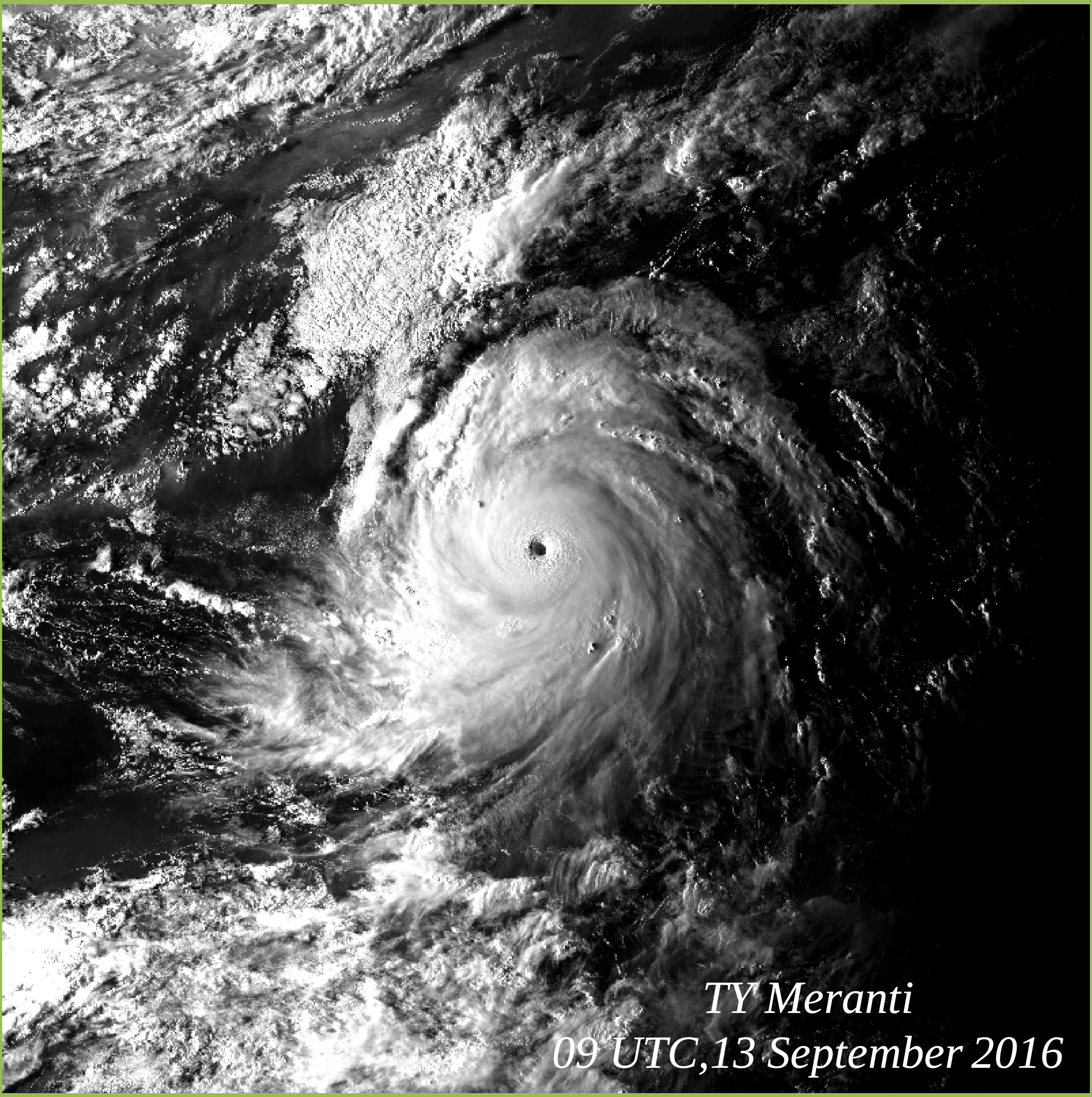
Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2016



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Japan Meteorological Agency

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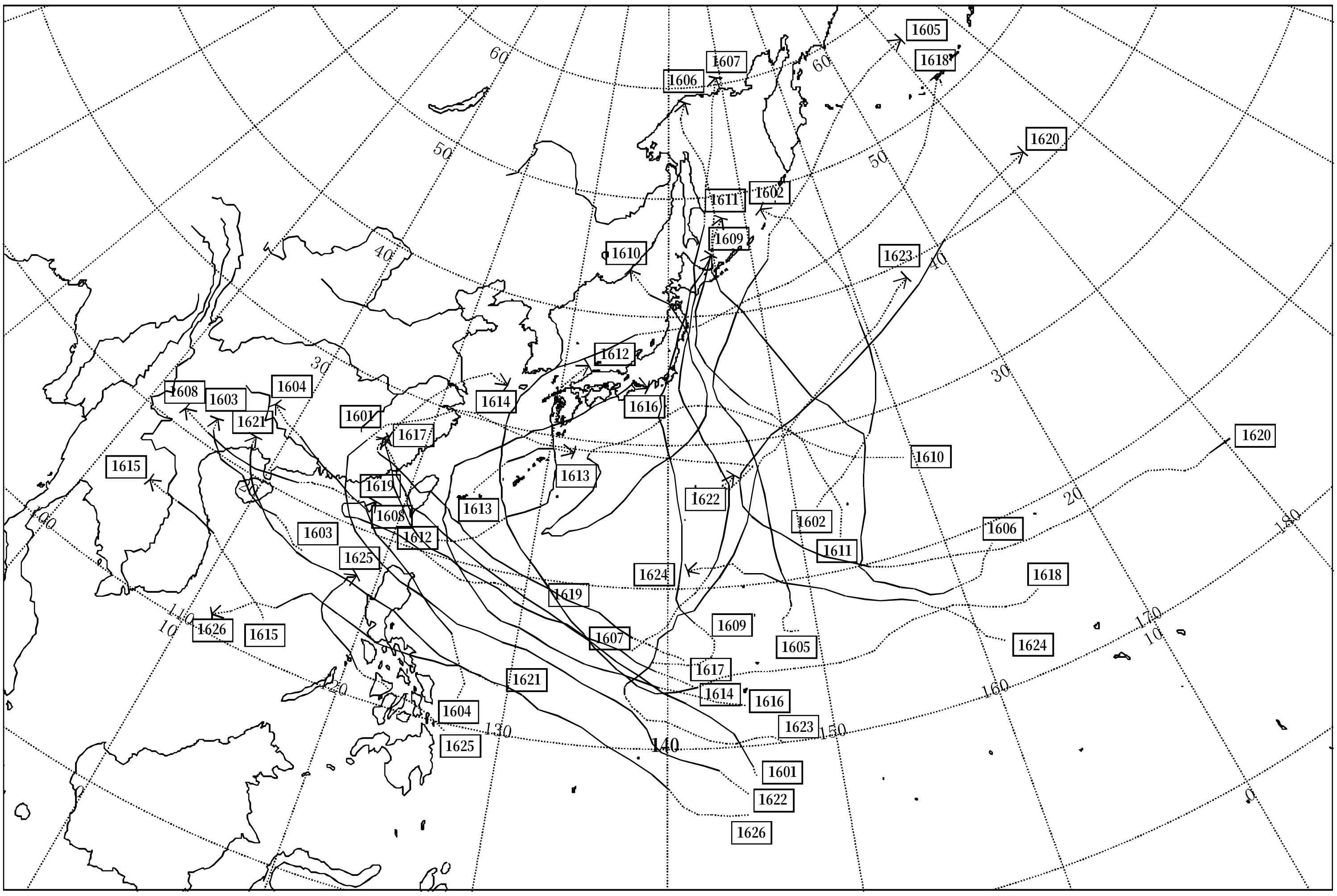

Japan Meteorological Agency

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Introduction

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

The Center conducts the following operations on a routine basis:

1. Preparation of information on the formation, movement and development of TCs and associated meteorological phenomena
2. Preparation of information on synoptic-scale atmospheric situations that affect the behavior of TCs
3. Provision of the above information to National Meteorological Services (NMSs), and in particular to 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 2016, Chapter 1 outlines routine operations performed at the Center and its operational products, while Chapter 2 reports on its major activities in 2016. Chapter 3 describes atmospheric and oceanic conditions in the tropics and notes the highlights of TC activity in 2016. Chapter 4 presents verification statistics relating to operational forecasts, results of JMA's numerical weather prediction (NWP) models, and storm surge prediction. Best track data for 2016 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 2016 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 2016

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.

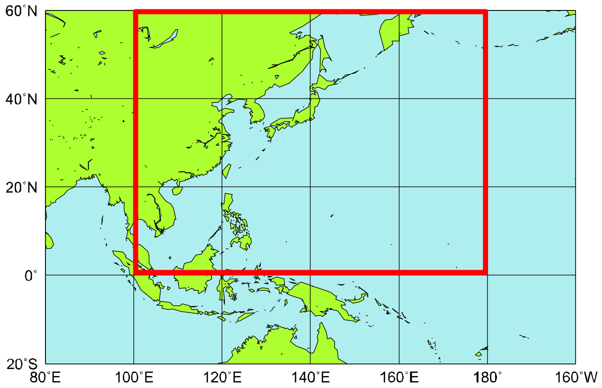


Figure 1.1
Area of responsibility of the RSMC Tokyo - Typhoon Center

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 central pressure of TCs is determined mainly from the CI number, which is derived from satellite imagery using the Dvorak method. The CI number also gives the maximum sustained wind speed in the vicinity of the center. The radii of circles representing winds with speeds of more than 30 and 50 knots are determined mainly from surface observation, ASCAT observation and low-level cloud motion winds (LCW) derived from cloud motion vectors of satellite images in the vicinity of the TC.

1.2 Forecasts

As a primary basis for TC track forecasts, JMA implements NWP using the Global Spectral Model (GSM) and the Typhoon Ensemble Prediction System (TEPS). The GSM (TL959L100; upgraded on 18 March, 2014) has a horizontal resolution of approximately 20 km and 100 vertical layers, while TEPS (TL479L60; operational as of 11 March 2014) has 25 members with a horizontal resolution of approximately 40 km and 60 vertical layers. Using mainly TEPS, 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. In relation to TC intensity, central pressure and maximum sustained wind speeds are forecasted using results of NWP models, guidance model based on climatology and persistence, and the Dvorak method.

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 TEPS.

1.3 Provision of RSMC Products

The Center prepares and distributes the RSMC bulletins listed below via the GTS and 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) RSMC Tropical Cyclone Advisory (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 TEPS 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

(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 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 (http://www.wis-jma.go.jp/). GSM products with resolution of 0.5 and 0.25 degrees (surface layer) and JMA SATAID Service (http://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.

1.5 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 http://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.

1.6 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, UKMO, NCEP 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.

1.7 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 (http://www.data.jma.go.jp/fcd/tca/data/index.html). This website is linked from the NTP website, and graphical TCA is also dispatched to World Area Forecast Centres (WAFCs).

Chapter 2

Major Activities of the RSMC Tokyo - Typhoon Center in 2016

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 2016 are listed in Table 2.1.

Table 2.1 Monthly and annual totals of products issued by the RSMC Tokyo - Typhoon Center in 2016

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
IUCC10	0	0	0	0	0	14	102	314	250	239	101	51	1071
WTPQ20-25	0	0	0	0	0	28	119	352	284	286	127	55	1251
WTPQ30-35	0	0	0	0	0	8	28	86	71	71	31	14	309
WTPQ50-55	0	0	0	0	0	0	22	80	70	62	14	17	265
FXPQ20-25	0	0	0	0	0	28	116	346	278	282	124	54	1228
FKPQ30-35	0	0	0	0	0	14	58	173	139	141	62	27	614
AXPQ20	2	0	0	0	0	0	0	2	9	6	5	3	27

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 2016, the 18th issue of the *RSMC Technical Review* was issued with the following areas of focus:

1. Development of a product based on consensus between Dvorak and AMSU tropical cyclone central pressure estimates at JMA
2. Tropical Cyclone Central Pressure Estimation Using Doppler Radar Observations at JMA

In December 2016, the Center published the *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2015*. Both publications are available on the Center's website at http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm.

2.3 Typhoon Committee Attachment Training

The 16th Typhoon Committee Attachment Training 2016 course was held at JMA Headquarters from 15 to 26 August 2016.

The Center has organized 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 Panel on Tropical Cyclones (PTC) have also been invited since 2015 to enhance training collaboration between PTC and the Typhoon Committee. The 2016 attendees were Mr. Thatsana Chanvilay from Lao PDR, Ms. Shelly Jo Igpuara Ignacio from the Philippines, Ms. Ton Thi Thao from Vietnam, Mr. Nasser Said Abdullah Al Ismaili from Oman, Mr. Habib Rehmat from Pakistan, and Mr. Ponna Handi Chaminda De Silva from Sri Lanka.

The training focused on imparting practical knowledge and skills relating 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 data, quantitative precipitation estimation, quantitative precipitation forecasting and storm surge forecasting. All attendees gave presentations to help JMA staff understand the current status of their meteorological and hydrological services. In 2016, two-day sessions on warning coordination were introduced, with focus on how to determine warning thresholds using disaster statistics and meteorological datasets based on a past tropical cyclone event in Japan.

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, 2015, to 31 October, 2016, was conducted for two tropical cyclones:

1. TY Chaba (1618), from 12UTC 30 September to 12UTC 5 October 2016
2. TY Haima (1622), from 15UTC 16 October to 15UTC 21 October 2016

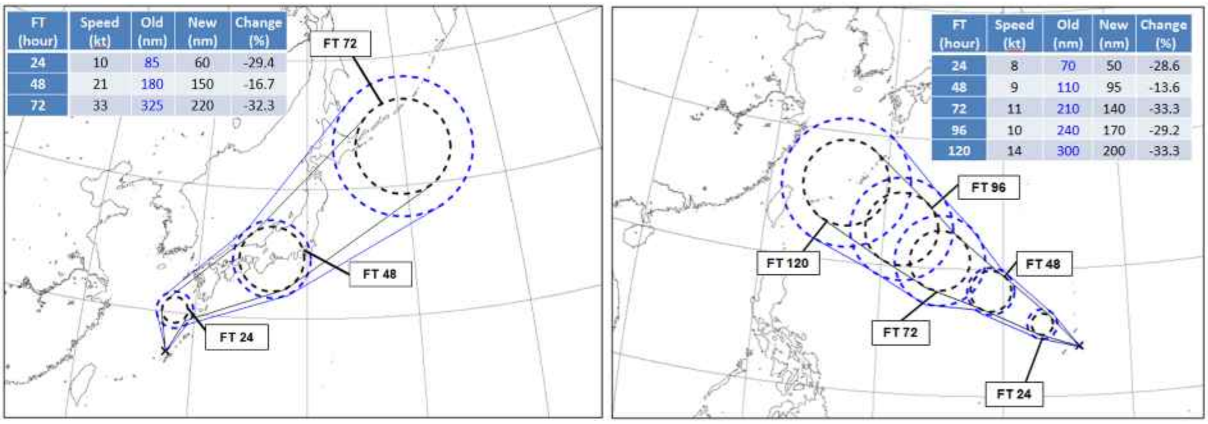
The results were distributed to all Typhoon Committee Members in March 2017, and are also available on the WIS GISC Tokyo server at http://www.wis-jma.go.jp/monitoring/data/monitoring/.

2.5 Other Activities in 2016

2.5.1 Reduction of Forecast Circle Radii

Based on TC track forecast improvements made in recent years via NWP model enhancement and other forecast techniques, the Center reduced the radius of forecast circles in its official forecasts by 20 – 40% (depending on TC direction and speed) in June 2016, starting with TY Nepartak (1601). This change addresses the issue of over-dispersiveness of warning areas.

The size of forecast circles is determined so that forecast track falls within the circles in a probability of about 70%. Based on the forecast results from 2011-2015, sizes of forecast circles were reviewed for all the forecast times (3, 6, 9, 12, 15, 18, 21, 24, 48, 72, 96 and 120 hours). For those for all forecast times, more than one sizes are defined based on the speed and direction of movement. Furthermore, for those for the forecast times of 96 and 120 hours, more types of circles are used depending on the forecast reliability estimated by the results of the JMA's TEPS for each typhoon. Changes in forecast circle size in typhoons with two directions are shown in Figure 2.1.



FT (hour)	Speed (kt)	Old (nm)	New (nm)	Change (%)
24	10	85	60	-29.4
48	21	180	150	-16.7
72	33	325	220	-32.3

FT (hour)	Speed (kt)	Old (nm)	New (nm)	Change (%)
24	8	70	50	-28.6
48	9	110	95	-13.6
72	11	210	140	-33.3
96	10	240	170	-29.2
120	14	300	200	-33.3

Figure 2.1 (left) changes in forecast circle size with northwestward movement; blue: old circles; black: new circles. The figure shows forecasts for TY Chan-hom (1509) with an initial time of 18 UTC on 4 July 2015. (right) changes in forecast circle size with northeastward movement; blue: old circles; black: new circles. The figure shows forecasts for TY Vongfong (1419) with an initial time of 18UTC on 11 October 2014.

2.5.2 Update of Numerical Typhoon Prediction Website

On 15 June and 23 August 2016, the Center started providing new products on the NTP website. These include:

(1) TC Activity Prediction (15 June)

The Center provides two- and five-day TC Activity Prediction Maps for its area of responsibility using the ensembles of ECMWF and UKMO and a related consensus. An example is shown in Figure 2.2. The maps display TC activity based on the probability that a TC will be present within a 300-km radius of a certain location during a particular forecast time window. The products are expected to help forecasters identify and monitor areas where a TC could form within two- and five-day periods. TC activity prediction maps of other NWP centers are also displayed if the necessary NWP data are provided to the Center.

(2) TC Track Ensembles of ECMWF, NCEP and UKMO (15 June)

TC track predictions of ECMWF, NCEP and UKMO ensemble systems are provided, in addition to JMA's TEPS, to help forecasters to develop TC track forecast scenarios in consideration of related uncertainty.

(3) Weighted Consensus of Satellite TC Intensity Estimates (15 June)

Weighted consensus of TC intensity estimates based on the Dvorak technique and warm-core intensity as observed by the Advanced Microwave Sounding Unit-A (AMSU-A) of NOAA and the MetOp series of polar-orbiting satellites are available. These estimates have higher accuracy than those made using the Dvorak technique, giving additional reliable information that helps forecasters estimate TC intensity.

(4) Detailed History Log of Dvorak Analysis (15 June)

Detailed logs of Dvorak analysis, including data on Cloud Pattern, DT, MET, PT, Final-T and CI, are provided to help forecasters understand the Center’s TC intensity estimates.

(5) Multi-scenario Storm Surge Prediction (15 June)

Multi-scenario storm surge prediction is now operational. This new product provides storm surge predictions based on the Center’s official advisory and five additional tropical cyclone track scenarios derived from JMA’s TEPS using cluster analysis. As storm surge prediction is sensitive to tropical cyclone track scenarios, the product will help forecasters to estimate the uncertainty of storm surge prediction with consideration of track forecast errors.

(6) Ensemble Ocean Wave Prediction (23 August)

Ensemble mean / 3rd quantile / maximum wave heights, probability of wave heights over 2, 3, 4, 5 and 6 m, and ensemble spread information are available along with boxplot data and information on exceeding probability at selected stations. These products are based on JMA’s global Wave Ensemble System (WENS), which began operation on 8 June 2016, and cover most of the globe with 1.25-degree grid resolution. The model is run once a day at 12 UTC and predicts ocean wave conditions up to 264 hours ahead with 27 members. The products will help to clarify maritime/coastal risk from waves with a lead time in the range of a week.

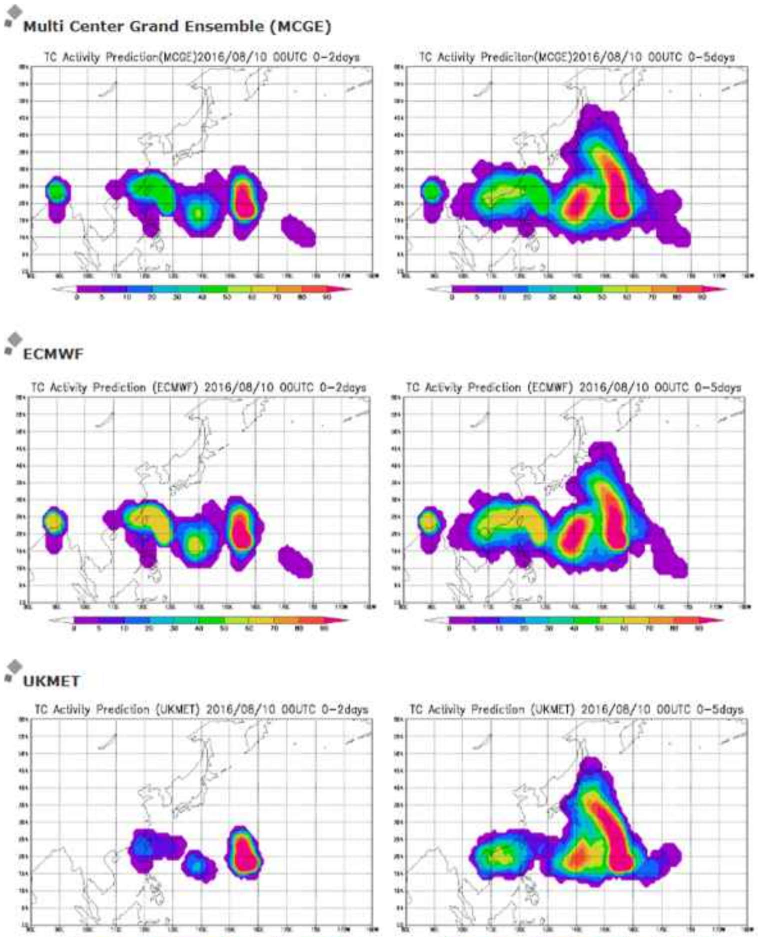


Figure 2.2 Two-day (left) and five-day (right) TC Activity Prediction Maps made using the ensembles of ECMWF (middle) and UKMO (bottom), and related consensus (top) with an initial time of 00 UTC on 8 August 2016

Chapter 3

Summary of the 2016 Typhoon Season

In 2016, 26 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 26 TCs, 13 reached typhoon (TY) intensity, 6 reached severe tropical storm (STS) intensity and 7 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 2016

Tropical Cyclone			Duration (UTC)	Minimum Central Pressure				Max Wind
			(TS or higher)	(UTC)	lat (N)	long (E)	(hPa)	(kt)
TY	Nepartak	(1601)	030000 Jul - 090600 Jul	060600	19.5	128.4	900	110
TS	Lupit	(1602)	231800 Jul - 241800 Jul	231800	28.9	157.1	1000	40
STS	Mirinae	(1603)	260600 Jul - 280600 Jul	271200	19.9	106.7	980	55
STS	Nida	(1604)	300600 Jul - 021200 Aug	310600	18.2	122.3	975	60
STS	Omais	(1605)	040000 Aug - 091800 Aug	060600	24.9	147.7	975	60
TS	Conson	(1606)	090000 Aug - 150000 Aug	130600	31.6	154.3	985	45
STS	Chanthu	(1607)	131800 Aug - 171800 Aug	160000	31.6	142.5	980	55
TS	Dianmu	(1608)	171800 Aug - 191200 Aug	181800	20.5	108.2	980	40
TY	Mindulle	(1609)	190600 Aug - 230300 Aug	211800	33.1	139.4	975	65
TY	Lionrock	(1610)	211200 Aug - 301500 Aug	280600	27.7	137.9	940	90
TS	Kompasu	(1611)	200000 Aug - 211800 Aug	200000	32.9	147.3	994	35
TY	Namtheun	(1612)	010000 Sep - 041800 Sep	021800	28.5	130.6	955	70
TS	Malou	(1613)	060600 Sep - 070000 Sep	060600	27.6	126.8	1000	40
TY	Meranti	(1614)	100600 Sep - 151200 Sep	131200	20.4	122.9	890	120
TS	Rai	(1615)	121800 Sep - 130600 Sep	121800	15.5	108.9	996	35
TY	Malakas	(1616)	121800 Sep - 201200 Sep	161800	23.0	123.1	930	95
TY	Megi	(1617)	231800 Sep - 281200 Sep	270000	23.3	123.3	945	85
TY	Chaba	(1618)	290600 Sep - 051200 Oct	030900	25.4	126.9	905	115
STS	Aere	(1619)	051800 Oct - 100000 Oct	071800	21.2	115.9	975	60
TY	Songda	(1620)	081200 Oct - 130600 Oct	111800	30.3	148.9	925	100
TY	Sarika	(1621)	131800 Oct - 190600 Oct	151800	15.8	121.8	935	95
TY	Haima	(1622)	150000 Oct - 211800 Oct	181800	16.0	127.5	900	115
TY	Meari	(1623)	030000 Nov - 070600 Nov	051200	18.3	140.7	960	75
TS	Ma-on	(1624)	100000 Nov - 120000 Nov	100000	16.9	156.9	1002	35
STS	Tokage	(1625)	251200 Nov - 280000 Nov	260000	13.2	118.7	992	50
TY	Nock-ten	(1626)	211800 Dec - 271800 Dec	240600	13.3	128.2	915	105

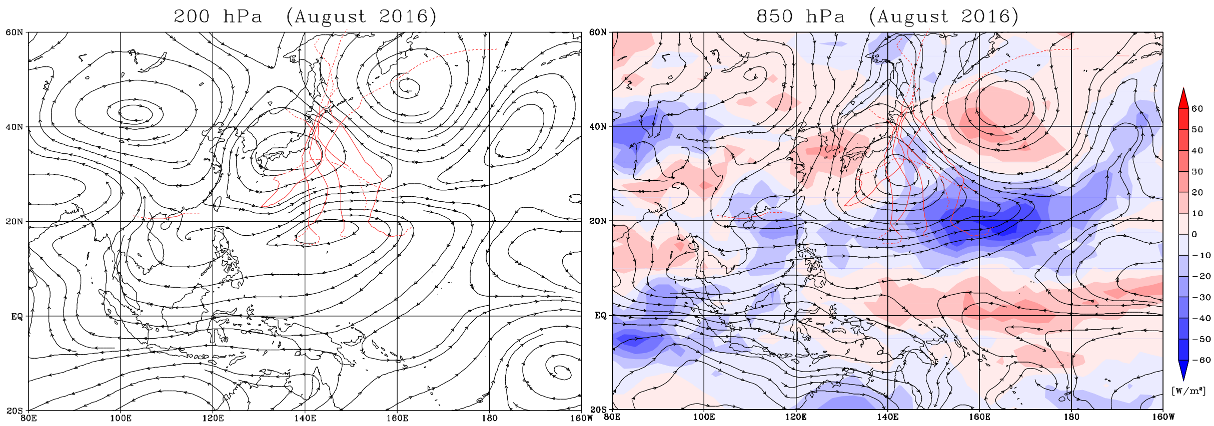
3.1 Atmospheric and Oceanographic Conditions in the Tropics

The El Niño event that started in summer 2014 and peaked in winter 2015/2016 ended in spring 2016. Consequently, zero-to-negative sea surface temperature (SST) anomalies became obscure in the tropical western North Pacific in late spring and then turned positive. Meanwhile, positive SST anomalies prevailed during 2016 over the South China Sea. In the Indian Ocean, positive SST anomalies were clearly seen until early summer.

The positive SST anomalies and associated enhanced convective activity in the Indian Ocean may have contributed to suppressed convective activity and lower-level anticyclonic circulation anomalies over the tropical western North Pacific and the South China Sea until early summer. After late summer, convective activity was generally enhanced over the tropical western North Pacific and the South China Sea.

Figure 3.1 shows monthly mean streamline anomalies at 200 and 850 hPa, Outgoing Longwave Radiation (OLR) anomalies (a lower OLR corresponds to stronger convective activity) and the tracks of TCs that formed in August 2016 when convective activity was enhanced from the South China Sea to the seas east of the Philippines in association with the positive SST anomalies in the area. In association with the northward meandering of the westerly jet stream near the Kamchatka Peninsula, an upper-level trough also formed in the central Pacific. From this, several upper-level lows were cut off and migrated westward. These conditions may have contributed to enhanced convective activity in the area of 20 - 30˚N to the southeast of Japan. It can be seen that seven named TCs formed in the area of 20 - 30˚N corresponding to strong convective activity, and six of them formed between 140 and 170˚E in line with particular areas of stronger 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.


200 hPa (August 2016)

850 hPa (August 2016)

Figure 3.1 Monthly mean streamline anomalies at 200 hPa (lines with arrows) (left) and 850 hPa (lines with arrows) and OLR anomalies (shading) (right) for August 2016. The tracks of the seven named TCs that formed in August are superimposed onto both figures.

3.2 Tropical Cyclones in 2016

A total of 26 named TCs formed over the western North Pacific and the South China Sea in 2016. Monthly and the climatological normal numbers of TC formations are shown in Figure 3.2, and the tracks of the 26 TCs are shown in Figure 3.3. Figure 3.4 shows the genesis points of the 26 TCs (dots) and related frequency distribution for past years (1951 – 2015).

The first named TC of 2016 formed on 3 July, which is the second latest formation of the annual first named TC since 1951 when the Center began keeping TC statistics. This late formation reflects suppressed convective activity over the tropics in the western North Pacific and the South China Sea until June, as seen in post-El Niño years such as 1998, 1973 and 1983. From August, monthly numbers of TC formations exceeded the climatological normal reflecting stronger convective activity in the area of 20 - 30˚N, 140 - 170˚E in August and in the western half of the western North Pacific and the South China Sea from September to December. The monthly and annual frequencies of named TCs forming since 1951 are detailed in Appendix 4.

The mean genesis point of the 26 named TCs forming in 2016 was at 18.0˚N and 136.5˚E, showing a northward deviation from the climatological normal (16.2˚N and 136.7˚E). The mean genesis point of named TCs forming in summer (June to August) was 20.8˚N and 138.6˚E, showing a northeastward deviation from the climatological normal (18.4˚N and 135.9˚E), whereas that of named TCs forming in autumn (September to November) was 16.5˚N and 134.5˚E, showing a westward deviation from the climatological normal (15.9˚N and 137.8˚E). The summer deviation corresponds to the large number of named TCs forming in the area of 20 - 30˚N, 140 - 170˚E in August, while the autumn deviation corresponds to stronger convective activity in the western half of the western North Pacific and the South China Sea.

The mean TC duration** was 4.2 days, which is shorter than the climatological normal (5.3 days). This reflects the northeastward deviation of the mean genesis point of named TCs forming in summer as compared to the climatological normal, causing increased proximity to a lower SST area, and the westward deviation of the mean genesis point in autumn, causing increased proximity to the continent.

*** TC duration is defined as the period during which a TC remains at TS intensity or higher.*

Detailed descriptions of each TC forming in 2016 are included on the DVD provided with this report.

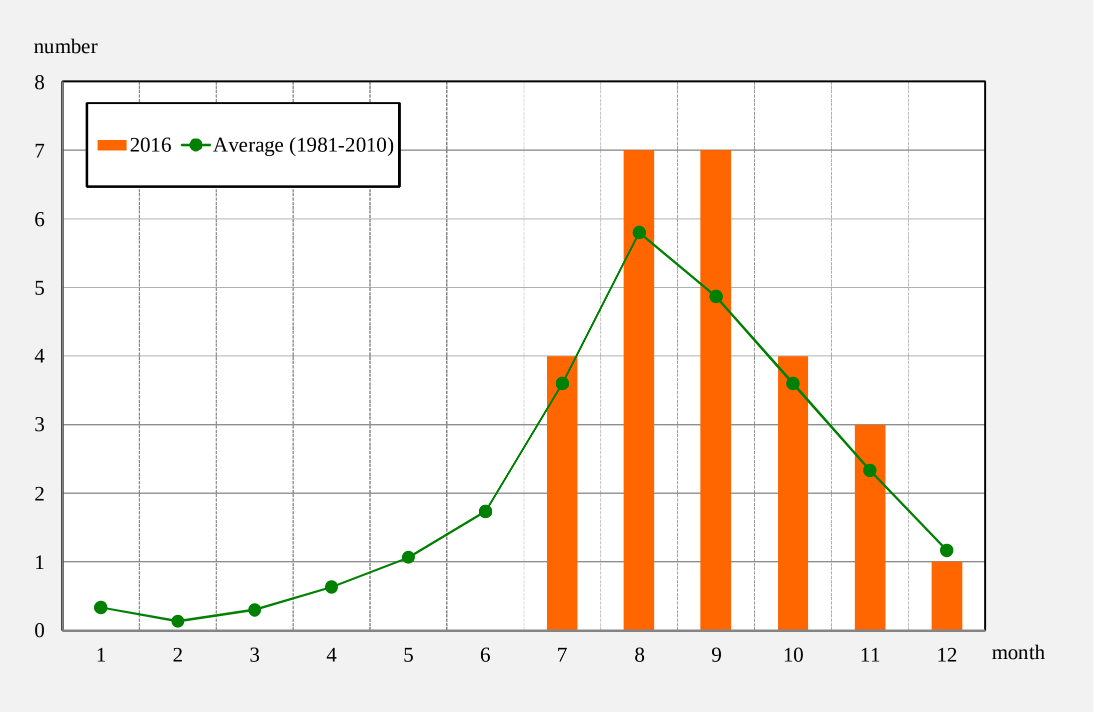


Figure 3.2 Monthly number of TC formations for 2016 compared to the climatological normal

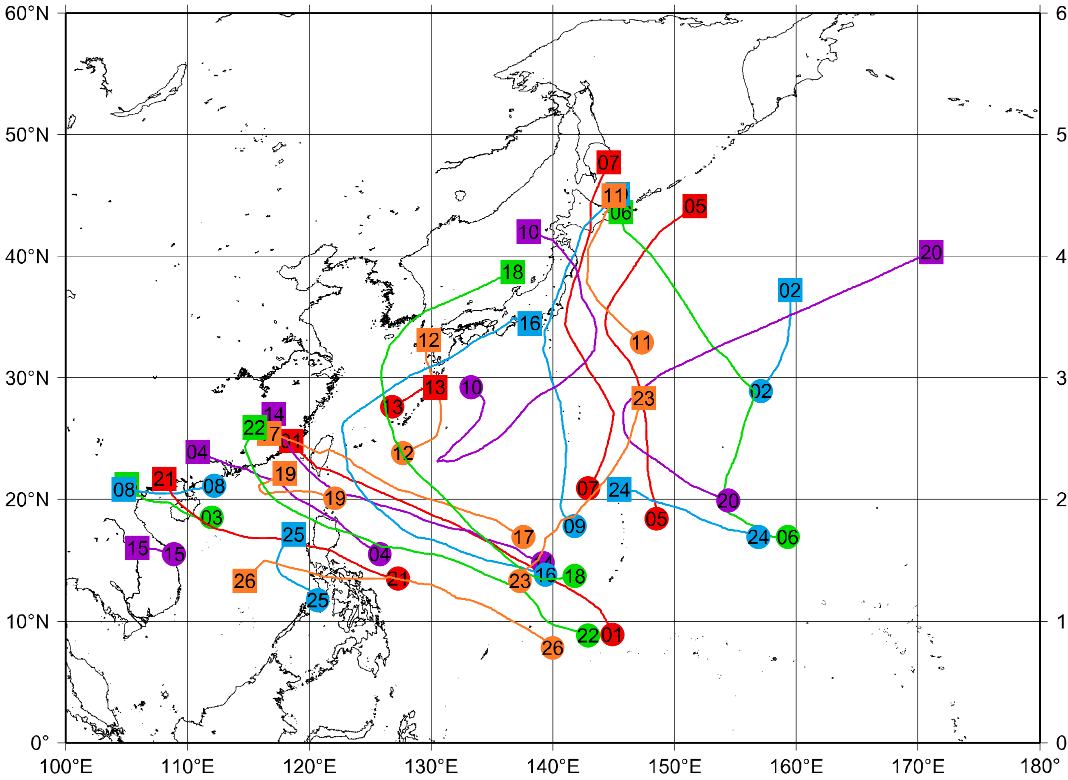


Figure 3.3 Tracks of the 26 named TCs forming in 2016. TC tracks for those with an intensity of TS or higher are shown.

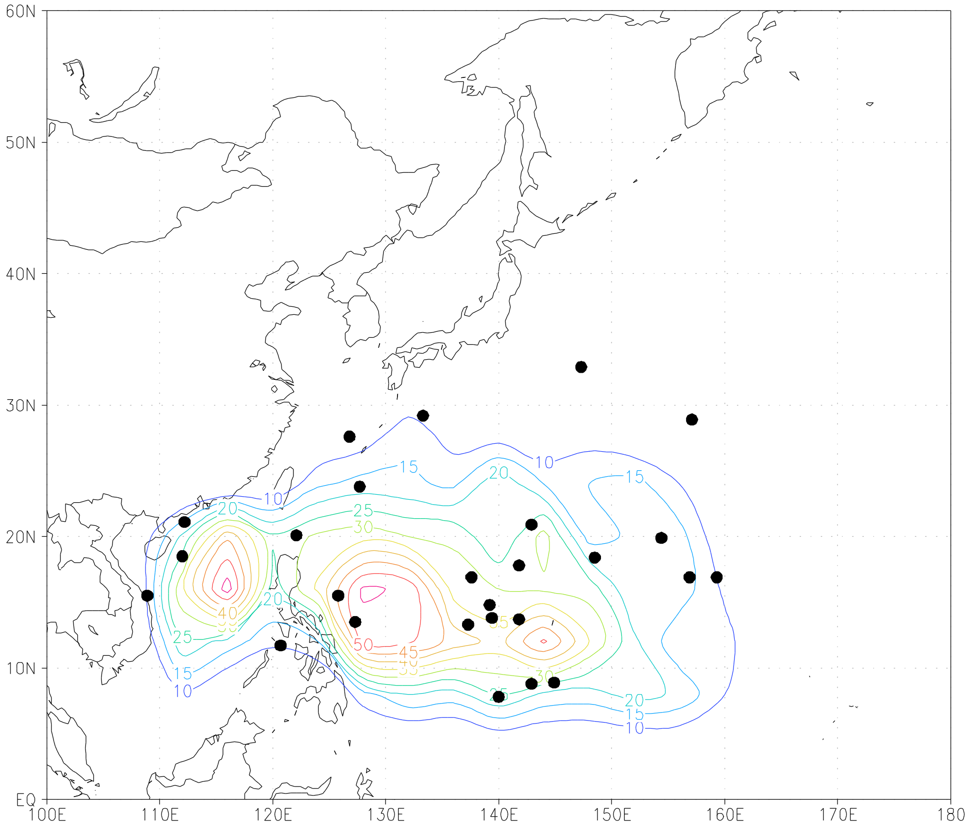


Figure 3.4 Genesis points of the 26 TCs forming in 2016 (dots) and related frequency distribution for 1951 – 2015 (lines)

Chapter 4

Verification of Forecasts in 2016

4.1 Verification of Operational Forecasts

Operational forecasts for the 26 TCs of TS intensity or higher that formed in 2016 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 2016 are indicated in Appendix 3.

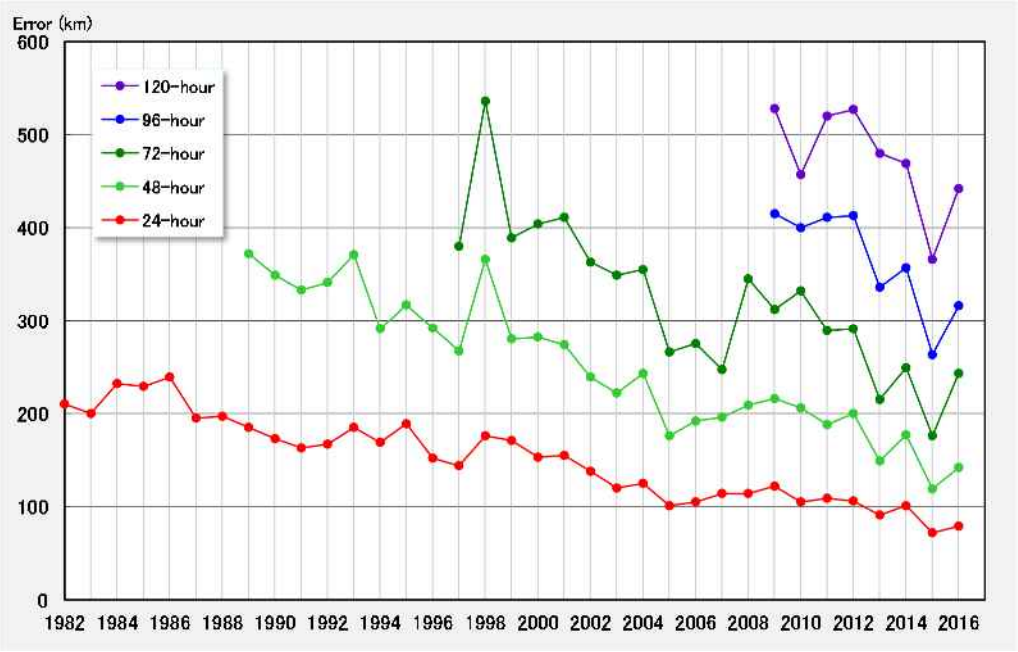


Figure 4.1 Annual mean position errors in 24-, 48-, 72-, 96- and 120-hour operational track forecasts

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 shows that operational TC track forecasts have steadily improved since 1982. The errors in 2016 were 79, 142, 243, 316 and 442 km for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively, all of which were greater than the corresponding figures for 2015. This is partially attributed to the fact that the number of readily forecastable TCs moving with constant direction and speed over a long duration in 2016 was lower than in 2015.

The details of errors for each TC forming in 2016 are summarized in Table 4.1. The forecasts for Chanthu (1607), which moved northward over the sea around Japan and hit Hokkaido Island, and Meari (1623), which moved northeastward over the sea west of the Mariana Islands, were characterized by large errors. The 96- and 120-hour forecasts for Conson (1606), which moved north-northwestward east of Japan, also showed large errors, while forecasts for Omais (1605) and Nock-ten (1626) exhibited relatively small errors.

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 2016 were 32% (36% in 2015), 26% (27%), 26% (24%), 23% (25%) and 24% (26%), respectively. Figure 4.2 shows a histogram of 24-hour forecast position errors. About 89% (91% in 2015) of 24-hour forecasts, 92% (97%) of 48-hour forecasts, 91% (97%) of 72-hour forecasts, 86% (93%) of 96-hour forecasts and 72% (83%) 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 2016. 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 (%)
TY	Nepartak	(1601)	60	45	21	35	92	49	17	22	156	52	13	22	327	94	9	35	508	127	5	40
TS	Lupit	(1602)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Mirinae	(1603)	71	53	4	16	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Nida	(1604)	68	25	9	40	133	33	4	31	-	-	0	-	-	-	0	-	-	-	0	-
STS	Omais	(1605)	76	48	19	28	141	72	15	37	214	66	10	30	124	62	6	11	144	26	2	8
TS	Conson	(1606)	108	52	20	37	145	74	16	19	187	82	12	15	492	105	8	32	907	102	4	44
STS	Chanthu	(1607)	168	54	12	42	330	99	8	39	792	74	4	86	-	-	0	-	-	-	0	-
TS	Dianmu	(1608)	52	30	3	67	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Mindulle	(1609)	90	74	12	19	212	75	8	40	388	141	4	31	-	-	0	-	-	-	0	-
TY	Lionrock	(1610)	102	58	33	43	165	106	29	30	225	118	25	21	267	118	21	17	449	96	17	24
TS	Kompasu	(1611)	141	60	3	11	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Namtheun	(1612)	48	21	11	30	51	27	7	9	340	94	3	16	-	-	0	-	-	-	0	-
TS	Malou	(1613)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Meranti	(1614)	63	31	17	58	138	95	13	69	169	108	9	52	214	29	5	58	302	0	1	-
TS	Rai	(1615)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Malakas	(1616)	73	44	27	42	174	113	23	33	275	150	19	28	385	174	15	26	506	216	11	24
TY	Megi	(1617)	73	16	15	55	111	30	11	47	160	37	7	42	167	44	3	26	-	-	0	-
TY	Chaba	(1618)	65	38	21	23	110	48	17	18	222	66	13	26	424	79	9	32	651	128	5	17
STS	Aere	(1619)	98	39	13	45	203	63	9	29	312	31	5	18	514	0	1	-	-	-	0	-
TY	Songda	(1620)	64	32	15	14	120	44	11	9	310	54	7	15	782	92	3	23	-	-	0	-
TY	Sarika	(1621)	30	13	18	17	104	33	14	19	168	46	10	24	197	37	6	23	220	26	2	-
TY	Haima	(1622)	52	28	23	26	87	46	19	23	128	47	15	23	178	30	11	20	220	36	7	19
TY	Meari	(1623)	137	99	13	36	297	198	9	46	1000	114	5	103	2066	0	1	-	-	-	0	-
TS	Ma-on	(1624)	136	66	4	28	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Tokage	(1625)	72	30	6	19	65	19	2	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Nock-ten	(1626)	58	42	20	30	85	55	16	22	103	41	12	17	127	47	8	12	115	65	4	13
Annual Mean (Total)			79	55	339	32	142	101	248	26	243	192	173	26	316	242	106	23	442	232	58	24

Table 4.2 presents the mean hitting ratios and radii of 70% probability circles** provided in operational forecasts for each TC forming in 2016. 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 (140 km in 2015), and their hitting ratio was 78% (89%). The corresponding values for 48-hour forecasts were 207 km (242 km in 2015) and 79% (93%), those for 72-hour forecasts were 290 km (355 km in 2015) and 79% (94%), those for 96-hour forecasts were 409 km (450 km in 2015) and 78% (88%), and those for 120-hour forecasts were 510 km (573 km in 2015) and 69% (83%). The annual mean radii of circles for all forecast times in 2016 were smaller than in 2015 and their hitting ratios were smaller, partially reflecting the review and reduction of probability circle radii in June 2016.

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

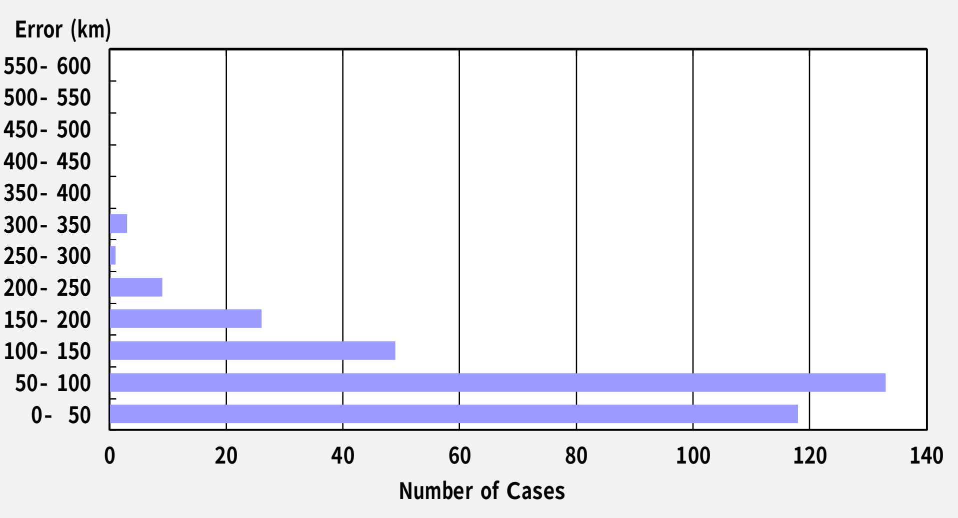


Figure 4.2 Histogram of 24-hour forecast position errors in 2016
(Histograms for 48-, 72-, 96- and 120-hour forecasts are included on the DVD provided with this report).

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 2016

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)
TY	Nepartak	(1601)	86	21	104	100	17	197	100	13	254	100	9	424	40	5	500
TS	Lupit	(1602)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
STS	Mirinae	(1603)	75	4	93	-	0	-	-	0	-	-	0	-	-	0	-
STS	Nida	(1604)	100	9	119	100	4	204	-	0	-	-	0	-	-	0	-
STS	Omais	(1605)	79	19	117	67	15	214	90	10	298	100	6	330	100	2	602
TS	Conson	(1606)	60	20	113	75	16	200	75	12	267	13	8	350	0	4	468
STS	Chanthu	(1607)	17	12	119	13	8	212	0	4	245	-	0	-	-	0	-
TS	Dianmu	(1608)	100	3	130	-	0	-	-	0	-	-	0	-	-	0	-
TY	Mindulle	(1609)	92	12	139	63	8	232	25	4	296	-	0	-	-	0	-
TY	Lionrock	(1610)	64	33	119	66	29	224	80	25	348	81	21	462	82	17	536
TS	Kompasu	(1611)	67	3	136	-	0	-	-	0	-	-	0	-	-	0	-
TY	Namtheun	(1612)	100	11	96	100	7	188	67	3	377	-	0	-	-	0	-
TS	Malou	(1613)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TY	Meranti	(1614)	82	17	108	69	13	197	78	9	251	100	5	444	100	1	648
TS	Rai	(1615)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TY	Malakas	(1616)	81	27	116	70	23	207	58	19	292	80	15	499	64	11	583
TY	Megi	(1617)	100	15	110	100	11	204	100	7	257	100	3	315	-	0	-
TY	Chaba	(1618)	86	21	115	100	17	224	92	13	339	56	9	469	20	5	602
STS	Aere	(1619)	46	13	101	33	9	179	20	5	256	0	1	315	-	0	-
TY	Songda	(1620)	80	15	121	91	11	230	100	7	368	0	3	482	-	0	-
TY	Sarika	(1621)	100	18	100	93	14	188	100	10	248	100	6	315	100	2	370
TY	Haima	(1622)	96	23	109	100	19	202	100	15	259	100	11	315	100	7	370
TY	Meari	(1623)	54	13	115	44	9	222	0	5	285	0	1	444	-	0	-
TS	Ma-on	(1624)	50	4	134	-	0	-	-	0	-	-	0	-	-	0	-
STS	Tokage	(1625)	83	6	105	100	2	204	-	0	-	-	0	-	-	0	-
TY	Nock-ten	(1626)	85	20	102	100	16	185	100	12	247	100	8	326	100	4	370
Annual Mean (Total)			78	339	112	79	248	207	79	173	290	78	106	409	69	58	510

4.1.2 Central Pressure and Maximum Wind Speed

Table 4.3 gives the root mean square errors (RMSEs) of 24-, 48- and 72-hour operational central pressure forecasts for each TC forming in 2016. 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 14.6 hPa (13.7 hPa in 2015) and 6.5 m/s (5.9 m/s). For 48-hour forecasts, the corresponding values were 21.5 hPa (19.1 hPa in 2015) and 8.9 m/s (8.2 m/s), while those for 72-hour forecasts were 23.4 hPa (21.2 hPa in 2015) and 10.0 m/s (9.0 m/s).

Table 4.3 Mean intensity errors of 24-, 48- and 72-hour operational central pressure forecasts for each TC forming in 2016

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.
TY	Nepartak	(1601)	7.4	20.5	21	15.2	35.8	17	16.4	45.8	13
TS	Lupit	(1602)	-	-	0	-	-	0	-	-	0
STS	Mirinae	(1603)	8.8	10.2	4	-	-	0	-	-	0
STS	Nida	(1604)	-11.1	15.5	9	-26.2	27.0	4	-	-	0
STS	Omais	(1605)	-3.6	7.6	19	-8.7	11.4	15	-15.0	15.2	10
TS	Conson	(1606)	-5.9	9.9	20	-13.7	17.5	16	-19.2	21.6	12
STS	Chanthu	(1607)	2.2	5.7	12	-1.1	6.1	8	-4.7	8.8	4
TS	Dianmu	(1608)	3.3	5.8	3	-	-	0	-	-	0
TY	Mindulle	(1609)	0.3	5.0	12	2.6	5.9	8	-1.7	2.7	4
TY	Lionrock	(1610)	-4.5	10.4	33	-6.8	15.5	29	-4.1	13.2	25
TS	Kompasu	(1611)	-3.3	3.8	3	-	-	0	-	-	0
TY	Namtheun	(1612)	-5.5	17.2	11	-9.3	20.8	7	-6.7	8.5	3
TS	Malou	(1613)	-	-	0	-	-	0	-	-	0
TY	Meranti	(1614)	3.8	23.2	17	6.1	35.6	13	-1.8	37.6	9
TS	Rai	(1615)	-	-	0	-	-	0	-	-	0
TY	Malakas	(1616)	-0.9	9.4	27	1.7	7.4	23	8.9	15.4	19
TY	Megi	(1617)	-14.1	19.7	15	-13.6	20.2	11	-5.7	9.6	7
TY	Chaba	(1618)	7.9	20.1	21	15.0	23.0	17	15.0	22.5	13
STS	Aere	(1619)	-6.5	12.9	13	-14.4	21.6	9	-21.0	21.1	5
TY	Songda	(1620)	17.3	22.1	15	27.3	30.9	11	20.0	25.5	7
TY	Sarika	(1621)	-7.4	13.9	18	-11.7	21.1	14	-20.9	26.4	10
TY	Haima	(1622)	0.6	9.0	23	-0.4	13.7	19	-3.5	17.8	15
TY	Meari	(1623)	1.5	13.0	13	8.9	18.4	9	12.0	12.6	5
TS	Ma-on	(1624)	-4.0	4.0	4	-	-	0	-	-	0
STS	Tokage	(1625)	-3.7	4.4	6	-5.0	5.1	2	-	-	0
TY	Nock-ten	(1626)	6.8	19.2	20	16.5	29.1	16	16.2	29.8	12
Annual Mean (Total)			-0.3	14.6	339	0.4	21.5	248	0.1	23.4	173

Figure 4.3 shows a histogram of maximum wind speed errors for 24-hour forecasts. Approximately 46% (47% in 2015) of 24-hour forecasts had errors of less than ±3.75 m/s, with figures of ±6.25 m/s for 51% (56%) of 48-hour forecasts and ±6.25 m/s for 52% (47%) of 72-hour forecasts.

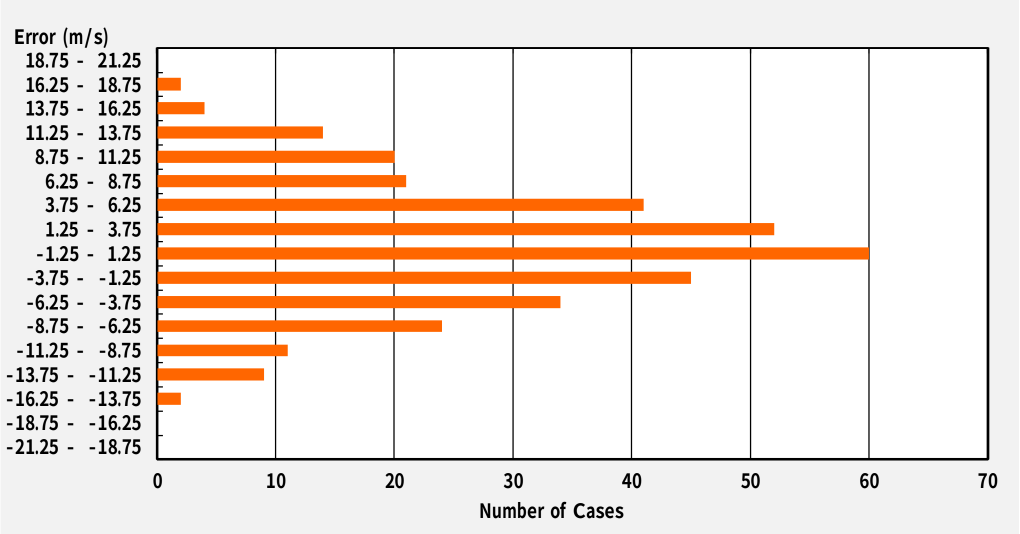


Figure 4.3 Histogram of 24-hour forecast maximum wind speed errors in 2016 (Histograms for 48-, 72-, 96- and 120-hour forecasts are included on the DVD provided with this report).

4.2 Verification of Numerical Models (GSM, TEPS)

The Global Spectral Model (GSM) and the Typhoon Ensemble Prediction System (TEPS) provide primary information for use by JMA forecasters in making operational TC track and intensity forecasts. The details of GSM and TEPS and information on recent related improvements are given in Appendix 6. GSM and TEPS 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 4.4. In 2016, the annual mean errors for 30-, 54- and 78-hour* predictions were 107 km (109 km in 2015), 190 km (173 km) and 301 km (256 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.*

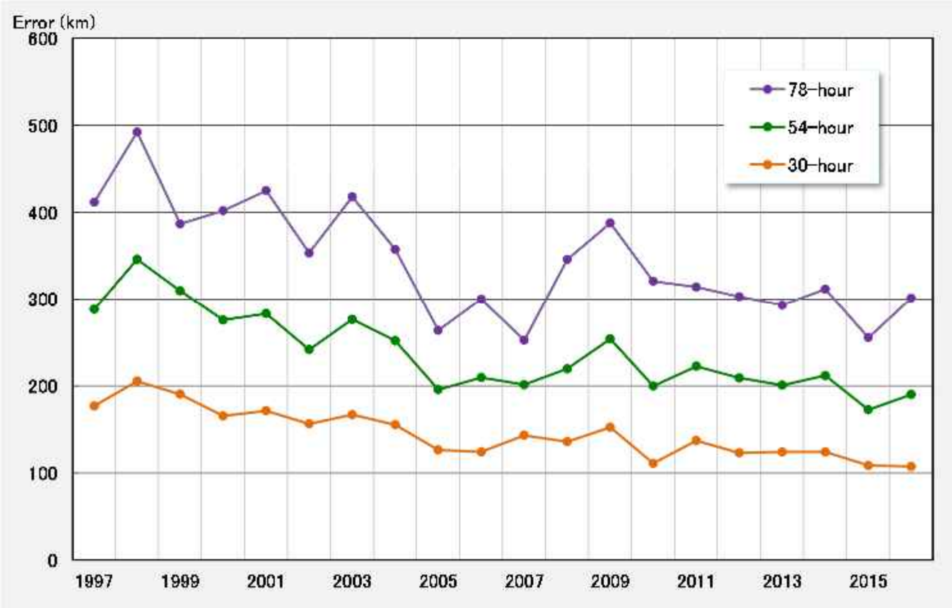


Figure 4.4 GSM annual mean position errors since 1997

Table 4.4 GSM mean position errors (km) for each TC forming in 2016. The number of samples is given in parentheses.

Tropical Cyclone			T=18		T=30		T=42		T=54		T=66		T=78	
TY	NEPARTAK	(1601)	71.9	(25)	127.7	(23)	187.8	(21)	244.7	(19)	289.3	(17)	333.3	(15)
TS	LUPIT	(1602)	153.0	(5)	228.8	(3)	298.1	(1)	-	(-)	-	(-)	-	(-)
STS	MIRINAE	(1603)	110.4	(7)	59.1	(4)	55.5	(2)	-	(-)	-	(-)	-	(-)
STS	NIDA	(1604)	80.7	(15)	113.3	(13)	157.1	(11)	232.5	(9)	319.5	(7)	415.2	(5)
STS	OMAIS	(1605)	119.1	(23)	140.4	(21)	172.2	(19)	221.5	(17)	265.8	(15)	301.4	(13)
TS	CONSON	(1606)	97.6	(24)	128.0	(22)	160.5	(20)	172.2	(18)	210.1	(16)	264.8	(14)
STS	CHANTHU	(1607)	130.8	(19)	186.3	(17)	254.9	(15)	357.0	(13)	546.5	(11)	797.6	(9)
TS	DIANMU	(1608)	88.4	(10)	93.7	(8)	179.0	(6)	188.4	(3)	295.2	(1)	-	(-)
TY	MINDULLE	(1609)	135.1	(17)	202.1	(15)	233.3	(13)	296.2	(10)	431.7	(8)	316.9	(6)
TY	LIONROCK	(1610)	59.9	(52)	89.6	(50)	131.1	(48)	166.6	(46)	190.4	(44)	219.6	(42)
TS	KOMPASU	(1611)	105.6	(6)	204.5	(4)	231.6	(2)	227.6	(1)	-	(-)	-	(-)
TY	NAMTHEUN	(1612)	51.3	(16)	63.6	(14)	72.5	(12)	92.3	(10)	193.9	(8)	363.9	(6)
TS	MALOU	(1613)	95.9	(5)	165.3	(3)	301.6	(1)	-	(-)	-	(-)	-	(-)
TY	MERANTI	(1614)	63.0	(20)	106.8	(18)	161.9	(16)	223.5	(14)	256.5	(12)	266.5	(10)
TS	RAI	(1615)	107.8	(5)	199.3	(3)	333.5	(1)	-	(-)	-	(-)	-	(-)
TY	MALAKAS	(1616)	54.9	(31)	93.6	(29)	146.4	(27)	226.0	(25)	319.0	(23)	402.7	(21)
TY	MEGI	(1617)	63.4	(20)	80.6	(18)	89.0	(16)	101.0	(14)	121.0	(12)	136.0	(10)
TY	CHABA	(1618)	74.4	(34)	91.6	(31)	126.3	(29)	170.7	(27)	223.0	(25)	283.8	(23)
STS	AERE	(1619)	78.3	(18)	116.4	(16)	159.3	(14)	187.3	(12)	209.9	(10)	264.0	(8)
TY	SONGDA	(1620)	51.8	(34)	92.8	(32)	138.3	(30)	169.6	(28)	207.6	(26)	242.5	(24)
TY	SARIKA	(1621)	45.4	(23)	61.5	(21)	98.3	(19)	136.2	(17)	192.3	(15)	258.1	(13)
TY	HAIMA	(1622)	60.9	(26)	85.4	(24)	99.4	(22)	125.7	(20)	152.3	(18)	159.1	(16)
TY	MEARI	(1623)	108.3	(24)	149.3	(22)	221.6	(20)	349.0	(17)	514.9	(15)	721.2	(13)
TS	MA-ON	(1624)	118.5	(10)	104.6	(6)	135.6	(4)	180.3	(2)	-	(-)	-	(-)
STS	TOKAGE	(1625)	61.3	(11)	68.1	(9)	85.8	(7)	157.0	(5)	278.1	(3)	434.6	(1)
TY	NOCK-TEN	(1626)	42.7	(23)	48.3	(21)	55.9	(19)	65.0	(17)	71.2	(15)	82.2	(13)
Annual Mean (Total)			77.3	(503)	107.3	(447)	145.5	(395)	190.1	(344)	247.1	(301)	301.2	(262)

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. 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 55% (44% in 2015), 64% (56%), 68% (65%) and 69% (67%) for 18-, 30-, 54- and 78-hour predictions, respectively.

About 78% (78% in 2015) of 30-hour predictions had errors of less than 150 km, while 83% (89%) of 54-hour predictions had errors of less than 300 km, and 85% (89%) 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 26 TCs forming in 2016 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	70.6 (284)	82.1 (106)	89.7 (113)	77.3 (503)
	PER	149.0 (284)	177.9 (106)	223.5 (113)	171.9 (503)
	IMPROV	52.7 %	53.9 %	59.9 %	55.0 %
T=30	GSM	93.6 (244)	123.8 (99)	123.7 (104)	107.3 (447)
	PER	242.9 (244)	318.5 (99)	408.5 (104)	298.2 (447)
	IMPROV	61.5 %	61.1 %	69.7 %	64.0 %
T=42	GSM	125.0 (206)	163.4 (93)	172.0 (96)	145.5 (395)
	PER	346.6 (206)	467.9 (93)	600.9 (96)	437.0 (395)
	IMPROV	63.9 %	65.1 %	71.4 %	66.7 %
T=54	GSM	158.1 (171)	213.3 (84)	229.7 (89)	190.1 (344)
	PER	473.2 (171)	641.1 (84)	811.6 (89)	601.7 (344)
	IMPROV	66.6 %	66.7 %	71.7 %	68.4 %
T=66	GSM	196.9 (141)	256.6 (75)	322.1 (85)	247.1 (301)
	PER	585.7 (141)	863.4 (75)	1066.3 (85)	790.6 (301)
	IMPROV	66.4 %	70.3 %	69.8 %	68.7 %
T=78	GSM	236.5 (117)	295.6 (65)	400.2 (80)	301.2 (262)
	PER	710.0 (117)	1041.5 (65)	1339.1 (80)	984.3 (262)
	IMPROV	66.7 %	71.6 %	70.1 %	69.4 %

2) Central Pressure and Maximum Wind Speed

The mean errors of 30-, 54- and 78-hour GSM central pressure predictions in 2016 were +14.7 hPa (+13.7 hPa in 2015), +16.5 hPa (+14.0 hPa) and +16.5 hPa (+14.0 hPa), respectively. Their root mean square errors (RMSEs) were 24.4 hPa (24.0 hPa in 2015) for 30-hour predictions, 27.6 hPa (26.2 hPa) for 54-hour predictions and 30.6 hPa (28.3 hPa) for 78-hour predictions. The biases for 30-, 54- and 78-hour maximum wind speed predictions were -8.0 m/s (-8.1 m/s in 2015) with a RMSE of 11.5 m/s (11.7 m/s), -8.4 m/s (-7.8 m/s) with a RMSE of 13.2 m/s (12.9 m/s) and -8.1 m/s (-7.5 m/s) with a RMSE of 14.4 m/s (13.9 m/s), respectively.

Figure 4.5 shows histograms of central pressure errors and maximum wind speed errors in 30-hour GSM predictions. It can be seen that the GSM has a small positive bias for central pressure prediction (left) and tends to underestimate the wind speed of TCs (right). This underestimation occurs because the model's current horizontal resolution (about 20 km) is not fine enough to produce the TC core structure, especially when the TC is intense and small.

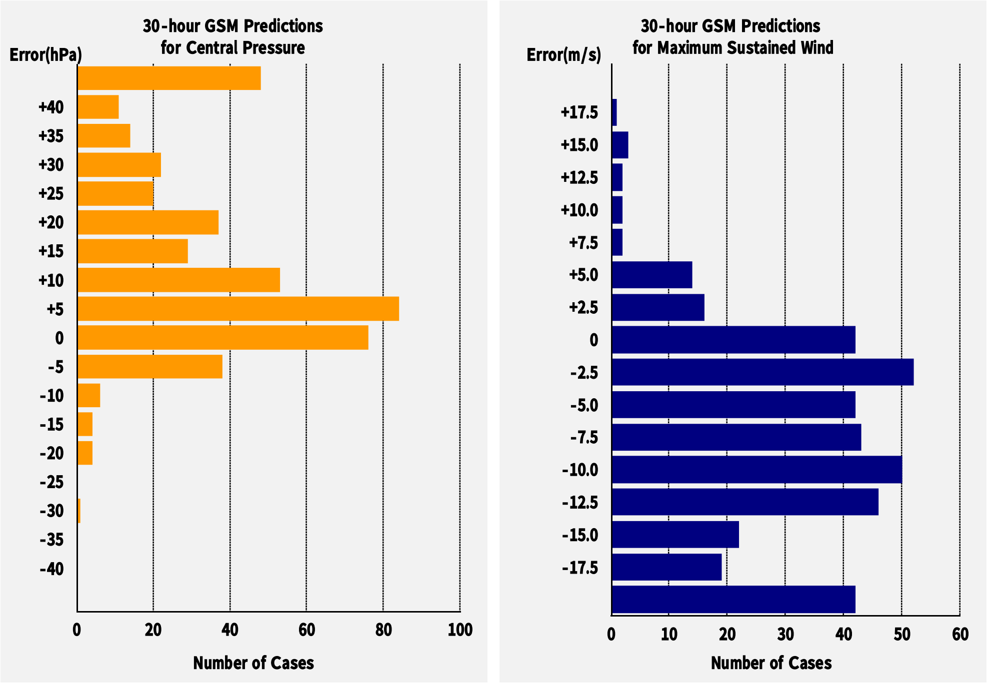


Figure 4.5 Error distribution of GSM 30-hour intensity predictions in 2016.
The figure on the left shows error distribution for central pressure, while the one on the right shows that for maximum wind speed (the error distributions of 54- and 78-hour predictions are included on the DVD provided with this report).

4.2.2 TEPS Prediction

1) Ensemble mean center position

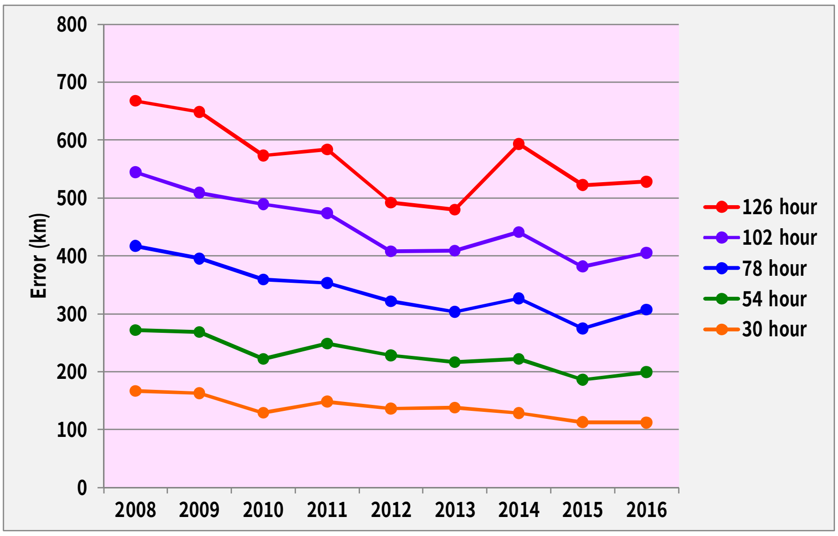


Figure 4.6 TEPS annual mean position errors since 2008

TEPS annual mean position errors observed since 2008 are presented in Figure 4.6. In 2016, the mean position errors of TEPS 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 112 km (107 km with the GSM), 199 km (190 km), 307 km (301 km), 405 km and 528 km, respectively.

Table 4.6 Mean position errors (km) of TEPS ensemble mean forecasts for each TC forming in 2016. The number of samples is given in parentheses.

Tropical Cyclone			T=30		T=54		T=78		T=102		T=126	
TY	NEPARTAK	(1601)	130.9	(23)	229.7	(19)	295.8	(15)	478.1	(11)	1124.5	(7)
TS	LUPIT	(1602)	232.9	(2)	-	(-)	-	(-)	-	(-)	-	(-)
STS	MIRINAE	(1603)	66.0	(5)	-	(-)	-	(-)	-	(-)	-	(-)
STS	NIDA	(1604)	130.1	(13)	226.5	(9)	413.4	(5)	677.6	(1)	-	(-)
STS	OMAIS	(1605)	127.1	(21)	214.8	(17)	271.2	(13)	270.1	(9)	267.9	(5)
TS	CONSON	(1606)	113.9	(22)	165.5	(18)	289.2	(14)	664.5	(10)	1076.2	(6)
STS	CHANTHU	(1607)	200.4	(17)	396.5	(13)	735.1	(9)	1037.0	(5)	1415.4	(1)
TS	DIANMU	(1608)	108.0	(3)	-	(-)	-	(-)	-	(-)	-	(-)
TY	MINDULLE	(1609)	172.5	(12)	370.2	(7)	576.1	(3)	-	(-)	-	(-)
TY	LIONROCK	(1610)	89.6	(42)	178.0	(38)	277.4	(34)	364.6	(30)	439.7	(26)
TS	KOMPASU	(1611)	158.0	(2)	-	(-)	-	(-)	-	(-)	-	(-)
TY	NAMTHEUN	(1612)	91.2	(14)	109.8	(10)	201.8	(6)	199.5	(2)	-	(-)
TS	MALOU	(1613)	177.1	(3)	-	(-)	-	(-)	-	(-)	-	(-)
TY	MERANTI	(1614)	95.5	(18)	175.5	(14)	225.1	(10)	283.4	(6)	434.9	(2)
TS	RAI	(1615)	220.2	(3)	-	(-)	-	(-)	-	(-)	-	(-)
TY	MALAKAS	(1616)	102.0	(29)	229.7	(25)	367.3	(21)	464.0	(17)	533.6	(13)
TY	MEGI	(1617)	74.0	(18)	111.4	(14)	179.7	(10)	177.6	(6)	142.5	(2)
TY	CHABA	(1618)	109.6	(32)	212.1	(28)	321.9	(24)	396.4	(20)	505.0	(16)
STS	AERE	(1619)	140.0	(16)	186.6	(12)	257.4	(8)	492.6	(4)	-	(-)
TY	SONGDA	(1620)	104.0	(31)	200.7	(27)	301.9	(23)	392.0	(18)	594.2	(14)
TY	SARIKA	(1621)	70.4	(21)	161.0	(17)	297.6	(13)	377.7	(9)	485.0	(5)
TY	HAIMA	(1622)	81.4	(24)	127.9	(20)	180.6	(16)	255.5	(12)	338.7	(8)
TY	MEARI	(1623)	147.6	(22)	270.6	(16)	534.9	(12)	630.9	(8)	331.4	(4)
TS	MA-ON	(1624)	99.1	(6)	214.2	(1)	-	(-)	-	(-)	-	(-)
STS	TOKAGE	(1625)	89.9	(9)	211.9	(5)	489.5	(1)	-	(-)	-	(-)
TY	NOCK-TEN	(1626)	95.6	(22)	136.0	(18)	131.7	(14)	144.9	(10)	211.5	(6)
All Mean (Total)			112.1	(430)	199.2	(328)	307.0	(251)	405.1	(178)	528.1	(115)

2) Spread-skill relationship

Although position errors of TEPS ensemble mean forecasts were larger than those of the GSM in short-range forecasts, TEPS provides useful information on the reliability of TC track forecasts with its ensemble spread. Figure 4.7 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, a significant position error is observed when the ensemble spread is large.

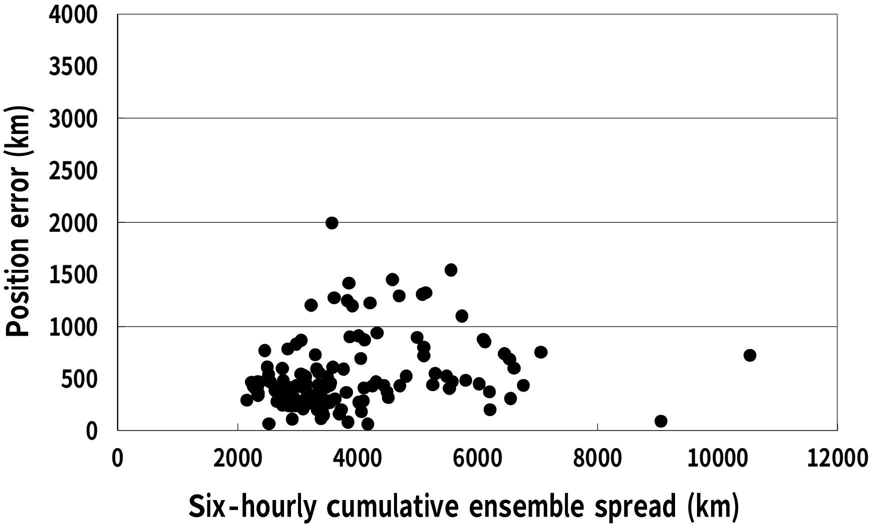


Figure 4.7 Relationship between six-hourly cumulative ensemble spread in TC position forecasts (km) and ensemble mean forecast position errors (km) in 126-hour predictions in 2016.

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 TEPS 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. However, B shows larger errors than C in 2016 TC track forecasts. Consequently, TEPS needs to be improved to enable the provision of better reliability information on TC track forecasts.

Table 4.7 Ensemble mean forecast position errors (km) in 2016 classified with six-hourly cumulative ensemble spread at each forecast time. The number of samples is given in parentheses.

	Reliability Index					
Time	A		B		C	
T=30	101.2	(232)	119.0	(176)	158.8	(49)
T=54	183.4	(189)	239.3	(121)	214.7	(47)
T=78	258.8	(147)	377.1	(94)	366.6	(31)
T=102	329.9	(116)	524.9	(66)	482.6	(16)
T=126	432.1	(80)	701.7	(40)	553.1	(12)

4.3 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 4.8) 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 2016. 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 STS Nida (1604) and TY Meranti (1614).

Table 4.8 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

4.3.1 Deterministic Prediction

No significant storm surges were observed at any of the eight stations in 2016 (Table 4.9). Figure 4.8 shows a scatter diagram of model storm surges (hindcast and forecast) against observation data. The root mean square errors (RMSEs; unit: m) were 0.086 (hindcast) and 0.088 (forecast), and the correlations were 0.37 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 mitigation caused by land topography.

Table 4.9 Maximum storm surges observed at the eight stations for each TC forming in 2016 (unit: m)

	T1601	T1602	T1603	T1604	T1605	T1606	T1607	T1608	T1609	T1610
QB	0.15	-0.05	-0.03	0.51	0.01	0.08	0.15	0.22	0.1	0.34
LK										
LG	0.09	0.09	0.07	0.15	0.1	0.14	0.12	0.07	0.15	0.15
ML	0.17	-0.03	0.01	0.12	0.09	0.16	0.21	0.14	0.13	0.15
SB	0.08	0.03	0.03	0.12	0.07	0.11	0.15	0.1	0.09	0.11
AP	0.1	0.08	0.08	0.13	0.1	0.16	0.18	0.19	0.16	0.15
QN	0.05	0.01	0.09	0.15	0.11	0.08	0.04	0.01	0.06	0.13
VT	0.22	0.24	0.24	0.27	0.19	0.1	0.05	0.08	0.08	0.16

	T1611	T1612	T1613	T1614	T1615	T1616	T1617	T1618	T1619	T1620
QB	0.05	0.22	0.1	0.35	0.23	0.35	0.27	0.12	0.24	0.26
LK										
LG	0.15	0.13	0.13	0.16	0.15	0.17	0.19	0.18	0.15	0.15
ML	0.11	0.16	0.05	0.13	0.07	0.13	0.19	0.15	0.13	0.12
SB	0.09	0.07	0.04	0.09	0.07	0.1	0.12	0.08	0.1	0.11
AP	0.15	0.11	0.08	0.13	0.08	0.11	0.12	0.11	0.14	0.14
QN	-0.02	0.06	-0.03	0.08	0.07	0.16	0.12	0.03	0.02	0.12
VT	0.06	0.22	0.08	0.08	-0.06	0.15	0.17	0.11	0.01	0.11

	T1621	T1622	T1623	T1624	T1625	T1626
QB	0.35	0.44	0.2	0.15	0.28	0.32
LK		0.08	0.06	-0.07	0.02	0.14
LG	0.2	0.18	0.15	0.09	0.14	0.23
ML	0.3	0.38	0.1	0.09		0.12
SB	0.15	0.22	0.1	0.04	0.15	0.14
AP	0.18	0.19	0.21	0.16	0.12	0.2
QN	0.17	0.18	0.35	0.14	0.16	
VT	0.2	0.17	0.22	0.06	0.25	0.14

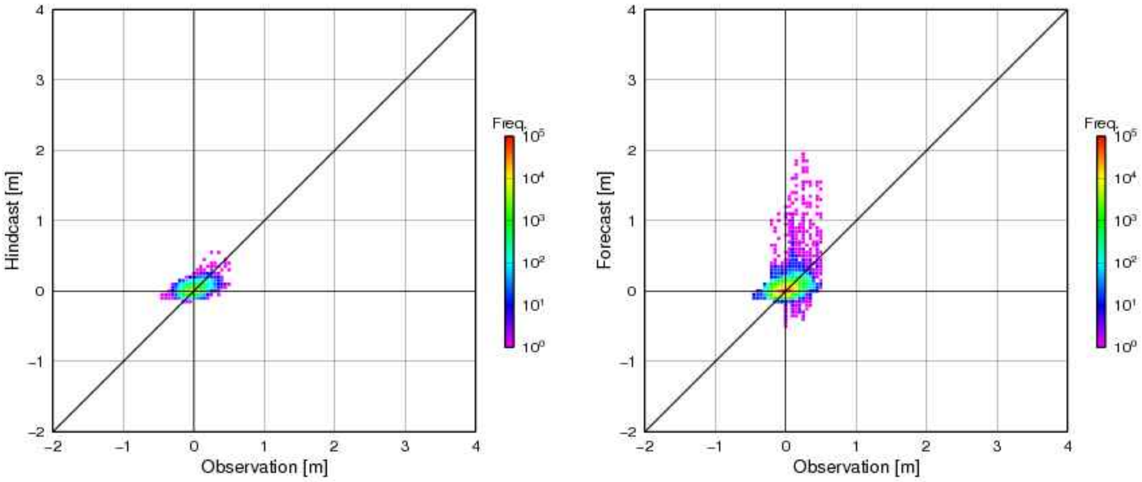


Figure 4.8 Scatter diagram of model storm surges against observation data from the eight stations for all TCs forming in 2016 (left: hindcast; right: forecast)

4.3.2 Multi-scenario Prediction

STS Nida (1604) hit the southern coast of China in August 2016 with a maximum wind speed of 30 m/s and a minimum pressure of 975 hPa. Storm surges are a concern along the wide, shallow sea area off the Chinese coast because the phenomenon is particularly intensified there. Figure 4.9 shows the analysis track and the predicted tracks (official and five selected ones) for Nida with the initial time of 24 hours before it landed. The official forecast track had the most westerly course, passing near Hong Kong and threatening the area. In reality, Nida landed on eastern Hong Kong with a track similar to that of scenario 2. The maximum storm tide and surge for Quarry Bay in Hong Kong in the official forecast were 4.04 m and 1.85 m, and those of scenario 2 were 2.87 m and 0.66 m, respectively (Figure 4.10). The values of scenario 2 correspond closely to the observation (2.93 m and 0.64 m).

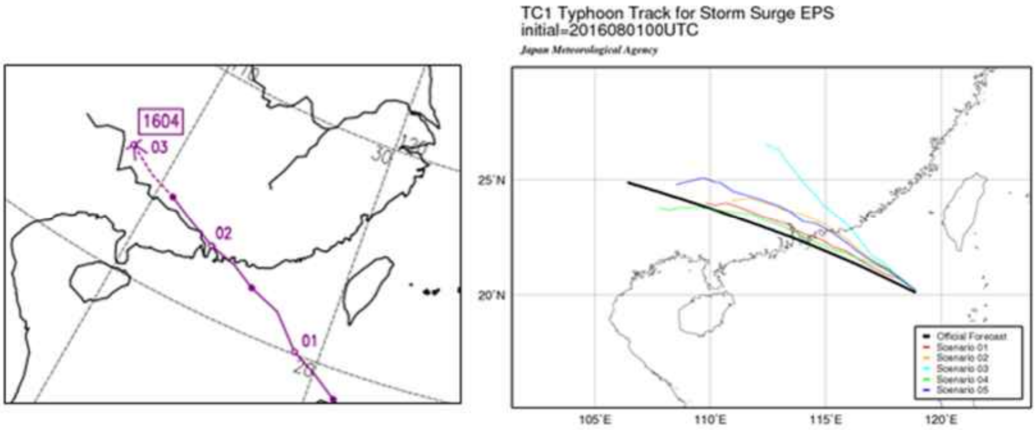


Figure 4.9 Analysis track (left) and predicted tracks (right) for Nida
In the figure on the right, colored lines show the five selected tracks and the bold black line shows the official JMA forecast.

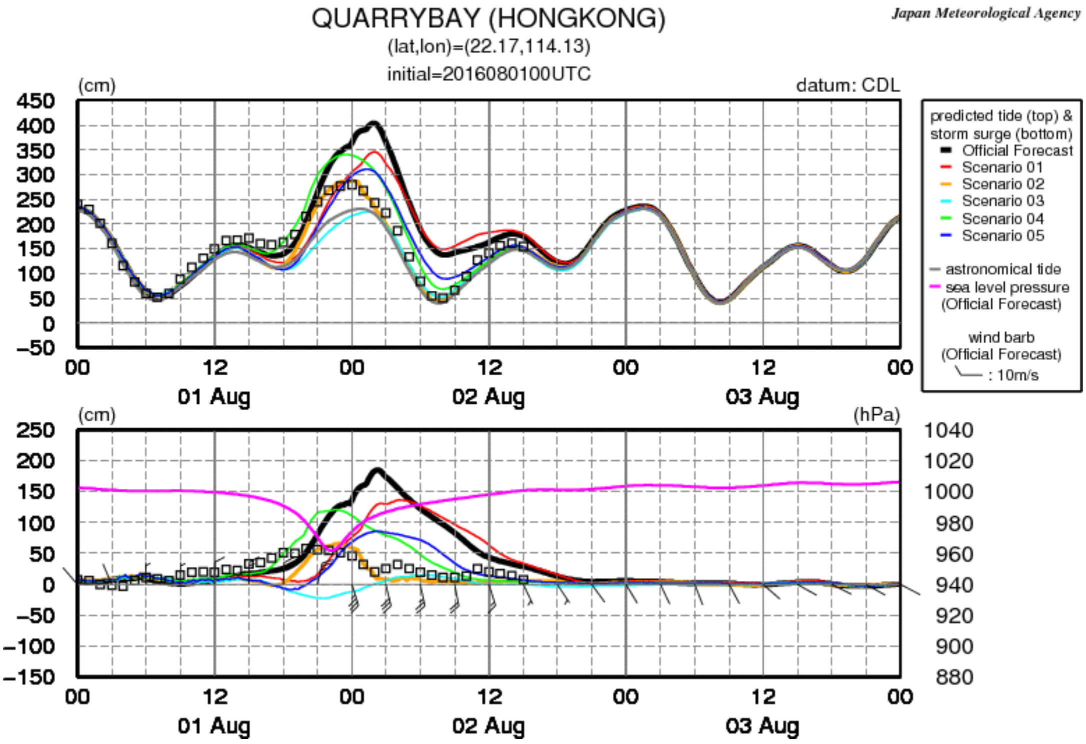


Figure 4.10 Time-series representation of storm tide and astronomical tide (top), storm surge, sea level pressure and surface wind (bottom) for Quarry Bay (Hong Kong)
Squares show hourly observations provided by HKO (Hong Kong Observatory).

Figure 4.11 shows another example of multi-scenario prediction. For TY Meranti (1614), the TC tracks of the five scenarios showed large variations. The map of maximum storm surges among all scenarios during the forecast time indicates the probability of high storm surges around wide areas along the southern coast of China. Multi-scenario prediction is especially valid for risk management in uncertain situations.

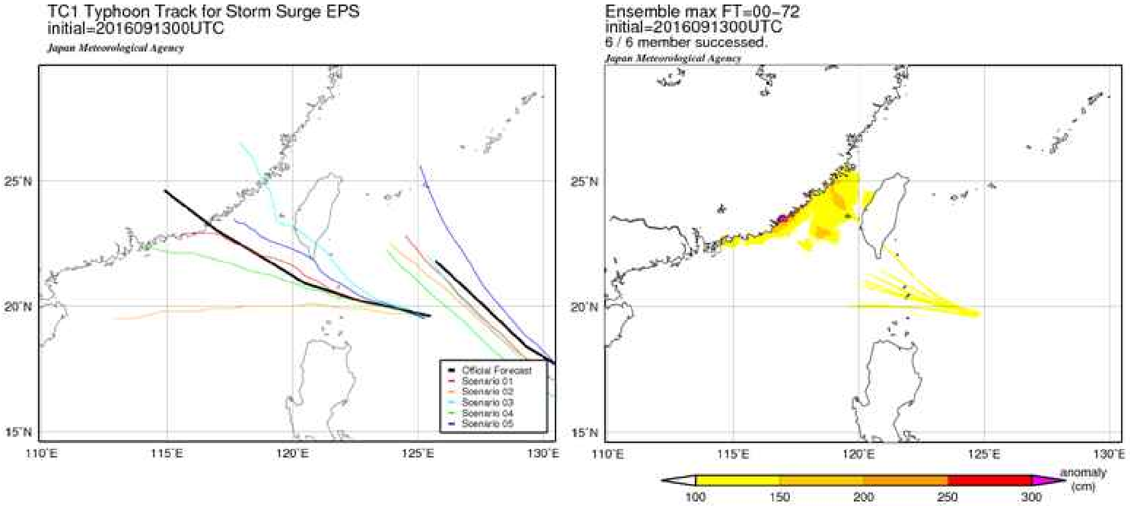


Figure 4.11 Predicted tracks (black line: official forecast; colored lines: five selected tracks). The figure on the right shows storm surge distribution maxima for all scenarios during the forecast time for Meranti.

[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 2016

Nepartak (1601)

Date/Time (UTC)		Center position		Central pressure (hPa)	Max wind (kt)	CI num.	Grade
		Lat (N)	Lon (E)				
Jul.	02/12	8.3	145.1	1006	-	1.0	TD
	02/18	8.6	145.0	1004	-	1.5	TD
	03/00	8.9	144.9	1002	35	2.0	TS
	03/06	9.2	144.8	1002	35	2.0	TS
	03/12	10.0	144.4	1000	35	2.5	TS
	03/18	10.9	143.9	996	40	3.0	TS
	04/00	11.9	142.6	996	40	3.0	TS
	04/06	12.8	141.1	994	45	3.0	TS
	04/12	13.5	139.6	990	50	4.0	STS
	04/18	14.5	138.2	980	60	4.5	STS
	05/00	15.3	136.6	965	65	4.5	TY
	05/06	16.3	135.1	955	75	5.0	TY
	05/12	17.1	133.5	940	85	6.0	TY
	05/18	18.0	131.9	925	95	6.5	TY
	06/00	18.7	130.1	915	100	7.0	TY
	06/06	19.5	128.4	900	110	7.5	TY
	06/12	20.1	127.0	900	110	7.5	TY
	06/18	20.7	125.6	900	110	7.5	TY
	07/00	21.3	124.3	900	110	7.5	TY
	07/06	21.6	123.4	900	110	7.5	TY
	07/12	22.0	122.6	900	110	7.0	TY
	07/18	22.4	121.7	920	90	6.5	TY
	08/00	22.6	120.6	950	75	5.5	TY
	08/06	23.2	120.1	975	65	5.5	TY
	08/12	23.2	119.9	985	50	4.5	STS
	08/18	23.4	119.8	985	45	4.5	TS
	09/00	24.3	118.8	992	35	4.0	TS
	09/06	24.8	118.5	994	-	3.5	TD
	09/12	25.4	117.9	996	-	3.0	TD
	09/18	25.9	117.2	996	-	-	TD
	10/00	26.4	116.7	998	-	-	TD
	10/06						Dissip.

Lupit (1602)

Date/Time (UTC)		Center position		Central pressure (hPa)	Max wind (kt)	CI num.	Grade
		Lat (N)	Lon (E)				
Jul.	22/18	24.6	151.5	1004	-	0.5	TD
	23/00	25.3	152.3	1004	-	1.0	TD
	23/06	26.4	154.0	1004	-	1.5	TD
	23/12	27.4	155.3	1004	-	1.5	TD
	23/18	28.9	157.1	1000	35	2.0	TS
	24/00	31.0	158.5	1000	40	2.0	TS
	24/06	33.0	159.3	1000	40	2.0	TS
	24/12	35.0	159.5	1000	40	2.0	TS
	24/18	37.2	159.5	1000	-	2.0	L
	25/00	40.3	159.3	1004	-	-	L
	25/06	44.1	157.4	1008	-	-	L
	25/12	45.6	156.5	1010	-	-	L
	25/18	47.0	155.5	1012	-	-	L
	26/00	47.5	153.7	1014	-	-	L
	26/06	48.4	152.1	1014	-	-	L
	26/12						Dissip.

Mirinae (1603)

Date/Time (UTC)		Center position		Central pressure (hPa)	Max wind (kt)	CI num.	Grade
		Lat (N)	Lon (E)				
Jul.	25/12	17.2	114.7	1006	-	1.0	TD
	25/18	17.3	113.9	1004	-	1.5	TD
	26/00	18.1	113.0	1002	-	2.0	TD
	26/06	18.5	112.0	998	40	2.5	TS
	26/12	18.5	110.8	996	40	2.5	TS
	26/18	18.9	109.7	996	40	2.5	TS
	27/00	19.7	108.6	998	35	2.0	TS
	27/06	19.8	107.3	990	45	2.5	TS
	27/12	19.9	106.7	980	55	3.0	STS
	27/18	20.2	106.2	985	45	3.0	TS
	28/00	20.6	105.6	996	35	2.5	TS
	28/06	21.2	105.0	1000	-	2.0	TD
	28/12	22.0	104.9	1004	-	1.5	TD
	28/18					1.0	Dissip.

Nida (1604)

Date/Time (UTC)		Center position		Central pressure (hPa)	Max wind (kt)	CI num.	Grade
		Lat (N)	Lon (E)				
Jul.	29/12	11.7	127.1	1002	-	0.5	TD
	29/18	12.7	127.3	1002	-	1.0	TD
	30/00	14.1	126.5	1002	-	1.5	TD
	30/06	15.5	125.8	998	35	2.0	TS
	30/12	16.4	124.4	994	40	2.5	TS
	30/18	16.9	123.8	990	45	3.0	TS
	31/00	17.5	123.1	985	50	3.5	STS
	31/06	18.2	122.3	975	60	4.0	STS
	31/12	18.8	121.2	975	60	3.5	STS
	31/18	19.5	120.1	980	55	3.0	STS
Aug.	01/00	20.1	118.9	980	55	3.0	STS
	01/06	21.4	117.5	980	55	3.0	STS
	01/12	21.9	116.0	980	55	3.0	STS
	01/18	22.5	114.8	980	50	3.0	STS
	02/00	22.8	113.5	985	45	2.5	TS
	02/06	23.4	112.0	990	35	2.5	TS
	02/12	23.9	110.8	994	-	2.0	TD
	02/18	24.3	109.4	996	-	1.5	TD
	03/00	25.0	107.9	998	-	1.0	TD
	03/06						Dissip.

Omais (1605)

Date/Time (UTC)		Center position		Central pressure (hPa)	Max wind (kt)	CI num.	Grade
		Lat (N)	Lon (E)				
Aug.	02/12	16.7	148.8	1004	-	-	TD
	02/18	16.7	148.2	1002	-	-	TD
	03/00	16.9	147.8	1004	-	-	TD
	03/06	17.6	147.8	1002	-	0.0	TD
	03/12	17.8	148.1	1002	-	0.5	TD
	03/18	18.1	148.3	1000	-	0.5	TD
	04/00	18.4	148.5	998	35	1.0	TS
	04/06	18.8	148.5	998	35	1.5	TS
	04/12	19.2	148.5	998	35	1.5	TS
	04/18	19.8	148.4	996	35	2.0	TS
	05/00	20.7	148.1	992	40	2.0	TS
	05/06	21.7	147.9	990	45	2.0	TS
	05/12	22.5	147.8	985	50	2.5	STS
	05/18	23.3	147.8	980	55	2.5	STS
	06/00	24.2	147.8	980	55	3.0	STS
	06/06	24.9	147.7	975	60	3.0	STS
	06/12	26.1	147.7	975	60	3.0	STS
	06/18	27.3	147.5	975	60	3.0	STS
	07/00	28.6	147.3	975	60	3.0	STS
	07/06	30.0	146.9	975	60	3.0	STS
	07/12	31.3	146.3	980	55	3.0	STS
	07/18	32.5	145.3	980	55	2.5	STS
	08/00	33.5	144.5	980	55	2.5	STS
	08/06	34.5	144.3	980	50	2.5	STS
	08/12	35.7	144.5	980	50	2.5	STS
	08/18	36.8	145.1	980	50	2.5	STS
	09/00	37.9	145.9	980	50	2.0	STS
	09/06	40.2	147.4	980	50	2.0	STS
	09/12	42.0	148.8	985	45	1.5	TS
	09/18	44.1	151.7	984	-	1.5	L
	10/00	46.2	152.5	988	-	-	L
	10/06	48.1	156.2	988	-	-	L
	10/12	50.0	159.8	986	-	-	L
	10/18	51.9	162.8	986	-	-	L
	11/00	53.5	165.5	984	-	-	L
	11/06	54.9	169.1	984	-	-	L
	11/12	55.6	172.5	984	-	-	L
	11/18	56.1	174.6	984	-	-	L
	12/00	56.3	177.1	986	-	-	L
	12/06	56.4	181.8	988	-	-	Out

Conson (1606)

Date/Time (UTC)		Center position		Central pressure (hPa)	Max wind (kt)	CI num.	Grade
		Lat (N)	Lon (E)				
Aug.	07/12	18.8	163.0	1010	-	0.0	TD
	07/18	18.0	162.0	1008	-	0.0	TD
	08/00	17.4	161.7	1008	-	0.5	TD
	08/06	17.1	161.4	1006	-	1.0	TD
	08/12	17.0	160.8	1006	-	1.5	TD
	08/18	17.0	160.1	1002	-	1.5	TD
	09/00	16.9	159.3	1000	35	2.0	TS
	09/06	16.8	158.7	996	40	2.0	TS
	09/12	17.0	157.8	990	45	2.5	TS
	09/18	17.7	156.9	990	45	2.5	TS
	10/00	18.0	156.0	990	45	2.5	TS
	10/06	18.6	155.1	990	45	2.5	TS
	10/12	18.9	154.4	990	45	2.5	TS
	10/18	19.6	154.0	990	45	2.5	TS
	11/00	20.0	153.6	990	45	2.5	TS
	11/06	20.5	154.0	990	45	2.5	TS
	11/12	21.9	154.3	990	45	2.5	TS
	11/18	23.5	155.0	990	45	2.5	TS
	12/00	25.2	155.5	990	45	2.5	TS
	12/06	26.2	155.7	990	40	2.5	TS
	12/12	28.0	156.4	990	40	2.5	TS
	12/18	28.9	156.6	990	40	2.5	TS
	13/00	29.9	155.5	990	40	2.5	TS
	13/06	31.6	154.3	985	45	2.5	TS
	13/12	32.6	153.1	985	45	2.0	TS
	13/18	33.9	152.2	985	45	2.0	TS
	14/00	35.7	151.1	985	45	2.0	TS
	14/06	38.1	149.5	985	45	2.0	TS
	14/12	40.2	148.0	990	40	2.0	TS
	14/18	42.1	145.9	990	40	1.5	TS
	14/23	43.3	145.5	988	40	-	TS
	15/00	43.6	145.6	990	-	1.5	L
	15/06	46.3	145.4	992	-	-	L
	15/12	48.8	146.1	996	-	-	L
	15/18	53.2	145.2	996	-	-	L
	16/00	56.1	142.6	996	-	-	L
	16/06	57.2	142.0	998	-	-	L
	16/12	58.7	143.1	1000	-	-	L
	16/18						Dissip.

Chanthu (1607)

Date/Time (UTC)		Center position		Central pressure (hPa)	Max wind (kt)	CI num.	Grade
		Lat (N)	Lon (E)				
Aug.	12/00	16.0	137.6	1002	-	0.0	TD
	12/06	16.3	138.0	1002	-	0.0	TD
	12/12	16.8	138.6	1002	-	0.0	TD
	12/18	17.2	139.4	1002	-	0.0	TD
	13/00	17.7	139.9	1002	-	0.5	TD
	13/06	18.8	140.7	1000	-	1.0	TD
	13/12	19.8	141.9	1000	-	1.5	TD
	13/18	20.9	142.9	994	35	2.0	TS
	14/00	22.0	143.6	994	35	2.5	TS
	14/06	23.4	144.2	992	40	2.5	TS
	14/12	24.6	144.5	990	45	3.0	TS
	14/18	25.7	144.8	985	50	3.0	STS
	15/00	27.1	145.0	985	50	3.0	STS
	15/06	28.1	144.5	985	50	3.0	STS
	15/12	29.4	143.8	985	45	2.5	TS
	15/18	30.5	143.0	985	45	2.5	TS
	16/00	31.6	142.5	980	50	2.5	STS
	16/06	33.4	141.4	980	50	2.5	STS
	16/12	34.4	141.0	980	50	2.5	STS
	16/18	35.8	141.2	980	50	2.5	STS
	17/00	37.8	141.7	980	55	2.5	STS
	17/03	39.0	142.2	980	55	-	STS
	17/06	40.8	142.7	980	55	2.5	STS
	17/08	41.8	143.0	980	55	-	STS
	17/09	42.3	143.1	980	55	-	STS
	17/12	44.3	143.1	984	55	2.5	STS
	17/18	47.7	144.6	984	-	-	L
	18/00	51.2	145.3	982	-	-	L
	18/06	54.6	146.7	980	-	-	L
	18/12	58.1	147.6	982	-	-	L
	18/18	60.7	149.1	986	-	-	Out

Dianmu (1608)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	15/06	21.7	117.0	996	-	-	TD
	15/12	21.7	116.3	996	-	-	TD
	15/18	21.7	115.4	996	-	-	TD
	16/00	21.8	114.7	996	-	-	TD
	16/06	21.7	114.0	994	-	-	TD
	16/12	21.6	113.5	994	-	-	TD
	16/18	21.5	113.3	992	-	-	TD
	17/00	21.5	113.2	992	-	0.0	TD
	17/06	21.5	113.1	992	-	0.5	TD
	17/12	21.4	112.9	990	-	1.0	TD
	17/18	21.1	112.2	985	35	1.5	TS
	18/00	20.9	111.3	985	35	1.5	TS
	18/06	20.8	110.3	985	35	1.5	TS
	18/12	20.5	109.2	985	35	2.0	TS
	18/18	20.5	108.2	980	40	2.0	TS
	19/00	20.5	107.3	980	40	2.0	TS
	19/06	20.6	106.4	980	40	2.0	TS
	19/12	20.8	104.8	990	-	1.5	TD
	19/18	21.2	102.5	994	-	1.0	TD
	20/00						Dissip.

Mindulle (1609)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	17/00	15.3	138.9	1002	-	-	TD
	17/06	15.2	139.9	998	-	-	TD
	17/12	15.2	140.7	998	-	0.5	TD
	17/18	15.1	141.3	996	-	0.5	TD
	18/00	15.2	142.0	996	-	1.0	TD
	18/06	15.6	142.8	996	-	0.5	TD
	18/12	16.1	143.1	996	-	1.0	TD
	18/18	16.6	143.1	996	-	1.5	TD
	19/00	17.2	142.5	996	-	2.0	TD
	19/06	17.8	141.8	994	35	2.0	TS
	19/12	18.7	140.9	994	35	2.0	TS
	19/18	19.4	140.6	992	40	2.0	TS
	20/00	20.4	140.8	992	40	2.5	TS
	20/06	22.1	141.0	990	45	2.5	TS
	20/12	24.4	141.1	985	50	2.5	STS
	20/18	26.2	140.8	985	50	2.5	STS
	21/00	28.0	140.6	985	50	2.5	STS
	21/06	29.8	139.9	985	50	2.5	STS
	21/12	31.5	139.5	980	55	2.5	STS
	21/15	32.3	139.2	980	55	-	STS
	21/18	33.1	139.4	975	65	2.5	TY
	21/21	33.8	139.3	975	65	-	TY
	22/00	34.2	139.5	975	65	3.0	TY
	22/03	34.8	139.8	975	65	-	TY
	22/06	35.9	140.0	980	60	3.0	STS
	22/09	36.6	140.3	985	55	-	STS
	22/12	37.8	140.8	990	55	2.5	STS
	22/15	38.9	141.1	990	55	-	STS
	22/18	40.4	141.9	992	50	2.0	STS
	22/20	41.8	142.3	992	50	-	STS
	22/21	42.4	142.6	992	50	-	STS
	23/00	43.6	143.8	992	50	-	STS
	23/03	45.1	145.3	992	-	-	L
	23/06						Dissip.

Lionrock (1610)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	17/00	26.4	159.1	996	-	0.5	TD
	17/06	27.0	157.0	996	-	0.5	TD
	17/12	27.4	155.4	996	-	1.0	TD
	17/18	28.3	153.6	996	-	0.5	TD
	18/00	29.3	152.0	996	-	0.5	TD
	18/06	30.4	150.4	996	-	0.5	TD
	18/12	31.4	148.6	996	-	0.5	TD
	18/18	32.2	146.8	996	-	0.5	TD
	19/00	32.9	144.9	996	-	0.5	TD
	19/06	33.1	142.8	996	-	0.5	TD
	19/12	33.1	141.3	996	-	0.5	TD
	19/18	32.3	139.7	996	-	0.5	TD
	20/00	31.5	138.5	996	-	0.5	TD
	20/06	31.0	137.6	996	-	1.0	TD
	20/12	30.5	136.7	996	-	1.5	TD
	20/18	30.1	135.5	996	-	1.5	TD
	21/00	29.8	134.3	996	-	1.5	TD
	21/06	29.5	133.7	996	-	2.0	TD
	21/12	29.2	133.3	992	35	2.0	TS
	21/18	28.8	133.2	990	40	2.5	TS
	22/00	28.8	133.4	990	40	2.5	TS
	22/06	28.7	133.7	990	40	2.5	TS
	22/12	28.5	134.1	990	40	2.5	TS
	22/18	28.2	134.3	990	45	3.0	TS
	23/00	28.0	134.4	985	50	3.5	STS
	23/06	27.3	134.2	980	55	3.5	STS
	23/12	26.6	134.0	975	60	4.5	STS
	23/18	25.8	133.3	965	70	4.5	TY
	24/00	25.3	132.8	960	75	4.5	TY
	24/06	24.8	132.3	950	80	5.5	TY
	24/12	24.4	131.8	950	80	5.5	TY
	24/18	23.9	131.4	945	85	5.5	TY
	25/00	23.6	131.1	945	85	5.5	TY
	25/06	23.5	130.9	945	85	5.5	TY
	25/12	23.5	130.8	945	85	5.5	TY
	25/18	23.1	130.5	945	85	5.5	TY
	26/00	23.2	131.0	945	85	5.5	TY
	26/06	23.1	131.3	945	85	5.5	TY
	26/12	23.2	132.1	950	80	5.0	TY
	26/18	23.5	132.5	950	80	5.0	TY
	27/00	23.7	133.1	945	85	5.5	TY
	27/06	24.0	133.9	945	85	5.5	TY
	27/12	24.5	134.6	945	85	5.5	TY
	27/18	25.1	135.6	945	85	5.5	TY
	28/00	26	137	945	85	5.5	TY
	28/06	27.7	137.9	940	90	6.0	TY
	28/12	28.5	138.8	940	90	6.0	TY
	28/18	29.4	140.5	940	90	6.0	TY
	29/00	30.4	141.7	945	85	5.5	TY
	29/06	31.3	142.7	950	80	5.0	TY
	29/12	32.3	143.4	960	75	4.5	TY
	29/18	34.0	143.6	965	70	4.0	TY
	29/21	34.8	143.4	965	70	-	TY
	30/00	35.6	143.0	965	65	3.5	TY
	30/03	36.6	142.4	965	65	-	TY
	30/06	37.8	142.2	965	65	3.0	TY
	30/08	38.8	142.0	965	65	-	TY
	30/09	39.3	141.7	970	60	-	STS
	30/12	41.3	140.0	972	60	2.5	STS
	30/15	42.0	138.0	976	-	-	L
	30/18	43.9	135.7	980	-	-	L
	31/00						Dissip.

Kompasu (1611)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	18/12	22.3	152.8	998	-	0.5	TD
	18/18	24.1	153.4	996	-	0.5	TD
	19/00	25.7	152.8	996	-	1.0	TD
	19/06	27.4	152.2	996	-	1.0	TD
	19/12	29.5	151.5	996	-	1.5	TD
	19/18	31.8	149.3	996	-	1.5	TD
	20/00	32.9	147.3	994	35	2.0	TS
	20/06	34.3	145.7	994	35	2.0	TS
	20/12	36.3	143.7	994	35	2.0	TS
	20/18	37.8	142.8	996	35	2.0	TS
	21/00	38.8	142.9	996	35	2.0	TS
	21/06	40.6	142.9	996	35	2.0	TS
	21/12	42.5	143.9	1000	35	1.5	TS
	21/14	42.9	144.1	1002	35	-	TS
	21/18	45.0	145.0	1002	-	1.0	L
	22/00	46.8	145.8	1002	-	-	L
	22/06	48.2	147.0	1002	-	-	L
	22/12						Dissip.

Namtheun (1612)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug.	31/00	21.1	123.2	1002	-	0.5	TD
	31/06	21.3	124.4	1002	-	1.0	TD
	31/12	22.0	125.8	1002	-	1.5	TD
	31/18	23.0	126.9	1000	-	2.0	TD
Sep.	01/00	23.8	127.7	998	35	2.5	TS
	01/06	24.4	129.0	994	45	3.0	TS
	01/12	25.0	130.2	985	55	3.5	STS
	01/15	25.3	130.5	985	55	-	STS
	01/18	25.7	130.6	975	60	4.0	STS
	01/21	26.1	130.7	975	60	-	STS
	02/00	26.4	130.8	970	65	4.0	TY
	02/03	26.8	130.8	970	65	-	TY
	02/06	27.2	130.8	965	70	4.5	TY
	02/09	27.5	130.8	965	70	-	TY
	02/12	27.8	130.8	965	70	4.5	TY
	02/15	28.1	130.7	960	70	-	TY
	02/18	28.5	130.6	955	70	5.0	TY
	02/21	28.9	130.5	955	70	-	TY
	03/00	29.3	130.3	955	70	5.0	TY
	03/03	29.7	130.2	955	70	-	TY
	03/06	30.0	130.1	960	65	5.0	TY
	03/09	30.3	130.0	960	65	-	TY
	03/12	30.5	129.9	965	60	4.5	STS
	03/15	30.7	129.9	970	60	-	STS
	03/18	31.0	129.8	975	55	4.0	STS
	03/21	31.2	129.7	980	55	-	STS
	04/00	31.4	129.6	985	50	3.5	STS
	04/03	31.6	129.6	990	50	-	STS
	04/06	31.8	129.6	992	45	3.0	TS
	04/09	32.1	129.6	994	45	-	TS
	04/12	32.4	129.6	998	40	3.0	TS
	04/15	32.7	129.7	1000	35	-	TS
	04/16	32.8	129.7	1000	35	-	TS
	04/18	33.1	129.8	1004	-	2.5	TD
	04/21	33.5	129.9	1006	-	-	TD
	05/00	33.9	130.2	1008	-	2.0	TD
	05/06	34.8	131.0	1008	-	-	TD
	05/12	35.9	132.3	1008	-	-	TD
	05/18						Dissip.

Malou (1613)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep.	05/12	24.8	124.8	1006	-	1.0	TD
	05/18	25.2	124.8	1004	-	1.5	TD
	06/00	26.4	125.8	1002	-	1.5	TD
	06/06	27.6	126.8	1000	40	1.5	TS
	06/12	28.3	128.1	1002	40	1.5	TS
	06/18	29.0	129.1	1000	40	1.5	TS
	07/00	29.2	130.3	1002	-	1.5	TD
	07/06	29.1	132.1	1002	-	1.5	TD
	07/12					1.5	Dissip.

Meranti (1614)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep.	09/12	13.7	141.7	1004	-	1.0	TD
	09/18	14.0	141.2	1004	-	1.5	TD
	10/00	14.4	140.2	1004	-	2.0	TD
	10/06	14.8	139.2	1000	35	2.5	TS
	10/12	15.3	137.9	998	35	2.5	TS
	10/18	16.0	136.9	990	45	3.0	TS
	11/00	16.4	135.7	980	55	3.5	STS
	11/06	16.7	134.5	970	65	4.0	TY
	11/12	17.4	133.2	950	80	5.0	TY
	11/18	17.6	131.7	940	85	5.5	TY
	12/00	18.0	130.4	930	95	6.0	TY
	12/06	18.3	129.4	920	100	6.5	TY
	12/12	18.9	128.2	910	105	7.0	TY
	12/18	19.3	126.7	910	105	7.0	TY
	13/00	19.6	125.5	900	115	7.5	TY
	13/06	20.2	124.1	900	115	7.5	TY
	13/12	20.4	122.9	890	120	8.0	TY
	13/18	20.9	121.8	900	115	8.0	TY
	14/00	21.6	120.8	910	105	8.0	TY
	14/06	22.5	119.8	930	90	7.0	TY
	14/12	23.5	118.9	940	85	6.5	TY
	14/18	24.4	118.3	965	70	6.5	TY
	15/00	25.2	117.7	980	55	5.5	STS
	15/06	26.1	116.9	996	45	5.0	TS
	15/12	27.0	117.1	1002	-	5.0	TD
	15/18	28.1	117.5	1004	-	-	TD
	16/00	30.2	118.9	1004	-	-	TD
	16/06	31.6	120.1	1004	-	-	L
	16/12	32.7	121.5	1004	-	-	L
	16/18	33.7	123.4	1004	-	-	L
	17/00	33.5	123.8	1004	-	-	L
	17/06	33.3	124.4	1004	-	-	L
	17/12	33.2	125.2	1006	-	-	L
	17/18						Dissip.

Rai (1615)

Date/Time (UTC)		Center position		Central pressure	Max wind	CI num.	Grade
		Lat (N)	Lon (E)	(hPa)	(kt)		
Sep.	11/06	12.3	114.3	1002	-	0.5	TD
	11/12	12.7	113.9	1002	-	1.0	TD
	11/18	13.2	113.2	1002	-	1.0	TD
	12/00	13.7	112.1	1002	-	1.5	TD
	12/06	14.4	111.0	1002	-	1.5	TD
	12/12	14.9	109.9	1000	-	1.5	TD
	12/18	15.5	108.9	996	35	2.0	TS
	13/00	15.9	107.3	996	35	2.0	TS
	13/06	16.0	105.9	998	-	1.5	TD
	13/12	16.0	104.7	1000	-	-	TD
	13/18	16.1	103.5	1004	-	-	TD
	14/00						Dissip.

Malakas (1616)

Date/Time (UTC)		Center position		Central pressure	Max wind	CI num.	Grade
		Lat (N)	Lon (E)	(hPa)	(kt)		
Sep.	11/18	12.5	144.8	1006	-	0.5	TD
	12/00	12.8	143.1	1008	-	1.0	TD
	12/06	13.2	141.9	1006	-	1.5	TD
	12/12	13.5	140.8	1006	-	1.5	TD
	12/18	13.8	139.4	1000	35	2.0	TS
	13/00	14.2	138.1	996	40	2.5	TS
	13/06	14.5	137.0	990	45	3.0	TS
	13/12	14.7	135.9	990	45	3.0	TS
	13/18	15.0	134.6	985	55	3.5	STS
	14/00	15.4	133.4	975	65	4.0	TY
	14/06	15.8	132.2	965	70	4.5	TY
	14/12	16.3	131.2	965	70	4.5	TY
	14/18	16.7	130.0	965	70	4.5	TY
	15/00	16.9	128.8	965	70	4.5	TY
	15/06	17.5	127.7	950	80	5.0	TY
	15/12	18.4	126.7	940	85	5.5	TY
	15/18	19.2	125.7	940	85	5.5	TY
	16/00	20.1	124.7	940	85	5.5	TY
	16/06	21.1	123.9	940	85	5.5	TY
	16/09	21.5	123.7	940	85	-	TY
	16/12	22.1	123.4	940	85	5.5	TY
	16/15	22.5	123.1	940	85	-	TY
	16/18	23.0	123.1	930	95	5.5	TY
	16/21	23.6	123.0	930	95	-	TY
	17/00	24.1	123.0	930	95	5.5	TY
	17/03	24.7	122.9	930	95	-	TY
	17/06	25.3	122.8	940	90	5.5	TY
	17/09	25.6	122.7	940	90	-	TY
	17/12	25.9	122.7	950	80	5.0	TY
	17/18	26.3	122.8	950	80	5.0	TY
	18/00	26.9	123.5	950	80	5.0	TY
	18/06	27.4	124.2	950	80	5.0	TY
	18/12	28.0	125.1	945	85	5.5	TY
	18/18	28.7	126.1	940	95	6.0	TY
	19/00	29.4	127.1	940	95	6.0	TY
	19/03	29.7	127.6	940	95	-	TY
	19/06	30.2	128.3	940	95	6.0	TY
	19/09	30.5	129.1	940	95	-	TY
	19/12	30.8	129.7	950	80	5.0	TY
	19/15	31.1	130.5	955	75	-	TY
	19/18	31.6	131.5	960	75	5.0	TY
	19/21	32.2	132.5	960	75	-	TY
	20/00	32.9	133.4	965	70	4.5	TY
	20/02	33.3	134.1	970	70	-	TY
	20/03	33.5	134.6	970	65	-	TY
	20/04	33.7	135.1	980	55	-	STS
	20/06	34.3	136.1	985	50	4.0	STS
	20/08	34.9	136.8	992	45	-	TS
	20/09	34.8	137.1	992	45	-	TS
	20/12	34.5	138.1	1006	-	3.5	L
	20/18						Dissip.

Megi (1617)

Date/Time (UTC)		Center position		Central pressure	Max wind	CI num.	Grade
		Lat (N)	Lon (E)	(hPa)	(kt)		
Sep.	22/18	15.4	141.1	1002	-	0.5	TD
	23/00	15.7	140.6	1000	-	0.5	TD
	23/06	16.0	139.7	1000	-	1.0	TD
	23/12	16.4	138.8	998	-	1.5	TD
	23/18	16.9	137.6	994	35	2.0	TS
	24/00	17.5	136.5	990	40	2.5	TS
	24/06	18.3	135.3	980	45	3.0	TS
	24/12	18.7	133.9	975	55	3.5	STS
	24/18	19.0	132.9	970	65	4.0	TY
	25/00	19.5	131.6	970	65	4.0	TY
	25/06	19.9	130.3	970	65	4.0	TY
	25/12	20.2	129.3	970	65	4.0	TY
	25/18	20.6	128.2	970	65	4.0	TY
	26/00	20.8	127.3	970	65	4.0	TY
	26/06	21.4	126.2	960	70	4.5	TY
	26/09	21.6	125.9	960	70	-	TY
	26/12	21.9	125.3	960	70	4.5	TY
	26/15	22.2	124.8	960	70	-	TY
	26/18	22.5	124.4	950	80	5.0	TY
	26/21	22.8	123.7	950	80	-	TY
	27/00	23.3	123.3	945	85	5.5	TY
	27/03	23.7	122.5	945	85	-	TY
	27/06	24.1	121.6	950	80	5.5	TY
	27/09	23.8	120.9	960	75	-	TY
	27/12	23.9	120.6	965	65	5.5	TY
	27/18	24.4	119.6	975	55	5.0	STS
	28/00	25.0	118.1	985	45	4.5	TS
	28/06	25.3	117.0	990	35	4.0	TS
	28/12	25.4	116.7	994	-	3.5	TD
	28/18	25.6	116.6	998	-	-	TD
	29/00	25.9	116.5	1002	-	-	TD
	29/06	26.5	117.2	1002	-	-	TD
	29/12						Dissip.

Chaba (1618)

Date/Time (UTC)		Center position		Central pressure	Max wind	CI num.	Grade
		Lat (N)	Lon (E)	(hPa)	(kt)		
Sep.	24/18	14.9	164.6	1008	-	-	TD
	25/00	14.5	163.4	1008	-	-	TD
	25/06	14.7	162.2	1008	-	-	TD
	25/12	15.1	161.0	1008	-	0.5	TD
	25/18	15.6	160.0	1008	-	0.5	TD
	26/00	15.9	159.0	1008	-	1.0	TD
	26/06	15.9	158.0	1008	-	1.0	TD
	26/12	15.8	156.2	1008	-	1.0	TD
	26/18	15.3	154.5	1008	-	1.0	TD
	27/00	14.6	153.3	1008	-	1.5	TD
	27/06	14.4	152.0	1006	-	2.0	TD
	27/12	14.3	151.0	1004	-	2.0	TD
	27/18	14.3	149.8	1004	-	2.0	TD
	28/00	14.4	148.1	1004	-	2.0	TD
	28/06	14.4	146.5	1004	-	2.0	TD
	28/12	14.5	145.5	1004	-	2.0	TD
	28/18	14.4	144.4	1002	-	2.0	TD
	29/00	14.3	143.4	1002	-	2.0	TD
	29/06	13.7	141.8	1000	35	2.0	TS
	29/12	13.5	140.5	1000	35	2.5	TS
	29/18	13.4	139.2	992	45	3.0	TS
	30/00	13.8	138.1	990	50	3.0	STS
	30/06	14.3	137.4	990	50	3.0	STS
	30/12	14.8	136.7	990	50	3.0	STS
	30/18	15.4	136.0	985	55	3.5	STS
Oct.	01/00	16.1	135.2	985	55	3.5	STS
	01/06	16.8	134.4	980	60	4.0	STS
	01/12	17.6	133.4	970	70	4.5	TY
	01/18	18.5	132.6	955	80	5.0	TY
	02/00	19.7	131.5	935	95	6.0	TY
	02/06	20.8	130.4	935	95	6.0	TY
	02/12	21.8	129.2	935	95	6.0	TY
	02/18	22.8	128.3	935	95	6.0	TY
	02/21	23.3	127.9	935	95	-	TY
	03/00	23.8	127.6	925	100	6.5	TY
	03/03	24.5	127.3	925	100	-	TY
	03/06	24.9	127.0	915	110	7.0	TY
	03/09	25.4	126.9	905	115	-	TY
	03/12	25.8	126.8	905	115	7.5	TY
	03/15	26.2	126.6	905	115	-	TY
	03/18	26.8	126.4	910	110	7.5	TY
	03/21	27.3	126.3	920	100	-	TY
	04/00	27.9	126.2	925	95	7.5	TY
	04/03	28.5	126.1	925	95	-	TY
	04/06	29.4	126.0	940	85	7.5	TY
	04/09	30.2	125.9	950	80	-	TY
	04/12	31.0	126.0	950	80	7.0	TY
	04/15	31.7	126.3	960	75	-	TY
	04/18	32.7	126.6	965	70	6.0	TY
	04/21	33.3	127.2	965	70	-	TY
	05/00	34.4	128.1	970	65	5.5	TY
	05/03	35.4	129.4	985	55	-	STS
	05/06	36.1	131.1	990	50	5.0	STS
	05/09	37.3	133.8	992	45	-	TS
	05/12	38.7	136.7	996	-	4.5	L
	05/18	39.4	143.4	998	-	-	L
	06/00	41.1	148.8	992	-	-	L
	06/06	41.8	153.5	988	-	-	L
	06/12	42.9	158.7	984	-	-	L
	06/18	44.2	164.2	980	-	-	L
	07/00	45.7	170.0	972	-	-	L
	07/06	47.8	175.1	960	-	-	L
	07/12	50.2	179.2	956	-	-	L
	07/18	52.0	182.4	956	-	-	Out

Aere (1619)

Date/Time (UTC)		Center position		Central pressure	Max wind	CI num.	Grade
		Lat (N)	Lon (E)	(hPa)	(kt)		
Oct.	04/12	19.2	130.0	1004	-	1.0	TD
	04/18	19.2	127.8	1002	-	1.5	TD
	05/00	19.0	126.5	1004	-	1.5	TD
	05/06	18.9	125.5	1004	-	1.5	TD
	05/12	19.5	123.8	1002	-	1.5	TD
	05/18	20.1	122.1	998	35	1.5	TS
	06/00	20.6	120.5	998	35	1.5	TS
	06/06	20.7	119.0	998	35	1.5	TS
	06/12	20.6	117.8	994	40	2.0	TS
	06/18	20.6	117.2	994	40	2.0	TS
	07/00	20.4	116.4	992	40	2.5	TS
	07/06	20.7	116.0	985	50	3.0	STS
	07/12	21.0	115.9	980	55	3.5	STS
	07/18	21.2	115.9	975	60	3.5	STS
	08/00	21.3	116.1	980	55	3.5	STS
	08/06	21.3	116.3	985	50	3.5	STS
	08/12	21.6	116.9	990	45	3.5	TS
	08/18	21.8	117.2	992	40	3.5	TS
	09/00	21.6	117.4	996	40	3.0	TS
	09/06	21.3	117.8	996	40	3.0	TS
	09/12	21.6	117.9	998	35	2.5	TS
	09/18	21.8	117.9	998	35	2.5	TS
	10/00	22.1	118.0	1004	-	2.0	TD
	10/06						Dissip.

Songda (1620)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Oct.	03/18	16.4	180.5	1008	-	-	Out
	04/00	16.5	178.8	1008	-	0.5	TD
	04/06	16.4	177.6	1006	-	0.5	TD
	04/12	16.6	176.7	1006	-	0.0	TD
	04/18	17.3	175.9	1006	-	0.5	TD
	05/00	18.0	174.7	1008	-	1.0	TD
	05/06	18.1	173.1	1008	-	0.5	TD
	05/12	18.0	171.5	1008	-	0.5	TD
	05/18	17.9	170.3	1006	-	0.5	TD
	06/00	17.9	168.7	1008	-	0.5	TD
	06/06	18.0	167.0	1006	-	0.5	TD
	06/12	18.0	165.5	1008	-	0.5	TD
	06/18	18.1	164.4	1008	-	0.5	TD
	07/00	18.2	163.4	1008	-	1.0	TD
	07/06	18.6	161.8	1006	-	1.0	TD
	07/12	18.9	160.4	1006	-	1.5	TD
	07/18	19.2	158.7	1006	-	1.5	TD
	08/00	19.3	157.3	1004	-	1.5	TD
	08/06	19.5	155.8	1002	-	2.0	TD
	08/12	19.9	154.4	1000	35	2.5	TS
	08/18	20.6	152.7	1000	35	2.5	TS
	09/00	21.2	151.3	1000	35	3.0	TS
	09/06	22.1	150.0	996	40	3.5	TS
	09/12	23.2	148.5	990	45	3.5	TS
	09/18	24.0	147.3	980	55	4.0	STS
	10/00	24.7	146.4	970	65	4.5	TY
	10/06	25.5	145.9	955	80	5.0	TY
	10/12	26.3	145.8	940	90	6.0	TY
	10/18	27.2	145.8	930	95	6.0	TY
	11/00	27.8	146.0	935	90	6.0	TY
	11/06	28.5	146.7	935	90	6.0	TY
	11/12	29.2	147.5	930	95	6.0	TY
	11/18	30.3	148.9	925	100	6.5	TY
	12/00	31.3	151.0	925	100	6.5	TY
	12/06	32.6	153.7	935	90	6.5	TY
	12/12	33.9	156.8	945	85	5.5	TY
	12/18	35.8	161.1	955	75	5.0	TY
	13/00	38.1	166.3	970	65	4.5	TY
	13/06	40.3	171.1	988	-	4.0	L
	13/12	41.7	176.5	992	-	-	L
	13/18	42.1	183.6	996	-	-	Out

Sarika (1621)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Oct.	13/00	12.9	129.4	1004	-	0.5	TD
	13/06	13.1	128.9	1004	-	1.0	TD
	13/12	13.3	128.1	1002	-	1.5	TD
	13/18	13.5	127.3	998	35	2.0	TS
	14/00	13.6	126.7	994	40	2.5	TS
	14/06	13.7	126.3	990	45	3.0	TS
	14/12	13.8	125.9	980	55	3.5	STS
	14/18	14.0	125.4	980	55	3.5	STS
	15/00	14.3	124.6	970	65	4.0	TY
	15/06	14.7	123.9	955	80	5.0	TY
	15/12	15.1	123.0	950	85	5.5	TY
	15/18	15.8	121.8	935	95	6.0	TY
	16/00	16.2	119.8	965	75	5.0	TY
	16/06	16.6	118.4	965	70	4.5	TY
	16/12	16.8	117.2	970	65	4.0	TY
	16/18	16.8	115.5	970	65	4.0	TY
	17/00	17.0	114.3	970	60	3.5	STS
	17/06	17.4	113.1	970	60	3.5	STS
	17/12	17.6	112.3	970	60	3.5	STS
	17/18	18.0	111.5	970	60	3.5	STS
	18/00	18.6	110.7	970	60	3.5	STS
	18/06	19.1	110.0	975	55	3.0	STS
	18/12	19.7	109.3	985	45	2.5	TS
	18/18	20.3	108.8	990	40	2.0	TS
	19/00	21.0	108.4	994	35	1.5	TS
	19/06	21.7	108.1	996	-	1.0	TD
	19/12	22.0	108.0	1000	-	0.5	TD
	19/18	22.4	108.0	1004	-	-	TD
	20/00						Dissip.

Haima (1622)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Oct.	14/12	7.4	144.5	1004	-	1.0	TD
	14/18	8.2	143.6	1004	-	1.5	TD
	15/00	8.8	142.9	1000	35	2.0	TS
	15/06	9.1	142.1	996	40	2.5	TS
	15/12	9.5	140.7	992	45	2.5	TS
	15/18	9.7	140.0	985	50	3.0	STS
	16/00	9.9	139.6	980	55	3.5	STS
	16/06	10.4	139.1	975	65	4.0	TY
	16/12	11.3	138.7	970	70	4.5	TY
	16/18	12.3	137.8	960	80	5.0	TY
	17/00	12.9	136.7	955	85	5.0	TY
	17/06	13.4	135.5	950	90	5.0	TY
	17/12	13.8	134.5	945	95	5.5	TY
	17/18	14.4	133.3	925	100	6.5	TY
	18/00	14.9	132.1	925	100	6.5	TY
	18/06	15.4	130.7	915	105	6.5	TY
	18/12	15.6	129.1	910	110	7.0	TY
	18/18	16.0	127.5	900	115	7.0	TY
	19/00	16.1	126.0	900	115	7.0	TY
	19/06	16.7	124.7	900	115	7.0	TY
	19/12	17.3	123.1	915	100	6.5	TY
	19/18	17.7	121.5	940	90	5.5	TY
	20/00	18.4	120.1	945	80	5.0	TY
	20/06	19.0	118.8	950	75	5.0	TY
	20/12	19.8	117.4	960	70	4.5	TY
	20/18	20.6	116.6	960	70	4.5	TY
	21/00	22.1	115.6	970	60	4.5	STS
	21/06	23.2	115.1	980	45	4.0	TS
	21/12	24.3	114.7	992	35	3.5	TS
	21/18	25.9	115.5	998	-	3.0	TD
	22/00	27.4	116.4	1004	-	-	L
	22/06	28.9	119.4	1004	-	-	L
	22/12	30.2	121.4	1004	-	-	L
	22/18	30.5	123.1	1004	-	-	L
	23/00	29.9	126.1	1002	-	-	L
	23/06	29.4	129.3	1002	-	-	L
	23/12	29.4	133.5	1002	-	-	L
	23/18	29.5	136.6	1000	-	-	L
	24/00	29.2	140.2	1002	-	-	L
	24/06	28.9	142.5	1002	-	-	L
	24/12	28.7	145.2	1006	-	-	L
	24/18	28.3	147.1	1008	-	-	L
	25/00	27.5	146.0	1012	-	-	L
	25/06	26.7	144.9	1010	-		L
	25/12	26.9	144.7	1012	-		L
	25/18	27.1	144.4	1012	-		L
	26/00	27.3	145.0	1014	-		L
	26/06	27.8	145.4	1012	-		L
	26/12						Dissip.

Meari (1623)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Oct.	30/18	10.1	146.9	1004	-	0.5	TD
	31/00	10.5	146.2	1004	-	0.5	TD
	31/06	10.5	145.2	1002	-	1.0	TD
	31/12	10.3	144.1	1002	-	1.5	TD
	31/18	10.3	143.5	1002	-	1.5	TD
Nov.	01/00	10.5	142.5	1002	-	1.5	TD
	01/06	10.9	141.6	1000	-	2.0	TD
	01/12	11.7	139.9	1000	-	2.0	TD
	01/18	11.8	138.7	1000	-	2.0	TD
	02/00	12.3	138.1	1000	-	2.0	TD
	02/06	12.6	137.8	1000	-	2.0	TD
	02/12	12.9	137.6	1000	-	2.0	TD
	02/18	13.1	137.4	998	-	2.0	TD
	03/00	13.3	137.3	996	35	2.5	TS
	03/06	13.7	137.3	996	35	2.5	TS
	03/12	14.0	137.4	996	35	2.5	TS
	03/18	14.3	137.9	992	40	3.0	TS
	04/00	15.0	138.8	990	45	3.0	TS
	04/06	15.6	139.1	985	55	3.0	STS
	04/12	16.2	139.3	985	55	3.5	STS
	04/18	16.8	139.4	975	60	4.0	STS
	05/00	17.2	139.9	970	65	5.0	TY
	05/06	17.5	140.3	965	70	5.0	TY
	05/12	18.3	140.7	960	75	5.0	TY
	05/18	18.6	141.8	960	75	5.0	TY
	06/00	19.5	142.5	960	75	5.0	TY
	06/06	20.7	143.6	960	75	5.0	TY
	06/12	22.2	144.8	960	75	5.0	TY
	06/18	24.3	146.1	965	70	5.0	TY
	07/00	27.3	147.0	970	65	5.0	TY
	07/06	28.3	147.5	976	-	5.0	L
	07/12	28.8	148.0	980	-	4.5	L
	07/18	29.2	149.1	984	-	-	L
	08/00	30.6	150.5	988	-	-	L
	08/06	31.9	152.2	992	-	-	L
	08/12	33.3	154.6	996	-	-	L
	08/18	34.9	157.1	998	-	-	L
	09/00	36.5	161.0	1000	-	-	L
	09/06	37.7	163.0	1002	-	-	L
	09/12	38.4	164.0	1002	-	-	L
	09/18	39.0	165.5	1004	-	-	L
	10/00						Dissip.

Ma-on (1624)

Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Nov.	08/18	12.8	161.4	1008	-	1.0	TD
	09/00	13.4	160.4	1006	-	1.0	TD
	09/06	14.6	159.7	1006	-	1.5	TD
	09/12	15.8	158.5	1006	-	1.5	TD
	09/18	16.3	157.7	1002	-	1.5	TD
	10/00	16.9	156.9	1002	35	1.5	TS
	10/06	17.3	155.9	1002	35	2.0	TS
	10/12	17.5	154.5	1002	35	2.0	TS
	10/18	17.9	153.5	1002	35	2.0	TS
	11/00	18.3	152.3	1002	35	2.5	TS
	11/06	19.1	150.9	1002	35	2.5	TS
	11/12	19.9	148.1	1004	35	2.5	TS
	11/18	20.7	146.8	1004	35	2.5	TS
	12/00	20.8	145.5	1006	-	2.5	TD
	12/06	21.6	144.7	1008	-	2.5	TD
	12/12	21.4	143.4	1012	-	-	TD
	12/18	21.4	142.4	1010	-	-	TD
	13/00	21.3	141.4	1014	-	-	TD
	13/06						Dissip.

Tokage (1625)

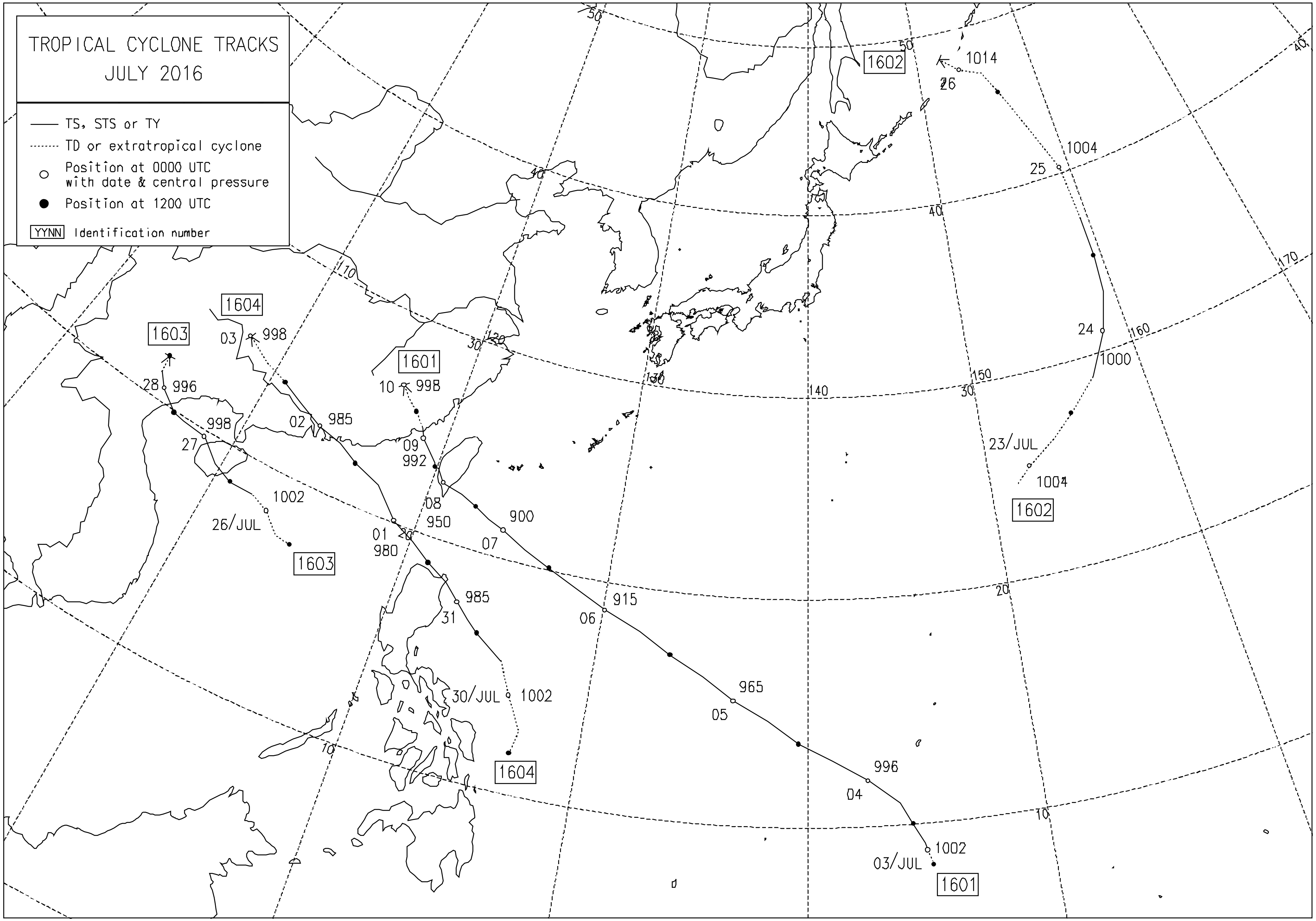
Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Nov.	24/00	9.7	126.8	1006	-	1.5	TD
	24/06	10.4	125.5	1004	-	1.5	TD
	24/12	10.8	124.3	1002	-	1.5	TD
	24/18	11.0	123.2	1000	-	1.5	TD
	25/00	11.4	122.5	1000	-	2.0	TD
	25/06	11.5	121.3	1000	-	2.0	TD
	25/12	11.7	120.7	998	35	2.5	TS
	25/18	12.6	119.9	994	45	3.0	TS
	26/00	13.2	118.7	992	50	3.5	STS
	26/06	13.8	117.7	994	45	3.5	TS
	26/12	14.3	117.4	994	45	3.5	TS
	26/18	14.8	117.3	994	45	3.5	TS
	27/00	15.7	117.6	994	45	3.5	TS
	27/06	16.4	118.0	994	45	3.5	TS
	27/12	16.8	118.2	994	45	3.5	TS
	27/18	17.0	118.5	1000	35	3.0	TS
	28/00	17.1	118.7	1006	-	2.5	TD
	28/06						Dissip.

Nock-ten (1626)

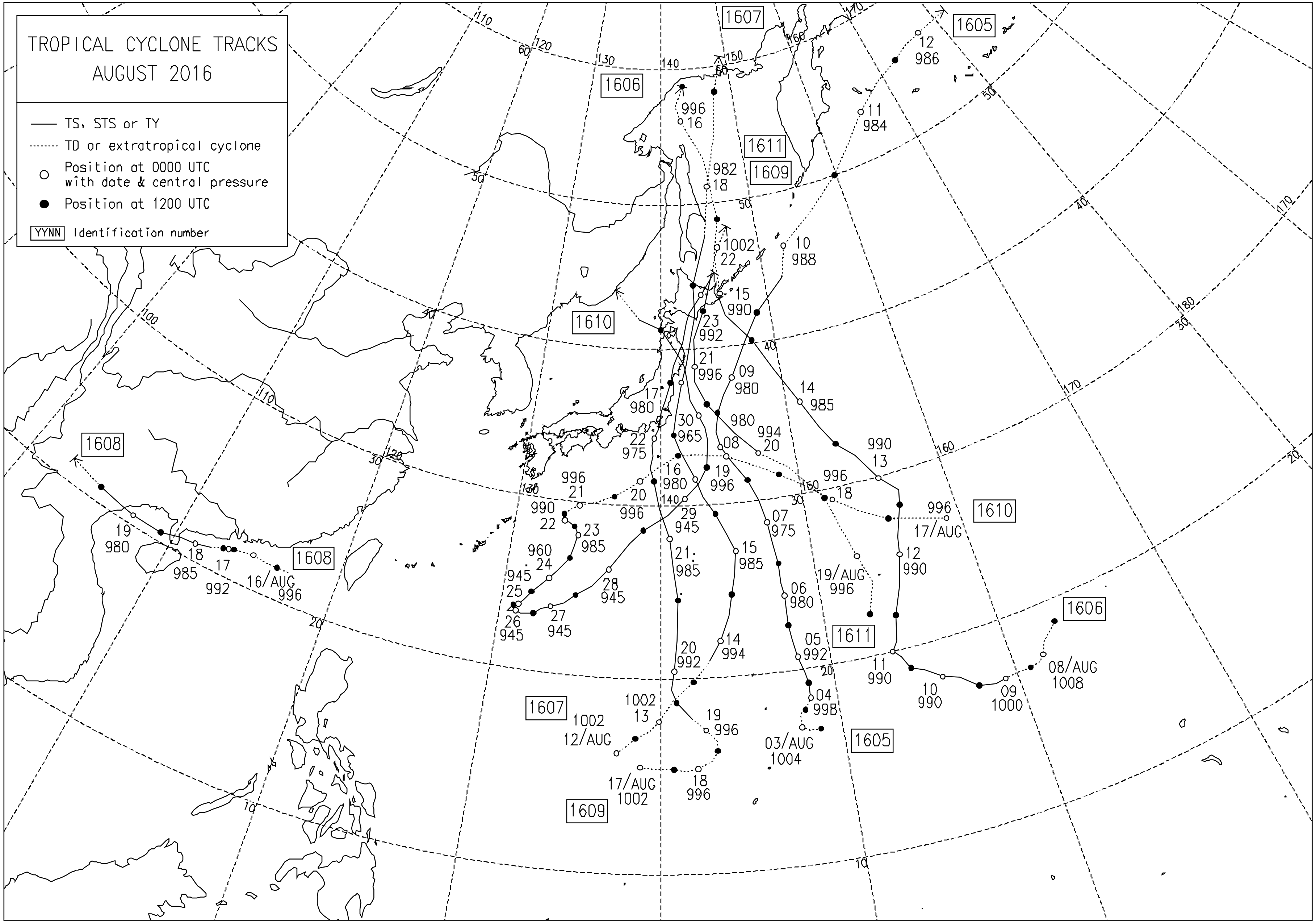
Date/Time (UTC)		Center position Lat (N)	Center position Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Dec.	20/12	6.2	144.5	1004	-	1.0	TD
	20/18	6.2	143.4	1004	-	1.5	TD
	21/00	6.3	142.4	1004	-	1.5	TD
	21/06	6.4	141.7	1002	-	1.5	TD
	21/12	6.8	140.9	1004	-	1.5	TD
	21/18	7.8	140.0	998	35	2.0	TS
	22/00	8.6	139.1	994	40	2.5	TS
	22/06	9.4	137.8	994	40	2.5	TS
	22/12	10.2	136.3	992	45	3.0	TS
	22/18	11.1	134.8	985	55	3.5	STS
	23/00	11.7	133.3	985	55	3.5	STS
	23/06	11.9	132.1	970	70	4.5	TY
	23/12	12.6	131.0	955	80	5.0	TY
	23/18	13.0	129.9	950	85	5.5	TY
	24/00	13.1	128.9	935	95	6.0	TY
	24/06	13.3	128.2	915	105	7.0	TY
	24/12	13.4	127.5	915	105	7.0	TY
	24/18	13.6	126.7	915	105	7.0	TY
	25/00	13.5	126.0	915	105	7.0	TY
	25/06	13.5	125.1	925	100	6.5	TY
	25/12	13.5	124.0	925	100	6.5	TY
	25/18	13.5	122.8	950	85	5.5	TY
	26/00	13.6	121.4	950	85	5.5	TY
	26/06	14.1	119.7	970	70	4.5	TY
	26/12	14.4	118.4	970	70	4.5	TY
	26/18	14.8	117.0	975	65	4.0	TY
	27/00	15.0	116.3	980	60	3.5	STS
	27/06	14.7	116.0	985	50	3.0	STS
	27/12	14.2	115.5	996	40	2.5	TS
	27/18	13.3	114.7	1004	-	2.0	TD
	28/00	13.0	113.3	1006	-	1.5	TD
	28/06	11.9	112.3	1006	-	1.0	TD
	28/12	11.2	111.4	1008	-	-	TD
	28/18						Dissip.

Appendix 2

Monthly Tracks of Tropical Cyclones in 2016



TROPICAL CYCLONE TRACKS
JULY 2016


TROPICAL CYCLONE TRACKS
AUGUST 2016
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
1605
03/AUG 1004
04 998
05 992
06 980
07 975
08 980
09 980
10 988
11 984
12 986
1606
08/AUG 1008
09 1000
10 990
11 990
12 990
13 990
14 985
15 990
16
996
1607
12/AUG 1002
13 1002
14 994
15 985
16 980
17 980
1608
16/AUG 996
17 992
18 985
19 980
1609
17/AUG 1002
18 996
19 996
20 992
21 985
22 975
23 992
1610
17/AUG 996
18 996
19/AUG 996
20 994
21 996
22 990
23 985
24 960
25 945
26 945
27 945
28 945
29 945
30 965
1611
19 996
20 996
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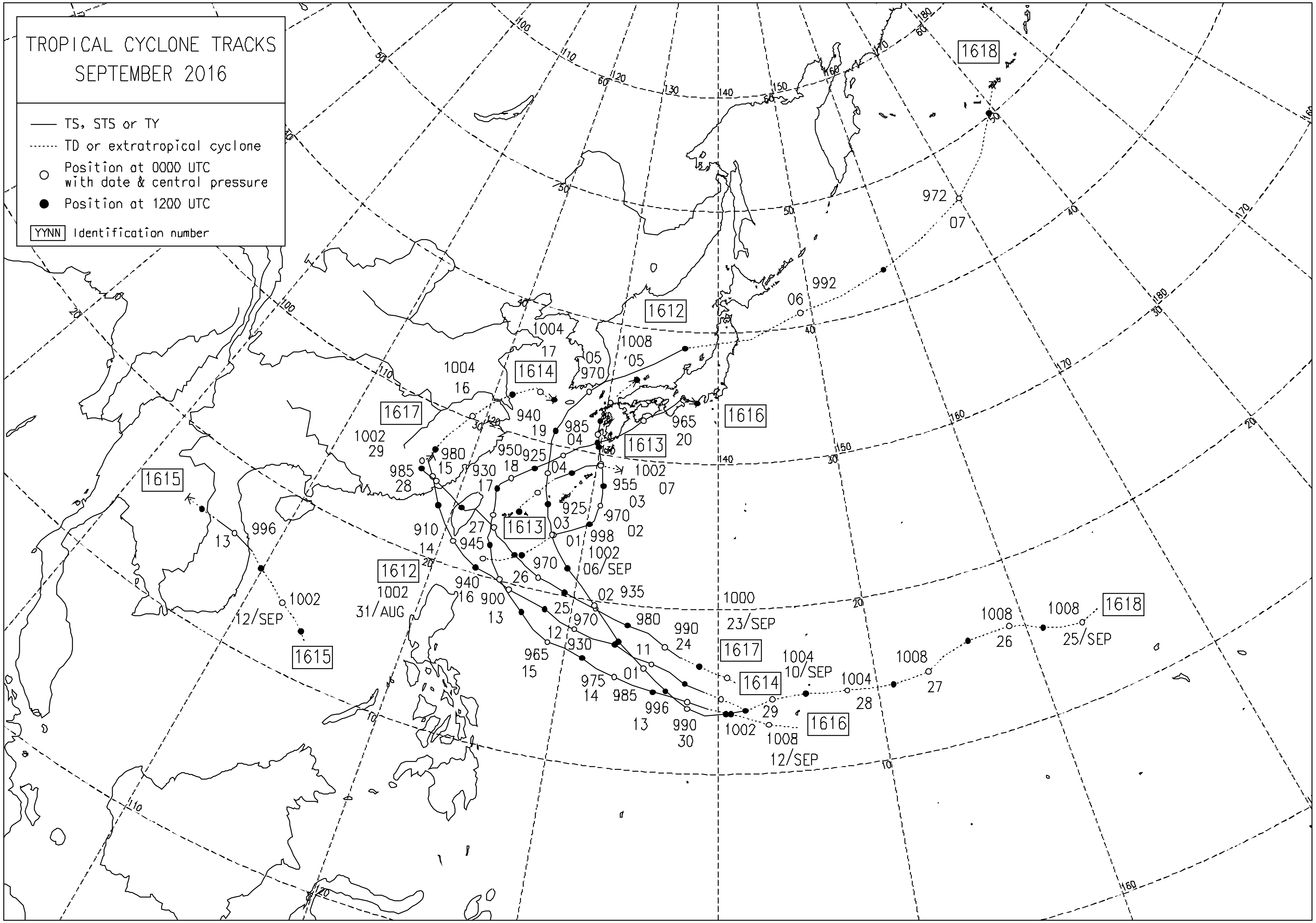
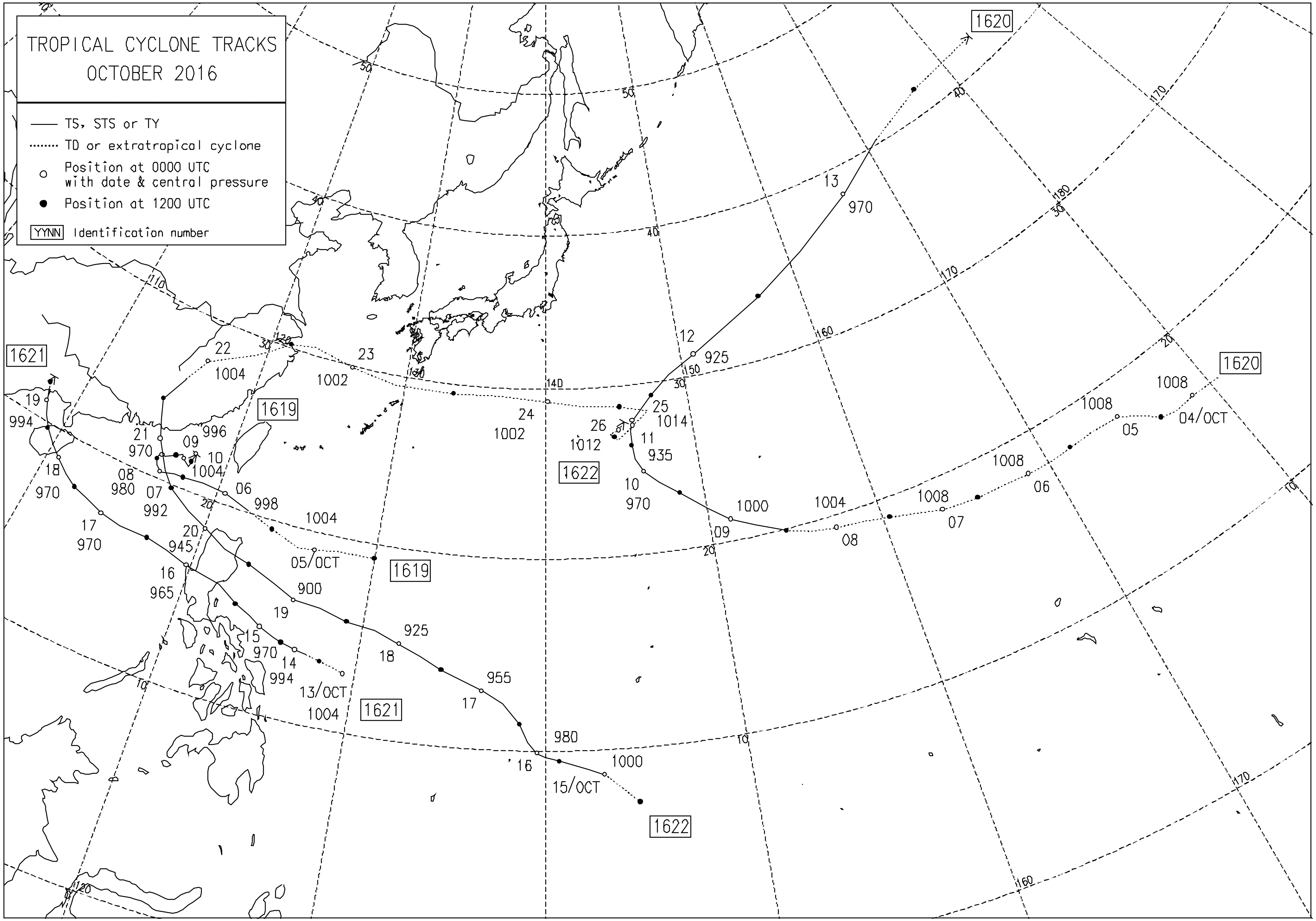
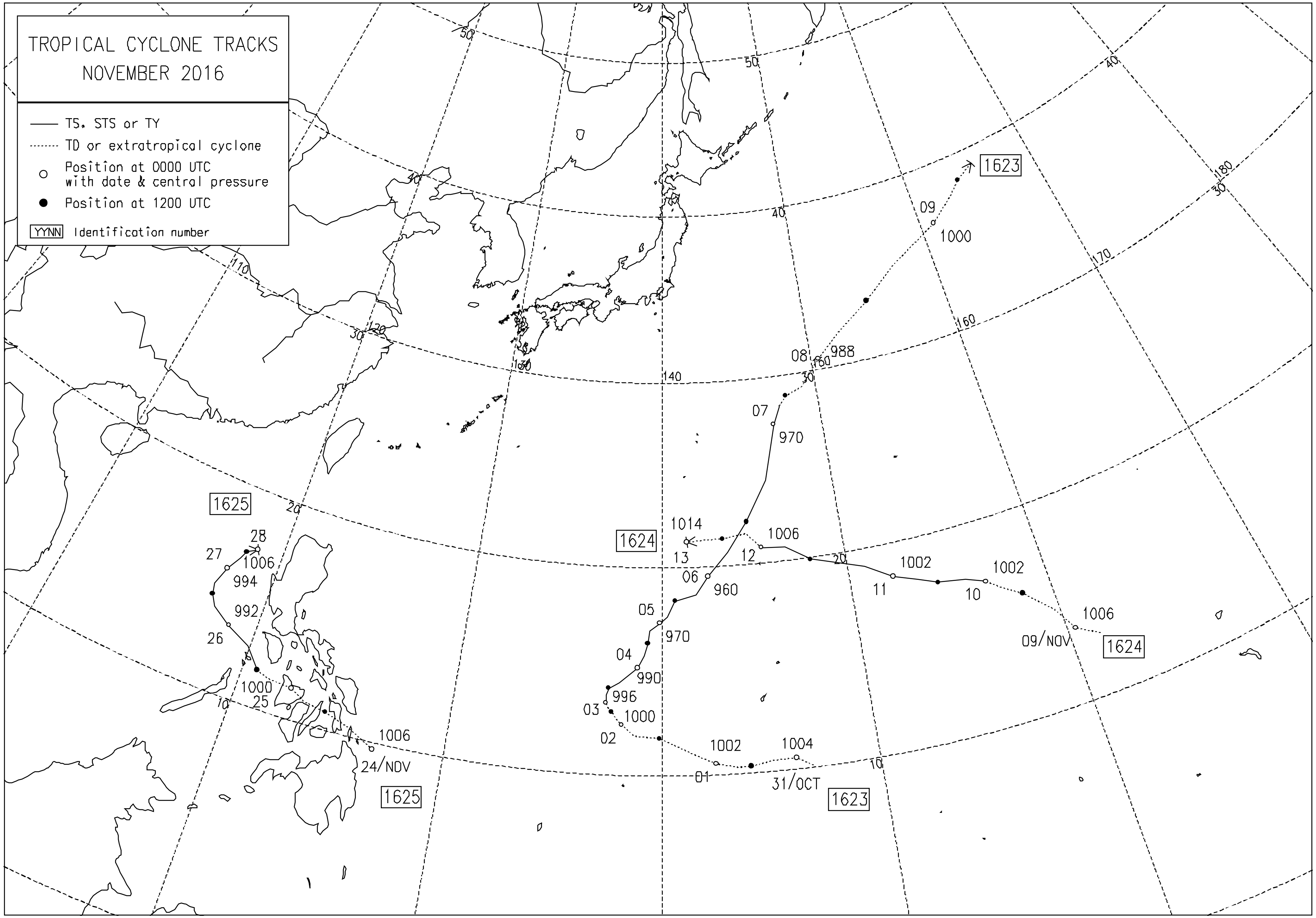
140
150
160
170
180



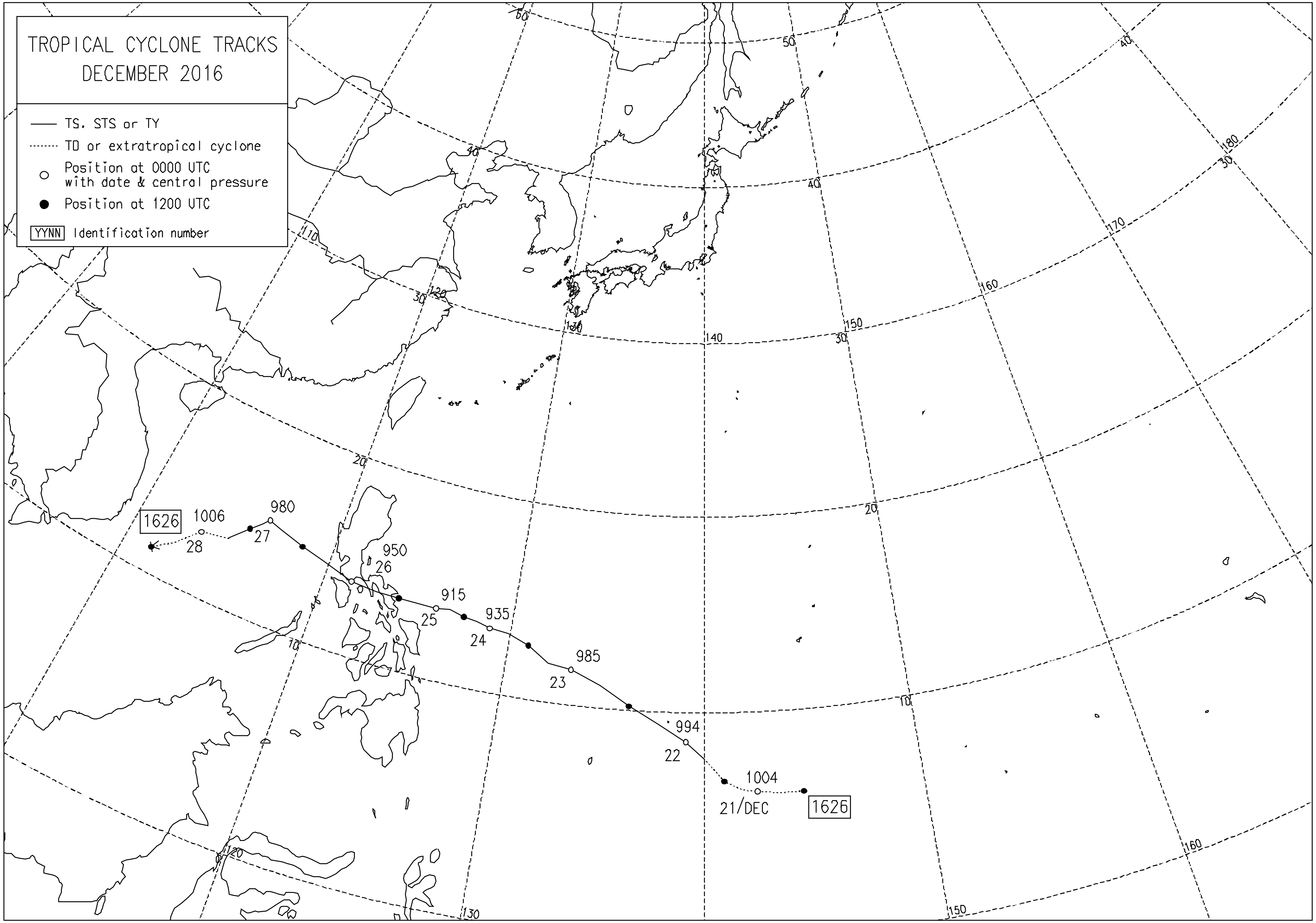
TROPICAL CYCLONE TRACKS
SEPTEMBER 2016



TROPICAL CYCLONE TRACKS
OCTOBER 2016



TROPICAL CYCLONE TRACKS
NOVEMBER 2016



TROPICAL CYCLONE TRACKS
DECEMBER 2016

Errors of Track and Intensity Forecasts for Each Tropical Cyclone in 2016

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 Nepartak (1601)												
Jul. 03/00	22	79	34	67	123	330	0	20	60	5	-10	-35
03/06	0	40	21	57	215	383	-2	25	70	0	-15	-40
03/12	11	46	90	170	317	642	0	35	60	-5	-25	-35
03/18	25	44	78	178	365	616	5	45	55	-5	-30	-35
04/00	34	58	77	129	319	570	15	40	45	-10	-20	-25
04/06	31	43	77	124	383		25	55	40	-20	-30	-20
04/12	25	168	204	151	376		30	55	40	-15	-30	-20
04/18	0	164	178	166	423		35	45	15	-20	-25	5
05/00	11	134	137	248	424		35	40	-15	-15	-20	20
05/06	11	95	94	213			40	25	-40	-20	-10	30
05/12	11	11	64	193			30	25	-50	-15	-10	45
05/18	0	10	49	189			20	0	-40	-5	15	40
06/00	11	15	91	147			10	-15	-27	0	20	35
06/06	10	22	57				0	-35		5	20	
06/12	0	30	89				5	-40		-5	30	
06/18	0	35	167				-10	-35		10	35	
07/00	10	64	67				-10	-27		0	35	
07/06	0	24					-15			10		
07/12	0	57					-25			25		
07/18	0	84					-15			20		
08/00	0	42					-17			25		
08/06	15											
08/12	63											
08/18	53											
09/00	23											
mean	15	60	92	156	327	508	7	15	16	-2	-4	-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
TS Lupit (1602)												
Jul. 23/18	53											
24/00	0											
24/06	0											
24/12	0											
mean	13	--	--	--	--	--	--	--	--	--	--	--
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
STS Mirinae (1603)												
Jul. 26/06	21	157					6			-5		
26/12	35	64					16			-15		
26/18	22	53					11			-5		
27/00	25	10					2			0		
27/06	24											
27/12	10											
27/18	15											
28/00	15											
mean	21	71	--	--	--	--	9	--	--	-6	--	--
sample	8	4	0	0	0	0	4	0	0	4	0	0

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
STS Nida (1604)												
Jul. 30/06	86	87					10			-10		
30/12	24	81	184				5	-15		-5	15	
30/18	22	33	138				-10	-30		10	30	
31/00	15	25	93				-15	-30		15	30	
31/06	11	100	117				-15	-30		15	40	
31/12	21	78					-15			15		
31/18	10	91					-20			25		
Aug. 01/00	0	54					-25			30		
01/06	15	60					-15			25		
01/12	0											
01/18	10											
02/00	10											
02/06	0											
mean	17	68	133	--	--	--	-11	-26	--	13	29	--
sample	13	9	4	0	0	0	9	4	0	9	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
STS Omais (1605)												
Aug. 04/00	158	79	168				2	5		-5	-10	
04/06	0	31	15	179	167	170	-5	0	-10	0	-5	0
04/12	15	15	40	169	104	118	0	0	-15	-5	-5	5
04/18	130	24	30	123	46		5	0	-15	-10	-5	5
05/00	114	49	101	212	52		5	0	-15	-10	-5	5
05/06	62	63	121	173	160		5	-5	-15	-10	-5	10
05/12	22	35	200	256	214		0	-15	-15	-5	5	10
05/18	0	30	212	178			0	-15	-15	0	10	15
06/00	23	51	200	194			0	-15	-15	0	10	15
06/06	35	135	233	351			0	-15	-15	0	15	15
06/12	30	176	213	302			-15	-15	-20	10	15	20
06/18	22	167	192				-15	-15		10	15	
07/00	15	146	128				-15	-15		10	15	
07/06	22	102	191				-10	-10		10	10	
07/12	15	48	75				-10	-15		10	15	
07/18	29	66					-10			10		
08/00	24	72					0			5		
08/06	35	98					0			5		
08/12	54	55					-5			10		
08/18	107											
09/00	110											
09/06	34											
09/12	74											
mean	49	76	141	214	124	144	-4	-9	-15	2	5	10
sample	23	19	15	10	6	2	19	15	10	19	15	10

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 Conson (1606)												
Aug. 09/00	35	11	94	224	384	833	-10	-20	-30	15	25	35
09/06	0	54	109	157	419	826	-5	-20	-30	10	25	40
09/12	34	95	143	190	478	1079	-5	-20	-30	10	25	40
09/18	22	183	89	325	358	893	-5	-20	-30	10	25	40
10/00	0	175	84	229	434		-15	-25	-25	20	25	30
10/06	0	143	119	255	609		-15	-25	-20	20	30	25
10/12	0	67	275	235	632		-15	-25	-20	20	30	25
10/18	0	59	294	247	624		-15	-25	-20	20	30	25
11/00	22	101	284	178			-20	-25	-10	20	30	15
11/06	0	128	226	116			-15	-10	-5	20	15	10
11/12	0	187	96	61			-10	-5	-5	15	10	10
11/18	33	204	119	27			-5	-5	-5	10	10	10
12/00	24	151	105				-5	0		10	5	
12/06	0	88	97				0	5		5	0	
12/12	50	86	93				5	0		0	5	
12/18	108	95	101				5	0		0	5	
13/00	40	69					5			0		
13/06	0	125					5			0		
13/12	0	85					0			5		
13/18	0	44					2			0		
14/00	0											
14/06	26											
14/12	0											
14/18	27											
mean	18	108	145	187	492	907	-6	-14	-19	11	18	25
sample	24	20	16	12	8	4	20	16	12	20	16	12

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
STS Chanthu (1607)												
Aug. 13/18	183	241	400	735			0	-15	-15	0	15	15
14/00	108	250	389	714			0	0	-5	0	5	5
14/06	42	212	481	900			-5	-5	-5	5	10	5
14/12	59	223	411	820			-5	0	6	10	5	-10
14/18	56	128	214				-5	0		10	5	
15/00	11	112	207				0	5		5	-5	
15/06	24	178	315				5	5		0	-5	
15/12	10	113	224				5	1		0	-5	
15/18	31	91					5			0		
16/00	31	151					10			-10		
16/06	48	207					10			-10		
16/12	11	116					6			-10		
16/18	14											
17/00	11											
17/06	0											
17/12	34											
mean	42	168	330	792	--	--	2	-1	-5	0	3	4
sample	16	12	8	4	0	0	12	8	4	12	8	4

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TS Dianmu (1608)												
Aug. 17/18	46	94					10			-5		
18/00	15	31					0			5		
18/06	0	30					0			5		
18/12	30											
18/18	74											
19/00	57											
19/06	15											
mean	34	52	--	--	--	--	3	--	--	2	--	--
sample	7	3	0	0	0	0	3	0	0	3	0	0

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TY Mindulle (1609)												
Aug. 19/06	0	310	379	223			0	0	0	-5	-5	-10
19/12	0	125	214	321			7	5	-5	-10	-10	-10
19/18	22	117	156	404			0	10	0	-5	-20	-15
20/00	30	83	156	606			0	10	-2	0	-15	-10
20/06	52	88	239				0	5		0	-10	
20/12	80	83	236				0	-5		0	-5	
20/18	15	44	204				5	-2		-10	-5	
21/00	15	86	112				10	-2		-15	-5	
21/06	0	55					0			-5		
21/12	19	49					-5			-5		
21/18	0	25					-7			0		
22/00	9	20					-7			0		
22/06	0											
22/12	0											
22/18	34											
23/00	0											
mean	17	90	212	388	--	--	0	3	-2	-5	-9	-11
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
TY Lionrock (1610)												
Aug. 21/12	24	90	223	395	461	443	-5	0	15	10	-5	-10
21/18	10	141	273	458	532	424	-5	10	20	5	-15	-15
22/00	31	157	323	498	506	413	-5	10	15	5	-10	-10
22/06	41	155	324	429	413	374	0	20	15	0	-15	-10
22/12	15	135	340	375	300	367	5	20	15	-5	-15	-10
22/18	37	150	284	314	214	494	5	15	5	-10	-15	-5
23/00	11	195	323	268	262	491	15	10	10	-10	-5	-5
23/06	15	248	331	271	240	677	25	10	10	-15	-5	-5
23/12	33	240	307	220	175	511	10	0	-10	-5	0	10
23/18	35	167	258	145	214	661	5	-5	-15	-5	0	10
24/00	0	183	198	132	220	279	0	-10	-10	0	5	5
24/06	0	143	171	194	236	382	-5	-15	-15	5	15	15
24/12	0	61	113	158	201	423	-5	-20	-15	5	20	15
24/18	0	131	73	181	312	464	-10	-20	-15	10	20	15
25/00	11	70	63	120	173	399	-15	-25	-15	15	20	15
25/06	0	59	98	187	172	405	-15	-25	-10	15	20	10
25/12	10	69	107	125	133	425	-20	-25	-10	20	20	10
25/18	0	70	129	179	143		-20	-25	-5	20	20	5
26/00	0	61	110	154	154		-15	-25	-5	15	20	5
26/06	10	78	148	130	181		-15	-15	-10	10	10	10
26/12	11	51	107	80	370		-10	-5	-15	5	0	5
26/18	11	64	112	108			-10	-5	-20	5	0	10
27/00	0	55	73	117			-10	-10	-20	5	5	15
27/06	10	98	36	141			-5	-10	-10	0	5	10
27/12	0	49	50	245			-5	-15	-7	0	5	5
27/18	0	45	14				-5	-20		0	10	
28/00	0	40	38				-5	-10		0	5	
28/06	10	58	58				0	0		0	0	
28/12	0	87	114				-10	-7		5	5	
28/18	0	78					-10			5		
29/00	10	21					-5			5		
29/06	11	56					0			5		
29/12	11	58					-2			5		
29/18	72											
30/00	29											
30/06	21											
30/12	0											
mean	13	102	165	225	267	449	-4	-7	-4	4	4	4
sample	37	33	29	25	21	17	33	29	25	33	29	25

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 Kompasu (1611)													
Aug.	20/00	22	211					-2			0		
	20/06	0	147					-2			0		
	20/12	0	64					-6			0		
	20/18	44											
	21/00	0											
	21/06	0											
	21/12	0											
	mean	9	141	--	--	--	--	-3	--	--	0	--	--
	sample	7	3	0	0	0	0	3	0	0	3	0	0

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TY Namtheun (1612)													
Sep.	01/00	10	75	89	443			15	20	0	-15	-10	0
	01/06	15	45	56	362			15	10	-7	-15	0	5
	01/12	15	53	11	215			0	0	-13	0	10	10
	01/18	11	56	69				10	-10		0	15	
	02/00	0	22	48				5	-25		5	25	
	02/06	11	39	15				0	-27		10	25	
	02/12	15	15	65				-5	-33		15	30	
	02/18	10	44					-15			15		
	03/00	11	73					-25			20		
	03/06	11	80					-27			25		
	03/12	10	29					-33			25		
	03/18	0											
	04/00	0											
	04/06	0											
	04/12	22											
	mean	9	48	51	340	--	--	-5	-9	-7	8	14	5
	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
TS Malou (1613)													
Sep.	06/06	56											
	06/12	60											
	06/18	15											
	mean	44	--	--	--	--	--	--	--	--	--	--	--
	sample	3	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
TY Meranti (1614)													
Sep.	10/06	0	15	39	115	176	302	10	35	35	-10	-20	-25
	10/12	54	40	57	99	198		30	45	45	-25	-25	-30
	10/18	24	35	79	102	257		30	40	30	-20	-25	-25
	11/00	11	25	79	100	235		35	45	20	-25	-30	-15
	11/06	0	54	70	113	202		30	30	10	-20	-20	-5
	11/12	0	24	43	88			15	30	-5	-10	-20	5
	11/18	15	25	46	179			10	20	-35	-5	-15	20
	12/00	0	70	126	322			15	5	-50	-10	0	40
	12/06	0	70	183	405			10	-15	-66	-5	15	50
	12/12	0	57	261				10	-15		0	15	
	12/18	0	84	300				10	-45		-5	25	
	13/00	0	84	255				0	-60		5	35	
	13/06	0	126	261				-20	-36		20	20	
	13/12	0	89					-20			20		
	13/18	0	101					-30			25		
	14/00	0	100					-40			35		
	14/06	0	78					-31			20		
	14/12	0											
	14/18	0											
	15/00	0											
	15/06	10											
	mean	5	63	138	169	214	302	4	6	-2	-1	-3	2
	sample	21	17	13	9	5	1	17	13	9	17	13	9

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TS Rai (1615)													
Sep.	12/18	31											
	13/00	25											
	mean	28	--	--	--	--	--	--	--	--	--	--	--
	sample	2	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
TY Malakas (1616)													
Sep.	12/18	25	68	144	236	252	401	5	10	25	-5	-5	-10
	13/00	0	57	175	216	227	409	10	5	25	-10	0	-10
	13/06	0	91	172	201	404	650	10	10	10	-10	-5	-5
	13/12	44	55	167	270	469	763	0	5	5	5	0	0
	13/18	0	92	204	368	567	841	-10	0	15	10	5	-10
	14/00	24	105	200	346	410	452	-20	0	15	15	5	-10
	14/06	11	89	124	177	415	391	-10	0	10	10	5	-10
	14/12	0	67	94	153	329	270	0	0	0	5	5	0
	14/18	0	25	24	78	147	131	0	10	0	5	-5	0
	15/00	0	33	54	111	145	466	0	10	0	5	-5	0
	15/06	11	15	32	119	316	791	-5	-5	0	5	0	0
	15/12	0	15	49	125	234		-15	-5	20	10	5	-20
	15/18	0	30	63	177	445		-5	-5	25	0	5	-30
	16/00	0	15	60	278	632		5	-5	25	-5	0	-30
	16/06	0	46	80	323	786		-5	-5	20	0	0	-25
	16/12	0	52	176	462			-15	0	5	10	0	-5
	16/18	0	40	191	421			-15	0	-10	10	-10	5
	17/00	0	60	228	530			-5	15	0	5	-20	0
	17/06	11	73	285	643			-5	15	-20	5	-20	20
	17/12	0	122	373				10	0		-10	0	
	17/18	15	189	432				15	-10		-20	5	
	18/00	11	126	288				15	5		-20	-5	
	18/06	0	137	382				10	-10		-15	10	
	18/12	0	49					0			0		
	18/18	0	86					5			-5		
	19/00	0	91					5			-10		
	19/06	0	157					-5			0		
	19/12	0											
	19/18	11											
	20/00	0											
	20/06	0											
	mean	5	73	174	275	385	506	-1	2	9	0	-1	-7
	sample	31	27	23	19	15	11	27	23	19	27	23	19

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
TY Megi (1617)													
Sep.	23/18	25	74	105	144	217		5	-15	-5	0	15	10
	24/00	11	85	162	238	110		-10	-20	-5	10	20	5
	24/06	0	67	135	178	172		-20	-35	10	20	30	-10
	24/12	11	83	141	144			-30	-35	-5	25	30	5
	24/18	54	84	125	120			-30	-25	-15	25	20	15
	25/00	44	66	131	132			-35	-20	-15	30	15	20
	25/06	0	73	113	161			-35	15	-5	30	-10	15
	25/12	0	83	62				-25	5		25	-5	
	25/18	11	85	69				-15	-5		15	5	
	26/00	15	79	78				-5	-10		5	10	
	26/06	0	99	105				-10	-5		10	5	
	26/12	0	62					5			-5		
	26/18	21	42					-5			5		
	27/00	15	35					-5			10		
	27/06	11	78					4			10		
	27/12	20											
	27/18	0											
	28/00	0											
	28/06	30											
	mean	14	73	111	160	167	--	-14	-14	-6	14	12	9
	sample	19	15	11	7	3	0	15	11	7	15	11	7

TY Chaba (1618)

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
Sep. 29/06	141	171	143	147	334	831	0	-5	20	0	5	-15
29/12	0	123	157	176	354	697	0	5	20	0	-5	-15
29/18	0	57	134	201	437	623	-5	5	5	5	-5	-5
30/00	60	31	81	141	504	669	-25	5	5	20	-5	-5
30/06	89	46	44	149	362	435	-10	15	35	10	-10	-25
30/12	0	90	101	267	540		10	35	45	-10	-25	-30
30/18	0	113	101	280	482		20	25	40	-15	-15	-25
Oct. 01/00	21	79	115	326	487		40	30	25	-30	-20	-10
01/06	32	61	102	292	314		35	35	10	-25	-25	0
01/12	0	53	151	287			20	45	5	-15	-30	0
01/18	0	56	177	234			15	40	-5	-10	-25	5
02/00	0	102	198	264			15	20	0	-10	-10	5
02/06	0	87	155	126			25	15	-10	-20	-5	10
02/12	0	32	66				35	5		-25	0	
02/18	0	60	58				30	0		-20	0	
03/00	0	24	35				10	0		0	0	
03/06	0	24	45				-5	-20		10	15	
03/12	0	36					0			5		
03/18	15	22					-10			10		
04/00	15	29					-15			15		
04/06	0	70					-20			20		
04/12	15											
04/18	9											
05/00	0											
05/06	24											
mean	17	65	110	222	424	651	8	15	15	-4	-9	-8
sample	25	21	17	13	9	5	21	17	13	21	17	13

STS Aere (1619)

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. 05/18	67	46	129	335	514		-2	10	-17	5	-10	20
06/00	0	57	94	264			0	5	-21	5	-5	20
06/06	15	46	152	288			0	-5	-21	0	10	25
06/12	33	59	182	325			5	-10	-23	-5	15	30
06/18	30	89	235	348			10	-12	-23	-10	15	25
07/00	0	101	221				5	-16		-5	15	
07/06	25	109	274				-10	-26		10	25	
07/12	21	156	274				-25	-38		30	45	
07/18	24	165	267				-27	-38		35	45	
08/00	0	114					-16			15		
08/06	15	116					-16			15		
08/12	11	70					-2			5		
08/18	46	144					-6			5		
09/00	30											
09/06	41											
09/12	22											
09/18	15											
mean	23	98	203	312	514	--	-6	-14	-21	8	17	24
sample	17	13	9	5	1	0	13	9	5	13	9	5

TY Songda (1620)

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. 08/12	11	70	156	222	670		0	35	35	5	-25	-20
08/18	22	106	188	257	779		10	45	40	-5	-30	-25
09/00	35	105	157	282	895		20	40	35	-15	-25	-25
09/06	15	97	156	369			30	35	20	-25	-20	-10
09/12	10	83	112	345			40	40	10	-30	-25	-5
09/18	15	102	128	376			40	40	0	-25	-25	5
10/00	0	89	116	320			25	25	0	-15	-20	5
10/06	0	56	131				15	20		-5	-10	
10/12	10	22	75				5	10		-5	-5	
10/18	0	22	63				20	10		-15	-5	
11/00	0	24	34				30	0		-25	0	
11/06	0	24					20			-15		
11/12	0	48					10			-10		
11/18	10	33					0			0		
12/00	9	71					-5			5		
12/06	15											
12/12	9											
12/18	18											
13/00	44											
mean	12	64	120	310	782	--	17	27	20	-12	-17	-11
sample	19	15	11	7	3	0	15	11	7	15	11	7

TY Sarika (1621)

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. 13/18	49	15	132	247	231	246	5	35	-5	0	-25	10
14/00	22	11	184	200	176	194	0	-10	-5	5	5	15
14/06	34	22	132	159	145		0	5	-15	0	0	20
14/12	15	46	144	161	200		0	0	-15	0	5	20
14/18	39	31	72	116	175		15	-10	-10	-10	10	15
15/00	34	44	68	119	256		10	0	-10	-15	10	15
15/06	0	11	79	102			5	-10	-15	-5	15	20
15/12	0	46	78	154			-5	-15	-40	5	20	40
15/18	11	31	90	187			-10	-25	-45	10	25	45
16/00	24	35	79	233			-15	-25	-49	20	25	50
16/06	11	46	123				-25	-30		25	30	
16/12	11	22	109				-25	-35		25	35	
16/18	0	11	84				-25	-30		25	35	
17/00	0	46	78				-20	-14		25	25	
17/06	0	11					-10			20		
17/12	0	38					-10			15		
17/18	0	39					-10			15		
18/00	25	39					-14			20		
18/06	39											
18/12	0											
18/18	33											
19/00	21											
mean	17	30	104	168	197	220	-7	-12	-21	10	15	25
sample	22	18	14	10	6	2	18	14	10	18	14	10

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
						TY Haima (1622)						
Oct. 15/00	184	111	46	89	144	180	5	-5	10	0	0	-5
15/06	40	112	70	78	205	276	5	0	20	-5	-5	-10
15/12	49	64	15	55	171	228	10	5	15	-10	-10	-10
15/18	0	45	15	86	171	192	10	15	15	-10	-10	-10
16/00	0	35	24	86	149	256	0	0	15	-5	0	-10
16/06	0	22	11	78	120	176	-5	10	15	-5	-5	-10
16/12	11	15	78	149	191	235	-5	15	0	-5	-10	5
16/18	0	24	99	160	170		5	20	-25	-5	-15	15
17/00	11	0	107	141	199		0	15	-5	0	-10	10
17/06	16	15	107	134	207		10	15	-15	-5	-10	20
17/12	0	44	109	147	225		10	0	-15	-10	5	10
17/18	0	44	96	122			10	-30	-5	-5	20	5
18/00	11	58	103	220			10	5	-15	-5	0	15
18/06	0	55	100	192			10	0	-25	-5	5	30
18/12	0	63	115	178			-15	-10	-37	15	10	40
18/18	11	49	89				-25	-10		10	10	
19/00	0	57	172				0	-15		5	15	
19/06	0	68	167				0	-25		5	30	
19/12	11	59	137				-5	-12		5	20	
19/18	11	57					0			5		
20/00	0	105					0			5		
20/06	11	70					-10			20		
20/12	0	35					-7			15		
20/18	0											
21/00	0											
21/06	0											
21/12	10											
mean	14	52	87	128	178	220	1	0	-3	0	2	6
sample	27	23	19	15	11	7	23	19	15	23	19	15

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
						TY Meari (1623)						
Nov. 03/00	16	330	628	1068	2066		2	15	15	-5	-15	-15
03/06	24	303	547	1083			7	20	15	-15	-20	-15
03/12	15	280	484	1005			7	25	15	-15	-25	-15
03/18	108	139	244	779			17	25	10	-20	-25	-10
04/00	140	154	291	1065			22	25	5	-25	-25	-5
04/06	0	119	94				10	5		-10	-5	
04/12	0	62	74				15	-5		-15	0	
04/18	0	68	84				5	-10		-5	5	
05/00	35	35	226				-5	-20		0	15	
05/06	15	25					-10			5		
05/12	0	61					-15			10		
05/18	24	90					-20			15		
06/00	0	113					-15			15		
06/06	0											
06/12	0											
06/18	0											
07/00	22											
mean	24	137	297	1000	2066	--	2	9	12	-5	-11	-12
sample	17	13	9	5	1	0	13	9	5	13	9	5

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
						TS Ma-on (1624)						
Nov. 10/00	11	185					-4			0		
10/06	48	183					-4			0		
10/12	54	25					-4			0		
10/18	57	152					-4			0		
11/00	46											
11/06	24											
11/12	257											
11/18	221											
mean	90	136	--	--	--	--	-4	--	--	0	--	--
sample	8	4	0	0	0	0	4	0	0	4	0	0

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=96	=120	T=24	=48	=72	T=24	=48	=72
						STS Tokage (1625)						
Nov. 25/12	44	58	46				0	-4		-5	0	
25/18	93	110	85				-4	-6		0	5	
26/00	11	34					-4			0		
26/06	11	40					-4			5		
26/12	22	84					-2			0		
26/18	24	104					-8			10		
27/00	22											
27/06	11											
27/12	67											
27/18	46											
mean	35	72	65	--	--	--	-4	-5	--	2	3	--
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 Nock-ten (1626)						
Dec. 21/18	25	86	99	113	140	56	9	40	75	-10	-35	-55
22/00	0	60	64	119	124	56	7	45	45	-5	-30	-25
22/06	11	22	46	76	49	137	20	60	35	-15	-35	-20
22/12	25	46	11	33	133	212	20	40	30	-15	-25	-20
22/18	24	40	55	58	177		20	40	15	-15	-25	-10
23/00	16	39	0	93	207		20	35	15	-15	-20	-10
23/06	11	11	22	108	92		40	25	5	-25	-15	-5
23/12	0	16	55	127	89		35	25	5	-20	-15	-10
23/18	0	16	86	202			30	5	0	-15	-5	-5
24/00	0	16	76	141			10	0	-5	-10	-5	0
24/06	0	22	113	89			10	-5	-10	-10	0	10
24/12	0	22	175	82			10	-5	-16	-10	0	15
24/18	0	45	195				-5	-5		-5	0	
25/00	0	76	161				0	-5		-10	0	
25/06	0	131	123				-15	-10		0	10	
25/12	0	144	74				-25	-21		5	20	
25/18	0	152					-20			10		
26/00	0	76					-15			10		
26/06	15	70					-5			5		
26/12	0	64					-11			10		
26/18	0											
27/00	21											
27/06	0											
27/12	0											
mean	6	58	85	103	127	115	7	17	16	-7	-11	-11
sample	24	20	16	12	8	4	20	16	12	20	16	12

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 - 2016

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
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) 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 =
```

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

```
AXPQ20 RJTD YYGGgg
RSMC TROPICAL CYCLONE BEST TRACK
NAME ty-No. name (common-No.)
PERIOD FROM MMMDDTTUTC TO MMMDDTTUTC
DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT     DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT
DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT     DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT
                              :
                              :
DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT     DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT
REMARKS1)
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=
```

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

The Global Spectral Model (GSM) and the Typhoon Ensemble Prediction System (TEPS) are used in JMA as a primary basis for TC forecasts. GSM (TL959L100) has about 20 km horizontal resolution and 100 vertical layers. Details on the GSM are found in Yonehara et al. (2014). TEPS (TL479L60) has 25 members with approximately 40 km horizontal resolution and 60 vertical layers. Details on the TEPS are found in Kyouda and Higaki (2015). A singular vector (SV) method is employed for the initial perturbation setup. The stochastic physics scheme (Buizza et al. 1999) is also introduced in consideration of model uncertainties associated with physical parameterizations. The general specifications of GSM and TEPS are summarized in Table 6.1.

Table 6.1 Specifications of GSM and TEPS

NWP Models	GSM (Global Spectral Model), TL959L100	TEPS (Typhoon Ensemble Prediction System), TL479L60
Resolution	20 km, 100 layers (Top: 0.01hPa)	40 km, 60 layers (Top: 0.1hPa)
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: SV-based perturbation Ensemble size: 25 (24 perturbed members and 1 control member) SV target areas: Northwestern Pacific (20°N -60°N, 100°E -180°) and vicinities of up to 3 TCs in the Typhoon Center’s area of responsibility (e.g. Figure 6.1)
Forecast time (and initials)	84h (00, 06, 18 UTC) 264h (12 UTC)	132h (00, 06, 12, 18 UTC)
Operational as from	18 March 2014	11 March 2014 (de facto from T1404)

[Recent upgrades on GSM and the Global Data Assimilation System and TEPS]

GSM:

- Parameterization schemes including land surface processes, deep convection, cloud, radiation and sea ice were revised. (March 2016).

Global Data Assimilation System:

- Quality Control for Himawari-8 AMV was revised, and assimilation of GRACE-B/BlackJack radio occultation data was enabled (December 2016).
- The typhoon bogus scheme was revised (September 2016).

- Assimilation of GPM Microwave Imager (GMI) data was started (March 2016).
- Assimilation of Himawari-8 AMV and CSR data was started (March 2016).

TEPS is an ensemble prediction system used mainly for TC track forecasts up to five days ahead. Two SV calculations are introduced into the system to efficiently capture the uncertainty of TC track forecasts. One produces SVs with a spatial target area fixed on the Northwestern Pacific (20°N - 60°N, 100°E - 180°), and the other produces SVs whose spatial target area can be moved within a 750 km radius of a predicted TC's position in one-day forecasting. Up to three movable areas can be configured for different TCs at one initial time. If more than three TCs are present in the area of responsibility, three are selected in the order of concern as prioritized by the RSMC Tokyo – Typhoon Center. Figure 6.1 shows an example of SV spatial target areas. At this initial time, there were three TCs in the area. Figure 6.2 shows an example of TEPS forecast tracks for PHANFONE (TY1418). In this case, the forecasted TC track of the control member showed that the typhoon would hit both Nansei Islands (southwestern islands off Kyushu) and Kyushu (southernmost of the four main islands of Japan). In addition, ensemble TC tracks suggested that there would be widespread probabilities of not only typhoon hitting but also typhoon passing by off the Pacific. As a result, some TC tracks were close to the best track during the period.

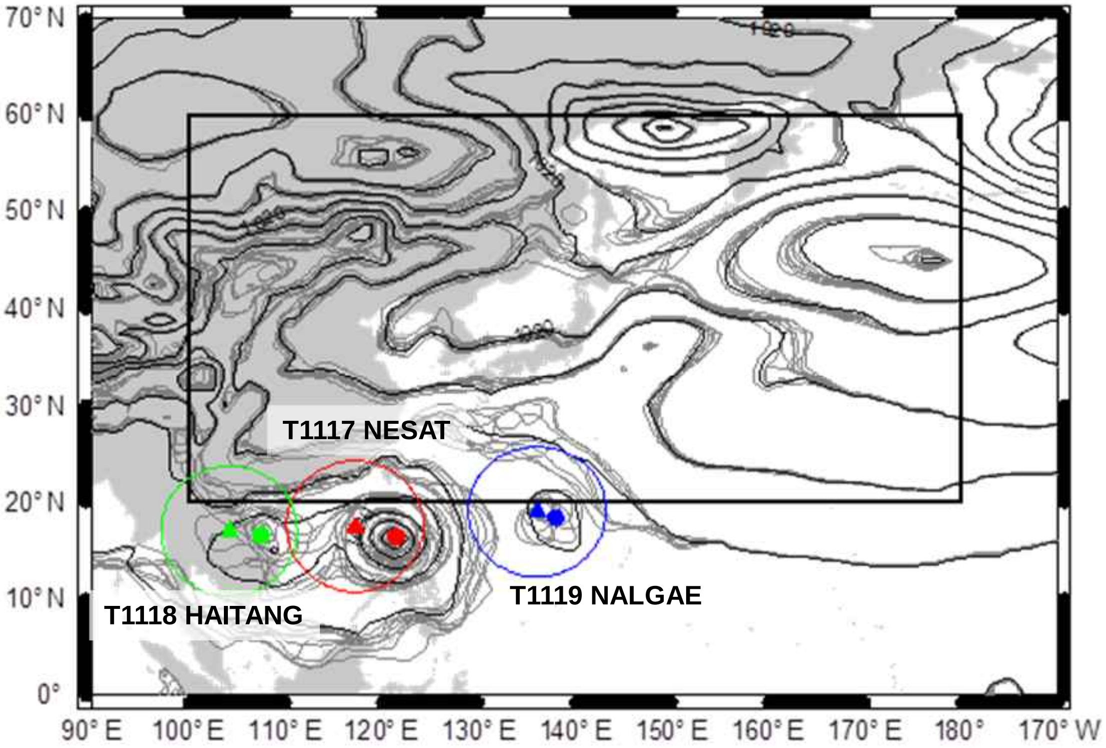


Figure 6.1 Example of SV spatial target areas of TEPS (Initial time: 00UTC 27 September 2011). The large thick rectangle shows the fixed area and the circles show the three movable areas which are set around a predicted TC's position. Filled circles and triangles show TCs' central positions at the initial time and in one-day forecasting, respectively. Gray contours show the initial sea level pressure of each member.

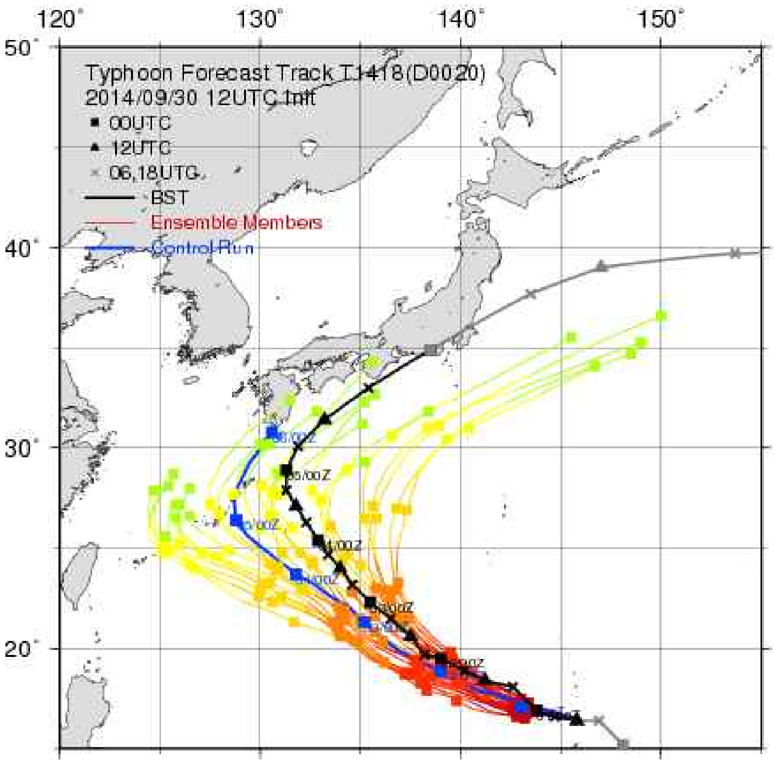


Figure 6.2 Example of TEPS forecast track (Initial time: 12UTC 30 September 2014). Black and blue lines denote TC best track and forecast track of control member respectively. Red, dark orange, orange, yellow and green lines show TC forecast tracks of all perturbed members up to 48, 72, 96, 120 and 132 hours, respectively.

[References]

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

Kyouda, M. and M. Higaki, 2015: Upgrade of JMA's Typhoon Ensemble Prediction System, RSMC Tokyo-Typhoon Center Technical Review, 17-1, p.13.
http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/techrev/text17-1.pdf

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

Products on WIS GISC Tokyo server

(Available at http://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	One-week 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 http://www.wis-jma.go.jp/cms/sataid/)

Products on NTP website

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

Products	Frequency	Details
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
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
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 TEPS 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 TEPS ensemble members (up to 72 hours ahead)
Wave Height Forecasts	4 times/day	• Distribution maps of ensemble mean wave height, maximum wave height, probability of exceeding various wave heights and ensemble spread based on global Wave EPS Model (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 global Wave EPS Model (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 2016 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 2016. 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 2016 in PDF)
            |---Figure (figures in PDF)
            |---Table (tables in PDF)
            |---Appendix (appendices for MS Word, Excel and PDF)
|------Best_Track
            |---E_BST_2016.txt (best track data for 2016)
            |---E_BST_201607.txt (best track data for TCs generated in July 2016)
                       :
            |---E_BST_201612.txt (best track data for TCs generated in December 2016)
|------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
            |---T1601 (hourly satellite image data for T1601)
            |---T1602 (hourly satellite image data for T1602)
                  :
            |---T1626 (hourly satellite image data for T1626)
```

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 2016, 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 2016>

Annual Report 2016 is provided in two formats as PDF files and MS Word/Excel files.

- PDF files:

Click *Annual Report 2016* 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 2016 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.

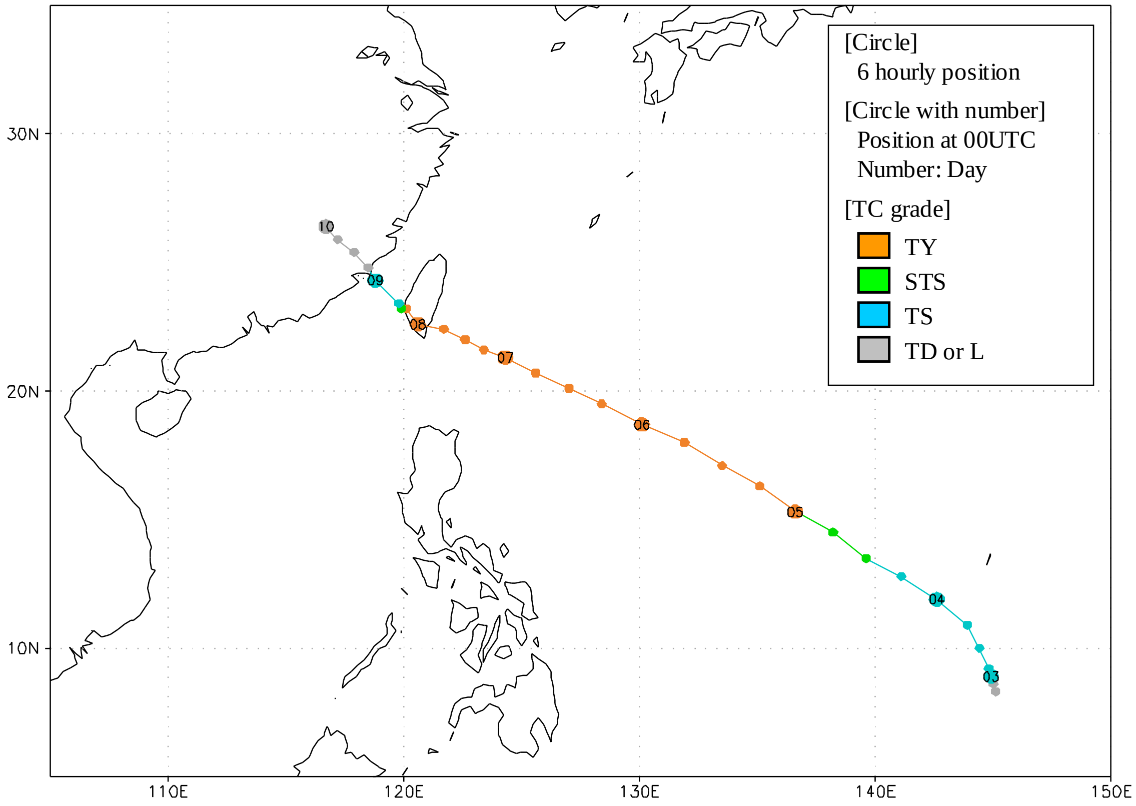
For further information, please contact:

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 2016

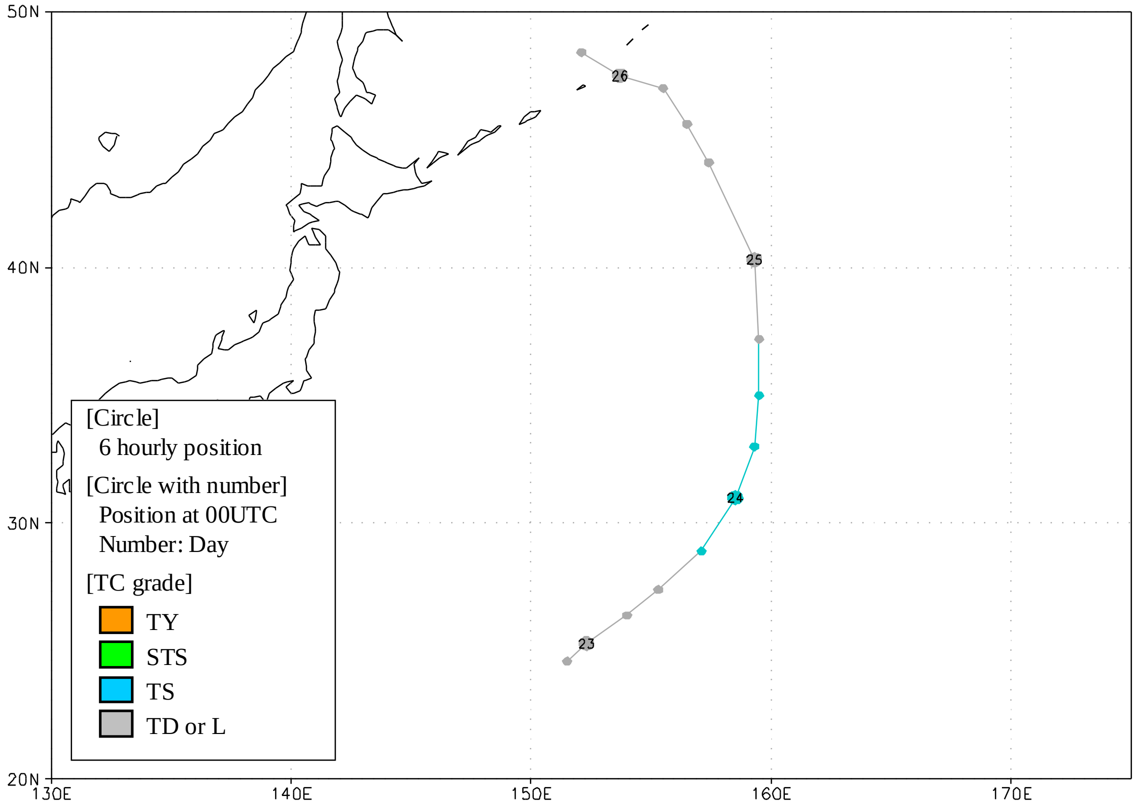
NEPARTAK (1601)

NEPARTAK formed as a tropical depression (TD) around the Caroline Islands at 12 UTC on 02 July 2016. After moving northwestward, it was upgraded to tropical storm (TS) intensity over the same waters 12 hours later. Keeping its northwestward track, NEPARTAK was upgraded to typhoon (TY) intensity over the sea east of the Philippines at 00 UTC on 05 July and reached its peak intensity with maximum sustained winds of 110 kt and a central pressure of 900 hPa south of Okinawa Island at 06 UTC on the next day. Keeping its northwestward track, NEPARTAK hit Taiwan Island with weakening its intensity rapidly. After it entered the Taiwan Strait, NEPARTAK hit southeast coast of China with TS intensity after 00 UTC on 09 July. Moving northwestward, NEPARTAK weakened to TD intensity in southern part of China 6 hours later. NEPARTAK dissipated there at 06 UTC on 10 July.



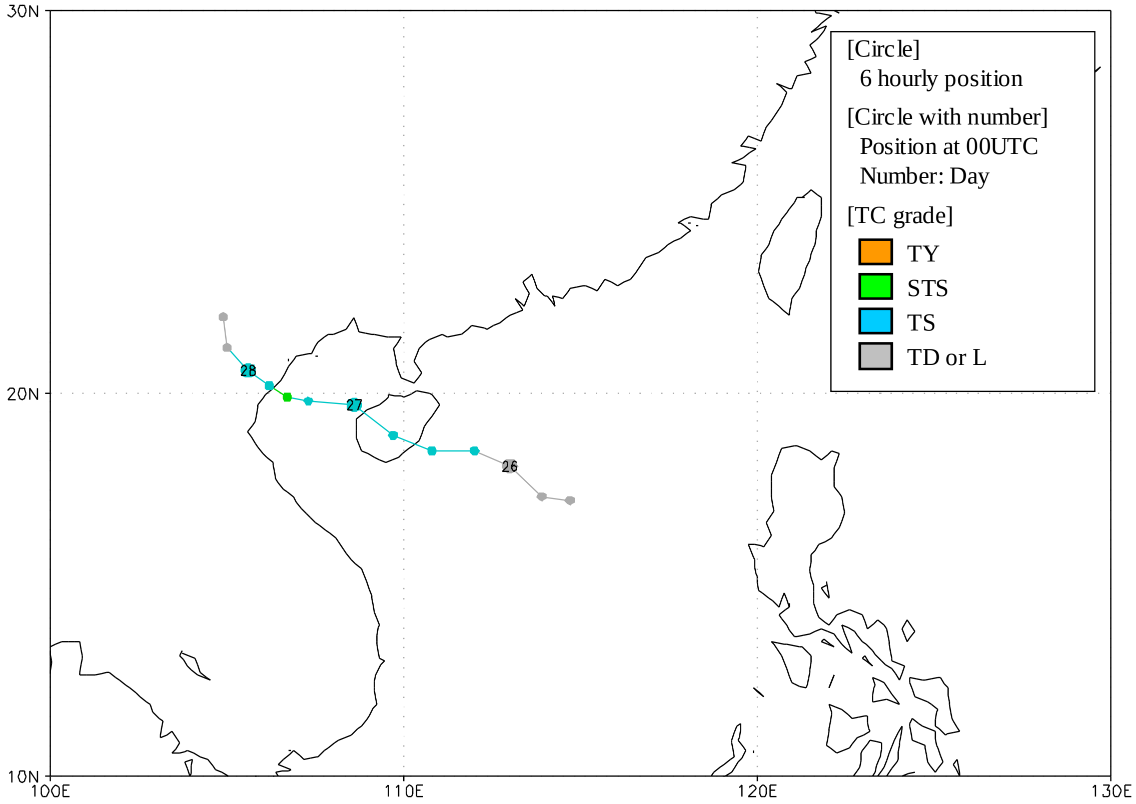
LUPIT (1602)

LUPIT formed as a tropical depression (TD) around Minamitorishima at 18 UTC on 22 July 2016 and moved northeastward. After upgrading to tropical storm (TS) intensity northeast of the same island at 18 UTC on 23 July and gradually turning northward, LUPIT reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 1000 hPa around far off east of Japan at 00 UTC on the next day. LUPIT transformed into an extratropical cyclone there at 18 UTC on 24 July. It gradually turned north-northwestward and dissipated around the Kuril Islands at 12 UTC on 26 July.



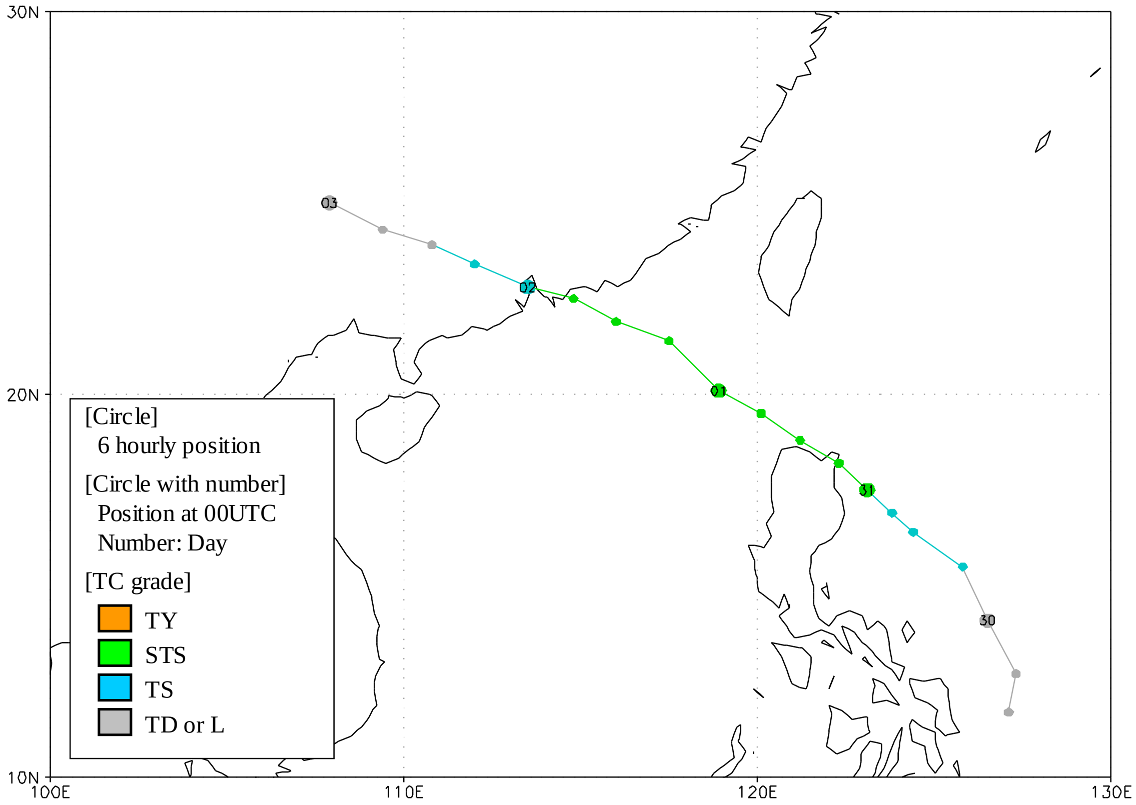
MIRINAE (1603)

MIRINAE formed as a tropical depression (TD) over the South China Sea at 12 UTC on 25 July 2016. After moving west-northwestward, it was upgraded to tropical storm (TS) intensity over the sea east of Hainan Island at 06 UTC on the next day. Keeping its west-northwestward track, MIRINAE crossed Hainan Island with TS intensity. It was upgraded to severe tropical storm (STS) intensity and reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 980 hPa in the Gulf of Tonkin at 12 UTC on 27 July. After crossing the coast line of Viet Nam, MIRINAE weakened to TD intensity in northern part of the county on 06 UTC on 28 July and dissipated there 12 hours later.



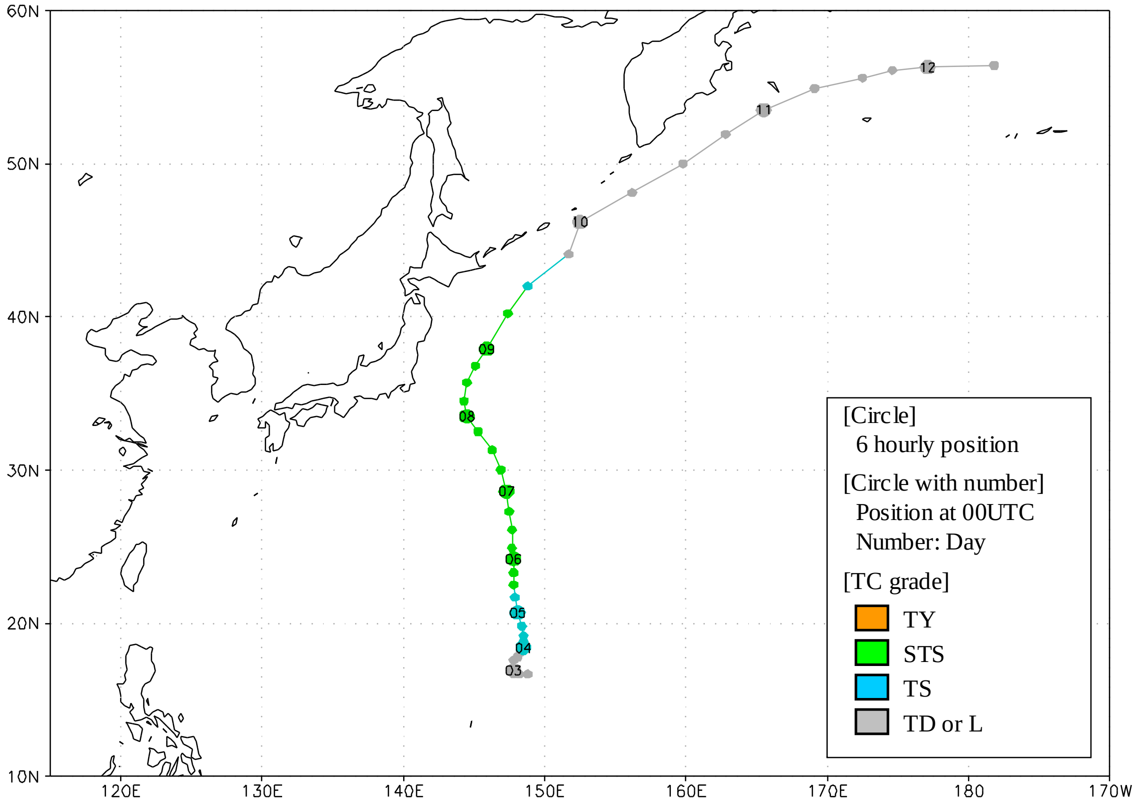
NIDA (1604)

NIDA formed as a tropical depression (TD) east of the Philippines at 12 UTC on 29 July 2016 and moved northward. After gradually turning northwestward, it upgraded to tropical storm (TS) intensity over the same waters at 06 UTC the next day. After turned west-northwestward, NIDA upgraded to severe tropical storm (STS) intensity around Luzon Island at 00 UTC on 31 July and reached its peak intensity with maximum sustained winds of 60 kt and a central pressure of 975 hPa 6 hours later. After hitting the southern part of China with TS intensity early on 02 August, it weakened to TD intensity in the same area 12 UTC on the same day. NIDA dissipated in the southern part of China at 06 UTC on 03 August.



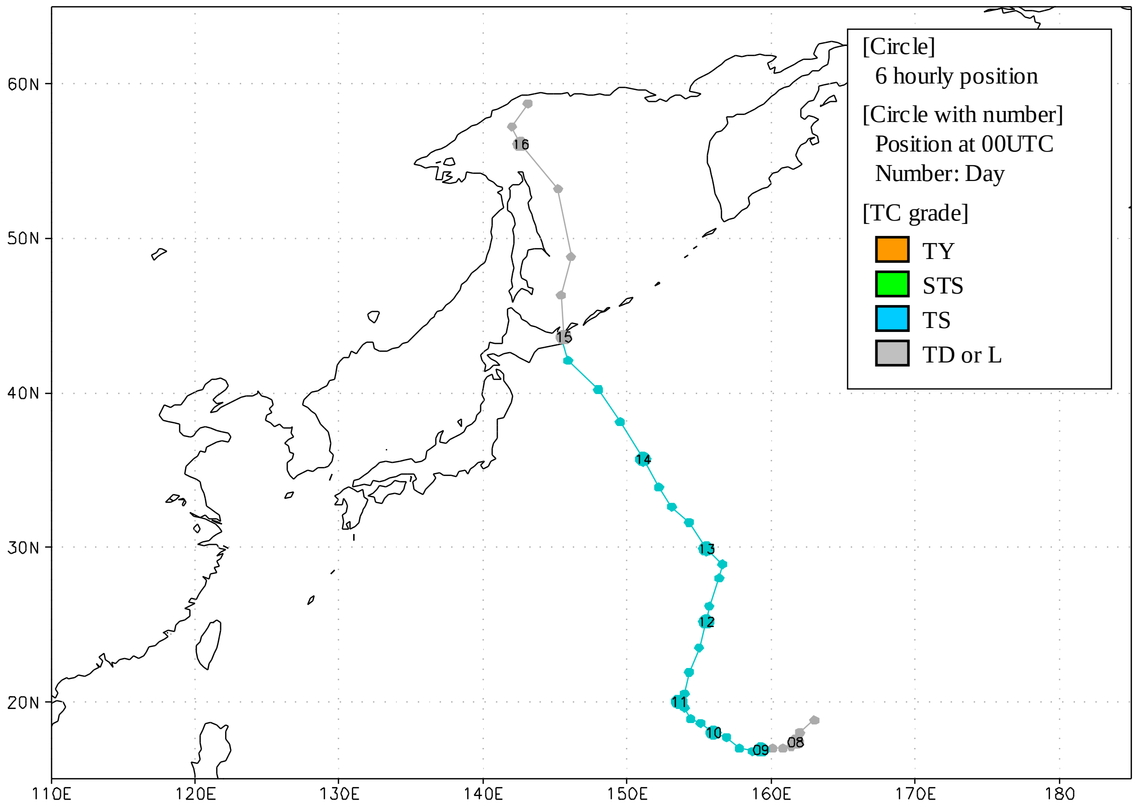
OMAIS (1605)

OMAIS formed as a tropical depression (TD) around the sea east of the Northern Mariana Islands at 12 UTC on 2 August 2016. After moving northward, it upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 4 August. Keeping its northward track, OMAIS reached its peak intensity with maximum sustained winds of 60 kt and a central pressure of 975 hPa around the Ogasawara Islands at 06 UTC on 6 August. Turning north-eastward, OMAIS transformed into an extratropical cyclone far east of Hokkaido at 18 UTC on 9 August. It crossed longitude 180 degrees east over the Bering Sea before 06 UTC on 12 August.



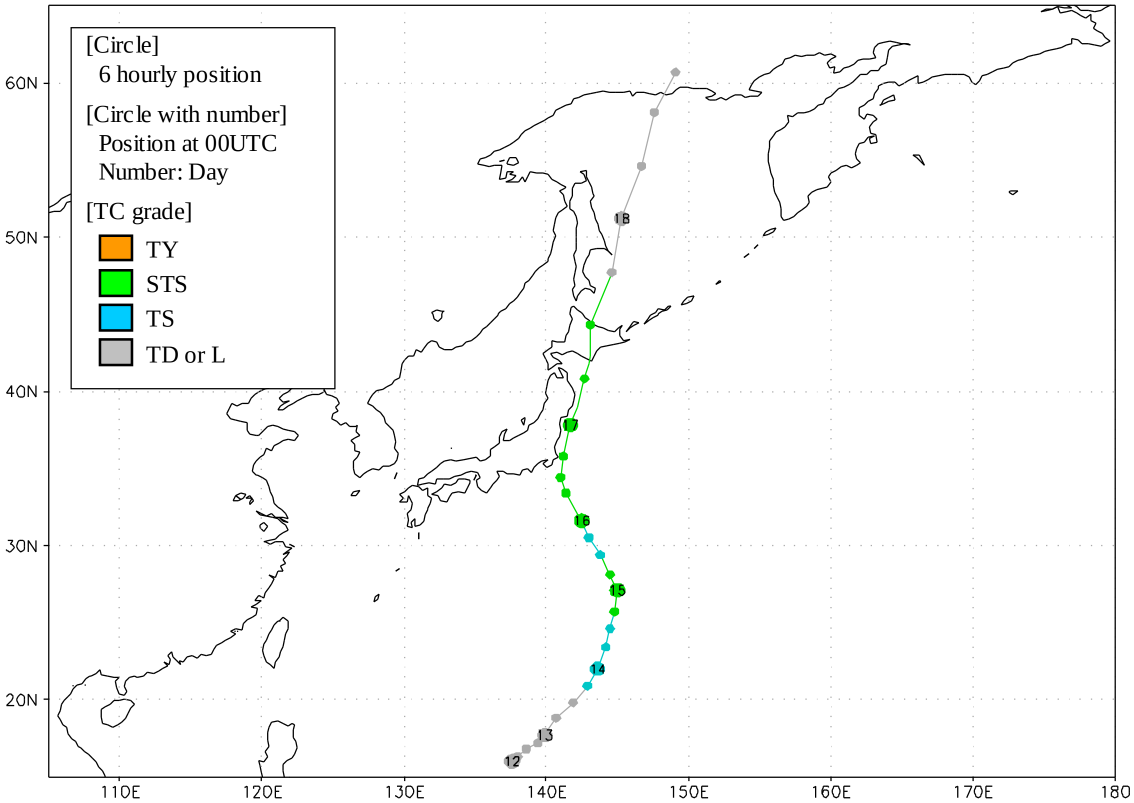
CONSON (1606)

CONSON formed as a tropical depression (TD) around Wake Island at 12 UTC on 7 August 2016 and moved southwestward. It was upgraded to tropical storm (TS) intensity around Minamitorishima Island at 00 UTC on 9 August and moved northwestward. After turning north-northeastward and then moving north-northwestward, CONSON reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 985 hPa east of Japan at 06 UTC on 13 August. Keeping its north-northwestward track, it crossed the Nemuro Peninsula, Hokkaido Prefecture with TS intensity around 23 UTC 14 August. CONSON transformed into an extratropical cyclone over the Sea of Okhotsk on 00 UTC on 15 August and moved northward. It dissipated over the same waters at 18 UTC on the next day.



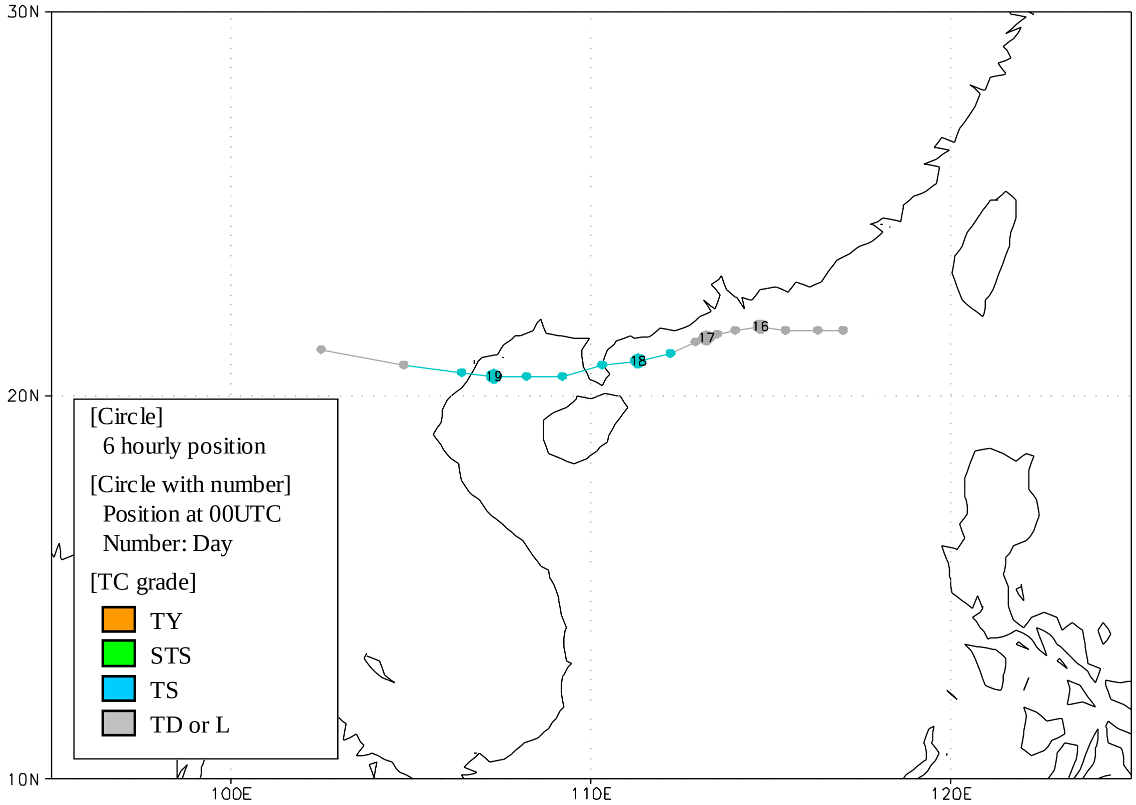
CHANTHU (1607)

CHANTHU formed as a tropical depression (TD) around the sea west of the Northern Mariana Islands at 00 UTC on 12 August 2016. After moving northeastward, it upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on the next day. Keeping its northward track, CHANTHU was upgraded to severe tropical storm (STS) intensity around the Ogasawara Islands at 18 UTC on 14 August. Turning northwestward and then northward, CHANTHU reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 980 hPa off the eastern coast of the Tohoku Region at 00 UTC on 17 August. Keeping its northward track, CHANTHU landed on around Cape Erimo, Hokkaido Prefecture around 0830UTC on 17 August. CHANTHU transformed into an extratropical cyclone around the Sakhalin Island at 18 UTC on the same day. It crossed latitude 60 degrees north over the Sea of Okhotsk at 18 UTC on 18 August.



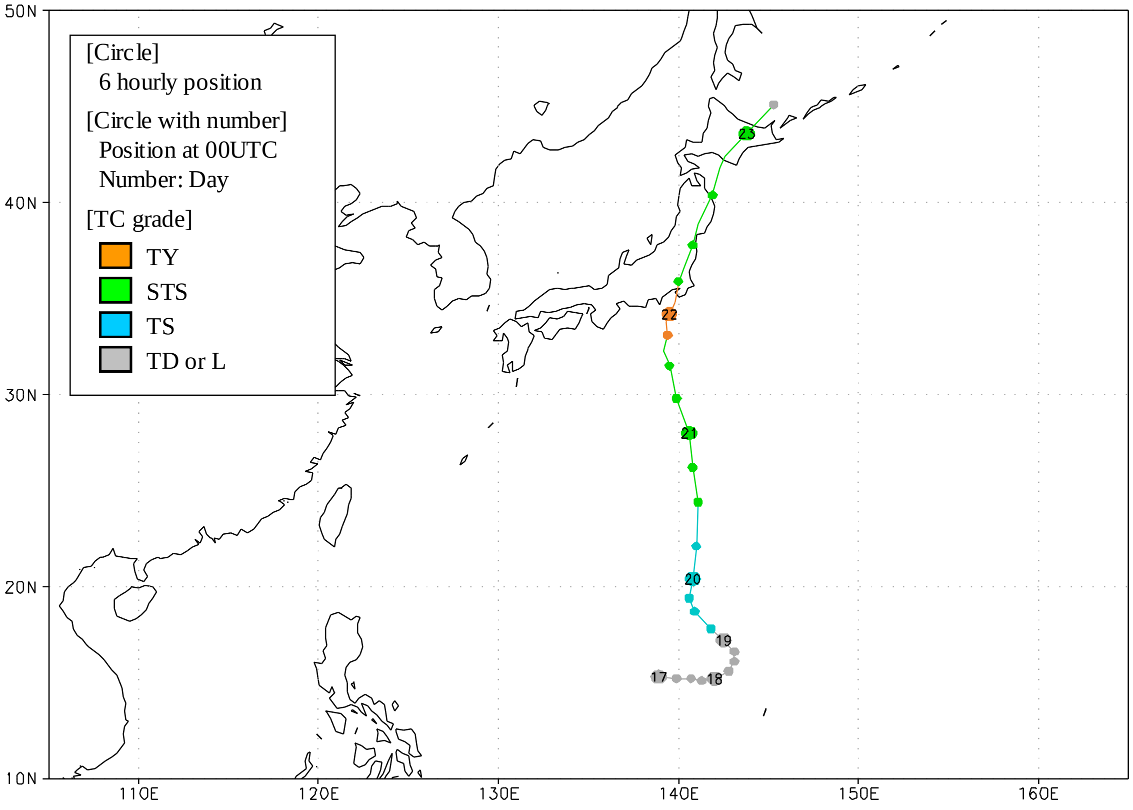
DIANMU (1608)

DIANMU formed as a tropical depression (TD) around the Taiwan Strait at 06 UTC on 15 August 2016. After moving westward, it was upgraded to tropical storm (TS) intensity over the South China Sea at 18 UTC on 17 August. Keeping its westward track, DIANMU reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 980 hPa in the Gulf of Tongking 24 hours later. After hitting the northern part of Viet Nam with TS intensity early on 19 August, it weakened to TD intensity there at 12 UTC on the same day and dissipated around Myanmar 00 UTC on 20 August.



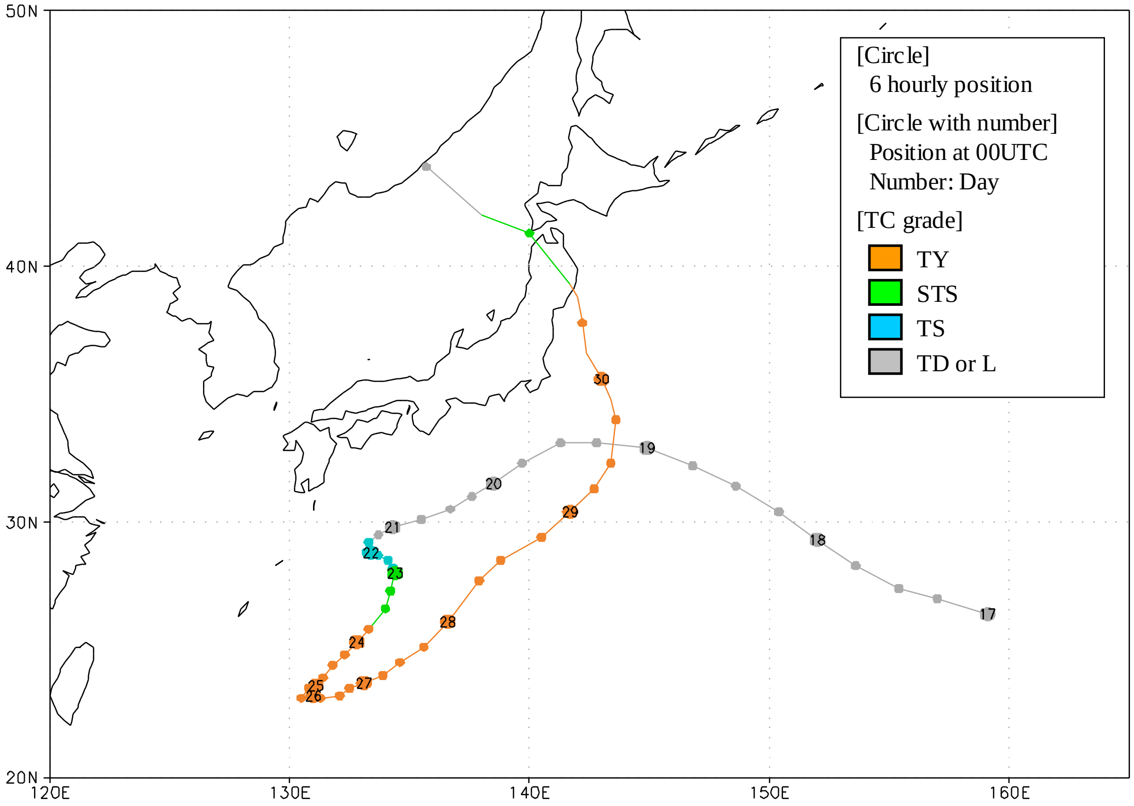
MINDULLE (1609)

MINDULLE formed as a tropical depression (TD) around the sea west of the Northern Mariana Islands at 00 UTC on 17 August 2016, and moved eastward and then northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 06 UTC on 19 August and moved northward. MINDULLE was upgraded to typhoon (TY) intensity and reached its peak intensity with maximum sustained winds of 65 kt and a central pressure of 975 hPa around Hachijojima Island at 18 UTC on 21 August. MINDULLE made landfall on Tateyama City, Chiba Prefecture around 0330 UTC 22 August and moved north-northeastward. After travelling over the eastern and northern part of Japan, it landed on again central part of Hidaka District, Hokkaido Prefecture before 21 UTC on that day. MINDULLE transformed into an extratropical cyclone over the Sea of Okhotsk at 03 UTC on 23 August and dissipated three hours later.



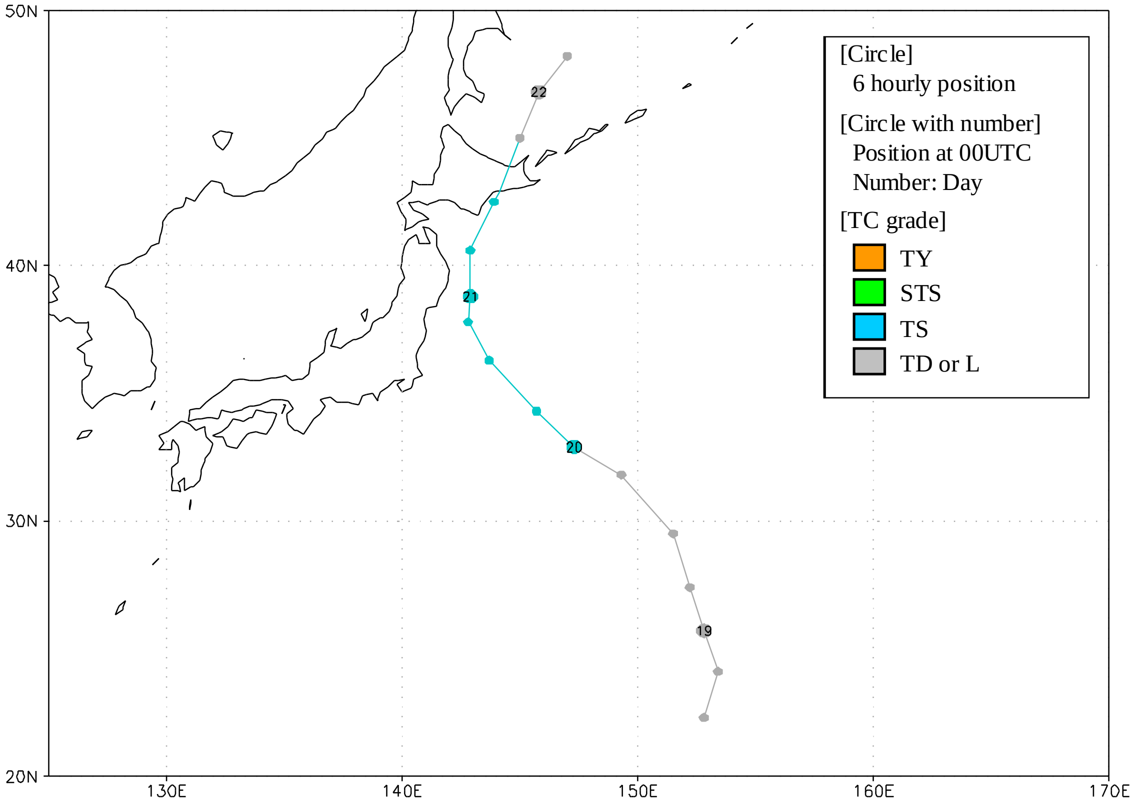
LIONROCK (1610)

LIONROCK formed as a tropical depression (TD) around the sea east-northeast of Minamitorishima Island at 00 UTC on 17 August 2016 and moved west-northwestward. After turning and decelerating southwestward, it was upgraded to tropical storm (TS) intensity south of Shikoku Island at 12 UTC on 21 August. After LIONROCK sharply turned southeastward and then gradually turned southwestward again, it was upgraded to typhoon (TY) intensity east of Minamidaitojima Island at 18 UTC on 23 August. LIONROCK kept its southwestward track and sharply turned eastward south of Minamidaitojima Island at 18 UTC on 25 August. It accelerated northeastward and reached its peak intensity with maximum sustained winds of 90 kt and a central pressure of 940 hPa west of Chichijima Island at 06 UTC on 28 August. After gradually turning north-northwestward, LIONROCK made landfall on Ofunato City, Iwate Prefecture with TY intensity around 0830 UTC on 30 August and moved northwestward. It transformed into an extratropical cyclone over the Sea of Japan at 15 UTC on 30 August and dissipated there nine hours later.



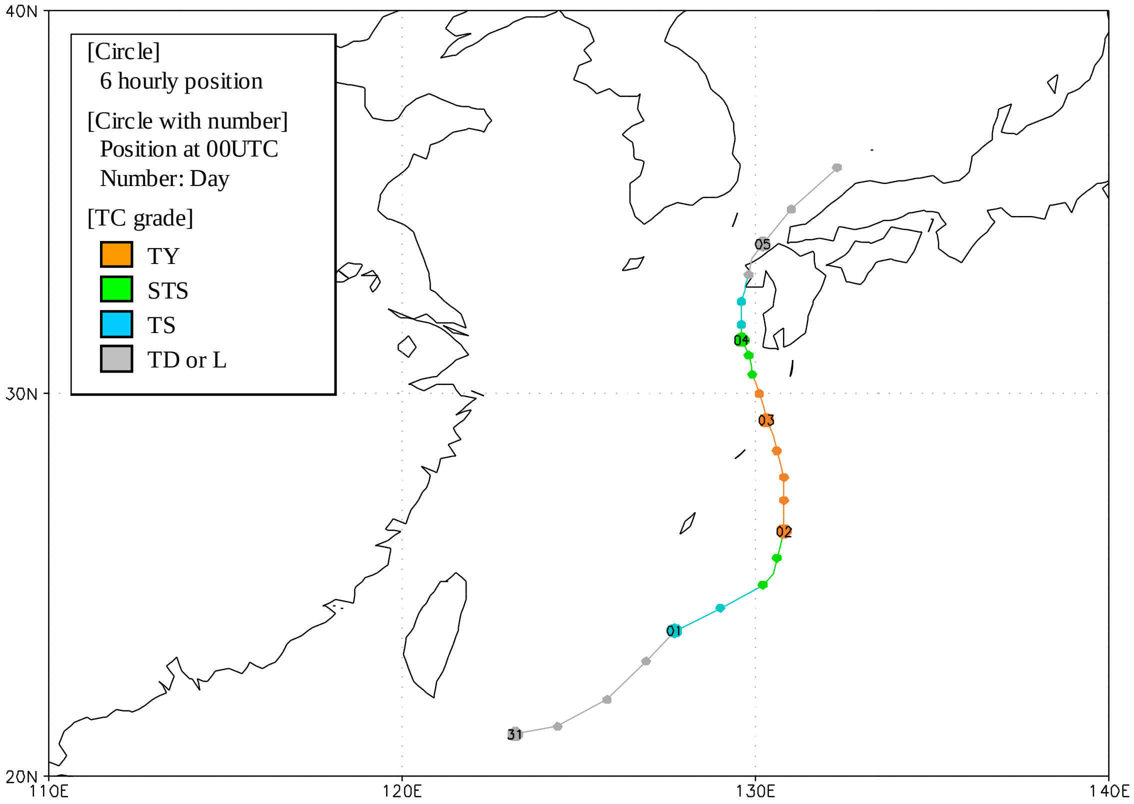
KOMPASU (1611)

KOMPASU formed as a tropical depression (TD) around Minamitorishima Island at 12 UTC on 18 August 2016 and moved northward. Gradually turning 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 994 hPa east of Japan at 00 UTC on 20 August. After turning north-northeastward, KOMPASU made landfall on Kushiro City, Hokkaido Prefecture with TS intensity after 1400 UTC on 21 August. It entered the Sea of Okhotsk and transformed into an extratropical cyclone on 18 UTC on that day. KOMPASU dissipated there at 12 UTC on 22 August.



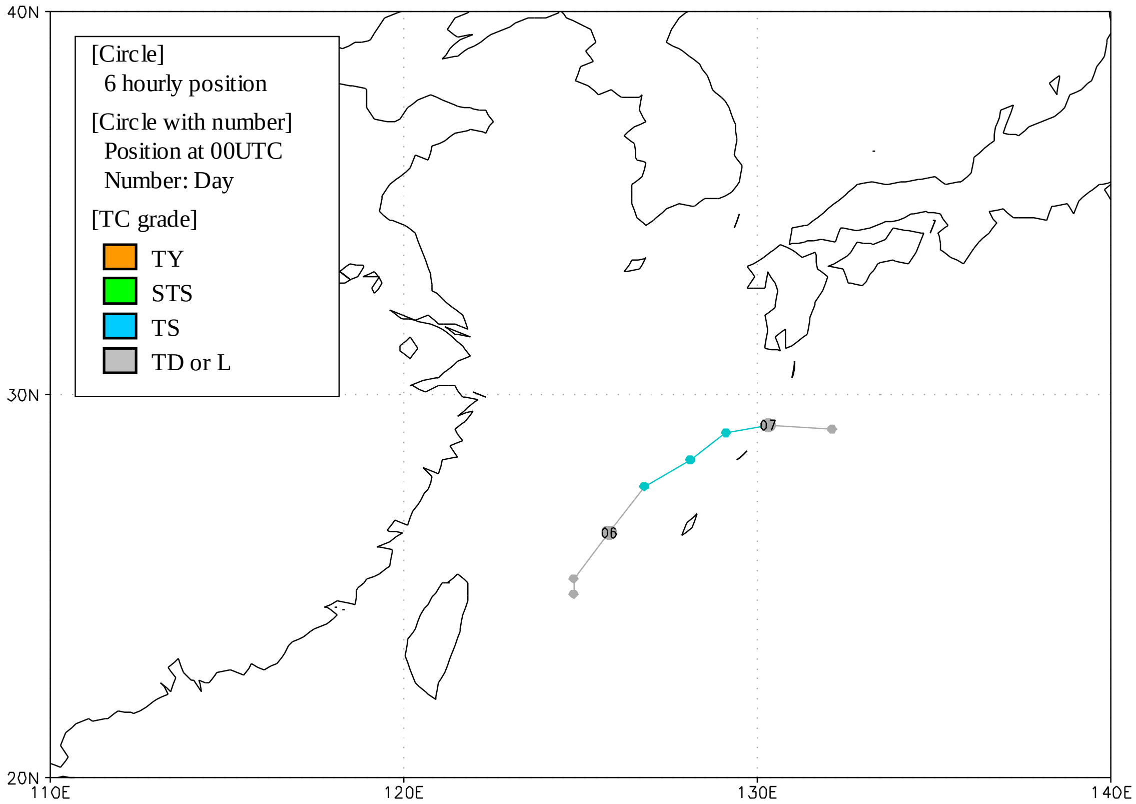
NAMTHEUN (1612)

NAMTHEUN formed as a tropical depression (TD) around the Luzon Strait at 00 UTC on 31 August 2016. Moving northeastward, it was upgraded to tropical storm (TS) intensity south of Okinawa Island at 00 UTC on 01 September. After NAMTHEUN turned northward, it reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 955 hPa east of Amami-Osima Island at 18 UTC on the next day. Keeping its northward track, NAMTHEUN made landfall on around Nagasaki City, Nagasaki Prefecture after 16 UTC on 4 September, and weakened to TD intensity 2 hours later. Turning northeastward, NAMTHEUN dissipated over the Sea of Japan at 18 UTC on the next day.



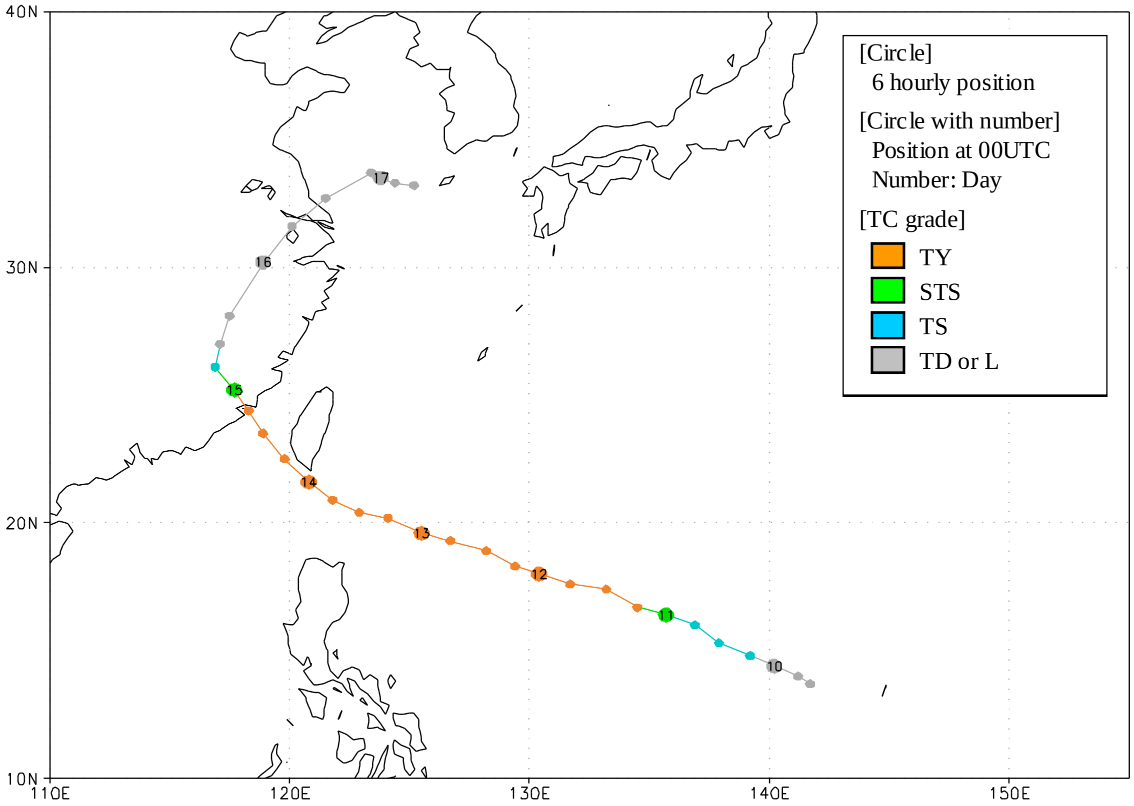
MALOU (1613)

MALOU formed as a tropical depression (TD) around Miyakojima Island at 12 UTC on 05 September 2016. Moving northeastward, it was upgraded to tropical storm (TS) intensity and reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 1000 hPa north of Kumejima Island at 06 UTC on 06 September. Gradually turning eastward, MALOU weakened to TD intensity south of Yakushima Island at 00 UTC on 07 September, and it dissipated south of Kyushu Island 12 hours later.



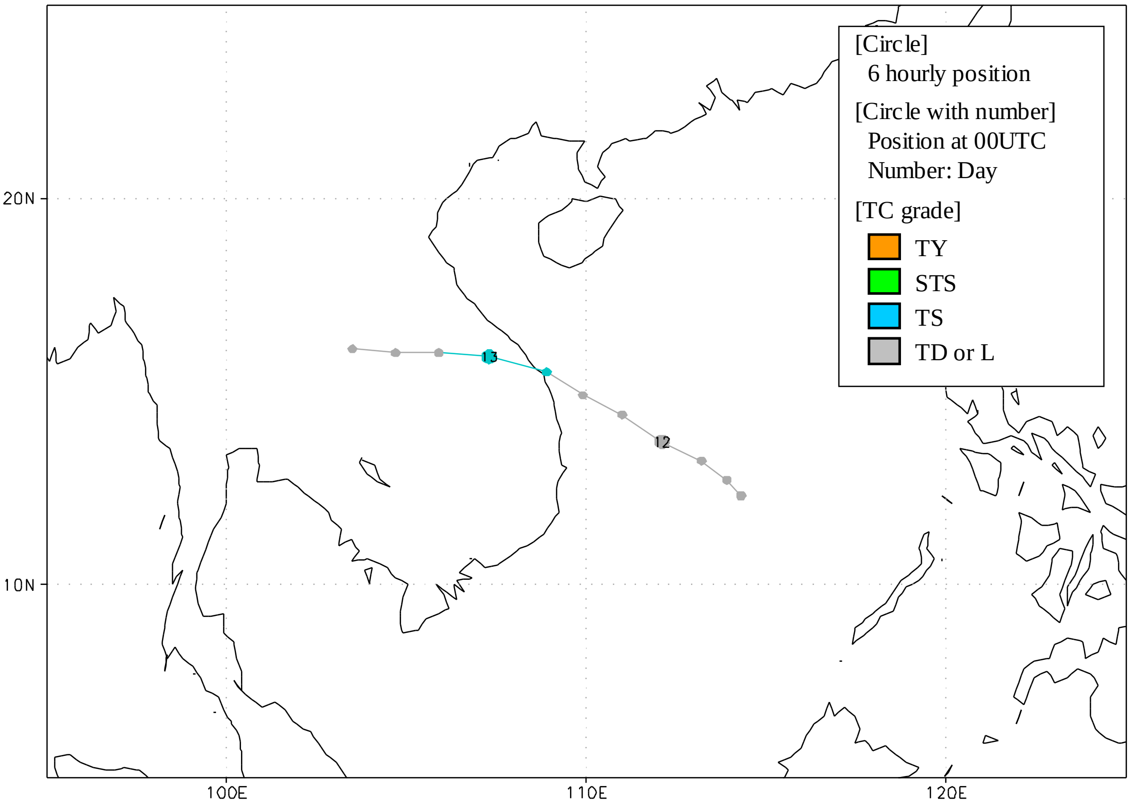
MERANTI (1614)

MERANTI formed as a tropical depression (TD) around the sea west of the Northern Mariana Islands at 12 UTC on 9 September 2016, and moved west-northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 06 UTC on 10 September and kept its west-northwestward track. MERANTI was upgraded to typhoon (TY) intensity over the same waters at 06 UTC on 11 September, and reached its peak intensity with maximum sustained winds of 120 kt and a central pressure of 890 hPa north of Luzon Island at 12 UTC on 13 September. After gradually turning northwestward, it hit southeast of China with TY intensity late on 14 September. After turning north-northeastward, it weakened to TD intensity in the same area at 12 UTC on 15 September. MERANTI transformed into an extratropical cyclone around the mouth of Yangtze River at 06 UTC on 16 September and dissipated around Jeju Island at 18 UTC on the next day.



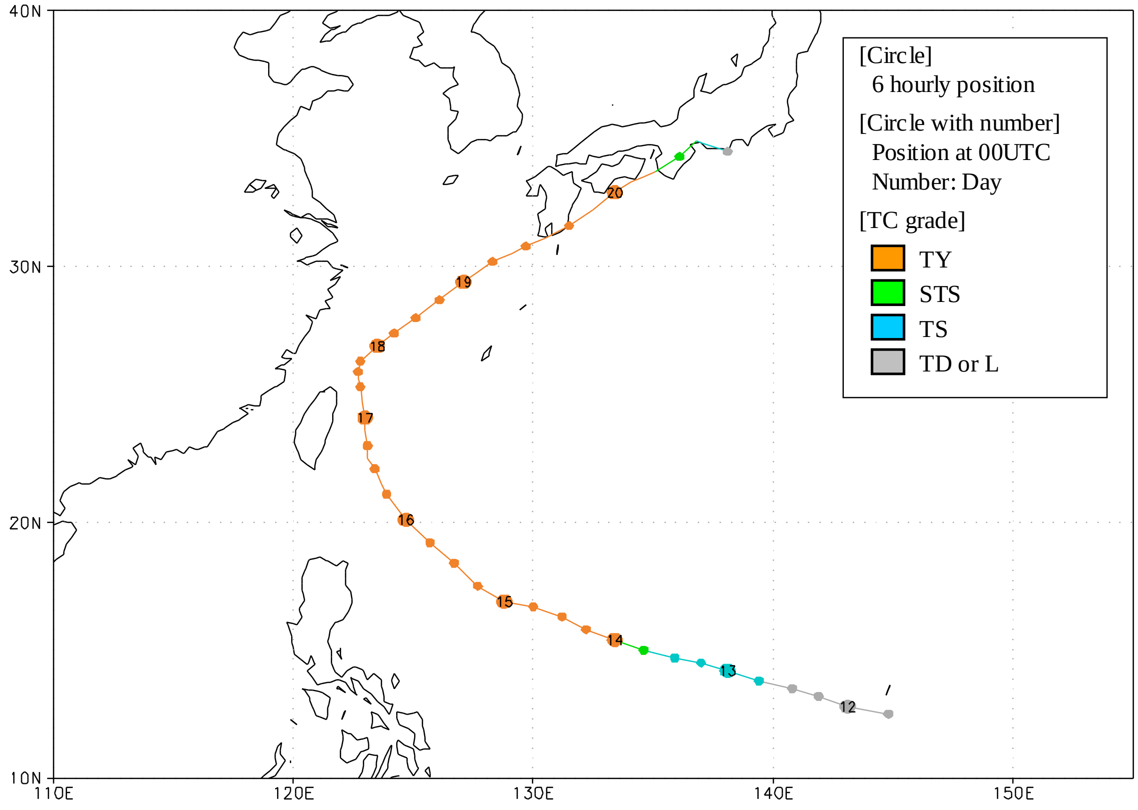
RAI (1615)

RAI formed as a tropical depression (TD) over the South China Sea at 06 UTC on 11 September 2016. After moving 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 996 hPa off the coast of Viet Nam on 18UTC on 12 September. After turning westward and hitting the central part of Viet Nam with TS intensity late on the same day, RAI weakened to TD intensity in Laos at 06 UTC on 13 September and dissipated in Thailand 18 hours later.



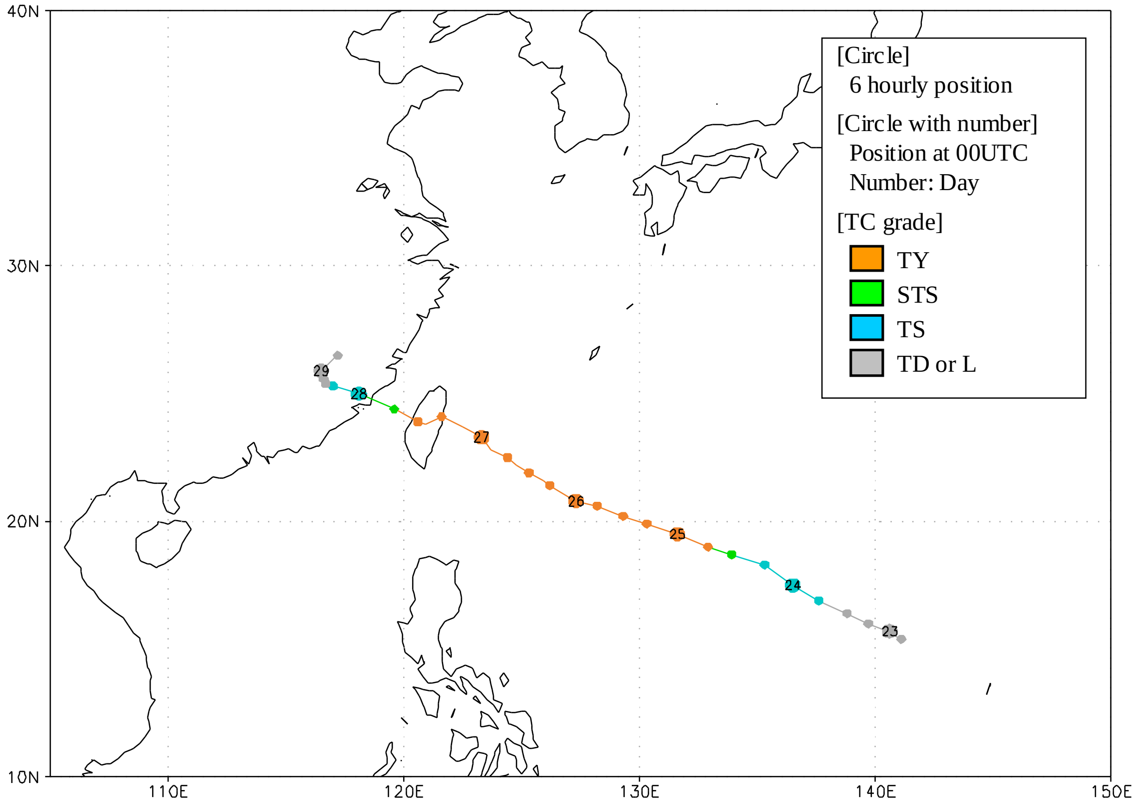
MALAKAS (1616)

MALAKAS formed as a tropical depression (TD) over the waters south of Guam Island at 18 UTC on 11 September 2016. Moving west-northwestward, it was upgraded to tropical storm (TS) intensity west of the Northern Mariana Islands at 18 UTC on the next day. Keeping its west-northwestward track, MALAKAS was upgraded to typhoon (TY) intensity east of the Philippines at 00 UTC on 14 September. Gradually turning northward, MALAKAS reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 930 hPa south of Yonagunijima Island at 18 UTC on 16 September. After entering the East China Sea, it turned northeastward and weakened its intensity slightly. MALAKAS developed again and reached its second peak intensity with maximum sustained winds of 95 kt and a central pressure of 940 hPa over the same waters at 18 UTC on 18 September. Keeping its northeastward track, MALAKAS made landfall on the Osumi Peninsula, Kagoshima Prefecture with TY intensity after 15 UTC on 19 September. Weakening its intensity rapidly, MALAKAS made landfall again on around Tanabe City in Wakayama Prefecture with severe tropical storm (STS) intensity around 0430 UTC, and then made landfall again around Tokoname City in Aichi Prefecture with TS intensity after 08 UTC on 20 September. It transformed into an extratropical cyclone off the coast of the Tokai region at 12 UTC on that day and dissipated 6 hours later.



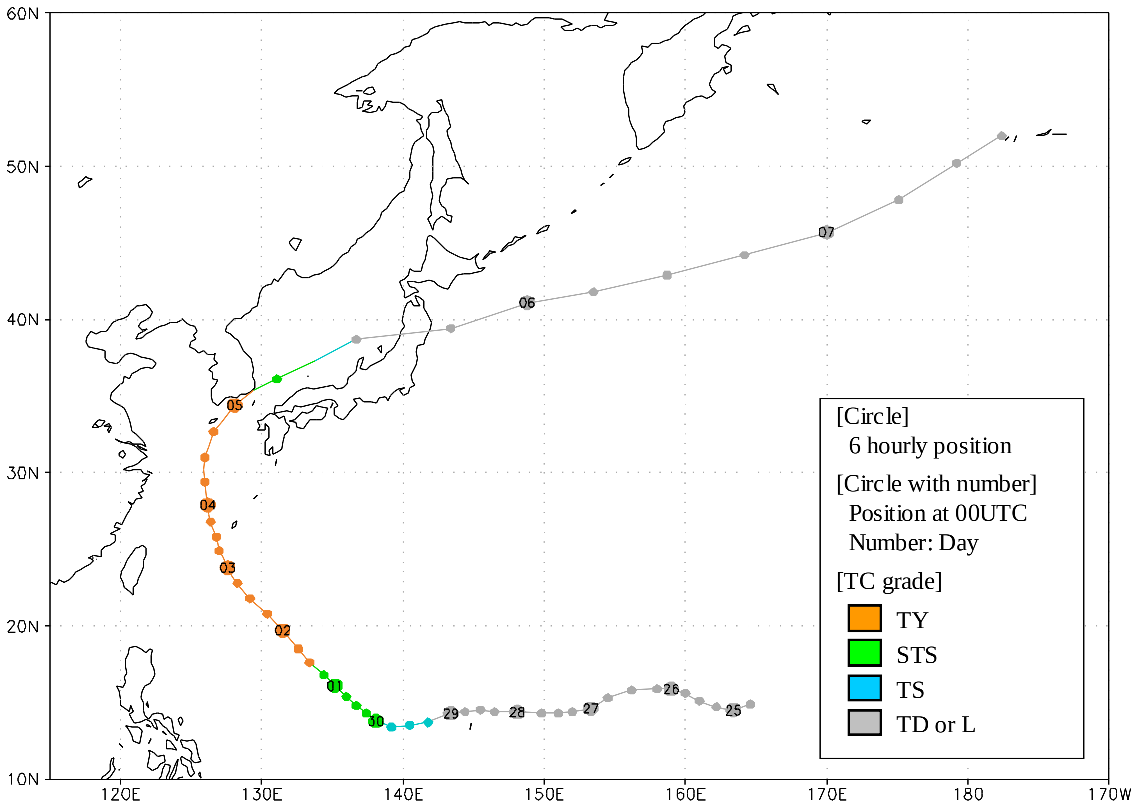
MEGI (1617)

MEGI formed as a tropical depression (TD) over the sea west of the Northern Mariana Islands at 18 UTC on 22 September 2016. After moving northwestward, it was upgraded to tropical storm (TS) intensity over the same waters 24 hours later. Keeping its northwestward track, MEGI was upgraded to typhoon (TY) intensity over the sea east of the Philippines at 18 UTC on 24 September. MEGI reached its peak intensity with maximum sustained winds of 85 kt and a central pressure of 945 hPa southwest of Ishigakijima Island at 00 UTC on 27 September and hit Taiwan Island with weakening its intensity on the same day. After entering the Taiwan Strait, MEGI hit southeast coast of China with TS intensity before 00 UTC on 28 September. Moving northwestward, it weakened to TD intensity in southern part of China 12 hours later. MEGI turned northeastward and dissipated at 12 UTC on 29 September.



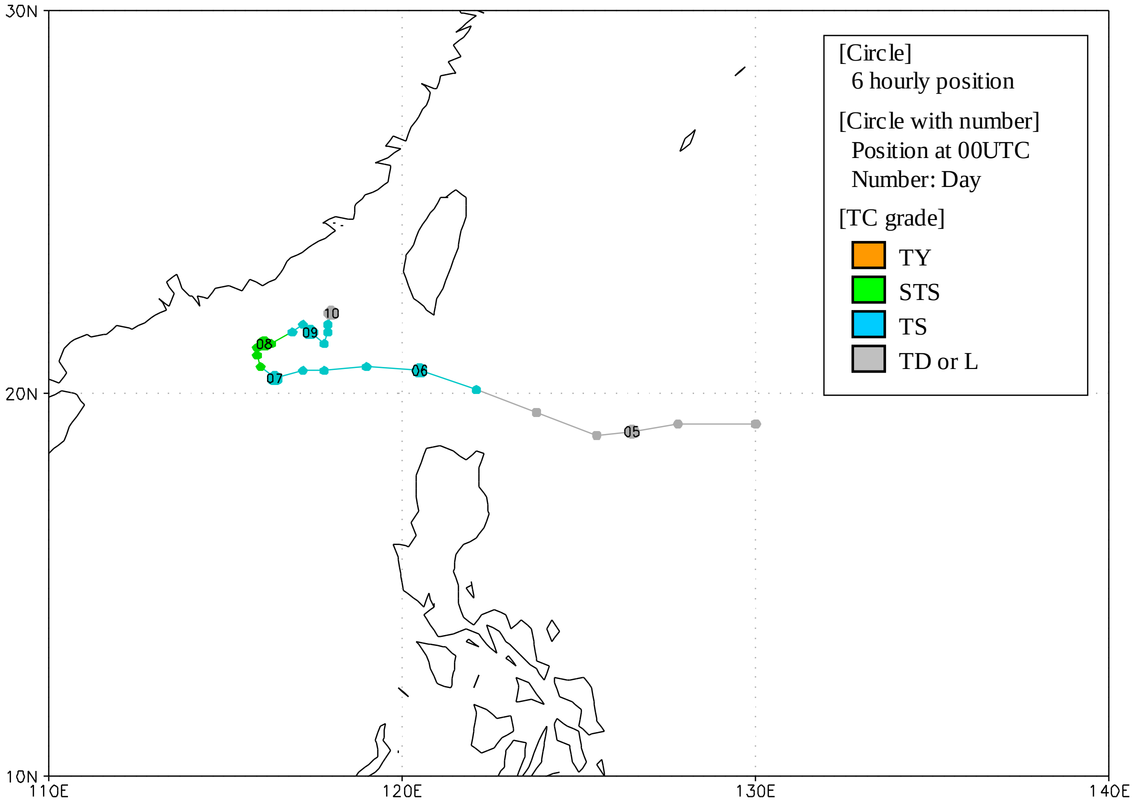
CHABA (1618)

CHABA formed as a tropical depression (TD) southwest of Wake Island at 18 UTC on 24 September 2016. After moving westward, it was upgraded to tropical storm (TS) intensity around the sea west of Guam Island at 06 UTC on 29 September. Turning northwestward, CHABA was upgraded to typhoon (TY) intensity around the sea far east of the Philippines at 12 UTC on 01 October, and reached its peak intensity with maximum sustained winds of 115 kt and a central pressure of 905 hPa southwest of Okinawa Island at 09 UTC on 03 October. After gradually turning northeastward, CHABA transformed into an extratropical cyclone around Noto Peninsula at 12 UTC on 05 October. It moved east-northeastward and crossed longitude 180 degrees east over the sea around the Aleutian Islands before 18 UTC on 7 October.



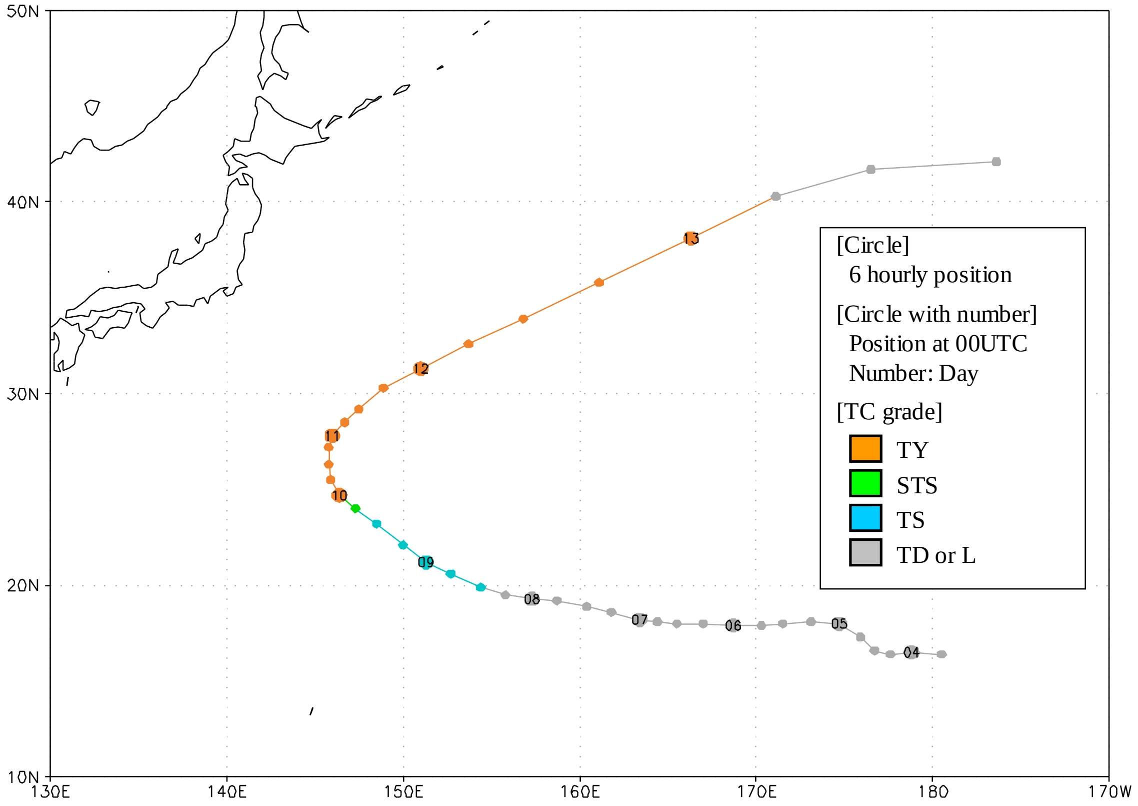
AERE (1619)

AERE formed as a tropical depression (TD) south of Okinawa Island at 12 UTC on 4 October 2016, and moved westward. It was upgraded to tropical storm (TS) intensity south of Taiwan Island at 18 UTC on 5 October and kept its west-northwestward track. AERE was upgraded to severe tropical storm (STS) intensity over the South China Sea at 06 UTC on 7 October, and reached its peak intensity with maximum sustained winds of 60 kt and a central pressure of 975 hPa over the same waters at 18 UTC on 7 October. Remaining almost stationary, it weakened to TD intensity at 00 UTC on 10 October, and dissipated over the same waters at 06 UTC on 10 October.



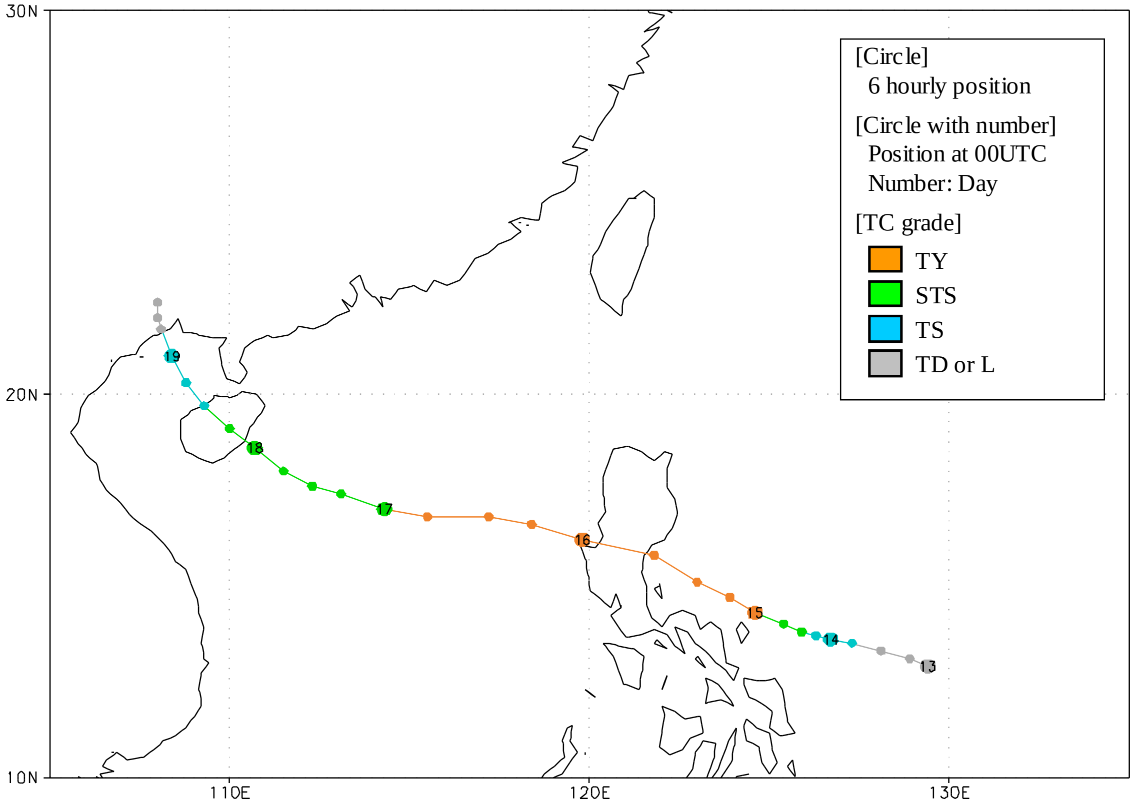
SONGDA (1620)

SONGDA crossed longitude 180 degrees east with tropical depression (TD) intensity over the sea northeast of the Marshall Islands after 18 UTC on 3 October 2016 and entered the western North Pacific. After moving west-northwestward, it was upgraded to tropical storm (TS) intensity south of Minamitorishima Island at 12 UTC on 8 October. Turning in a clockwise direction, SONGDA was upgraded typhoon (TY) intensity east of the Ogasawara Islands at 00 UTC on 10 October, and reached its peak intensity with maximum sustained winds of 100 kt and a central pressure of 925 hPa east of the Izu Islands on 18 UTC the next day. Keeping its northeastward track, SONGDA transformed into an extratropical cyclone around sea south of the Aleutian Islands at 06 UTC on 13 October and crossed longitude 180 degrees east after 12 UTC the same day.



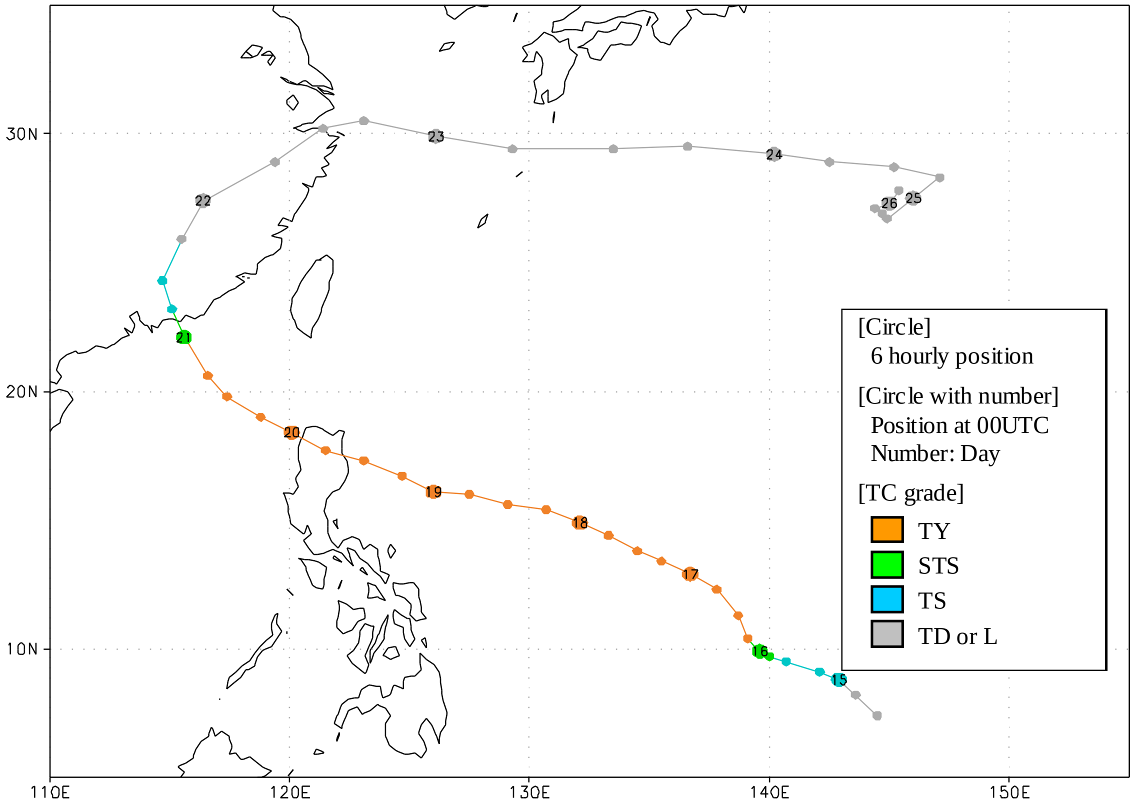
SARIKA (1621)

SARIKA formed as a tropical depression (TD) over the sea east of the Philippines at 00 UTC on 13 October 2016. Moving west-northwestward, it was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on that day. Keeping its west-northwestward track, SARIKA was upgraded to typhoon (TY) intensity around the Philippines at 00 UTC on 15 October. And then SARIKA reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 935 hPa around Luzon Island at 18 UTC on that day just before hitting Luzon Island. After entering the South China Sea, SARIKA gradually turned northwestward with weakening its intensity and crossed Hainan Island early on 18 October. It was downgraded to TD intensity near the border of China and Viet Nam at 06UTC on the next day and dissipated in the southern China 18 hours later.



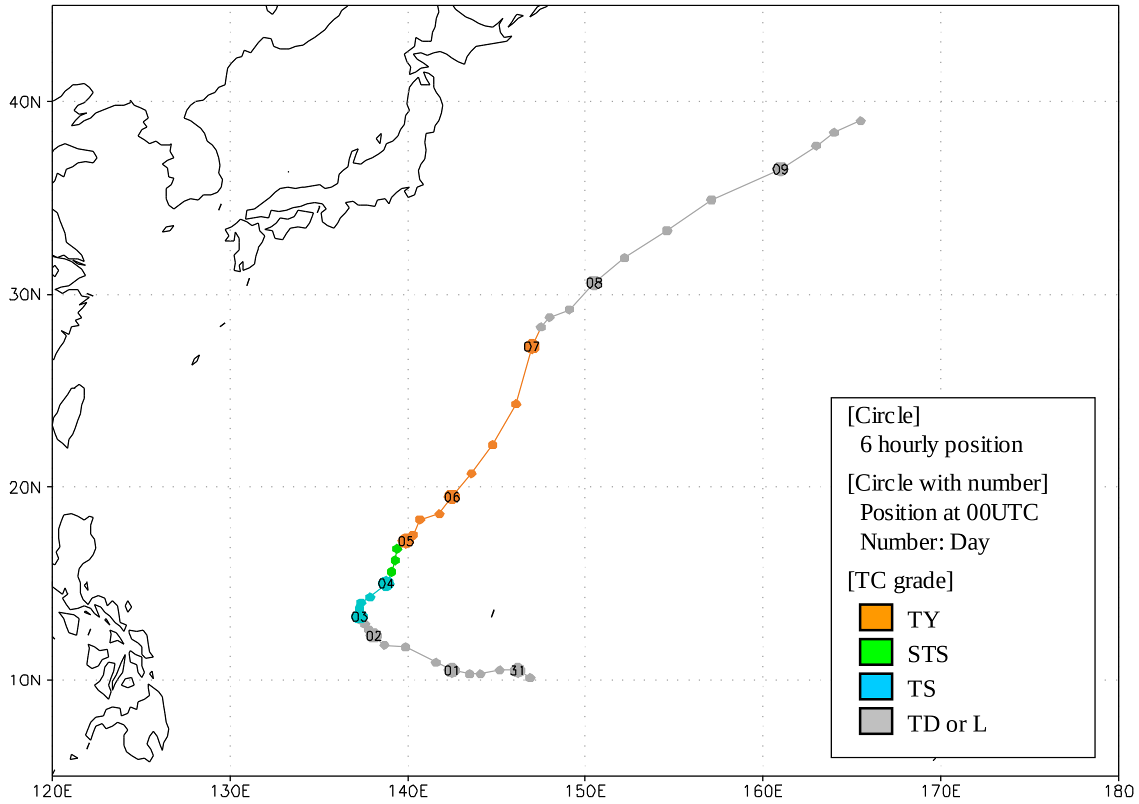
HAIMA (1622)

HAIMA formed as a tropical depression (TD) around the Caroline Islands at 12 UTC on 14 October 2016. Moving west-northwestward, it was upgraded to tropical storm (TS) intensity over the same waters 12 hours later. Moving northwestward, HAIMA was upgraded to typhoon (TY) intensity over the same waters at 06 UTC on 16 October and reached its peak intensity with maximum sustained winds of 115 kt and a central pressure of 900 hPa around sea east of the Philippines at 18 UTC on 18 October. After Moving west-northwestward, it hit Luzon Island with TY intensity the next day and entered the South China Sea. Turning northwestward, HAIMA hit the southern part of China and it was downgraded to tropical storm (TS) intensity at 06 UTC on 21 October. HAIMA weakened to TD intensity around southern part of China at 18 UTC on 21 October and transformed into an extratropical cyclone 6 hours later. After gradually turning eastward and entering the East China Sea, it moved to south of Japan and dissipated around sea east of the Ogasawara Islands at 12UTC on 26 October.



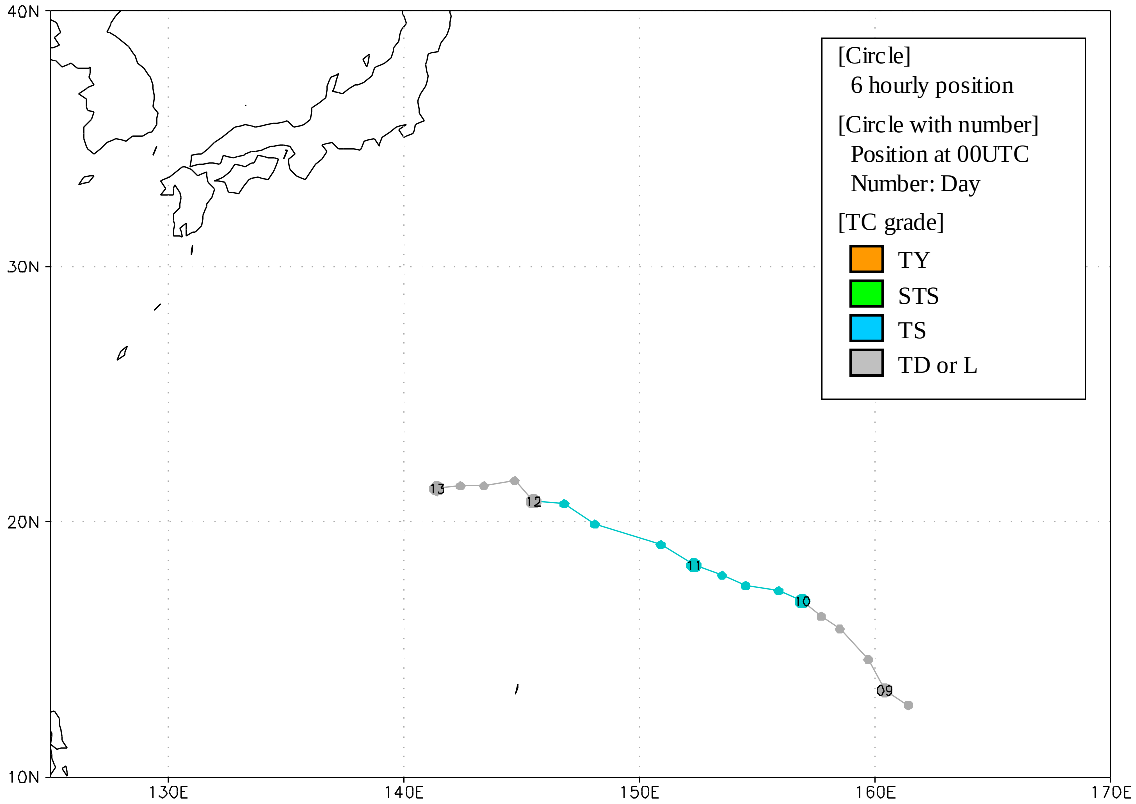
MEARI (1623)

MEARI formed as a tropical depression (TD) over the sea around the Caroline Islands at 18 UTC on 30 October 2016 and moved west-northwestward. Gradually turning northeastward, it was upgraded to tropical storm (TS) intensity west of the Mariana Islands at 00 UTC on 3 November. It reached its peak intensity with maximum sustained winds of 75 kt and a central pressure of 960 hPa south of the Ogasawara Islands at 12 UTC on 5 November. MEARI accelerated northeastward and transformed into an extratropical cyclone east of the Ogasawara Islands at 06 UTC on 7 November. MEARI kept its northeastward track and dissipated far east of Japan at 00 UTC on 10 November.



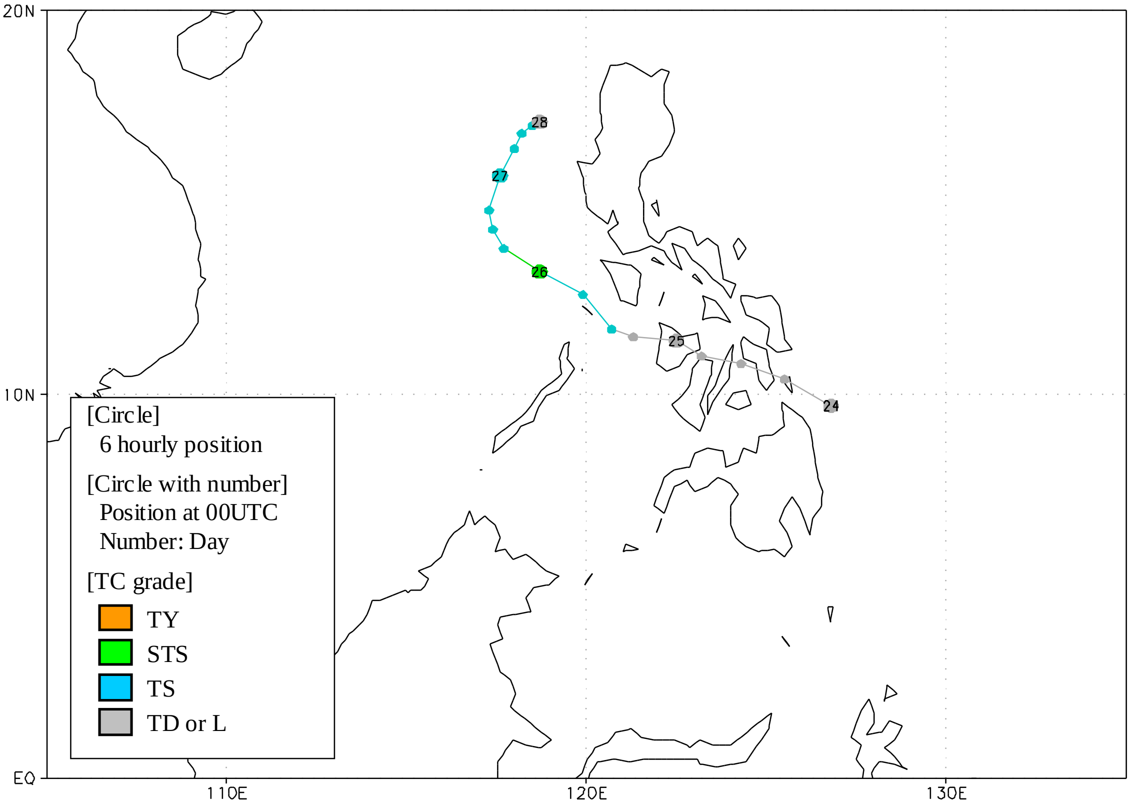
MA-ON (1624)

MA-ON formed as a tropical depression (TD) around the Marshall Islands at 18 UTC on 8 November 2016 and moved 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 Mariana Islands at 00 UTC on 10 November, and turned west-northwestward. MA-ON weakened to TD intensity around the Northern Mariana Islands at 00 UTC on 12 November and dissipated around the Ogasawara Islands at 06 UTC the next day.



TOKAGE (1625)

TOKAGE formed as a tropical depression (TD) over the sea northeast of Mindanao Island at 00 UTC on 24 November 2016 and moved west-northwestward. After hitting the middle of the Philippines, it was upgraded to tropical storm (TS) intensity south of Mindoro Island at 12 UTC the next day. TOKAGE turned northwestward and reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 992 hPa west of Mindoro Island at 00 UTC on 26 November. After turning north-northeastward, it weakened to TD intensity west of Luzon Island at 00 UTC on 28 November and dissipated there 6 hours later.



NOCK-TEN (1626)

NOCK-TEN formed as a tropical depression (TD) over the sea around the Caroline Islands at 12 UTC on 20 December 2016. Moving northwestward, it was upgraded to tropical storm (TS) intensity over the sea southeast of the Yap Islands at 18 UTC on the next day. Gradually turning westward, it was upgraded to typhoon (TY) intensity over the sea far east of the Philippines at 06 UTC on 23 December. Keeping its westward track, NOCK-TEN developed rapidly and reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 915 hPa over the sea east of the Philippines at 06 UTC on 24 December, and then hit Luzon Island with TY intensity late on the next day. Entering the South China Sea and turning southwestward, it was downgraded to TD intensity at 18UTC on 27 December. It dissipated over the same waters at 18UTC on the next day.