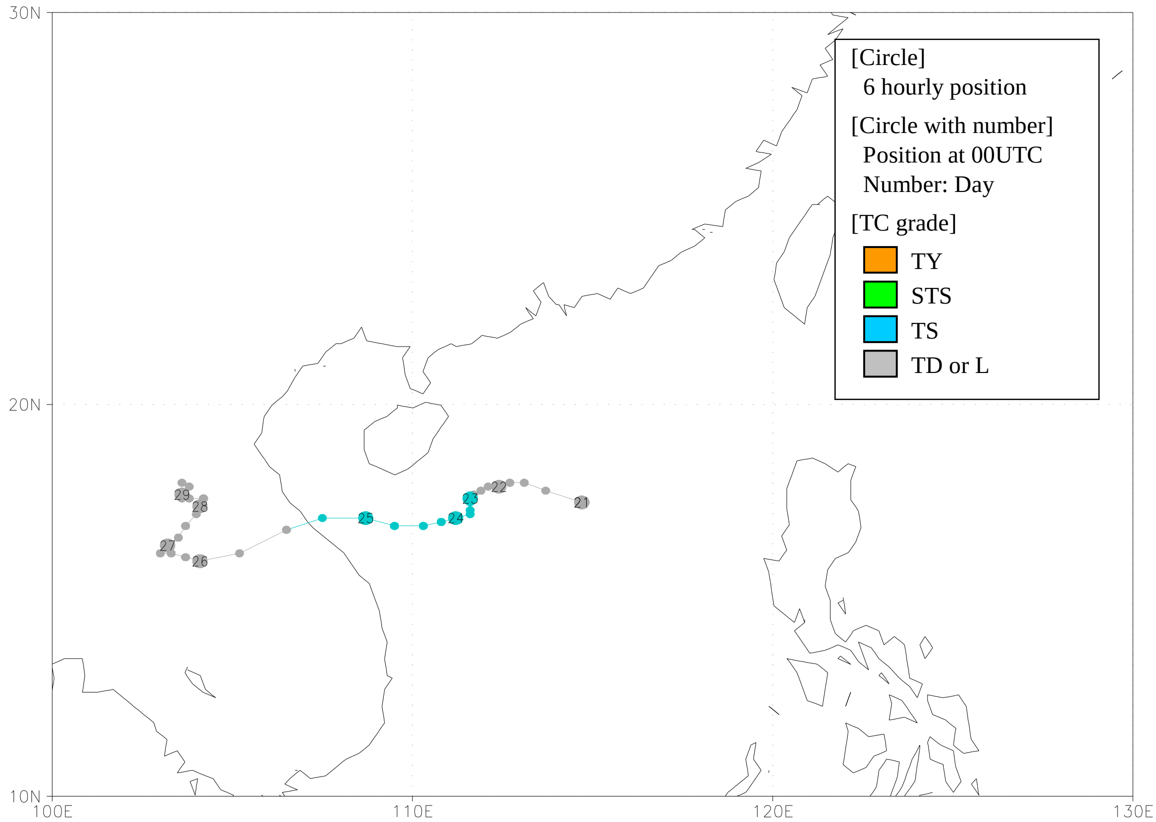
ROKE (1707)

ROKE formed as a tropical depression (TD) around the sea south-southwest of Okinawa Island at 06 UTC on 21 July 2017. After moving west-northwestward, it was upgraded to tropical storm (TS) intensity around the Luzon Strait at 06 UTC on 22 July and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 1002 hPa over the South China Sea six hours later. Keeping its west-northwestward track, ROKE crossed the coast line of the southern part of China with TS intensity early on 23 July. It weakened to TD intensity there at 06 UTC on 23 July and dissipated 12 hours later.



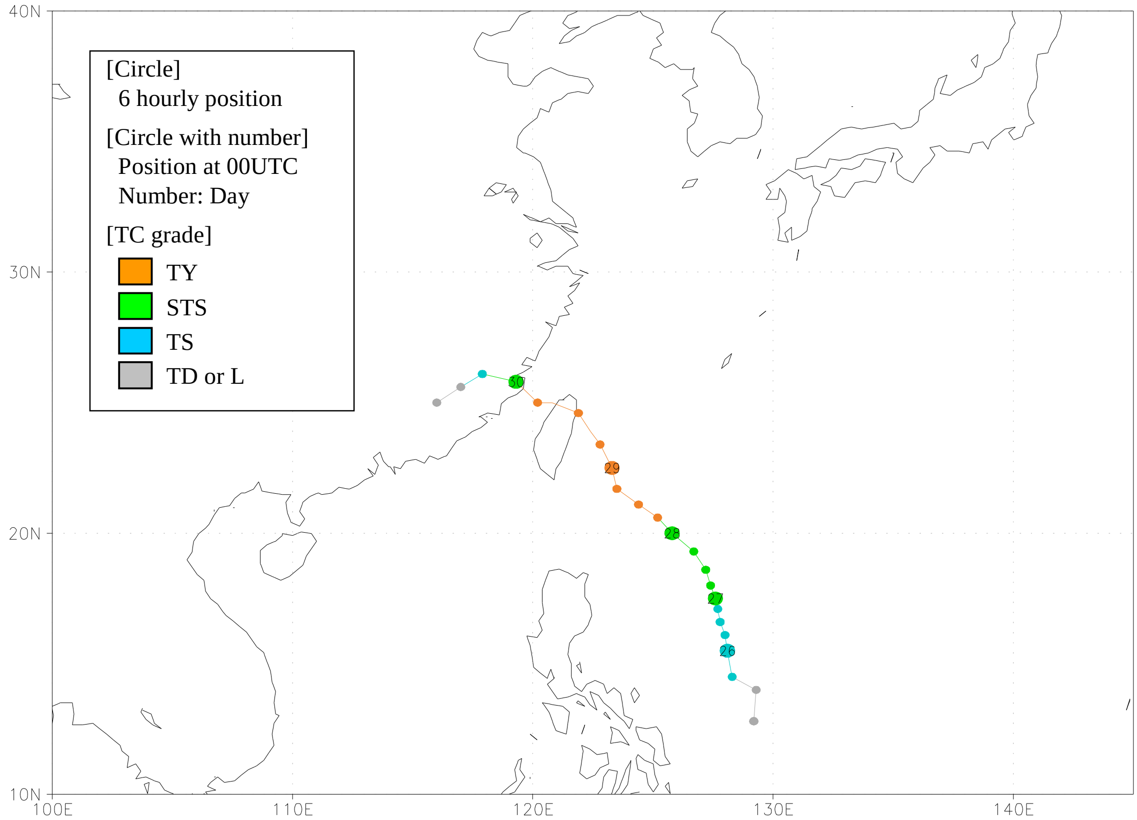
SONCA (1708)

SONCA formed as a tropical depression (TD) over the South China Sea at 00 UTC on 21 July 2017. After moving westward, it was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 23 July and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 994 hPa off the eastern coast of Viet Nam on 18UTC on 24 July. Moving westward, SONCA hit the central part of Viet Nam with TS intensity on the next day. It weakened to TD intensity in Laos at 12 UTC on 25 July and dissipated in Thailand on 18UTC on 29 July.



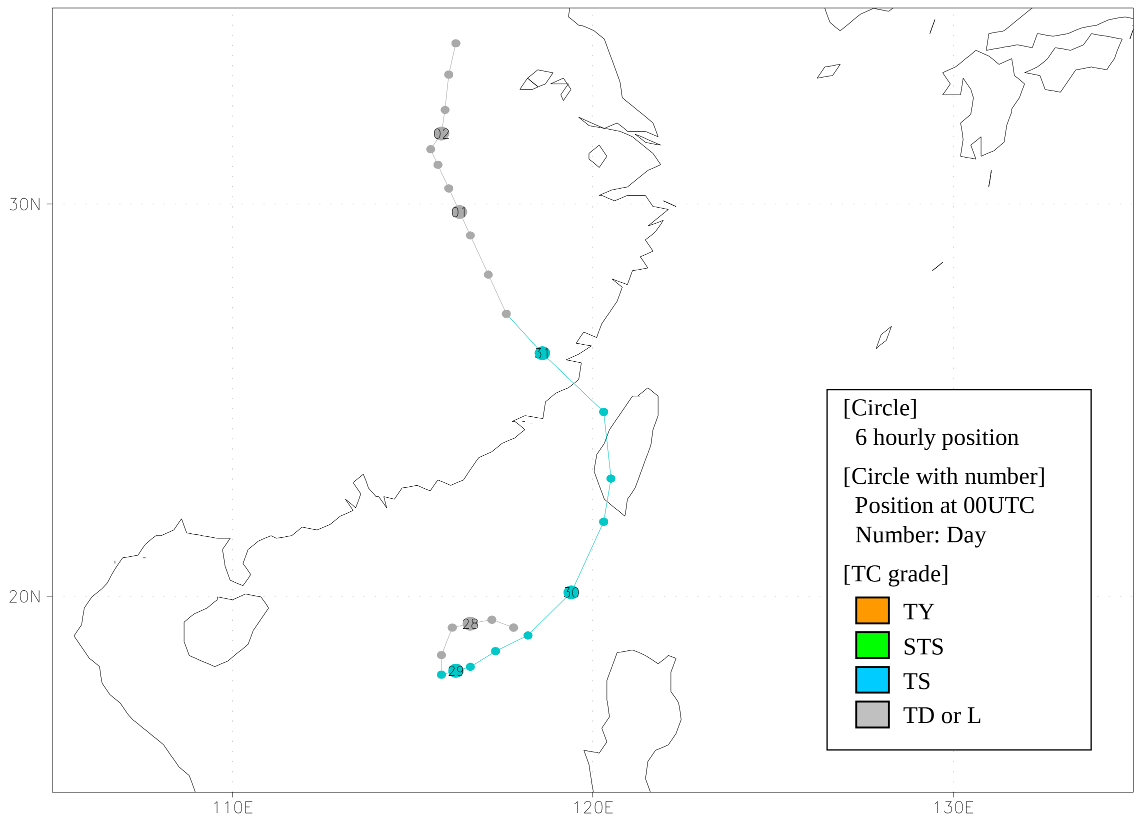
NESAT (1709)

NESAT formed as a tropical depression (TD) over the sea east of the Philippines at 06 UTC on 25 July 2017 and moved north-northwestward. NESAT was upgraded to tropical storm (TS) intensity at 18 UTC on the same day over the same waters and was upgraded to typhoon (TY) intensity at 06 UTC on 28 July over the sea southeast of Taiwan Island. It reached its peak intensity with maximum sustained winds of 80 kt and a central pressure of 960 hPa southeast of Taiwan Island at 18 UTC on 28 July. NESAT crossed Taiwan Island on 29 July and then turned west-northwestward. After entering the Taiwan Strait, it hit the coast of southeastern China at 00 UTC on 30 July and weakened to a TD at 12 UTC on the same day. NESAT dissipated on southeastern China at 00 UTC on 31 July.



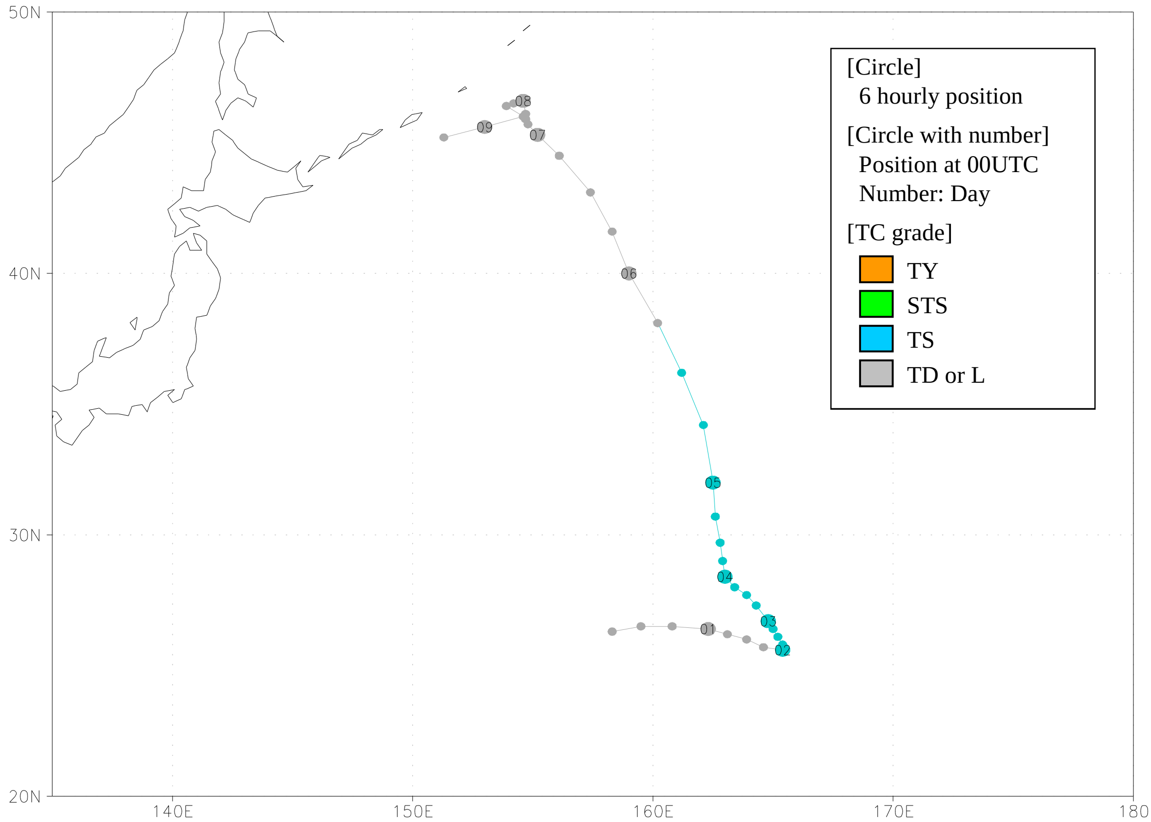
HAITANG (1710)

HAITANG formed as a tropical depression (TD) over the South China Sea at 12 UTC on 27 July 2017. Turning in a counterclockwise direction to circle, it was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on 28 July. HAITANG reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 985 hPa south of Taiwan Island at 06 UTC on 30 July. After crossing Taiwan Island, it hit southeast of China late on the same day. HAITANG weakened to TD intensity in the same area at 06 UTC on 31 July. It transformed into an extratropical cyclone around the lower Yangtze River at 06 UTC on 1 August and moved northward. It dissipated around the lower Yellow River at 00 UTC on 3 August.



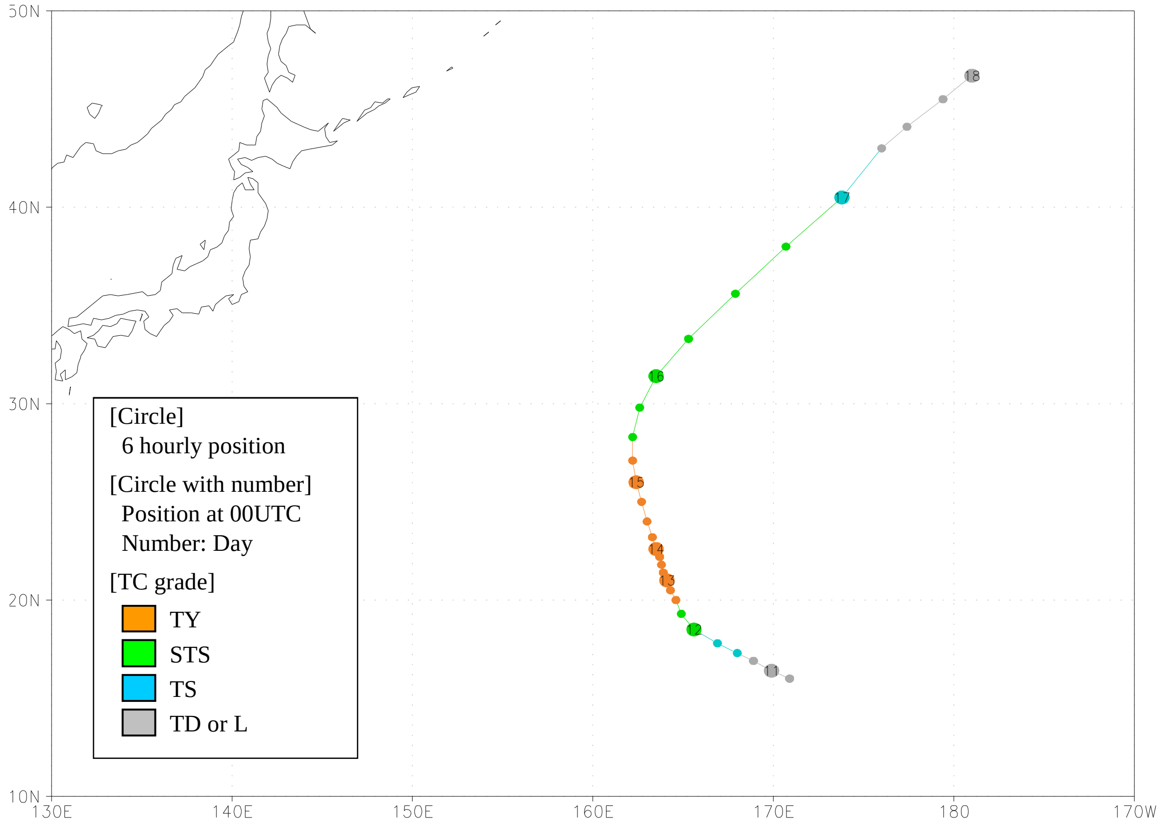
NALGAE (1711)

NALGAE formed as a tropical depression (TD) northeast of Minamitorishima Island at 06 UTC on 31 July 2017 and moved eastward. It was upgraded to tropical storm (TS) intensity north of Wake Island at 00 UTC on 2 August. NALGAE turned sharply north-northwestward and reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 990 hPa far east of Japan at 06 UTC on 5 August. It transformed into an extratropical cyclone over the same waters 12 hours later. After drawing a counterclockwise loop east of the Chishima Islands, NALGAE turned west-southwestward and dissipated around the same waters at 12 UTC on 9 August.



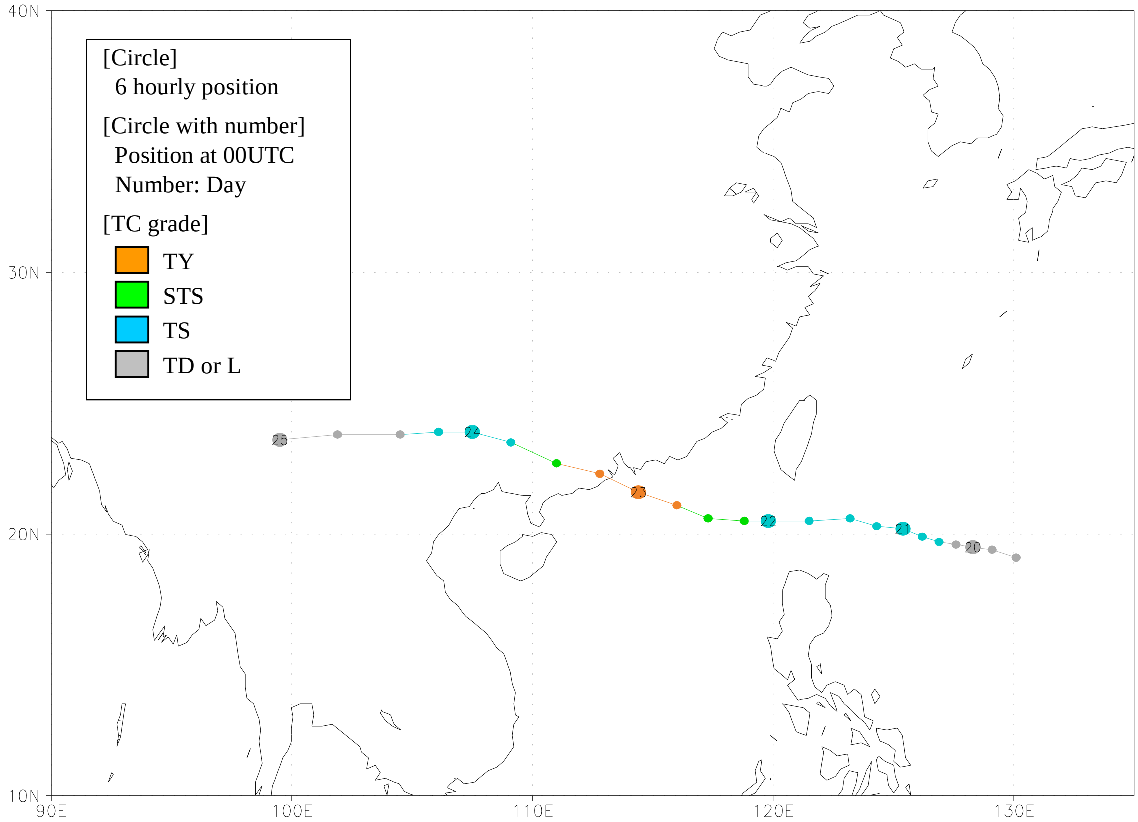
BANYAN (1712)

BANYAN formed as a tropical depression (TD) southeast of Wake Island at 18 UTC on 10 August 2017. After moving northwestward, it was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC the next day. Turning north-northwestward, BANYAN was upgraded to typhoon (TY) intensity northwest of Wake Island at 12 UTC on 12 August, and reached its peak intensity with maximum sustained winds of 80 kt and a central pressure of 955 hPa over the same waters 12 hours later. After accelerating northeastward, BANYAN transformed into an extratropical cyclone around sea south of the Aleutian Islands at 06 UTC on 17 August, and crossed longitude 180 degrees east over the same waters before 00 UTC the next day.



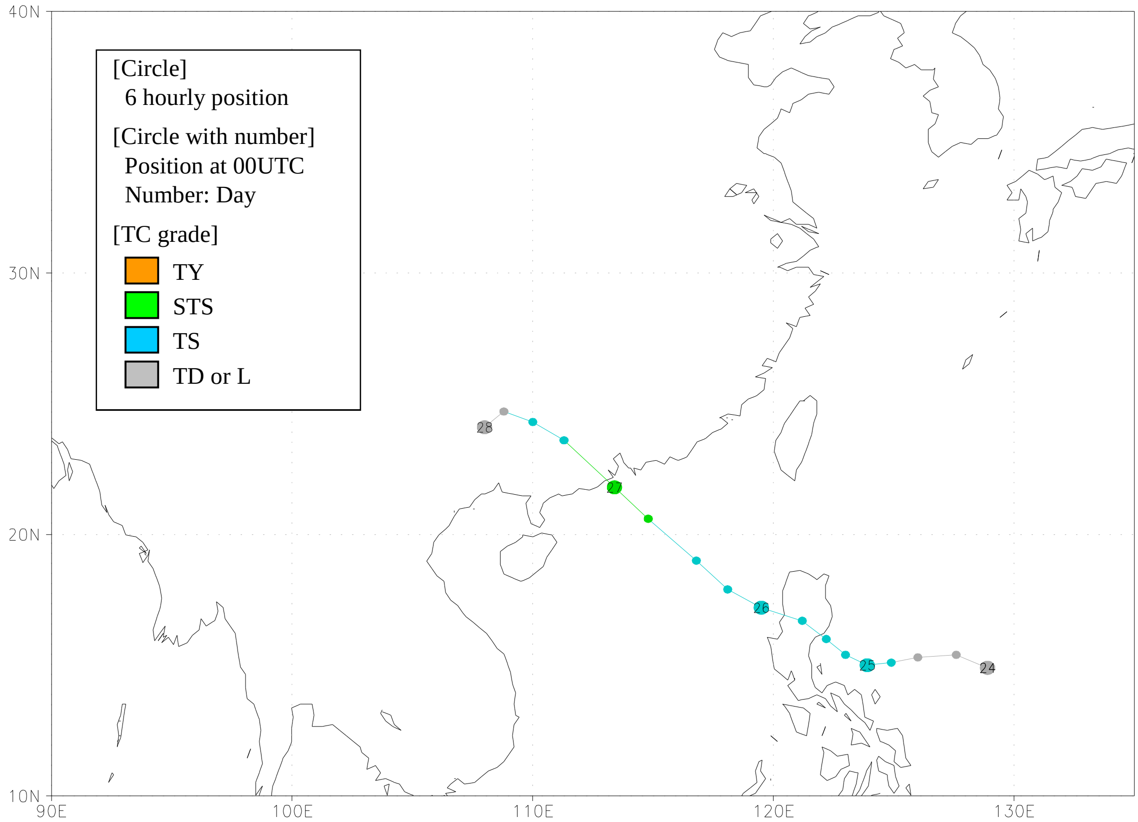
HATO (1713)

HATO formed as a tropical depression (TD) over the sea east of the Philippines at 12 UTC on 19 August 2017 and moved westward. It was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on 20 August. After passing the Luzon Strait, HATO was upgraded to typhoon (TY) intensity over the northern part of the South China Sea at 18 UTC on 22 August. It reached its peak intensity with maximum sustained winds of 75 kt and a central pressure of 965 hPa over the same waters 6 hours later. After hitting the southern part of China with TY intensity early on 23 August, HATO rapidly weakened to TD intensity there at 12 UTC on 24 August and crossed longitude 100 degrees east at 00 UTC on the next day.



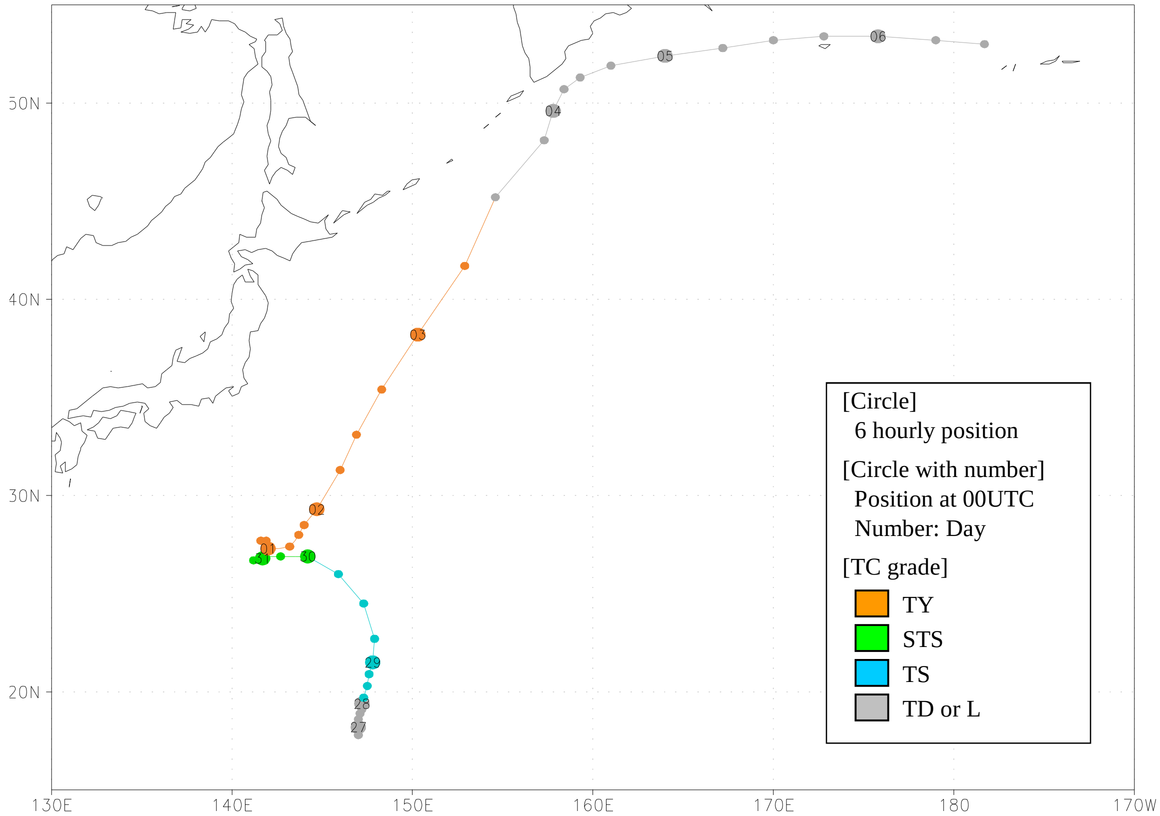
PAKHAR (1714)

PAKHAR formed as a tropical depression (TD) around sea east of the Philippines at 00 UTC on 24 August 2017. Moving westward, it was upgraded to tropical storm (TS) intensity east of Luzon Island at 18 UTC on the same day. Turning northwestward, it crossed the island late on 25 August and entered the South China Sea. PAKHAR was upgraded to severe tropical storm (STS) intensity at 18 UTC on 26 August, and reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 985 hPa over the same waters 6 hours later. After hitting the southern part of China, it weakened to TD intensity there at 18 UTC on 27 August and dissipated at 06 UTC on the next day.



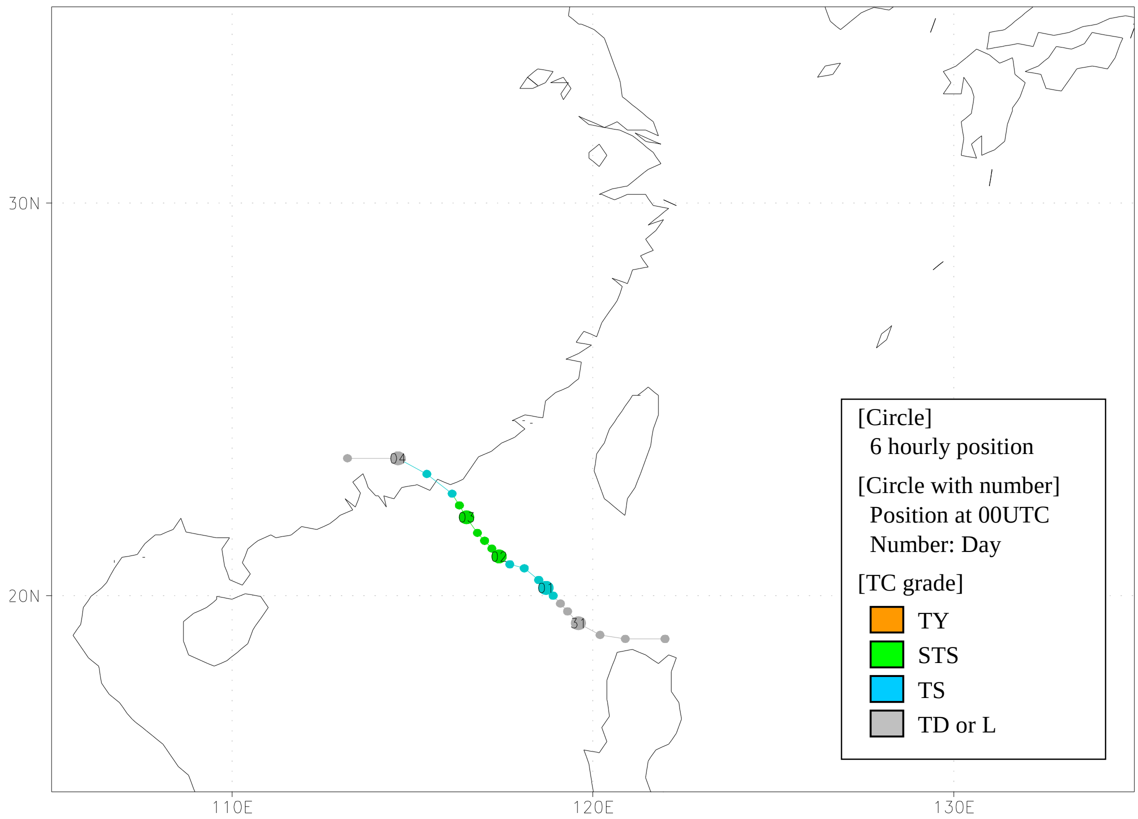
SANVU (1715)

SANVU formed as a tropical depression (TD) around the sea east of the Northern Mariana Islands at 18 UTC on 26 August 2017. After moving northward, it was upgraded to tropical storm (TS) intensity over the same waters at 06 UTC on 28 August. After gradually turned westward, SANVU was upgraded to typhoon (TY) intensity at 12 UTC on 31 August during its turning in a counterclockwise direction to circle twice around the Ogasawara Islands. SANVU reached its peak intensity with maximum sustained winds of 80 kt and a central pressure of 955 hPa over the same waters at 00 UTC on 1 September. SANVU turned north-eastward and transformed into an extratropical cyclone over the sea east of the Chishima Islands at 12 UTC on 3 September. It crossed longitude 180 degrees east over the sea around the Aleutian Islands before 12 UTC on 6 September.



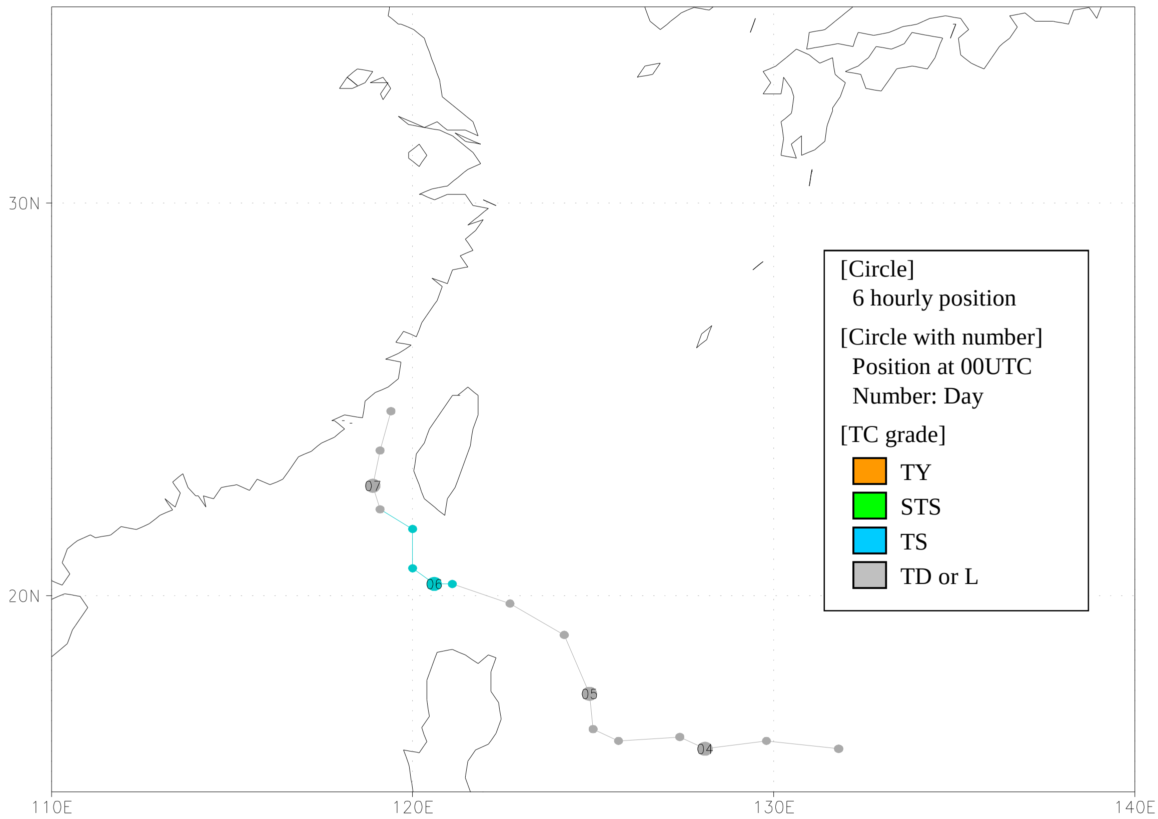
MAWAR (1716)

MAWAR formed as a tropical depression (TD) over the Balintang Channel at 06 UTC on 30 August 2017. Moving northwestward, it was upgraded to tropical storm (TS) intensity over the South China Sea at 18 UTC on 31 August. MAWAR 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 over the same waters at 00 UTC on 2 September. MAWAR hit the coast of southern China late on 3 September before weakening to TD intensity at 00 UTC on 4 September, and dissipated over southern China at 12 UTC on the same day.



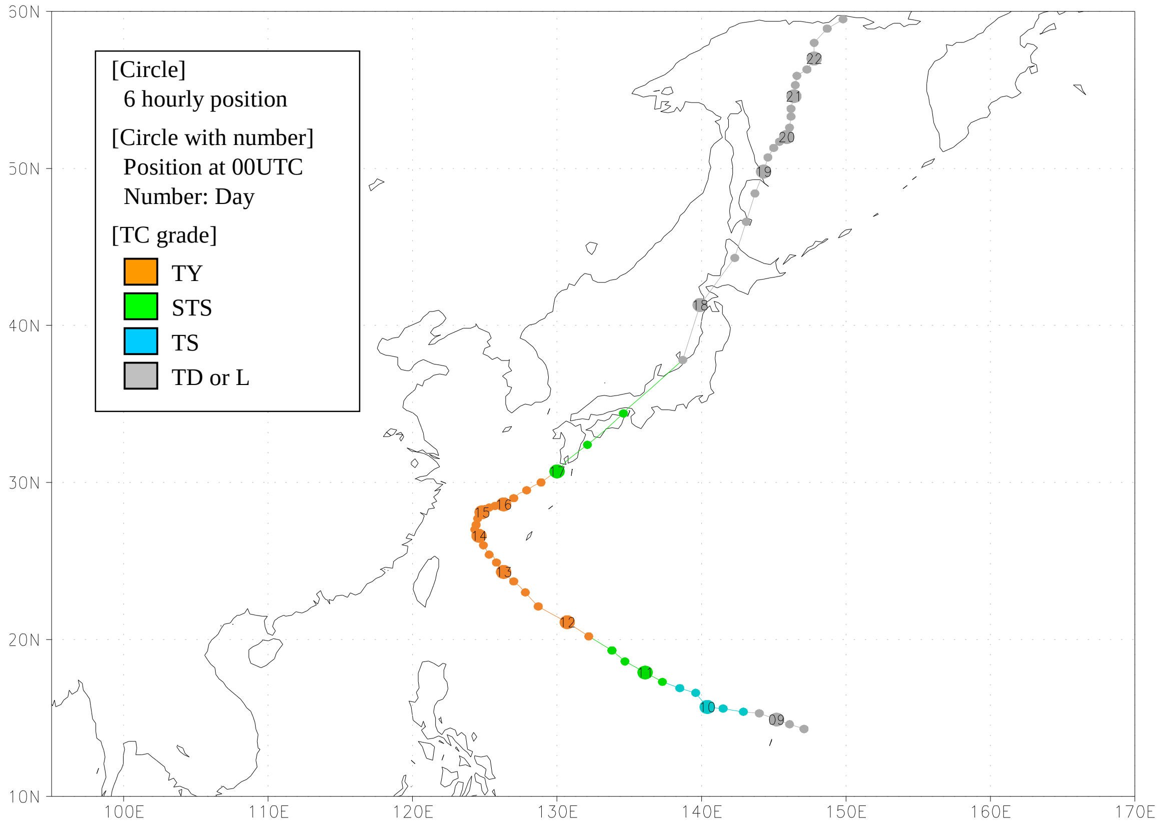
GUCHOL (1717)

GUCHOL formed as a tropical depression (TD) around the sea east of the Philippines at 12 UTC on 3 September 2017, and moved westward. After turning northwestward, it was upgraded to tropical storm (TS) intensity around the Luzon Strait and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 1000 hPa at 18 UTC on 5 September. After turning north-northwestward, GUCHOL was downgraded to TD intensity around the Taiwan Strait at 18 UTC on 6 September. Moving northward, it dissipated at 18 UTC the next day.



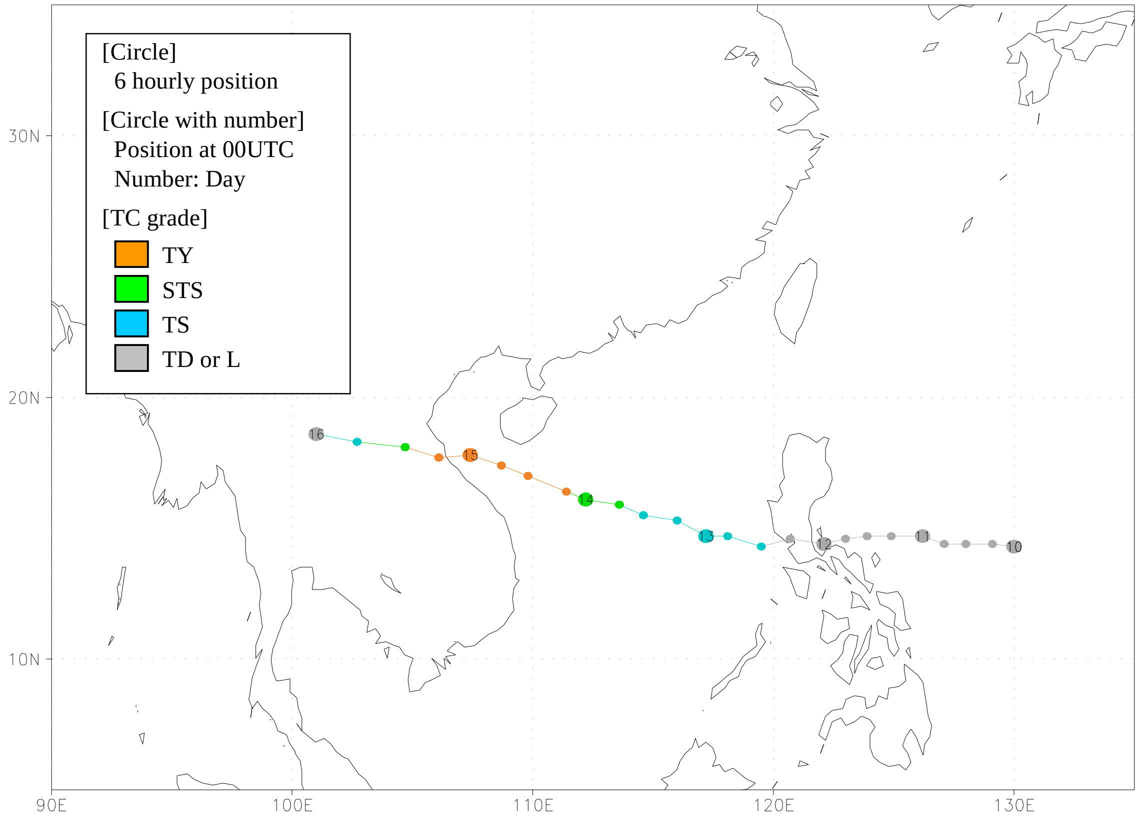
TALIM (1718)

TALIM formed as a tropical depression (TD) over the sea northeast of Guam Island at 12 UTC on 8 September 2017. Moving west-northwestward, it was upgraded to tropical storm (TS) intensity northwest of Guam Island at 12 UTC the next day. Keeping its west-northwestward track, TALIM was upgraded to typhoon (TY) intensity east of the Philippines at 18 UTC on 11 September. It reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 935 hPa north of Ishigakijima Island at 00 UTC on 14 September. After turning northeastward, TALIM was downgraded to severe tropical storm (STS) intensity west of Okinoerabu Island at 21 UTC on 16 September. Keeping its northeastward track, TALIM crossed the Satsuma Peninsula, Kagoshima Prefecture around 0230 UTC on 17 September and made landfall on Tarumizu City, Kagoshima Prefecture around 0300 UTC the same day. It made landfall again on the western part of Kochi Prefecture around 0730 UTC and around Akashi City, Hyogo Prefecture around 1300 UTC the same day. TALIM entered the Sea of Japan and transformed into an extratropical cyclone around Sado Island at 18 UTC the same day. It accelerated north-northeastward and dissipated over the Sea of Okhotsk at 00 UTC on 23 September.



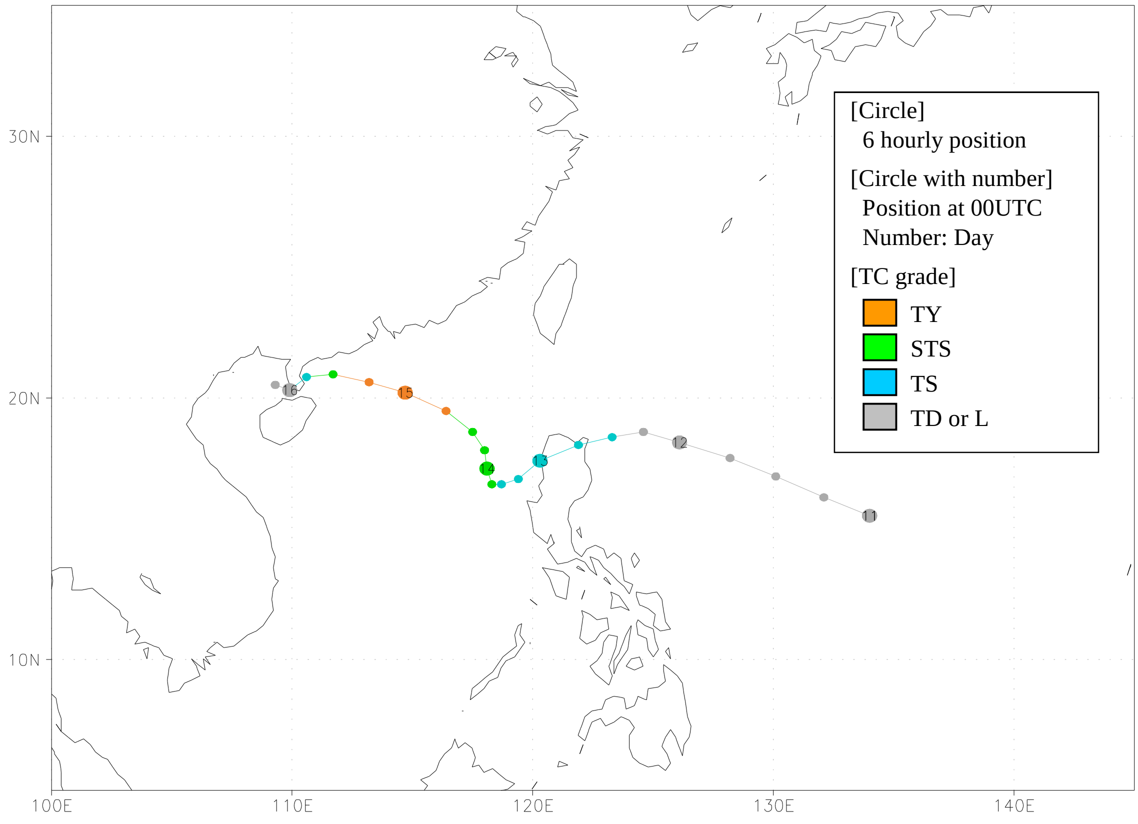
DOKSURI (1719)

DOKSURI formed as a tropical depression (TD) over the sea east of the Philippines at 00 UTC on 10 September 2017. Moving westward and hitting Luzon Island after 00 UTC on 12 September, DOKSURI was upgraded to tropical storm (TS) intensity at 12 UTC on 12 September over the South China Sea. After turning west-northwestward, it was upgraded to typhoon (TY) intensity at 06 UTC on 14 September. It reached its peak intensity with maximum sustained winds of 80 kt and a central pressure of 955 hPa at 12 UTC the same day. DOKSURI hit the coast of Vietnam with TY intensity after 00 UTC on 15 September and was downgraded to TS intensity at 18 UTC the same day. After moving westward, DOKSURI weakened to TD intensity in Thailand at 00 UTC on 16 September and dissipated there at 06 UTC the same day.



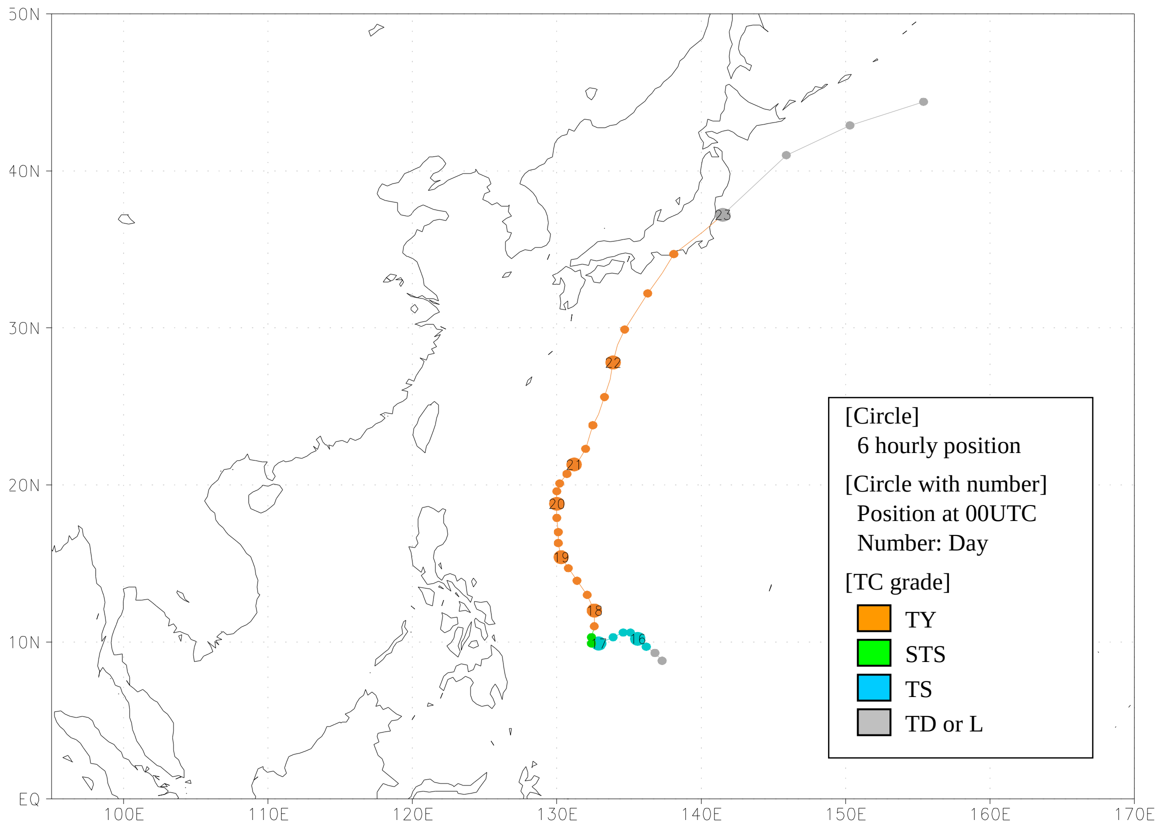
KHANUN (1720)

KHANUN formed as a tropical depression (TD) around the sea east of the Philippines at 00 UTC on 11 October 2017 and moved west-northwestward. After turning west-southwestward, it was upgraded to tropical storm (TS) intensity northeast of Luzon Island at 12 UTC on 12 October. KHANUN hit Luzon Island with TS intensity late on 12 October and entered the South China Sea. After turning northwestward, it was upgraded to typhoon (TY) intensity over the South China Sea at 18 UTC on 14 October. KHANUN reached its peak intensity with maximum sustained winds of 75 kt and a central pressure of 955 hPa over the same waters 6 hours later. It moved westward and weakened to TD intensity around the Gulf of Tonkin at 00 UTC on 16 October. KHANUN dissipated there 12 hours later.



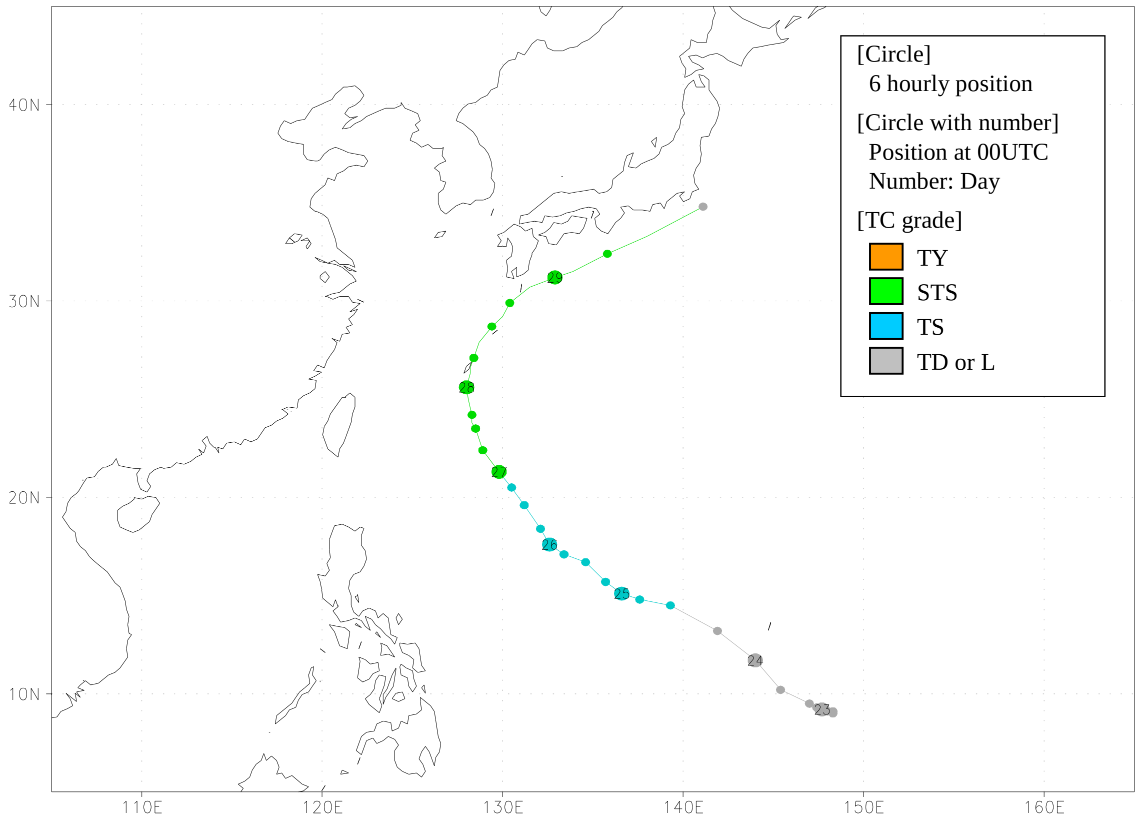
LAN (1721)

LAN formed as a tropical depression (TD) over the sea around the Yap Islands at 06 UTC on 15 October 2017 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters 12 hours later and turned west-southwestward. After turning northward sharply, LAN was upgraded to typhoon (TY) intensity around the sea east of the Philippines at 18 UTC on 17 October and turned northwestward. After turning northeastward, it accelerated gradually and reached its peak intensity with maximum sustained winds of 100 kt and a central pressure of 915 hPa east of Minamidaitojima Island at 18 UTC on 21 October. LAN made landfall on around Kakegawa City in Shizuoka Prefecture around 18 UTC on 22 October with TY intensity. After crossing the Kanto region, it transformed into an extratropical cyclone around the sea east of Japan at 00 UTC on 23 October and dissipated around the Kuril Islands 24 hours later.



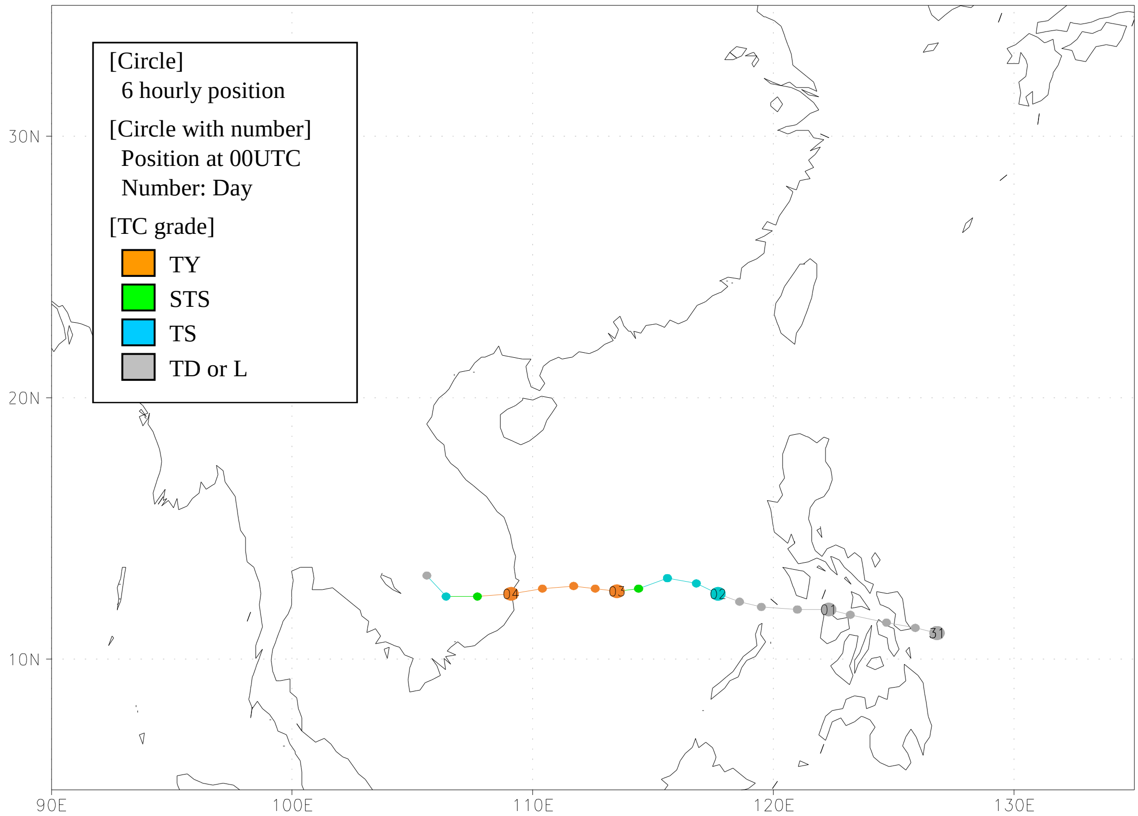
SAOLA (1722)

SAOLA formed as a tropical depression (TD) over the sea west of the Chuuk Islands at 06 UTC on 22 October 2017 and moved northwestward. It was upgraded to tropical storm (TS) intensity west of the Mariana Islands at 12 UTC on 24 October. Keeping the northwestward track, SAOLA was upgraded to severe tropical storm (STS) intensity south of Okinawa Island at 00 UTC on 27 October. After turning northward, it reached its peak intensity with maximum sustained winds of 60 kt and a central pressure of 975 hPa south of Okinawa Island at 18 UTC on the same day. SAOLA turned northeastward and passed over Okinawa Island before 05 UTC on 28 October. It transformed into an extratropical cyclone off the southeastern coast of Chiba Prefecture at 12 UTC on 29 October and dissipated 6 hours later.



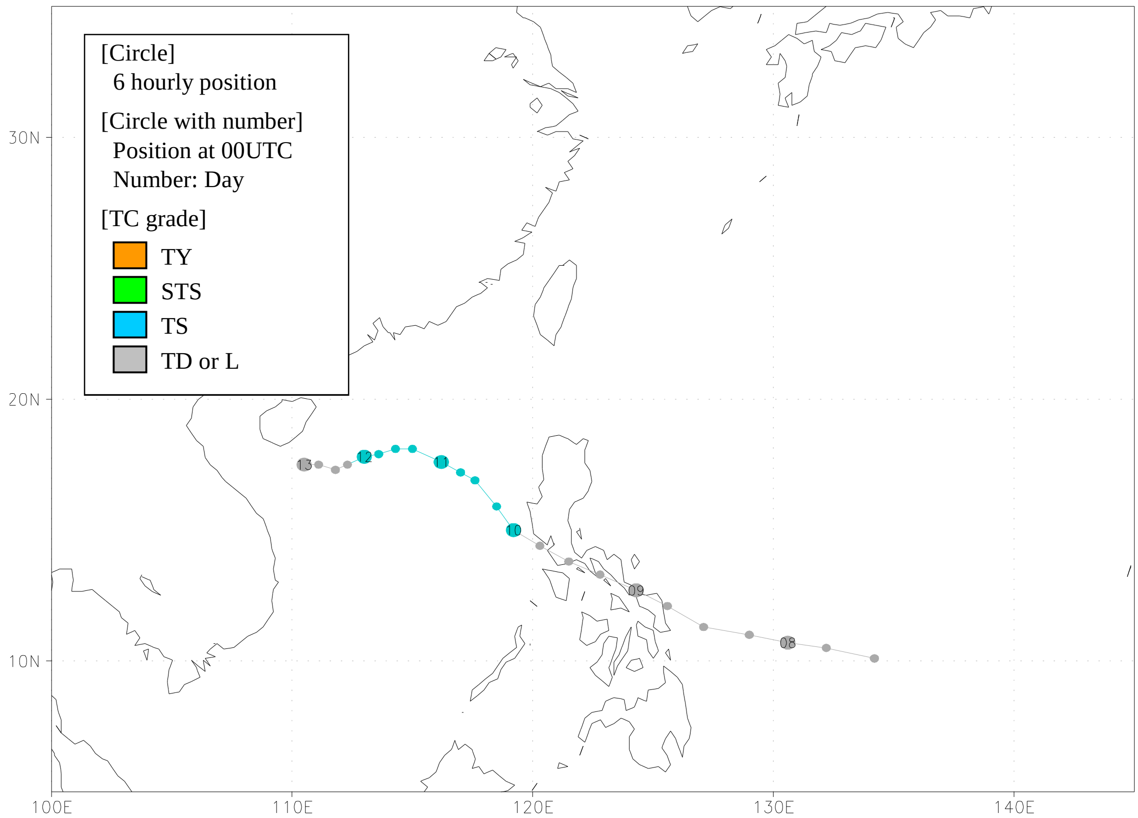
DAMREY (1723)

DAMREY formed as a tropical depression (TD) over the sea east of the Philippines at 00 UTC on 31 October 2017 and moved westward. After crossing islands of the Philippines, it was upgraded to tropical storm (TS) intensity over the South China Sea at 00 UTC on 2 November and was also upgraded to typhoon (TY) intensity over the same waters 24 hours later. DAMREY reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 970 hPa at 06 UTC on 3 November. It hit the south coast of Vietnam with TY intensity just before 00 UTC on 04 November and was downgraded to TS intensity in Cambodia at 12 UTC the same day. After moving northwestward, DAMREY weakened to TD intensity at 18 UTC on 4 November and dissipated there 6 hours later.



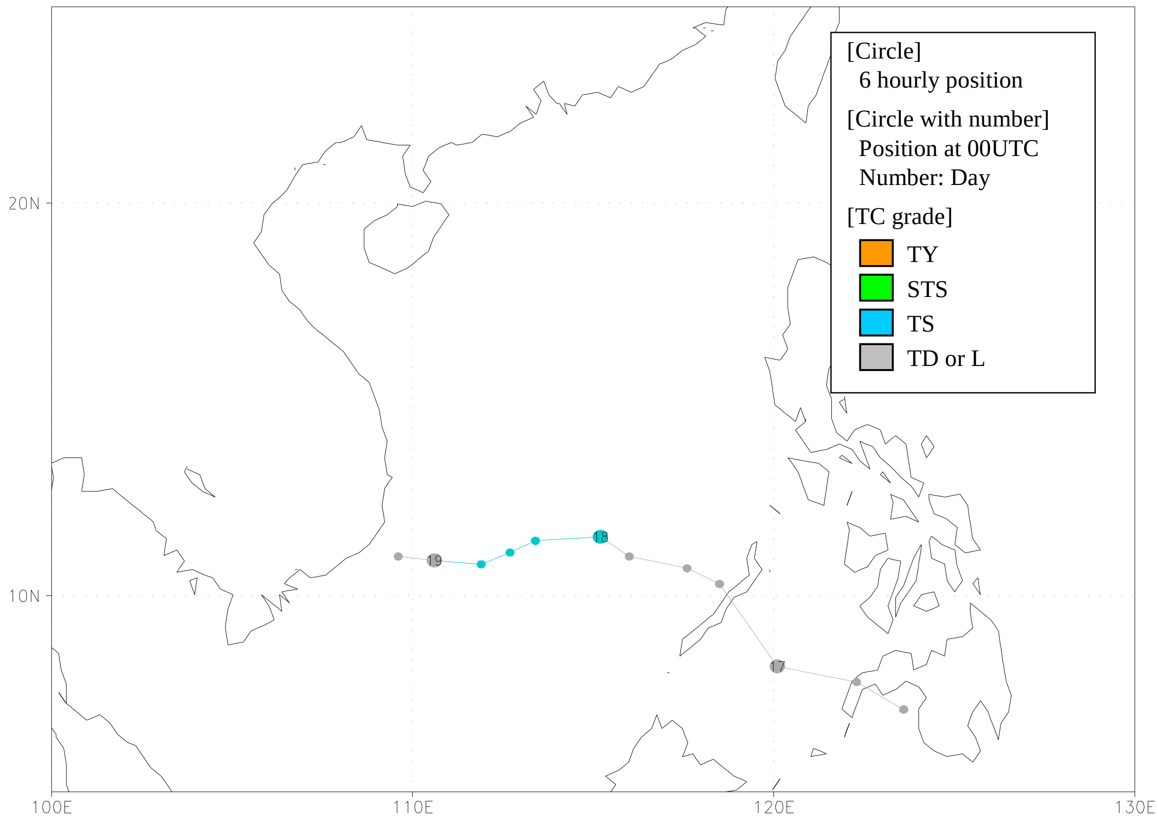
HAIKUI (1724)

HAIKUI formed as a tropical depression (TD) around the sea east of the Philippines at 12 UTC on 7 November 2017, and moved west-northwestward. After crossing Samar Island and Luzon Island with TD intensity, it entered the South China Sea late on 9 November. HAIKUI was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 10 November and reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 998 hPa at 00 UTC the next day. After turning westward, HAIKUI was weakened to TD intensity southeast of Hainan Island at 06 UTC on 12 November and dissipated south of the island at 06 UTC the next day.



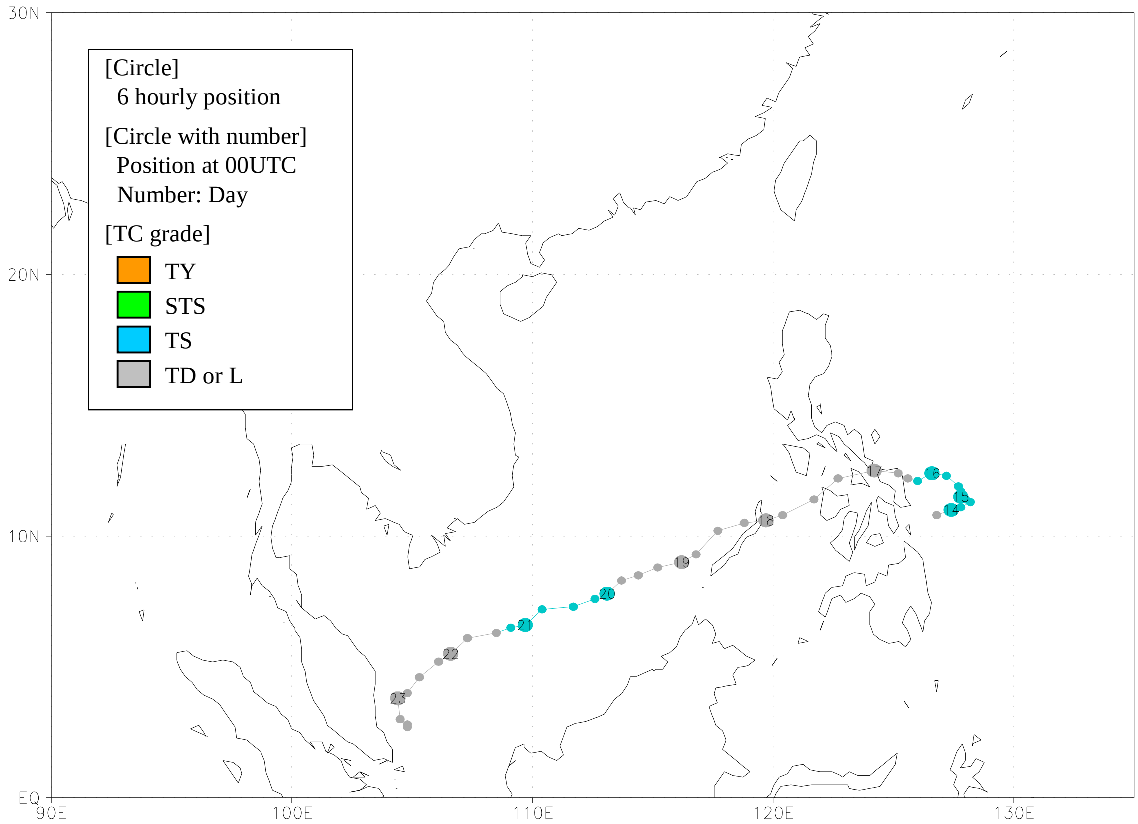
KIROGI (1725)

KIROGI formed as a tropical depression (TD) over the sea to the immediate south of Mindanao Island at 12 UTC on 16 November 2017 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity and also reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 1000 hPa over the South China Sea at 00 UTC on 18 November. Having moved westward over the same waters, KIROGI weakened to tropical depression (TD) intensity over the sea east of Viet Nam at 00 UTC on 19 November and dissipated there 12 hours later.



KAI-TAK (1726)

KAI-TAK formed as a tropical depression (TD) around the sea east of the Philippines at 18 UTC on 13 December 2017 and moved east-northeastward. It was upgraded to tropical storm (TS) intensity over the same waters six hours later. Remaining almost stationary there, it reached its first peak intensity with maximum sustained winds of 40 kt and a central pressure of 994 hPa at 06 UTC on 15 December. After moving westward, KAI-TAK weakened to TD intensity off the eastern coast of Samar Island at 12 UTC on 16 December. Keeping its TD intensity and west-southwestward track, KAI-TAK crossed several islands of the Philippines and entered the South China Sea. Moving west-southwestward in the South China Sea, it was re-upgraded to TS intensity at 00 UTC on 20 December and reached its second peak intensity with maximum sustained winds of 40 kt and a central pressure of 996 hPa 12 hours later. KAI-TAK downgraded to TD intensity over the South China Sea at 12 UTC on 21 December. After holding its TD intensity more than 2 days, KAI-TAK dissipated off the eastern coast of the Malay Peninsula at 00 UTC on 24 December.



TEMBIN (1727)

TEMBIN formed as a tropical depression (TD) north of the Palau Islands at 00 UTC on 20 December 2017. Moving westward, it was upgraded to tropical storm (TS) intensity east of Mindanao Island 18 hours later. After crossing Mindanao Island, TEMBIN gradually developed and was upgraded to typhoon (TY) intensity over the Sulu Sea at 12 UTC on 23 December It reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 970 hPa over the South China Sea 12 hours later. TEMBIN weakened to TD intensity south of Viet Nam at 12 UTC on 25 December and dissipated south of Cambodia 24 hours later.