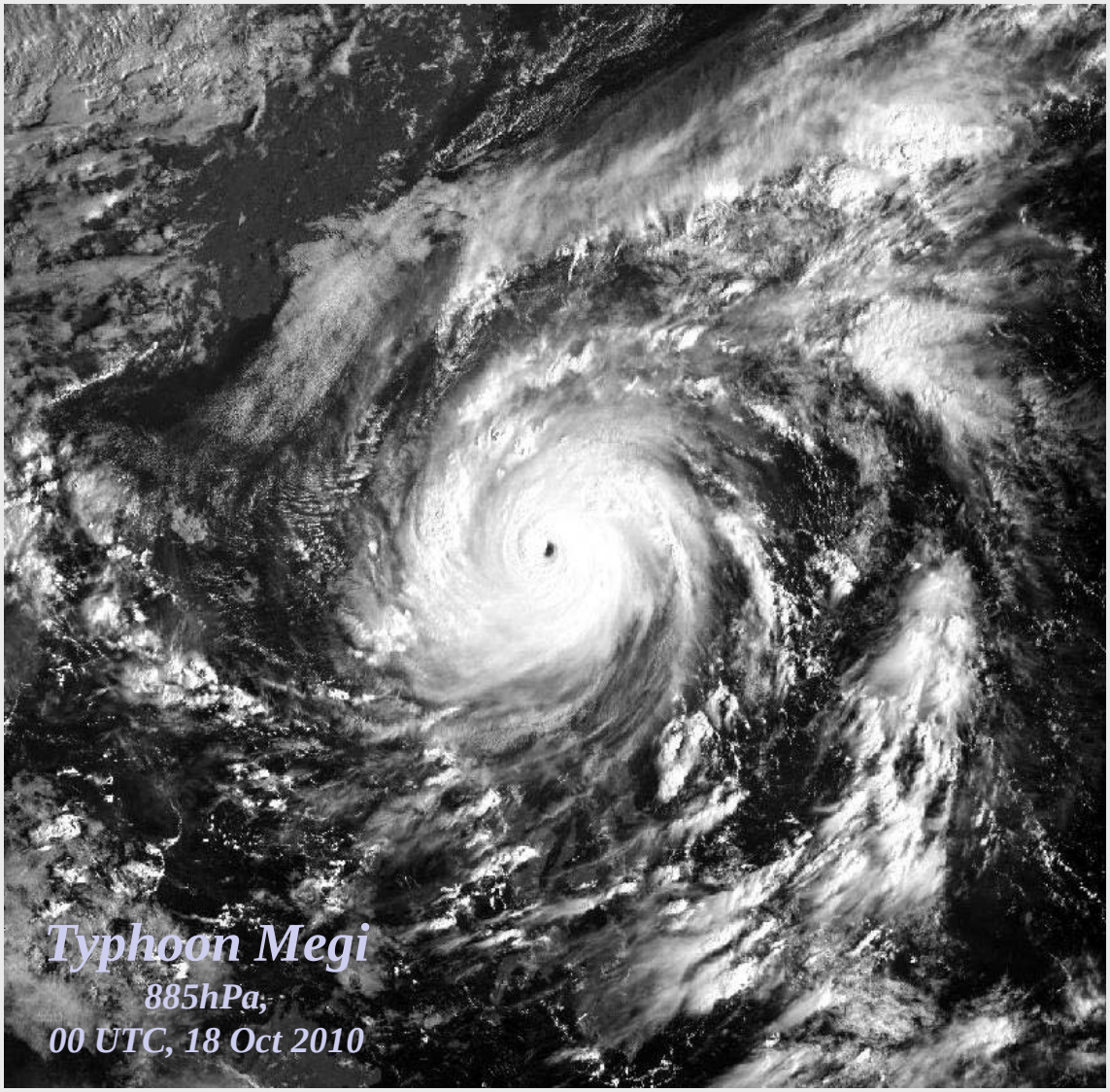
Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2010



Japan Meteorological Agency

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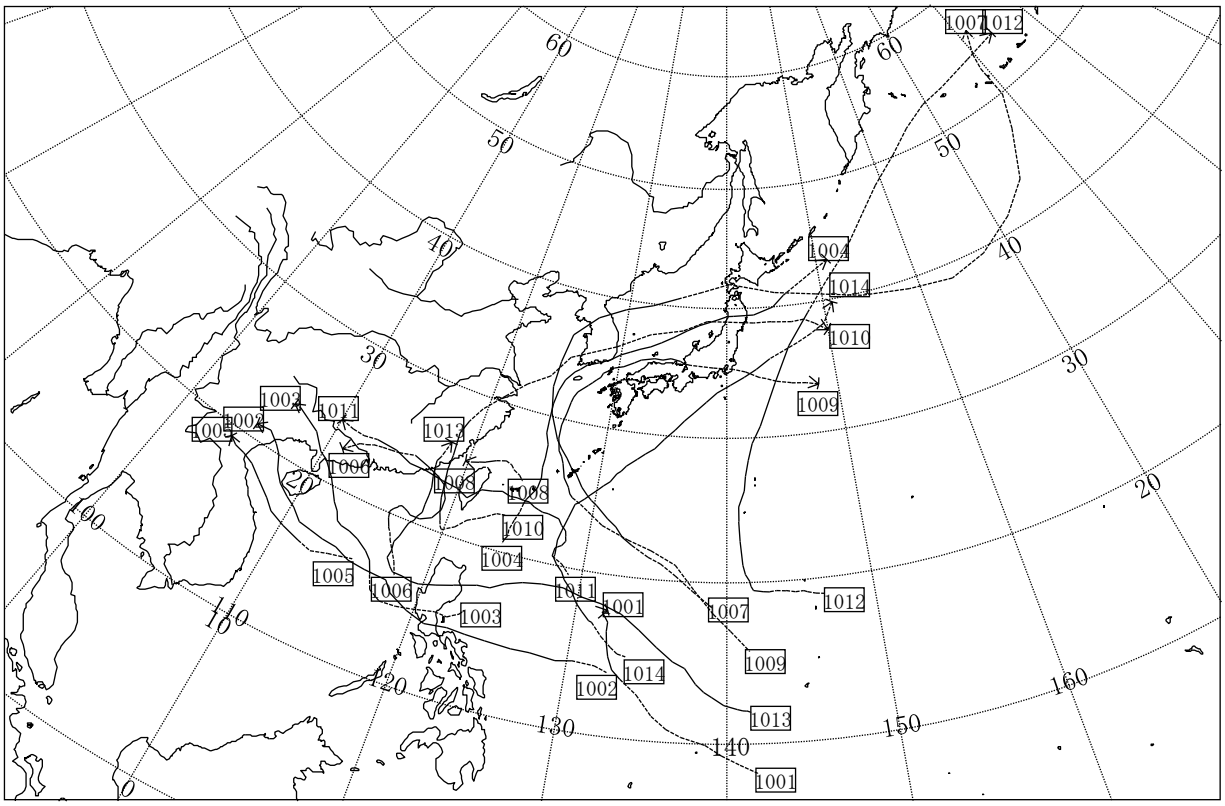

Japan Meteorological Agency

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Introduction

The RSMC Tokyo - Typhoon Center (referred to below 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) Dissemination of the above information to National Meteorological Services (NMSs) in particular to the Members of the ESCAP/WMO Typhoon Committee, 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* to serve as operational references for the NMSs concerned. The report is aimed at summarizing the activities of the Center and reviewing the TCs of the preceding year.

In this issue covering 2010, an outline of routine operations at the Center and its operational products are presented in Chapter 1, while Chapter 2 reports on the major activities of the Center in 2010. Chapter 3 describes atmospheric and oceanic conditions in the tropics and notes the highlights of TC activities in 2010. In Chapter 4, verification statistics of operational forecasts and predictions of the numerical weather prediction (NWP) models of the Center are presented. The best track data for TCs in 2010 are shown in table and chart forms in the appendices. All the relevant texts, tables, charts and appendices are included on the DVD attached to this report.

The DVD contains hourly cloud images of all the TCs in 2010 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 animation and is expected to facilitate efficient post-analysis of TCs and their environments. A setup program and a user manual for the software are also included on the DVD. Appendix 8 shows an outline of the DVD and how to use the software.

Chapter 1

Operations at the RSMC Tokyo - Typhoon Center in 2010

The Center's area of responsibility covers the western North Pacific and the South China Sea (0°-60°N, 100°-180°E) including the marginal seas and adjacent land areas (Figure 1.1). The Center carries out analyses and forecasts of tropical cyclones (TCs) when they are in or expected to move into the area. The Center provides the relevant National Meteorological Services (NMSs) with the RSMC products through such means as the GTS, the AFTN and the Internet.

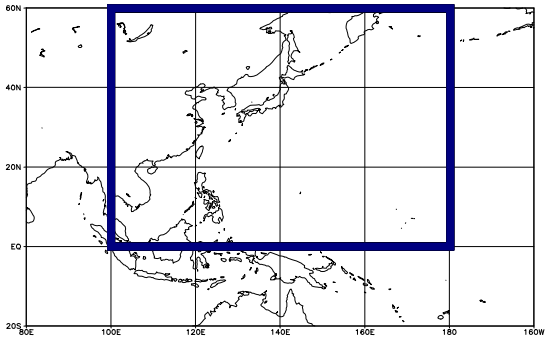


Figure 1.1
Area of responsibility of the RSMC Tokyo - Typhoon Center

1.1 Analysis

TC analyses are performed eight times a day at 00, 03, 06, 09, 12, 15, 18 and 21 UTC, and each analysis begins with the determination of the center position of the TC. Cloud images from the Multi-functional Transport Satellite (MTSAT) are the principal source for determining this, especially for TCs migrating over data-sparse ocean areas. The TC's direction and speed of movement are determined primarily from the six-hourly displacement vectors of the center position.

The central pressure of a TC 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 of winds more than 30 and 50 knots are determined mainly from surface observations, ASCAT observations 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 uses numerical weather prediction (NWP); the Global Spectral Model (GSM) and the Typhoon Ensemble Prediction System (TEPS). GSM (TL959L60), upgraded on 21 November 2007, has approx. 20 km horizontal resolution and 60 vertical layers while TEPS (TL319L60), became operational in February 2008, has 11 members with approx. 60 km horizontal resolution and 60 vertical layers. Using mainly TEPS, JMA extended its TC track forecast up to 5 days ahead as from April 2009. Further details and recent improvements on the models are shown in Appendix 6. As for the TC intensity, central pressure and the maximum sustained wind speeds are forecasted based on the results from NWP 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 is statistically determined according to the speed of TC movement based on the verification results of recent TC track forecasts.

1.3 Provision of RSMC Products

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

- a TC of tropical storm (TS) intensity or higher exists in the area of responsibility of the Center
- a TC is expected to reach TS intensity or higher in the area within 24 hours

The RSMC products are continually issued as long as a TC keeps TS intensity or higher within the 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 the observation times at 00, 03, 06, 09, 12 18, and 21 UTC and reports the following elements in the analysis, 24-, 48- and 72-hour forecasts of a TC:

Analysis	Center position Accuracy of determination of the center position 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 the 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)

In addition to three-day track and intensity forecast, five-day track forecast was started in April 2009. The RSMC Tropical Cyclone Advisory for Five-day Track Forecast is issued four times a day after the observation times at 00, 06, 12 and 18UTC including the following elements in the analysis, 24-, 48-, 72-, 96- and 120-hour forecasts of a TC:

Analysis	Center position Accuracy of determination of the center position 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 the probability circle Direction and speed of movement Central pressure Maximum sustained wind speed (10-minute average) Maximum gust wind speed
96-, 120 and forecasts	Center position and radius of the 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 GSM predictions; GSM is run four times a day with initial analyses at 00, 06, 12 and 18 UTC. The Guidance presents GSM's six-hourly predictions of a TC up to 84 hours ahead and TEPS mean six-hourly predictions up to 132 hours ahead. It includes 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, TCNA20/21 RJTD: via GTS)

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

MTSAT imagery analysis	Center position Accuracy of determination of the center position Direction and speed of movement Mean diameter of the overcast cloud Apparent change in intensity in the last 24 hours** Dvorak Intensity (CI, T, DT, MET, PT number) ** Cloud pattern type of the DT number** Trend of past 24-hour change** Cloud picture type of the PT number** Type of the final T-number**

*** These parameters are reported only at 00, 06, 12 and 18 UTC.*

In accordance with the WMO migration plan to table-driven code forms, the Center has been disseminating SAREP reports in BUFR format (IUCC10 RJTD) since November 2005 and discontinued the dissemination of SAREP reports in alphanumeric format at the end of 2010. 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 provides a brief reasoning for a TC forecast. It 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 of 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 provides post-analysis data on TCs of TS intensity or higher. It contains the center position, the central pressure and the maximum sustained wind speed. The best track for a TC is usually finalized one and a half months after the termination of issuance of the above RSMC bulletins for the TC.

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

The Center, as one of the Tropical Cyclone Advisory Centres within the framework of the International Civil Aviation Organization (ICAO), provides Tropical Cyclone Advisory for SIGMET to Meteorological Watch Offices (MWOs) to support their preparations of SIGMET information on TCs. It includes the following elements in the analysis and the 6-, 12-, 18- and 24-hour forecasts***:

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

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 RSMC Data Serving System

Since 1995, JMA has been operating the RSMC Data Serving System which allows the NMSs concerned to retrieve NWP products such as predicted fields in grid-point-value (GPV) form and observational data. The products and data provided through the system are listed in Appendix 7. JMA plans to update the RSMC Data Serving System to WMO Information System (WIS) GISC server in February 2012.

1.5 RSMC Tokyo - Typhoon Center Website

The RSMC Tokyo - Typhoon Center Website provides TC advisories on a real-time basis, as well as a wide variety of products including TC analysis archives, technical reviews and annual reports on the activities of the Center. The website address is:

http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm.

1.6 Numerical Typhoon Prediction Website

JMA has been operating the Numerical Typhoon Prediction (NTP) website since 1 October 2004 (https://tynwp-web.kishou.go.jp/). The site provides predictions of TC tracks performed by models of eight major NWP centers i.e. BoM (Australia), CMA (China), CMC (Canada), DWD (Germany), ECMWF, KMA (Republic of Korea), NCEP (USA), UKMO (UK) and JMA to assist the NMSs of the Typhoon Committee Members in improving TC forecasting and warning services. The site includes:

- TC track predictions, in table and chart format, of the participating NWP centers with several useful functions such as deriving an ensemble mean from any combination of predictions by the centers
- Weather charts of the NWP models of the participating NWP centers
- JMA's operational TC analysis using satellite image (conventional Dvorak analysis and Early-stage Dvorak analysis)
- Storm surge distribution maps for the Typhoon Committee region is to be provided from 2011 typhoon season.

Chapter 2

Major Activities of the RSMC Tokyo - Typhoon Center in 2010

2.1 Dissemination of RSMC Products

The Center provides operational products for tropical cyclone (TC) forecasting to NMSs via such networks as the GTS and the AFTN. Its monthly and annual totals of issuance of the products in 2010 are listed in Table 2.1.

Products	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
TCNA20	0	0	7	0	0	0	40	52	76	66	0	0	241
TCNA21	0	0	14	0	0	0	45	79	89	88	0	0	315
IUCC10	0	0	21	0	0	0	85	124	166	154	0	0	550
WTPQ20-25	0	0	28	0	0	0	88	139	168	178	0	0	601
WTPQ30-35	0	0	7	0	0	0	24	35	46	44	0	0	156
WTPQ50-55	0	0	4	0	0	0	20	28	32	50	0	0	134
FXPQ20-25	0	0	28	0	0	0	90	138	173	175	0	0	604
FKPQ30-35	0	0	14	0	0	0	45	72	88	87	1	0	307
AXPQ20	0	0	0	0	1	0	0	0	3	4	4	2	14

Notes:

TCNA20/21 RJTD	SAREP (TACs)
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 (from 2009)
FXPQ20-25 RJTD	RSMC Guidance for Forecast
FKPQ30-35 RJTD	Tropical Cyclone Advisory for SIGMET
AXPQ20 RJTD	RSMC Tropical Cyclone Best Track

Table 2.1 Monthly and annual total numbers of products issued by the RSMC Tokyo - Typhoon Center in 2010

2.2 Publication

In March 2010, *the twelfth issue of the RSMC Technical Review* was issued with the following three topics.

1. THORPEX - Pacific Asian Regional Campaign (T-PARC)
   - Summary
   - DLR Falcon Dropsonde Operation in T-PARC and Analysis of the Environment Surrounding Typhoons
   - Total Energy Singular Vector Guidance Developed at JMA for T-PARC
   - Observing-system Experiments Using the Operational NWP System of JMA
   - T-PARC Website at MRI
2. JMA's Five-day Tropical Cyclone Track Forecast

In December 2010, the Center published the *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center in 2009*. Both of the publications are available on the website.

2.3 Monitoring of Observational Data Availability

The Center carried out regular monitoring of information exchange for enhanced TC observations 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 1st November 2009 to 31st October 2010 was conducted for the following two typhoons:

1. TY Conson (1002), from 00 UTC 13 July to 23 UTC 17 July 2010
2. TY Fanapi (1011), from 00 UTC 17 September to 23 UTC 21 September 2010

The results were distributed to all the Typhoon Committee Members in March 2011, and are also available on the WMO Distributed Database server at ftp://ddb.kishou.go.jp/pub/monitoring/.

Chapter 3

Summary of the 2010 Typhoon Season

In 2010, 14 TCs of tropical storm (TS) intensity or higher formed in the western North Pacific and the South China Sea. This total is nearly half of the 30-year average* frequency of 25.6 and broke the record low of 16 in 1998. Out of these 14 TCs, 7 reached typhoon (TY) intensity, 4 reached severe tropical storm (STS) intensity, and 3 reached TS intensity (Table 3.1).

Tropical Cyclone			Duration (UTC) (TS of higher)	Minimum Central Pressure (UTC)	lat (N)	long (E)	(hPa)	Max Wind (kt)
TS	Omais	(1001)	241200 Mar - 260000 Mar	241200	13.6	133.4	998	35
TY	Conson	(1002)	120000 Jul - 180000 Jul	160600	17.6	110.2	970	70
TY	Chanthu	(1003)	191200 Jul - 230600 Jul	220000	20.5	111.5	970	70
STS	Dianmu	(1004)	081200 Aug - 121800 Aug	090300	26.4	125.6	985	50
TS	Mindulle	(1005)	230000 Aug - 250000 Aug	240000	18.0	107.3	985	45
STS	Lionrock	(1006)	281800 Aug - 020600 Sep	300600	20.8	116.7	985	50
TY	Kompasu	(1007)	291800 Aug - 021800 Sep	310000	25.1	129.4	960	80
TS	Namtheun	(1008)	301200 Aug - 310600 Aug	301200	25.9	122.0	996	35
STS	Malou	(1009)	040000 Sep - 080300 Sep	051800	31.4	126.5	992	50
STS	Meranti	(1010)	081800 Sep - 101200 Sep	091800	24.3	118.8	985	55
TY	Fanapi	(1011)	151200 Sep - 201800 Sep	181500	23.8	123.8	930	95
TY	Malakas	(1012)	220000 Sep - 251200 Sep	241800	30.9	142.8	945	85
TY	Megi	(1013)	131200 Oct - 231800 Oct	171800	17.6	124.2	885	125
TY	Chaba	(1014)	241800 Oct - 301800 Oct	280600	24.8	129.2	930	95

Table 3.1 List of the tropical cyclones reaching TS intensity or higher in 2010

3.1 Atmospheric and Oceanographic Conditions in the Tropics

The El Niño event, which started in early summer of 2009, lasted until spring 2010. From summer 2010, the La Niña event was observed through the end of the year. Consequently, SST over the tropics of east of 160°E showed positive anomaly until spring 2010 and negative anomaly after summer 2010. As for the South China Sea, a slightly positive SST anomaly prevailed throughout the year.

Not only SST but also atmospheric condition over the tropics (south of 20°N, east of 120°E) was unfavorable for TC formations. The Pacific high pressure system over the area was strong and suppressed convective cloud developments, and thereby contributed to much fewer than normal TC formations of the year (5 in 2010 compared to 15.2 in average*). The monthly and annual frequencies of named TCs since 1951 are presented in Appendix 4.

To see atmospheric and oceanographic conditions, the following charts are included on the attached DVD: monthly mean SST anomalies for the western North Pacific and the South China Sea, monthly mean streamlines at 850 hPa and 200 hPa, and OLR for the months from January to December (SST anomalies 2010.ppt and Streamline 2010.ppt).

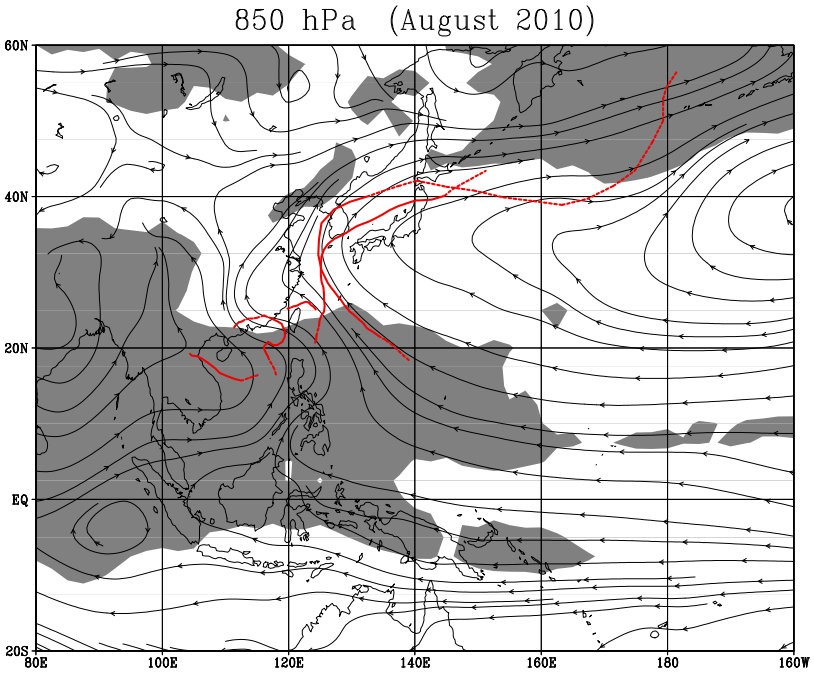


Figure 3.1 Monthly mean streamline at 850 hPa (lines with arrows) and areas of less than 230 w/m^2 of OLR (shaded) in August 2010. The tracks of the seven named TCs formed in August are superimposed onto the figure.

3.2 Tropical Cyclones in 2010

Over the western North Pacific and the South China Sea, 14 named TCs formed in 2010. The monthly and 30-year average* TC formations are shown in Figure 3.2. Tracks of the 14 TCs are shown in Figure 3.3. Figure 3.4 shows genesis points of the 14 TCs (dots) and frequency distribution of the past years (1951 - 2009).

The TC season in 2010 began with the formation of Omais (1001) in March, which formed over the Caroline Islands and held Tropical Storm (TS) intensity for only 1.5 days. After Omais, no tropical cyclones formed in April, May and June during which more than 3 named TCs generate on average. In August and September, convective activities in the tropics were enhanced (see figure 3.1 for the case of August) and 9 named TCs formed, which is almost the same as 10.6 TCs, the 30-year average*.

From October to December, only 2 named TCs formed (the 30-year average* 7.1). It is the least TC formations in history since 1951. However, in terms of the strength, the typhoon Megi recorded the lowest atmospheric pressure of 885 hPa since Vanessa in 1984 (880 hPa). The detailed descriptions of each TC in 2010 are found in the attached DVD.

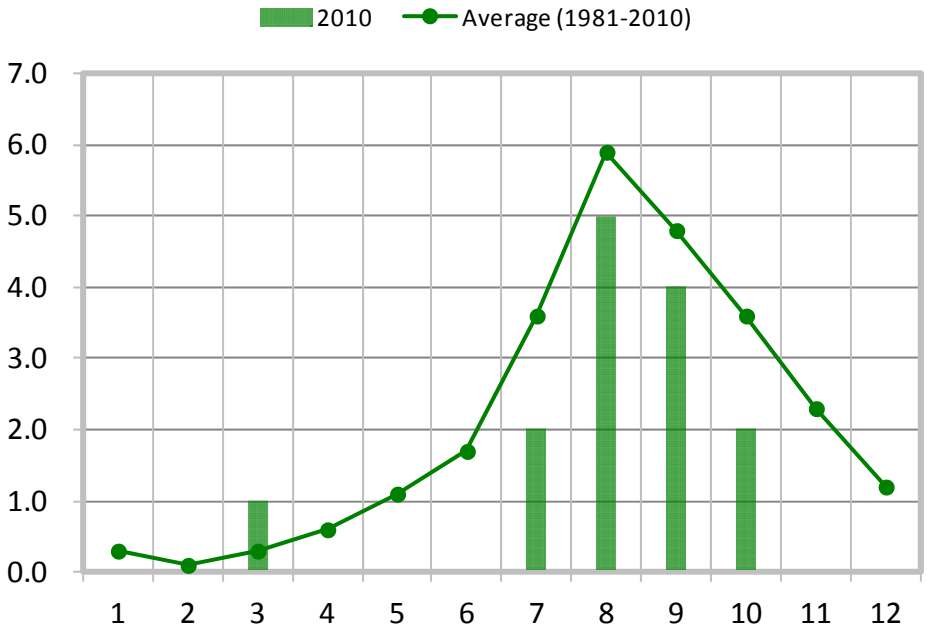


Figure 3.2 Monthly formations of TCs in 2010 compared to the 30-year average*

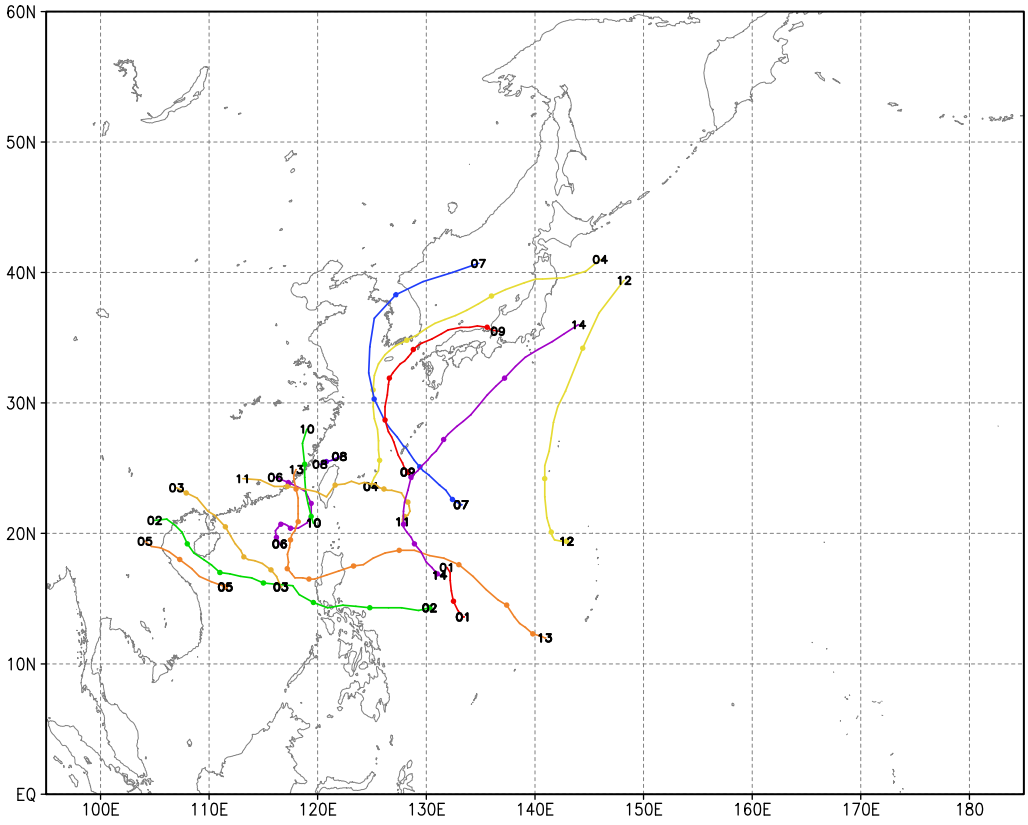


Figure 3.3 Tracks of the 14 named TCs in 2010.
TC tracks for the period of TS or higher are shown.

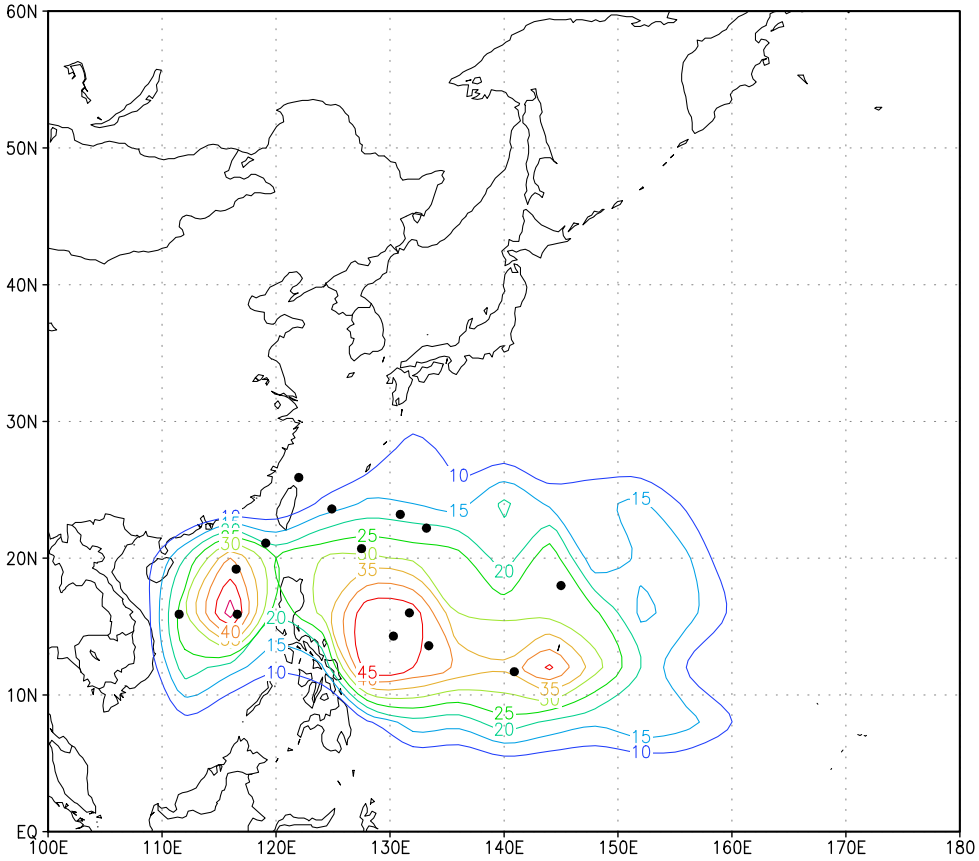


Figure 3.4 Genesis points of the 14 TCs generated in 2010 (dots) and frequency distribution of genesis points for 1951 - 2009 (lines)

* *The 30-year average is from 1981 to 2010.*

Chapter 4

Verification of Forecasts in 2010

4.1 Verification of Operational Forecasts

Operational forecasts of the 14 TCs of TS intensity or higher in 2010 were verified with the RSMC TC best track data. The verified elements are forecasts of the center position (up to 5 days), central pressure and maximum sustained wind (up to 3 days). The position and intensity errors of operational forecasts for each TC in 2010 are indicated in Appendix 3.

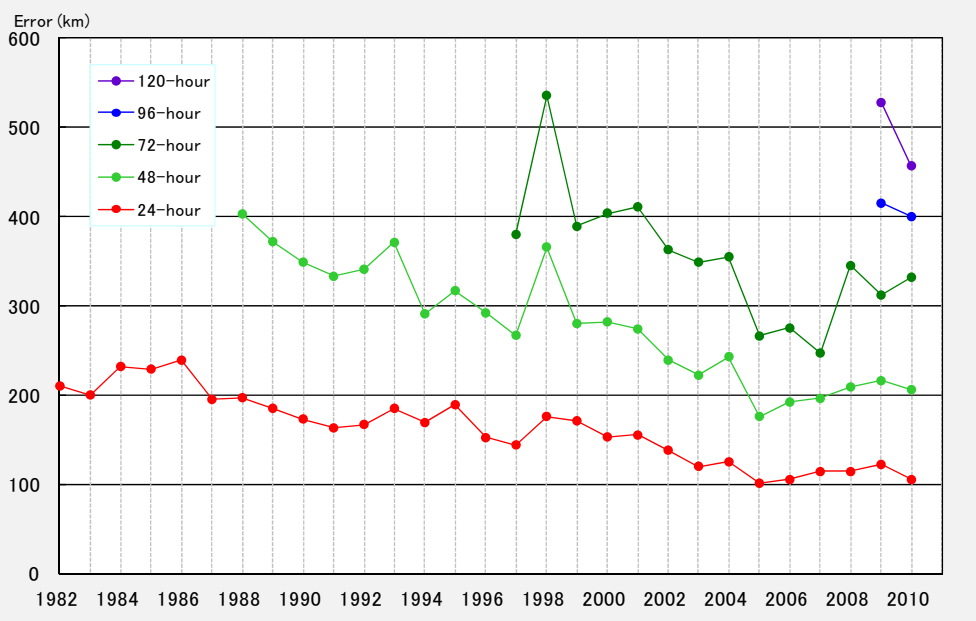


Figure 4.1 Annual means of position errors in 24-, 48-, 72-, 96- and 120-hour operational track forecasts

4.1.1 Center Position

Figure 4.1 shows annual mean errors of 24-hour (since 1982), 48-hour (since 1988), 72-hour (since 1997), 96- and 120- hour (since 2009) forecasts of center position. The errors in 2010 were 105 km, 206 km, 332 km, 400 km and 457 km for 24-hour, 48-hour, 72-hour, 96-hour and 120-hour forecasts respectively.

The details of the errors for each TC in 2010 are shown in Table 4.1. Kompasu (1007), Malou (1009) and Chaba (1014) which all recurved around Japan had larger forecast track errors. Lionrock (1006), Fanapi (1011) and Megi (1013) which moved around the Philippines or Taiwan had relatively small errors.

The position errors were also compared with those of 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 of smaller/greater than 100% indicates that the operational forecast is better/worse than the PER method forecast. The annual mean EO/EPs for the 24-,

48-, 72-, 96- and 120-hour forecasts in 2010 were 47% (52% in 2009), 40% (39%), 37% (35%), 31% (34%) and 32% (39%) respectively. Figure 4.2 shows a histogram of 24-hour forecast position errors. About 78% (74% in 2009) of 24-hour forecasts, 77% (79%) of 48-hour forecasts, 77% (83%) of 72-hour forecasts, 78% (76%) of 96-hour forecasts and 73% (74%) of 120-hour forecasts had errors of less than 150km, 300km, 450 km, 500km, and 600km respectively.

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

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
			Mean (km)	S.D. (km)	Num.	EO/EP (%)	Mean (km)	S.D. (km)	Num.	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)	Mean (km)	S.D. (km)	Num	EO/EP (%)
TS	Omais	(1001)	179	29	2	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Conson	(1002)	144	67	20	104	283	95	16	90	400	67	12	98	526	67	8	75	609	13	4	97
TY	Chanthu	(1003)	113	45	11	56	107	36	7	38	315	100	3	68	-0	-0	0	-	-	-	0	-
STS	Dianmu	(1004)	106	72	13	35	264	109	9	35	450	122	5	45	508	0	1	-	-	-	0	-
TS	Mindulle	(1005)	74	25	4	145	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Lionrock	(1006)	62	30	14	29	118	55	10	36	176	60	6	41	89	24	2	-	-	-	0	-
TY	Kompasu	(1007)	149	54	12	41	371	136	8	47	780	61	4	67	-	-	0	-	-	-	0	-
TS	Namtheun	(1008)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Malou	(1009)	161	50	13	64	265	97	9	40	479	33	5	35	998	0	1	-	-	-	0	-
STS	Meranti	(1010)	130	68	3	27	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Fanapi	(1011)	58	43	17	30	77	45	13	17	151	77	9	15	365	98	5	24	743	0	1	-
TY	Malakas	(1012)	121	48	10	29	259	106	6	21	681	134	2	-	-	-	0	-	-	-	0	-
TY	Megi	(1013)	75	37	37	41	150	60	33	32	229	62	29	26	319	101	25	23	386	124	21	27
TY	Chaba	(1014)	109	44	20	59	282	152	16	62	409	224	12	47	538	320	8	47	602	243	4	45
Annual Mean (Total)			105	60	176	47	206	127	127	40	332	189	87	37	400	208	50	31	457	175	30	32

Table 4.1 Mean position errors of 24-, 48-, 72-, 96- and 120-hour operational forecasts for each TC in 2010. 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.

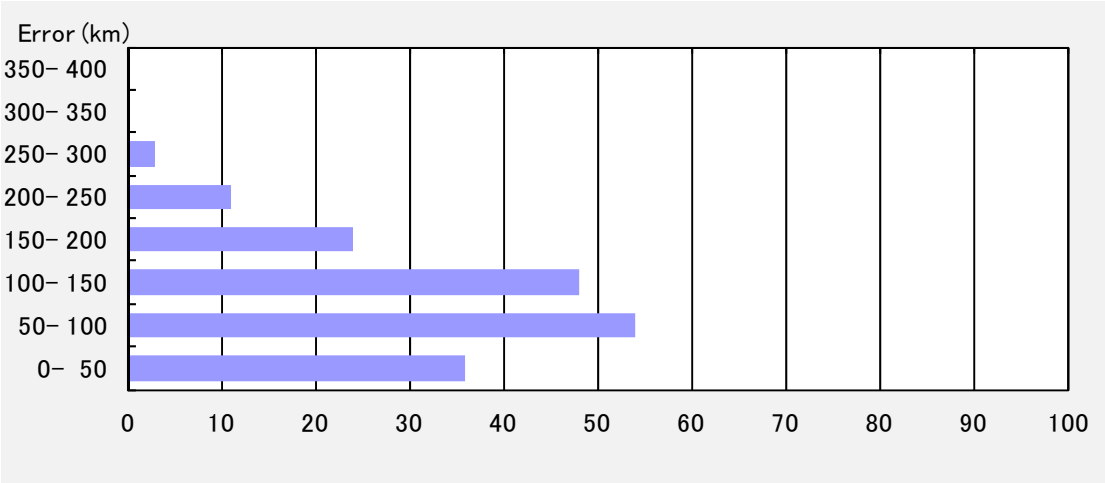


Figure 4.2 Histogram of 24-hour forecast position errors in 2010
(Those for 48-, 72-, 96- and 120-hour forecasts are included on the attached DVD).

Table 4.2 presents the mean hitting ratios and radii of the 70% probability circles* of operational forecasts for each TC in 2010. The term *hitting ratio* here is used to describe the ratio of forecasts of 70% probability circles within which the actual TC center fell. The annual mean radius of the circles issued for 24-hour position forecasts was 143 km (145 km in 2009), and their hitting ratio was 76% (69%). The corresponding ones for 48-hour forecasts were 252 km (256 km in 2009) and 65% (70%), those for 72-hour forecasts were 364 km (361 km in 2009) and 61% (70%), those for 96-hour forecasts were 498 km (537 km in 2009) and 74 % (76%) and those for 120-hour forecasts were 610 km (695 km in 2009) and 77 % (79 %).

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast			96-hour Forecast			120-hour Forecast		
			Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)
TS	Omais	(1001)	0	2	130	-	0	-	-	0	-	-	0	-	-	0	-
TY	Conson	(1002)	40	20	132	12	16	204	8	12	296	25	8	463	50	4	625
TY	Chanthu	(1003)	55	11	130	100	7	204	33	3	296	-	0	-	-	0	-
STS	Dianmu	(1004)	85	13	156	67	9	313	60	5	463	100	1	788	-	0	-
TS	Mindulle	(1005)	100	4	130	-	0	-	-	0	-	-	0	-	-	0	-
STS	Lionrock	(1006)	100	14	154	100	10	296	100	6	408	100	2	718	-	0	-
TY	Kompasu	(1007)	42	12	144	25	8	280	0	4	408	-	0	-	-	0	-
TS	Namtheun	(1008)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
STS	Malou	(1009)	46	13	151	44	9	280	0	5	385	0	1	519	-	0	-
STS	Meranti	(1010)	100	3	164	-	0	-	-	0	-	-	0	-	-	0	-
TY	Fanapi	(1011)	94	17	142	100	13	224	100	9	307	80	5	445	0	1	556
TY	Malakas	(1012)	80	10	144	50	6	306	0	2	463	-	0	-	-	0	-
TY	Megi	(1013)	97	37	141	85	33	232	93	29	351	96	25	448	86	21	567
TY	Chaba	(1014)	80	20	145	50	16	272	50	12	422	50	8	632	75	4	834
Annual Mean (Total)			76	176	143	65	127	252	61	87	364	74	50	498	77	30	610

Table 4.2 Mean hitting ratios (%) and radii (km) of 70% probability circles for 24-, 48-, 72-, 96- and 120-hour operational forecasts for each TC in 2010

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

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 in 2010. The RMSEs for maximum wind speed forecasts are included on the attached DVD. The annually averaged RMSEs of the central pressure and the maximum wind speed for 24-hour forecasts were 12.2 hPa (13.2 hPa in 2009) and 5.6 m/s (6.4 m/s). For 48-hour forecasts, the corresponding ones were 17.4 hPa (20.1 hPa in 2009) and 7.4 m/s (8.7 m/s), while those for 72-hour forecasts were 22.6 hPa (22.6 hPa) and 9.8 m/s (9.5 m/s) respectively.

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast		
			Error (hPa)	RM SE (hPa)	Num.	Error (hPa)	RM SE (hPa)	Num.	Error (hPa)	RM SE (hPa)	Num.
TS	Omais	(1001)	-3.0	3.2	2	-	-	0	-	-	0
TY	Conson	(1002)	-3.1	12.2	20	-9.1	15.7	16	-11.9	13.1	12
TY	Chanthu	(1003)	0.8	6.2	11	3.7	6.5	7	-7.0	9.7	3
STS	Dianmu	(1004)	-3.4	7.2	13	-0.4	4.6	9	1.6	2.5	5
TS	Mindulle	(1005)	1.0	4.6	4	-	-	0	-	-	0
STS	Lionrock	(1006)	-0.6	4.2	14	-2.6	5.4	10	-6.8	7.9	6
TY	Kompasu	(1007)	1.0	12.8	12	-0.9	13.4	8	-13.0	13.9	4
TS	Namtheun	(1008)	-	-	0	-	-	0	-	-	0
STS	Malou	(1009)	-9.2	10.8	13	12.7	13.7	9	-15.4	16.4	5
STS	Meranti	(1010)	5.0	6.6	3	-	-	0	-	-	0
TY	Fanapi	(1011)	4.2	8.7	17	12.5	16.2	13	11.2	21.7	9
TY	Malakas	(1012)	4.0	7.4	10	6.7	10.0	6	2.5	3.5	2
TY	Megi	(1013)	1.6	20.3	37	0.7	26.5	33	1.1	31.9	29
TY	Chaba	(1014)	3.0	7.6	20	5.6	14.7	16	5.8	21.5	12
Annual Mean (Total)			0.2	12.2	176	0.4	17.4	127	-1.3	22.6	87

Table 4.3 Mean intensity errors of 24-, 48- and 72-hour operational central pressure forecasts for each TC in 2010

Figure 4.3 shows a histogram of maximum wind speed errors for 24-hour forecasts. About 53% (53% in 2009) of 24-hour forecasts had errors of less than ±3.75 m/s, with figures of ±6.25 m/s for 71% (59%) of 48-hour forecasts and ±6.25 m/s for 61% (52%) of 72-hour forecasts.

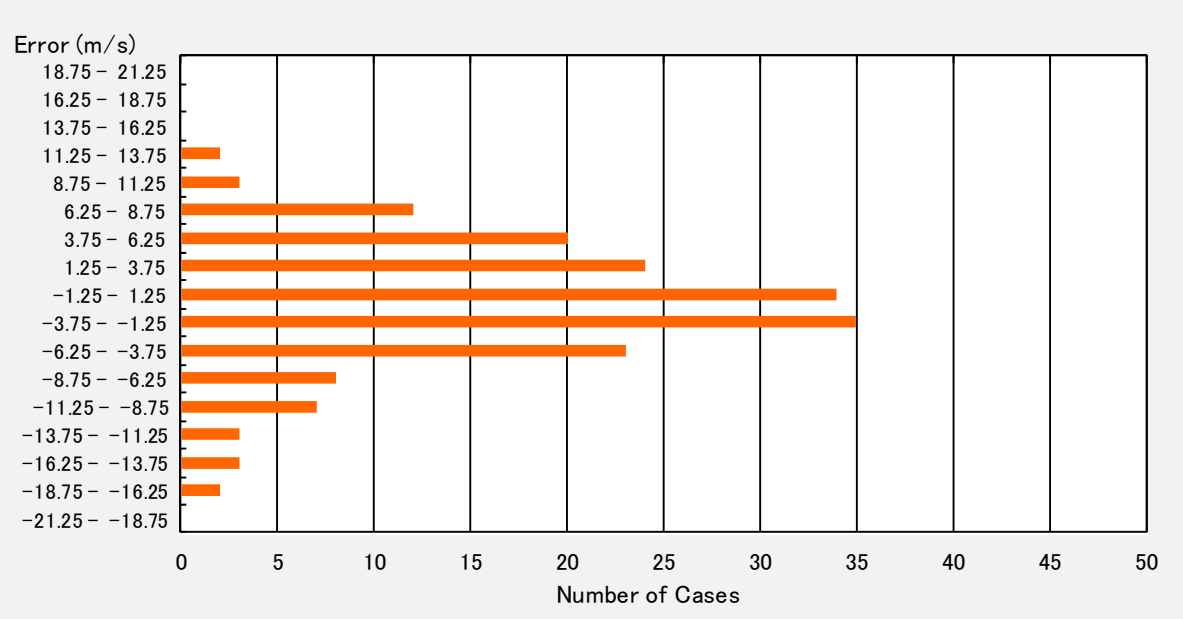


Figure 4.3 Histogram of 24-hour forecast maximum wind speed errors in 2010
(Those for 48- and 72-hour forecasts are shown on the attached DVD)

4.2 Verification of Numerical Models (GSM, TEPS)

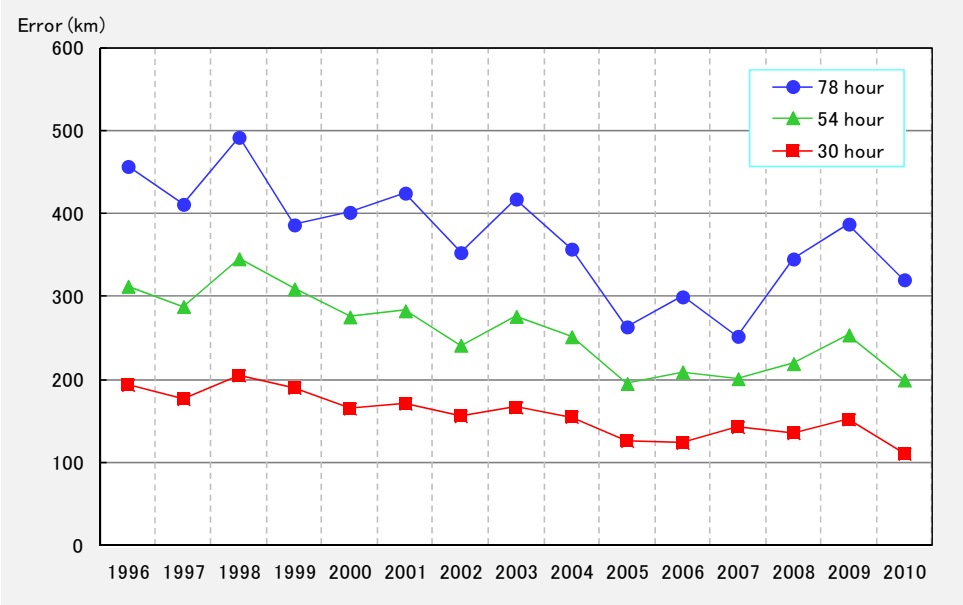


Figure 4.4 GSM annual mean position errors since 1996

The Global Spectral Model (GSM) and the Typhoon Ensemble Prediction System (TEPS) provide primary information for JMA forecasters to make operational TC track and intensity forecasts. The details and recent improvements on GSM and TEPS 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 the both systems.

4.2.1 GSM Predictions

1) Center Position

The GSM annual mean position errors since 1996 are presented in Figure 4.4. In 2010, the annual mean errors for 30-, 54- and 78-hour* predictions were 111 km (153 km in 2009), 200 km (254 km) and 321 km (388 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- 78-hour predictions using GSM are the primary information for forecasters preparing 24-, 48- and 72-hour operational forecasts respectively.*

Tropical Cyclone			T=18		T=30		T=42		T=54		T=66		T=78	
TS	1001	Omais	134.0	(12)	163.3	(10)	179.5	(8)	219.0	(6)	227.2	(4)	236.7	(2)
TY	1002	Conson	85.8	(22)	145.4	(20)	202.7	(18)	273.3	(16)	329.5	(13)	391.4	(11)
TY	1003	Chanthu	64.1	(15)	92.2	(13)	87.1	(11)	62.0	(9)	95.1	(7)	59.9	(5)
STS	1004	Dianmu	72.5	(18)	95.5	(15)	142.1	(13)	212.7	(11)	237.8	(9)	392.8	(7)
TS	1005	Mindulle	99.2	(8)	107.9	(6)	146.0	(4)	176.1	(2)	-	(-)	-	(-)
STS	1006	Lionrock	62.9	(19)	89.1	(17)	127.5	(15)	155.7	(13)	231.2	(11)	277.2	(9)
TY	1007	Kompasu	92.3	(16)	152.0	(14)	222.8	(12)	344.1	(9)	451.7	(7)	646.1	(5)
TS	1008	Namtheun	64.8	(2)	120.4	(1)	-	(-)	-	(-)	-	(-)	-	(-)
STS	1009	Malou	103.2	(27)	125.8	(24)	159.0	(22)	237.6	(21)	331.8	(19)	451.9	(17)
STS	1010	Meranti	105.6	(7)	164.6	(5)	261.7	(3)	424.4	(1)	-	(-)	-	(-)
TY	1011	Fanapi	69.5	(21)	78.7	(19)	90.8	(17)	110.7	(15)	135.7	(13)	153.0	(10)
TY	1012	Malakas	90.6	(17)	115.3	(15)	145.3	(13)	178.0	(11)	182.5	(9)	255.5	(7)
TY	1013	Megi	58.5	(39)	80.0	(37)	108.7	(35)	147.6	(33)	180.3	(31)	215.8	(29)
TY	1014	Chaba	80.7	(25)	117.4	(23)	190.9	(21)	274.4	(19)	359.9	(17)	446.3	(15)
	Annual Mean		81.4	(248)	111.0	(219)	148.9	(192)	199.9	(166)	250.9	(140)	320.6	(117)

Table 4.4 Mean position errors (km) of GSM for each TC in 2010.
The number of samples is given in parentheses.

Table 4.5 gives GSM's relative performance compared with the PER method. In this comparison, life stages of TCs were classified into the three stages of before, during and after recurvature. Each stage is defined with the direction of movement of each TC at each prediction time. The table indicates that GSM outperformed the PER method throughout the forecast period beyond 18 hours from the initial time, and that the rates of error reduction for GSM compared to the PER method were about 51% (34% in 2009), 64% (48%), 67% (58%) and 68% (60%) for 18-, 30-, 54- and 78-hour predictions respectively.

About 76% (60% in 2009) of 30-hour predictions had errors of less than 150 km, while 81% (69%) of 54-hour predictions had errors of less than 300 km, and 80% (70%) of 78-hour predictions had errors of less than 450 km respectively. Histograms of the position errors of 30-, 54- and 78-hour predictions are included on the attached DVD.

TIME	MODEL	Before		During		After		All	
T=18	GSM	74.3	(104)	88.1	(80)	84.5	(64)	81.4	(248)
	PER	149.0	(104)	180.9	(80)	177.1	(64)	166.5	(248)
	IMPROV	50.2 %		51.3 %		52.3 %		51.1 %	
T=30	GSM	103.5	(89)	105.5	(69)	128.1	(61)	111.0	(219)
	PER	257.1	(89)	327.9	(69)	348.9	(61)	305.0	(219)
	IMPROV	59.8 %		67.8 %		63.3 %		63.6 %	
T=42	GSM	128.2	(73)	132.8	(61)	191.8	(58)	148.9	(192)
	PER	355.5	(73)	458.6	(61)	592.5	(58)	459.9	(192)
	IMPROV	63.9 %		71.0 %		67.6 %		67.6 %	
T=54	GSM	158.8	(58)	180.2	(52)	260.6	(56)	199.9	(166)
	PER	477.5	(58)	561.7	(52)	800.3	(56)	612.8	(166)
	IMPROV	66.8 %		67.9 %		67.4 %		67.4 %	
T=66	GSM	200.7	(48)	223.2	(39)	316.7	(53)	250.9	(140)
	PER	627.2	(48)	686.2	(39)	1032.3	(53)	797.0	(140)
	IMPROV	68.0 %		67.5 %		69.3 %		68.5 %	
T=78	GSM	228.8	(40)	266.4	(27)	423.3	(50)	320.6	(117)
	PER	742.5	(40)	847.0	(27)	1295.6	(50)	1003.0	(117)
	IMPROV	69.2 %		68.6 %		67.3 %		68.0 %	

Table 4.5 Mean position errors (km) of GSM and PER method predictions for the 14 TCs in 2010 in the stages before, during and after recurvature. The number of samples is given in parentheses. IMPROV is error reduction rate of GSM to the PER method.

2) Central Pressure and Maximum Wind Speed

The mean errors of 30-, 54-, 78-hour central pressure predictions by GSM in 2010 were +12.1 hPa (+8.8 hPa in 2009), +12.7 hPa (+10.6 hPa) and +12.8 hPa (+10.8 hPa) respectively. Their root mean square errors (RMSEs) were 20.9 hPa (22.0 hPa in 2009) for 30-hour predictions, 21.9 hPa (26.1 hPa) for 54-hour predictions and 27.4 hPa (28.1 hPa) for 78-hour predictions. The bias for 30-, 54-, and 78-hour maximum wind speed predictions were -7.5 m/s (-5.2 m/s in 2009) with RMSE of 10.3 m/s (11.3 m/s), -7.8 m/s (-5.6 m/s) with RMSE of 11.1 m/s (13.4 m/s) and -7.1 m/s (-5.1 m/s) with RMSE of 13.3 m/s (13.9 m/s) respectively.

Figure 4.5 shows histograms of the central pressure errors and the maximum wind speed errors of 30-hour GSM predictions. The figures show that GSM tends to underestimate the wind speed of TCs (right) and have a positive bias for the central pressure prediction (left). This underestimate results from the fact that the current horizontal resolution of GSM (about 20 km) is not fine enough to produce the TC core structure especially when it is intense and small.

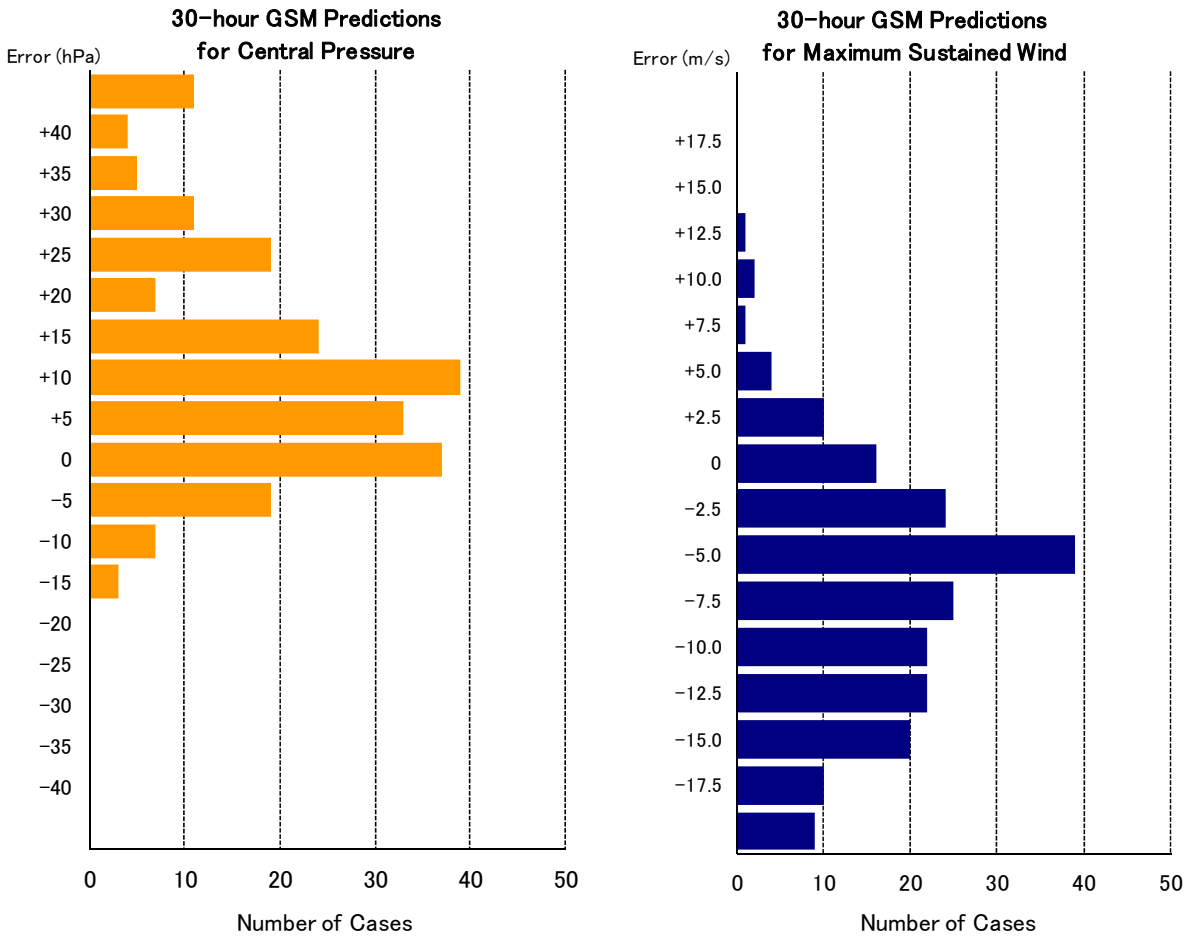


Figure 4.5 Error distributions of GSM 30-hour intensity predictions in 2010.
The figure on the left shows error distributions for central pressure, while the one on the right shows those for maximum wind speed (the error distributions of 54- and 78-hour predictions are included on the attached DVD).

4.2.2 TEPS Predictions

1) Ensemble mean center position

The mean position error of TEPS ensemble mean forecasts at 30-, 54-, 78-, 102- and 126-hour predictions for each TC are given in Table 4.6. Annual means of ensemble mean position error at 30-, 54-, 78-, 102- and 126-hour predictions are 129 km (111 km in GSM), 222 km (200 km), 359 km (321 km), 489 km and 573 km, respectively.

Tropical Cyclone			T=30		T=54		T=78		T=102		T=126	
TS	1001	OMAIS	179.5	(10)	238.2	(6)	329.2	(2)	-	(-)	-	(-)
TY	1002	CONSON	190.4	(19)	333.7	(14)	515.7	(8)	602.8	(4)	-	(-)
TY	1003	CHANTHU	119.0	(12)	87.1	(7)	132.9	(1)	-	(-)	-	(-)
STS	1004	DIANMU	120.0	(12)	297.5	(8)	619.8	(3)	-	(-)	-	(-)
TS	1005	MINDULLE	144.7	(6)	252.1	(2)	-	(-)	-	(-)	-	(-)
STS	1006	LIONROCK	92.9	(16)	137.9	(12)	203.2	(8)	349.4	(3)	-	(-)
TY	1007	KOMPASU	189.2	(14)	377.4	(9)	776.0	(5)	1207.6	(1)	-	(-)
TS	1008	NAMTHEUN	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
STS	1009	MALOU	143.1	(21)	272.6	(17)	505.5	(13)	897.1	(8)	1391.5	(4)
STS	1010	MERANTI	170.8	(4)	-	(-)	-	(-)	-	(-)	-	(-)
TY	1011	FANAPI	88.7	(19)	104.9	(15)	157.6	(10)	385.0	(7)	848.8	(3)
TY	1012	MALAKAS	117.4	(14)	183.9	(10)	241.1	(6)	556.5	(2)	-	(-)
TY	1013	MEGI	77.3	(37)	138.0	(33)	215.7	(29)	268.5	(25)	304.6	(21)
TY	1014	CHABA	153.6	(23)	342.0	(19)	518.5	(15)	680.2	(11)	793.8	(7)
All	Annual	Mean	129.0	(207)	222.0	(152)	359.1	(100)	489.3	(61)	573.3	(35)

Table 4.6 Mean position errors (km) of TEPS ensemble mean forecasts for each TC in 2010. The number of samples is given in parentheses.

2) Spread-skill relationship

While position error of TEPS ensemble mean forecast was larger than GSM in short range forecast, TEPS gives the useful information on the reliability of the TC track forecast with its ensemble spread. Figure 4.6 shows relationship between 6-hourly accumulated ensemble spread on the TC position forecast and ensemble mean forecast position error at 126-hour prediction. In an ideal EPS with a large number of samples, large position error is found when the ensemble spread is large.

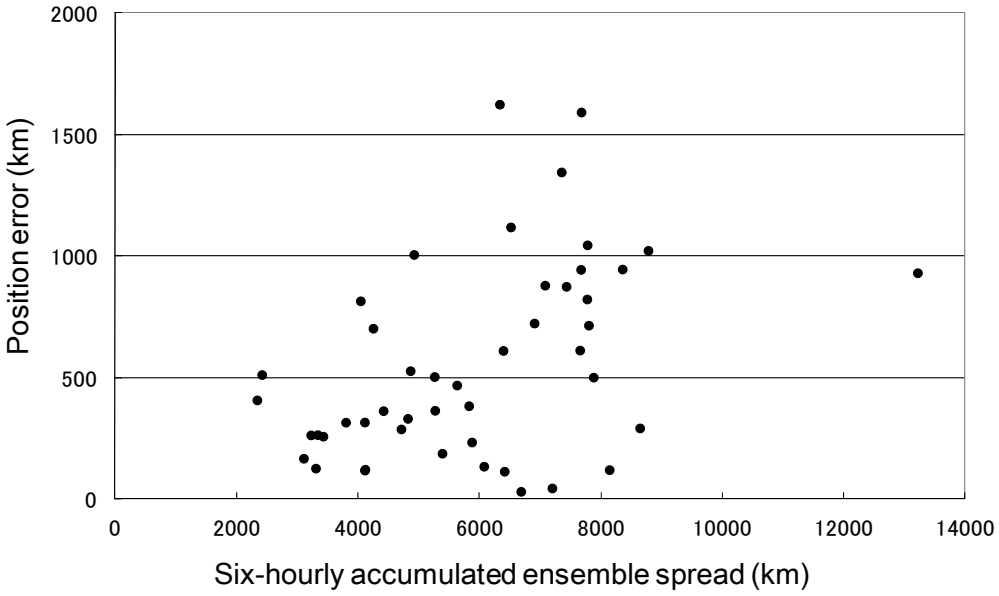


Figure 4.6 Relation between 6-hourly accumulated ensemble spread on the TC position forecast (km) and ensemble mean forecast position error (km) at 126-hour prediction in 2010.

To add reliability information to TC track forecasts, we have introduced a reliability index in which the categories A, B and C represent the highest, middle-level and lowest reliability, respectively. The

index is determined by 6-hourly accumulated ensemble spread at each forecast time. The levels of the categories were set with the results from the pre-operational runs of TEPS so that the frequency of each category becomes 40%, 40% and 20%, respectively. Table 4.7 shows ensemble mean forecast errors classified with the reliability index. Theoretically, mean position errors of reliability A should be smaller than those of the reliability B and C throughout the forecast times with a sufficient number of samples in an ideal EPS. The result shows that TEPS can give the appropriate reliability information on the typhoon forecast in 2010.

Table 4.7 Ensemble mean forecast position errors (km) in 2010 classified with 6-hourly accumulated ensemble spread at each forecast time. The number of samples is given in parentheses.

	Reliability Index		
Time	A	B	C
T=30	119.4 (85)	135.9 (115)	150.8 (23)
T=54	165.9 (53)	248.6 (98)	228.2 (19)
T=78	259.5 (41)	385.1 (64)	509.2 (9)
T=102	390.8 (26)	512.9 (39)	779.4 (6)
T=126	384.3 (18)	640.6 (25)	798.6 (4)

Appendices

RSMC Tropical Cyclone Best Track Data in 2010

Appendix 1

Omais (1001)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Mar. 22/12	8.4	141.7	1006	-	1.0	TD
22/18	8.9	140.7	1004	-	1.0	TD
23/00	9.4	139.7	1002	-	1.5	TD
23/06	10.0	138.7	1002	-	1.5	TD
23/12	10.4	137.3	1004	-	1.5	TD
23/18	10.8	136.4	1002	-	1.5	TD
24/00	11.5	135.5	1000	-	2.0	TD
24/06	12.7	134.5	1000	-	2.0	TD
24/12	13.6	133.4	998	35	2.5	TS
24/18	14.1	132.9	998	35	2.5	TS
25/00	14.8	132.5	998	35	2.5	TS
25/06	15.6	132.3	998	35	2.5	TS
25/12	16.4	132.2	998	35	2.5	TS
25/18	17.0	132.2	1000	35	2.5	TS
26/00	17.4	131.9	1004	-	2.5	TD
26/06	17.6	131.8	1006	-	2.0	TD
26/12	17.7	132.1	1008	-	-	TD
26/18						Dissip.

Conson (1002)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul. 11/12	13.9	132.6	1008	-	1.5	TD
11/18	14.2	131.8	1004	-	2.0	TD
12/00	14.3	130.3	1000	35	2.5	TS
12/06	14.1	129.3	994	45	3.0	TS
12/12	14.3	127.7	985	55	4.0	STS
12/18	14.3	126.5	975	65	4.5	TY
13/00	14.3	124.8	975	65	4.5	TY
13/06	14.4	123.5	975	65	4.5	TY
13/12	14.5	122.3	975	65	4.5	TY
13/18	14.3	120.9	980	60	4.0	STS
14/00	14.7	119.6	985	55	3.5	STS
14/06	15.3	118.3	990	50	3.0	STS
14/12	16.0	117.7	992	45	3.0	TS
14/18	16.1	116.1	992	45	3.0	TS
15/00	16.2	115.0	990	50	3.0	STS
15/06	16.6	113.9	985	55	3.5	STS
15/12	16.7	112.9	975	65	4.0	TY
15/18	16.9	111.9	975	65	4.0	TY
16/00	17.0	111.0	975	65	4.0	TY
16/06	17.6	110.2	970	70	4.5	TY
16/12	18.0	109.5	970	65	4.0	TY
16/18	18.5	108.6	970	65	4.0	TY
17/00	19.2	108.0	980	55	3.5	STS
17/06	20.1	107.5	990	50	3.0	STS
17/12	20.6	106.9	992	45	2.5	TS
17/18	21.1	106.1	996	40	2.5	TS
18/00	21.0	105.0	1000	-	2.0	TD
18/06						Dissip.

Chanthu (1003)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Jul. 17/06	15.8	123.1	1008	-	1.0	TD
17/12	15.5	122.8	1008	-	1.0	TD
17/18	15.3	122.4	1008	-	1.0	TD
18/00	15.1	122.1	1008	-	1.0	TD
18/06	15.2	121.3	1006	-	1.5	TD
18/12	14.9	119.9	1006	-	1.5	TD
18/18	14.7	118.9	1004	-	2.0	TD
19/00	14.6	117.8	1004	-	2.0	TD
19/06	15.1	117.0	1002	-	2.0	TD
19/12	15.9	116.6	1000	35	2.5	TS
19/18	16.7	116.2	1000	35	2.5	TS
20/00	17.2	115.7	998	35	2.5	TS
20/06	17.7	114.9	994	40	3.0	TS
20/12	17.9	114.2	990	45	3.0	TS
20/18	18.0	113.6	985	50	3.5	STS
21/00	18.2	113.2	985	55	3.5	STS
21/06	18.7	112.9	985	60	3.5	STS
21/12	19.2	112.4	980	65	4.0	TY
21/18	19.8	112.0	975	65	4.0	TY
22/00	20.5	111.5	970	70	4.5	TY
22/06	21.4	110.5	970	70	4.5	TY
22/12	21.7	109.9	980	65	4.0	TY
22/18	22.7	108.9	985	55	3.5	STS
23/00	23.1	107.9	996	45	3.0	TS
23/06	23.5	107.0	1000	-	2.5	TD
23/12	23.5	106.5	1000	-	2.0	TD
23/18						Dissip.

Dianmu (1004)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug. 07/00	20.7	124.2	1002	-	0.0	TD
07/06	21.0	124.3	1000	-	0.5	TD
07/12	21.2	124.4	1000	-	1.0	TD
07/18	21.6	124.4	998	-	1.0	TD
08/00	22.3	124.6	998	-	1.0	TD
08/06	22.9	124.8	996	-	1.5	TD
08/12	23.6	124.9	994	35	1.5	TS
08/15	23.9	125.0	992	40	-	TS
08/18	24.3	125.2	990	45	1.5	TS
08/21	24.8	125.6	990	45	-	TS
09/00	25.6	125.7	990	45	1.5	TS
09/03	26.4	125.6	985	50	-	STS
09/06	27.1	125.6	985	50	2.0	STS
09/09	28.0	125.5	985	50	-	STS
09/12	28.8	125.2	985	50	2.5	STS
09/18	29.7	125.1	985	50	2.5	STS
10/00	31.0	125.1	985	50	2.5	STS
10/06	32.1	125.2	985	50	2.5	STS
10/12	33.0	125.6	985	50	2.5	STS
10/15	33.7	126.2	985	50	-	STS
10/18	34.0	126.6	985	50	2.5	STS
10/21	34.4	127.2	990	45	-	TS
11/00	34.8	128.2	990	45	2.5	TS
11/03	35.2	129.1	992	45	-	TS
11/06	35.7	130.0	992	45	2.5	TS
11/09	36.1	130.8	992	45	-	TS
11/12	36.4	131.7	992	45	2.5	TS
11/15	36.7	132.7	992	45	-	TS
11/18	37.1	133.7	994	40	2.0	TS
11/21	37.6	134.8	994	40	-	TS
12/00	38.2	136.0	994	40	2.0	TS
12/03	38.7	137.3	994	40	-	TS
12/06	39.2	139.0	994	40	2.0	TS
12/08	39.5	140.1	994	40	-	TS
12/09	39.5	140.7	994	40	-	TS
12/12	39.6	142.7	996	35	2.0	TS
12/15	40.1	144.7	996	35	-	TS
12/18	41.0	146.0	994	-	1.5	L
13/00	43.4	151.2	998	-	-	L
13/06						Dissip.

Mindulle (1005)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug. 22/00	16.4	115.1	1002	-	0.5	TD
22/06	16.2	114.3	1000	-	1.0	TD
22/12	16.0	113.6	998	-	1.5	TD
22/18	15.7	112.5	996	-	2.0	TD
23/00	15.9	111.5	994	35	2.5	TS
23/06	16.3	110.2	994	35	2.5	TS
23/12	16.7	109.1	992	40	3.0	TS
23/18	17.3	108.4	990	40	3.0	TS
24/00	18.0	107.3	985	45	3.0	TS
24/06	18.6	106.3	985	45	3.0	TS
24/12	18.9	105.5	990	40	2.5	TS
24/18	19.0	104.7	996	35	2.0	TS
25/00	19.4	104.1	1000	-	1.5	TD
25/06						Dissip.

Lionrock (1006)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug. 27/18	16.5	118.0	1004	-	1.0	TD
28/00	17.3	117.7	1004	-	1.0	TD
28/06	18.5	116.9	1002	-	1.5	TD
28/12	18.9	116.7	1002	-	2.0	TD
28/18	19.2	116.5	1000	35	2.5	TS
29/00	19.7	116.2	1000	35	2.5	TS
29/06	20.2	116.1	998	35	2.5	TS
29/12	20.4	116.3	996	40	2.5	TS
29/18	20.6	116.5	996	40	2.5	TS
30/00	20.7	116.6	990	45	3.0	TS
30/06	20.8	116.7	985	50	3.5	STS
30/12	20.7	117.0	985	50	3.5	STS
30/18	20.6	117.2	985	50	3.5	STS
31/00	20.4	117.5	985	50	3.5	STS
31/06	20.4	118.2	985	50	3.5	STS
31/12	20.8	119.0	985	50	3.5	STS
31/18	21.5	119.4	985	50	3.5	STS
Sep. 01/00	22.3	119.4	990	45	3.0	TS
01/06	22.8	119.1	990	45	3.0	TS
01/12	23.2	118.9	990	45	3.0	TS
01/18	23.5	118.3	990	45	3.0	TS
02/00	23.9	117.3	996	35	2.5	TS
02/06	24.3	116.1	998	-	2.0	TD
02/12	24.0	115.0	1002	-	-	TD
02/18	23.9	114.3	1002	-	-	TD
03/00	23.9	113.7	1002	-	-	TD
03/06	23.7	113.0	1002	-	-	TD
03/12	23.5	112.6	1002	-	-	TD
03/18	23.4	112.1	1002	-	-	TD
04/00	23.0	111.6	1004	-	-	TD
04/06	22.5	111.2	1002	-	-	TD
04/12						Dissip.

Kompasu (1007)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug. 28/12	18.4	139.0	1008	-	0.5	TD
28/18	19.4	137.7	1006	-	1.0	TD
29/00	20.4	136.4	1004	-	1.0	TD
29/06	21.1	135.3	1004	-	1.5	TD
29/12	21.5	134.4	1002	-	2.0	TD
29/18	22.2	133.2	998	35	2.5	TS
30/00	22.6	132.4	994	45	3.0	TS
30/06	23.3	131.8	990	50	3.5	STS
30/12	23.7	131.2	980	60	4.0	STS
30/18	24.5	130.2	970	70	5.0	TY
30/21	24.8	129.7	965	75	-	TY
31/00	25.1	129.4	960	80	5.5	TY
31/03	25.6	128.9	960	80	-	TY
31/06	26.2	128.4	960	80	5.5	TY
31/08	26.6	128.1	960	80	-	TY
31/09	26.7	127.9	960	80	-	TY
31/12	27.4	127.3	960	80	5.5	TY
31/15	28.0	126.7	960	80	-	TY
31/18	28.6	126.2	960	80	5.5	TY
Sep. 01/00	30.3	125.2	965	75	5.5	TY
01/06	32.3	124.7	970	70	5.0	TY
01/12	34.3	124.8	970	70	4.5	TY
01/18	36.5	125.2	980	60	4.0	STS
02/00	38.3	127.2	990	50	3.5	STS
02/06	39.3	129.7	994	45	3.0	TS
02/12	40.0	132.4	998	35	2.5	TS
02/18	40.7	134.8	1002	-	2.0	TD
03/00	41.4	137.4	1004	-	-	TD
03/06	42.1	140.3	1004	-	-	TD
03/12	41.3	145.0	1006	-	-	L
03/18	40.8	149.3	1002	-	-	L
04/00	39.9	154.0	1000	-	-	L
04/06	39.4	158.8	998	-	-	L
04/12	38.9	163.3	998	-	-	L
04/18	39.7	167.3	996	-	-	L
05/00	41.4	171.4	994	-	-	L
05/06	43.4	174.8	988	-	-	L
05/12	47.2	177.6	984	-	-	L
05/18	50.0	179.3	984	-	-	L
06/00	52.9	179.3	984	-	-	L
06/06	54.4	179.8	984	-	-	L
06/12	56.4	181.4	980	-	-	Out

Namtheun (1008)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Aug. 29/06	25.1	124.3	1004	-	0.5	TD
29/12	25.4	124.0	1004	-	0.5	TD
29/18	25.7	123.5	1002	-	1.0	TD
30/00	26.0	123.2	1000	-	1.5	TD
30/06	26.1	122.7	998	-	2.0	TD
30/12	25.9	122.0	996	35	2.5	TS
30/18	25.6	121.3	996	35	2.5	TS
31/00	25.5	120.8	996	35	2.5	TS
31/06	25.3	120.2	998	-	2.0	TD
31/12	25.2	119.8	1000	-	2.0	TD
31/18						Dissip.

Malou (1009)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep. 01/12	15.6	141.4	1008	-		TD
01/18	16.9	140.2	1008	-		TD
02/00	18.0	139.1	1008	-		TD
02/06	19.5	137.8	1008	-		TD
02/12	21.1	136.4	1010	-		TD
02/18	21.9	134.6	1010	-		TD
03/00	22.5	132.8	1008	-	1.5	TD
03/06	23.2	130.9	1006	-	1.5	TD
03/12	23.8	129.9	1004	-	1.5	TD
03/18	24.4	129.0	1002	-	1.5	TD
04/00	24.7	128.3	1000	35	2.0	TS
04/03	25.0	128.0	1000	35	-	TS
04/06	25.4	127.8	1000	35	2.0	TS
04/09	26.0	127.4	1000	35	-	TS
04/12	27.0	127.0	998	40	2.0	TS
04/15	27.4	126.8	998	40	-	TS
04/18	27.8	126.5	998	40	2.0	TS
05/00	28.7	126.2	996	45	2.0	TS
05/06	29.7	126.2	996	45	2.0	TS
05/12	30.6	126.4	994	45	2.5	TS
05/18	31.4	126.5	992	50	3.0	STS
06/00	31.9	126.6	992	50	3.0	STS
06/06	32.3	126.9	992	50	3.0	STS
06/12	33.0	127.6	994	50	2.5	STS
06/15	33.2	128.0	994	50	-	STS
06/18	33.5	128.3	994	50	2.5	STS
06/21	33.8	128.6	994	50	-	STS
07/00	34.1	128.8	996	45	2.0	TS
07/02	34.4	129.2	996	45	-	TS
07/03	34.6	129.6	996	45	-	TS
07/06	34.9	130.5	996	45	2.0	TS
07/09	35.3	131.4	996	45	-	TS
07/12	35.6	132.0	996	45	2.0	TS
07/15	35.8	133.2	998	45	-	TS
07/18	35.8	134.0	1000	40	2.0	TS
07/21	35.9	134.7	1002	40	-	TS
08/00	35.8	135.6	1004	35	1.5	TS
08/02	35.6	136.0	1004	35	-	TS
08/03	35.5	136.6	1004	-	-	TD
08/06	35.4	138.7	1004	-	1.5	TD
08/12	35.3	140.6	1004	-	-	TD
08/18	35.1	141.7	1004	-	-	TD
09/00	34.7	142.9	1004	-	-	TD
09/06	34.5	143.5	1004	-	-	TD
09/12	34.3	144.5	1004	-	-	TD
09/18	34.1	145.8	1004	-	-	TD
10/00	33.9	147.1	1004	-	-	TD
10/06	33.7	148.2	1004	-	-	TD
10/12						Dissip.

Meranti (1010)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep. 07/00	22.5	123.8	1004	-	1.0	TD
07/06	22.4	123.2	1004	-	1.0	TD
07/12	21.9	122.3	1004	-	1.0	TD
07/18	21.4	121.4	1004	-	1.5	TD
08/00	20.7	120.7	1004	-	2.0	TD
08/06	20.3	119.9	1002	-	2.0	TD
08/12	20.5	119.7	1002	-	2.0	TD
08/18	20.8	119.6	998	35	2.5	TS
09/00	21.3	119.4	994	40	3.0	TS
09/06	22.3	119.1	992	45	3.0	TS
09/12	23.1	118.9	990	50	3.0	STS
09/18	24.3	118.8	985	55	3.5	STS
10/00	25.3	118.8	996	40	3.0	TS
10/06	26.9	118.6	1000	35	2.5	TS
10/12	28.0	119.0	1004	-	2.0	TD
10/18	29.1	119.6	1006	-	-	TD
11/00	30.6	121.1	1006	-	-	TD
11/06	31.9	122.5	1006	-	-	TD
11/12	33.0	124.2	1006	-	-	TD
11/18	34.7	125.5	1004	-	-	TD
12/00	36.3	129.5	1004	-	-	L
12/06	37.6	132.5	1002	-	-	L
12/12	38.2	135.7	1002	-	-	L
12/18	39.0	138.0	1002	-	-	L
13/00	38.9	142.7	1004	-	-	L
13/06	38.9	144.4	1002	-	-	L
13/12	38.8	146.4	1002	-	-	L
13/18	38.9	147.7	1002	-	-	L
14/00	38.4	148.7	1004	-	-	L
14/06	37.8	150.0	1004	-	-	L
14/12						Dissip.

Fanapi (1011)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep. 14/18	19.6	129.1	1008	-	1.0	TD
15/00	20.2	128.5	1006	-	1.5	TD
15/06	20.6	127.8	1004	-	2.0	TD
15/12	20.9	127.8	1000	35	2.5	TS
15/18	21.1	127.8	990	45	3.0	TS
16/00	21.3	128.0	985	50	3.5	STS
16/06	21.4	128.3	980	55	3.5	STS
16/12	21.7	128.5	975	60	3.5	STS
16/18	22.1	128.4	970	65	4.0	TY
17/00	22.4	128.3	970	65	4.0	TY
17/06	22.7	128.0	965	70	4.5	TY
17/12	23.1	127.7	955	75	5.0	TY
17/18	23.3	126.8	950	80	5.0	TY
17/21	23.3	126.4	940	85	-	TY
18/00	23.4	126.1	940	85	5.5	TY
18/03	23.5	125.7	940	85	-	TY
18/06	23.8	125.3	940	85	5.5	TY
18/09	23.8	124.8	940	85	-	TY
18/12	23.9	124.3	940	85	5.5	TY
18/15	23.8	123.8	930	95	-	TY
18/18	24.0	123.1	930	95	5.5	TY
18/21	23.8	122.5	940	85	-	TY
19/00	23.7	121.6	950	80	5.5	TY
19/06	22.8	120.8	970	65	4.5	TY
19/12	23.2	119.9	975	60	4.0	STS
19/18	23.4	118.7	975	60	4.0	STS
20/00	23.6	117.2	985	50	3.5	STS
20/06	23.6	116.0	990	45	3.0	TS
20/12	24.1	114.7	996	40	2.5	TS
20/18	24.2	113.1	1000	-	2.0	TD
21/00	24.0	112.1	1002	-	-	TD
21/06	24.0	111.1	1002	-	-	TD
21/12	24.3	110.1	1004	-	-	TD
21/18						Dissip.

Malakas (1012)

Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Sep. 20/06	19.0	146.5	1008	-	1.0	TD
20/12	19.1	146.0	1010	-	1.0	TD
20/18	19.2	145.5	1008	-	1.5	TD
21/00	19.3	145.2	1008	-	1.5	TD
21/06	19.3	144.6	1006	-	1.5	TD
21/12	19.4	144.0	1006	-	2.0	TD
21/18	19.4	143.4	1004	-	2.0	TD
22/00	19.4	142.9	1002	35	2.5	TS
22/06	19.4	142.4	998	40	2.5	TS
22/12	19.5	141.8	994	45	3.0	TS
22/18	19.8	141.6	990	50	3.0	STS
23/00	20.1	141.5	985	55	3.5	STS
23/06	20.6	141.3	980	65	4.0	TY
23/12	21.2	141.1	980	65	4.0	TY
23/18	22.8	140.9	970	70	4.5	TY
24/00	24.2	140.9	970	70	4.5	TY
24/03	25.2	140.9	965	70	-	TY
24/06	26.3	141.3	960	75	5.0	TY
24/09	27.3	141.5	960	75	-	TY
24/12	28.5	141.7	955	80	5.0	TY
24/15	29.7	142.1	950	80	-	TY
24/18	30.9	142.8	945	85	5.5	TY
25/00	34.2	144.4	945	80	5.5	TY
25/06	36.9	145.9	955	75	5.5	TY
25/12	39.4	148.2	966	-	5.0	L
25/18	41.6	150.6	966	-	4.5	L
26/00	43.8	153.4	968	-	-	L
26/06	46.3	156.3	970	-	-	L
26/12	48.4	159.0	970	-	-	L
26/18	50.3	162.6	970	-	-	L
27/00	51.9	165.8	972	-	-	L
27/06	53.1	169.5	972	-	-	L
27/12	53.6	173.2	972	-	-	L
27/18	54.3	178.7	974	-	-	L
28/00	54.7	184.1	976	-	-	Out

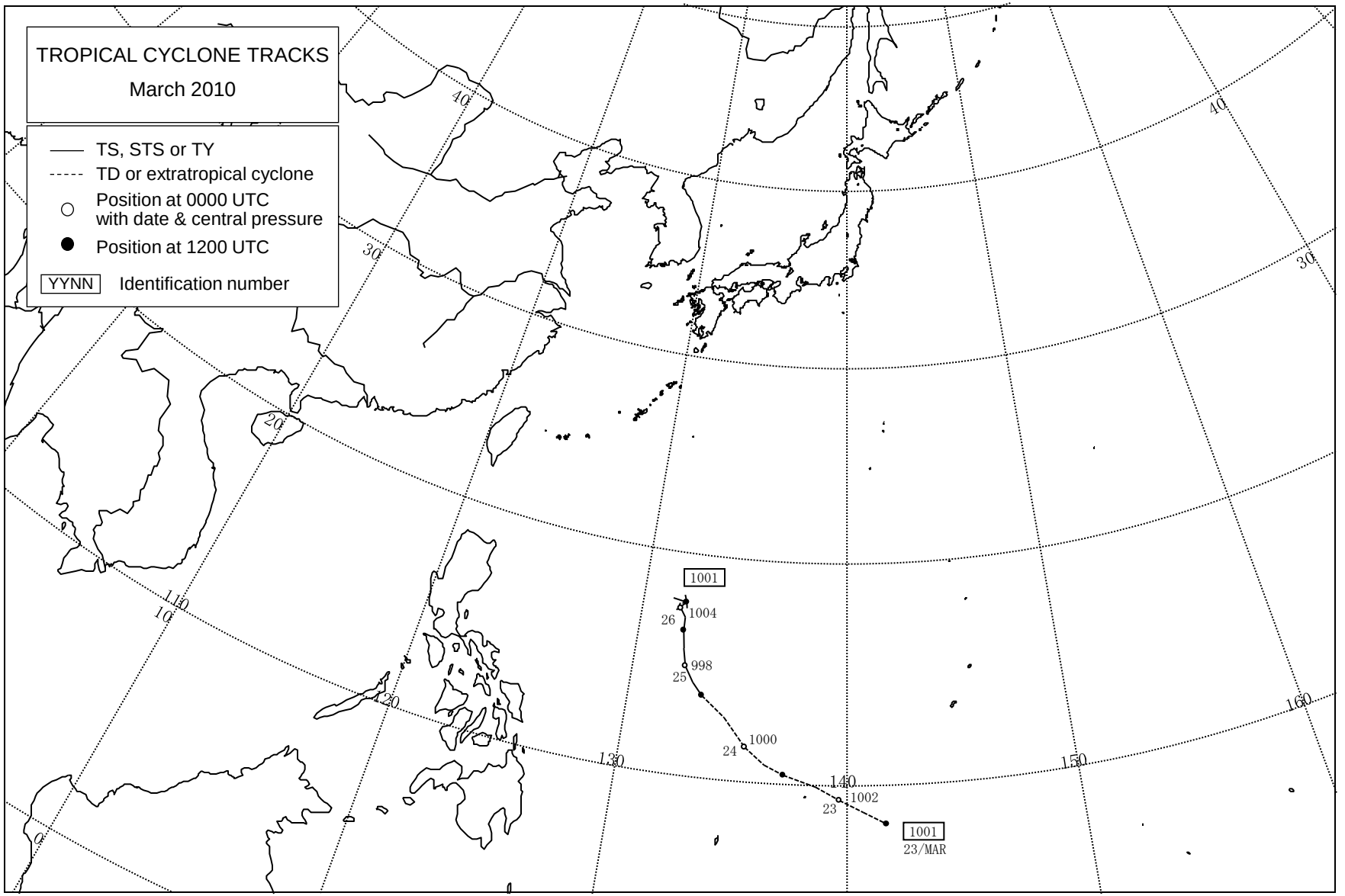
Megi (1013)

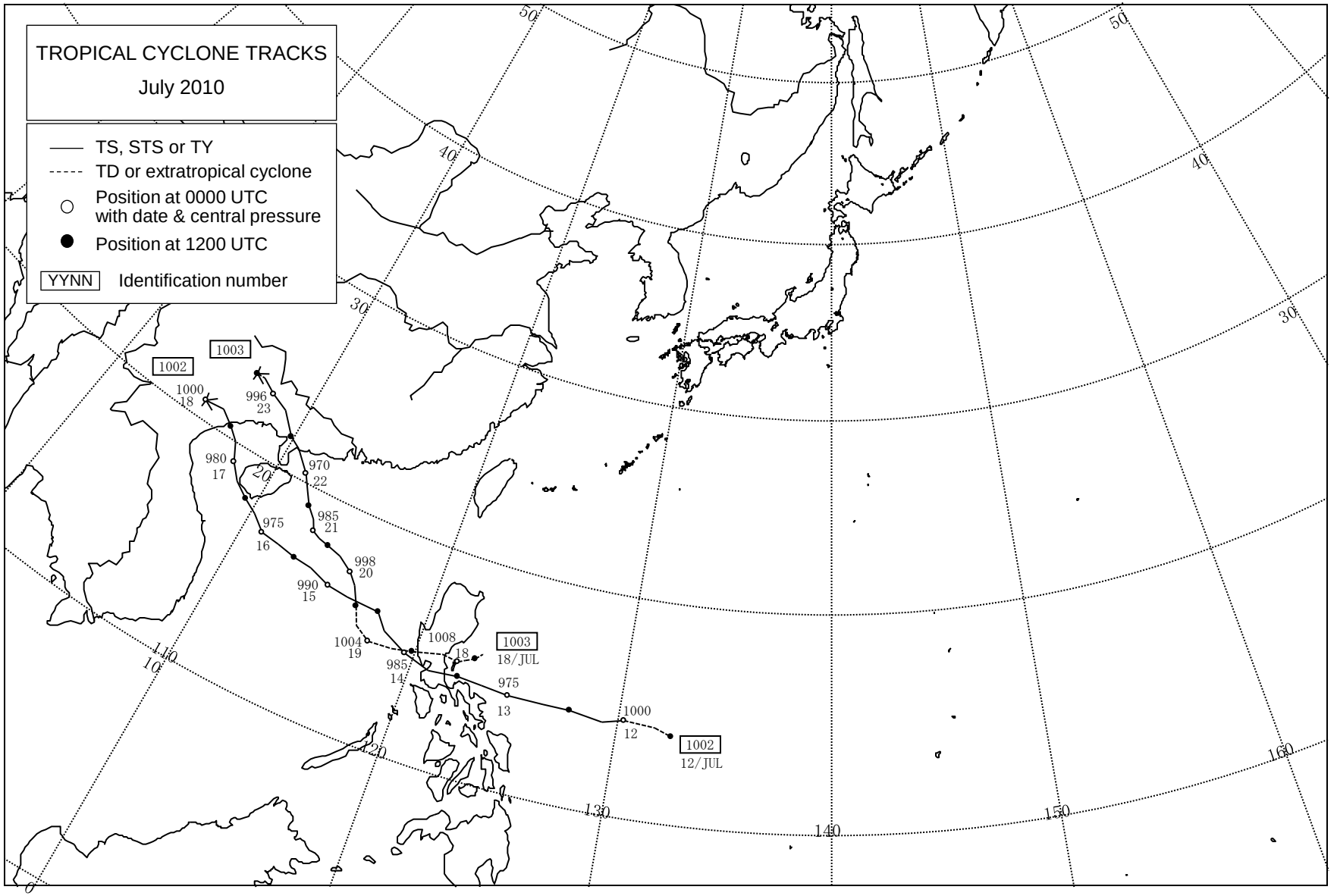
Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Oct. 13/00	11.9	141.4	1006	-	0.5	TD
13/06	12.0	141.2	1004	-	0.5	TD
13/12	12.0	140.9	1002	35	1.0	TS
13/18	12.1	140.6	1000	35	1.5	TS
14/00	12.3	139.8	996	40	1.5	TS
14/06	12.8	139.1	990	45	2.0	TS
14/12	13.1	138.6	985	50	2.5	STS
14/18	13.6	138.1	980	55	3.0	STS
15/00	14.5	137.4	975	60	3.5	STS
15/06	14.9	136.6	970	65	4.0	TY
15/12	15.7	135.5	965	70	4.5	TY
15/18	16.7	134.3	960	75	5.0	TY
16/00	17.6	133.0	960	75	5.0	TY
16/06	18.1	131.6	955	80	5.0	TY
16/12	18.3	130.3	945	85	5.5	TY
16/18	18.7	128.9	925	100	6.5	TY
17/00	18.7	127.5	915	105	6.5	TY
17/06	18.5	126.2	905	110	7.0	TY
17/12	18.1	125.1	895	120	7.5	TY
17/18	17.6	124.2	885	125	8.0	TY
18/00	17.5	123.3	885	125	8.0	TY
18/06	17.1	121.9	910	105	7.0	TY
18/12	16.8	120.8	940	90	6.5	TY
18/18	16.5	119.7	950	85	6.0	TY
19/00	16.5	119.2	950	80	5.5	TY
19/06	16.6	118.6	950	80	5.5	TY
19/12	16.6	117.9	950	80	5.5	TY
19/18	16.9	117.6	950	80	5.5	TY
20/00	17.3	117.2	950	80	5.5	TY
20/06	17.8	117.3	950	80	5.0	TY
20/12	18.4	117.2	945	85	5.0	TY
20/18	18.9	117.4	945	85	5.0	TY
21/00	19.5	117.5	940	90	5.5	TY
21/06	19.9	117.6	935	95	6.0	TY
21/12	20.2	117.9	935	95	6.0	TY
21/18	20.5	118.0	945	85	6.0	TY
22/00	20.9	118.2	950	80	5.5	TY
22/06	21.5	118.2	955	75	5.0	TY
22/12	22.1	118.2	965	70	4.5	TY
22/18	22.7	118.2	975	60	4.0	STS
23/00	23.4	118.0	985	50	4.0	STS
23/06	24.2	117.8	992	40	3.5	TS
23/12	24.5	117.8	1000	35	3.0	TS
23/18	24.9	118.0	1004	-	2.5	TD
24/00	25.3	118.1	1006	-	-	TD
24/06	26.1	118.3	1006	-	-	TD
24/12						Dissip.

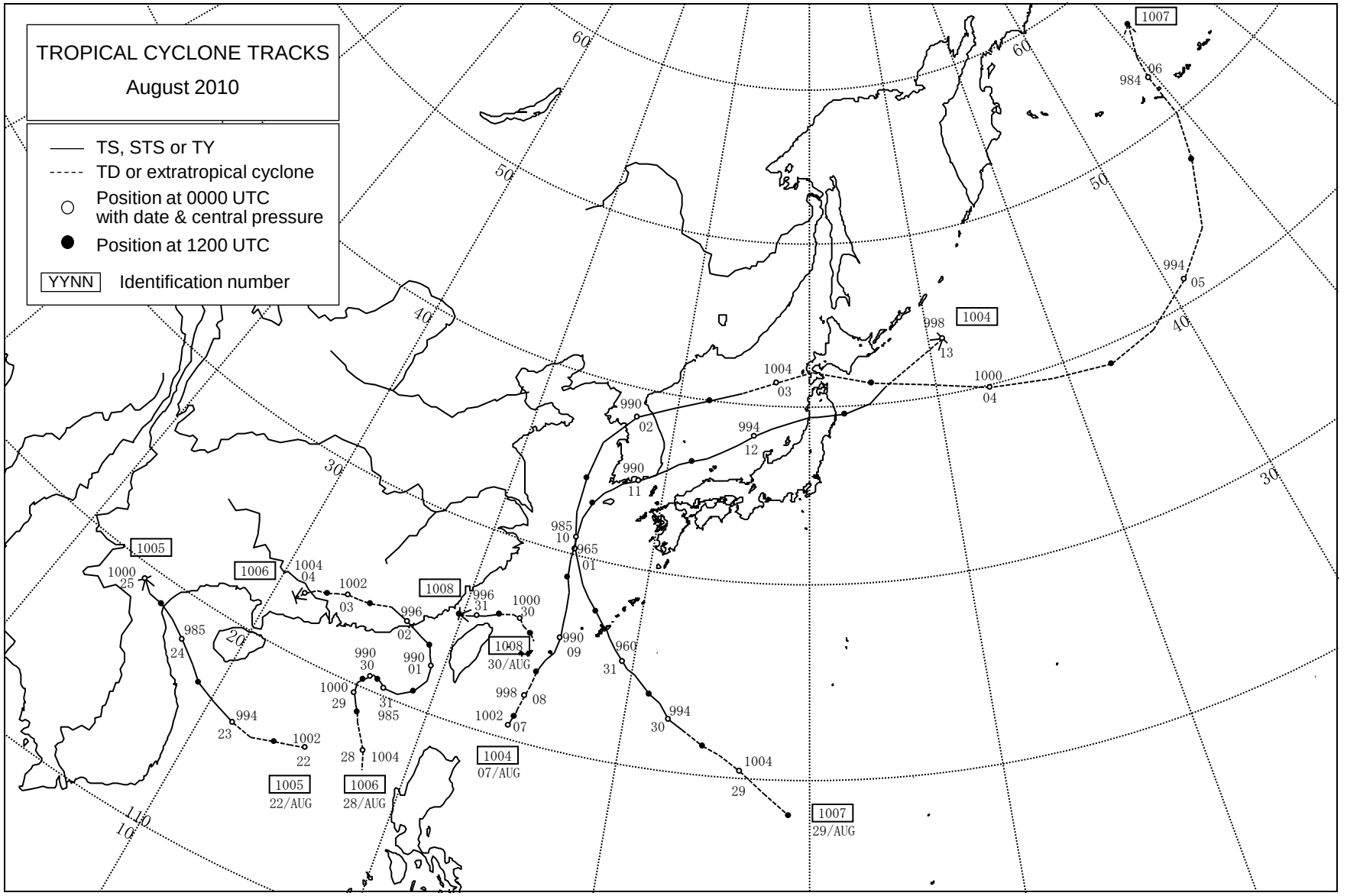
Date/Time (UTC)	Center position Lat (N)	Lon (E)	Central pressure (hPa)	Max wind (kt)	CI num.	Grade
Chaba (1014)						
Oct. 23/18	15.0	133.6	1004	-	1.0	TD
24/00	15.1	133.1	1004	-	1.0	TD
24/06	15.4	132.6	1002	-	1.5	TD
24/12	16.0	131.9	1000	-	2.0	TD
24/18	16.8	131.2	996	35	2.5	TS
25/00	16.9	131.0	992	45	3.0	TS
25/06	17.4	130.5	990	45	3.0	TS
25/12	17.8	130.0	985	55	3.5	STS
25/18	18.6	129.5	980	60	4.0	STS
26/00	19.2	128.9	975	65	4.0	TY
26/06	19.7	128.6	975	65	4.0	TY
26/12	20.1	128.2	970	70	4.5	TY
26/18	20.5	127.9	965	70	4.5	TY
27/00	20.7	127.9	960	75	4.5	TY
27/06	21.7	127.9	955	80	5.0	TY
27/12	22.4	128.0	945	85	5.5	TY
27/18	23.3	128.3	945	85	5.5	TY
28/00	24.3	128.6	935	90	6.0	TY
28/03	24.5	128.8	935	90	-	TY
28/06	24.8	129.2	930	95	6.5	TY
28/09	25.2	129.6	930	95	-	TY
28/12	25.6	130.1	935	95	6.5	TY
28/15	26.0	130.5	940	90	-	TY
28/18	26.3	130.9	940	85	6.5	TY
28/21	26.9	131.4	940	85	-	TY
29/00	27.2	131.6	945	80	5.5	TY
29/03	27.6	132.0	950	75	-	TY
29/06	28.2	132.8	955	70	5.0	TY
29/09	28.6	133.4	955	70	-	TY
29/12	29.1	134.1	960	70	5.0	TY
29/15	29.8	134.8	960	70	-	TY
29/18	30.6	135.6	965	65	4.5	TY
29/21	31.3	136.4	970	65	-	TY
30/00	31.9	137.2	975	65	4.0	TY
30/03	32.8	138.2	975	65	-	TY
30/06	33.5	139.1	980	65	3.5	TY
30/09	34.1	140.3	985	65	-	TY
30/12	34.7	141.6	990	60	3.0	STS
30/15	35.3	142.7	994	55	-	STS
30/18	36.0	144.0	998	-	2.5	L
31/00	37.1	146.7	1004	-	-	L
31/06	37.7	148.2	1010	-	-	L
31/12	38.3	149.6	1012	-	-	L
31/18	39.1	150.3	1012	-	-	L
Nov. 01/00	39.9	150.9	1012	-	-	L
01/06						Dissip.

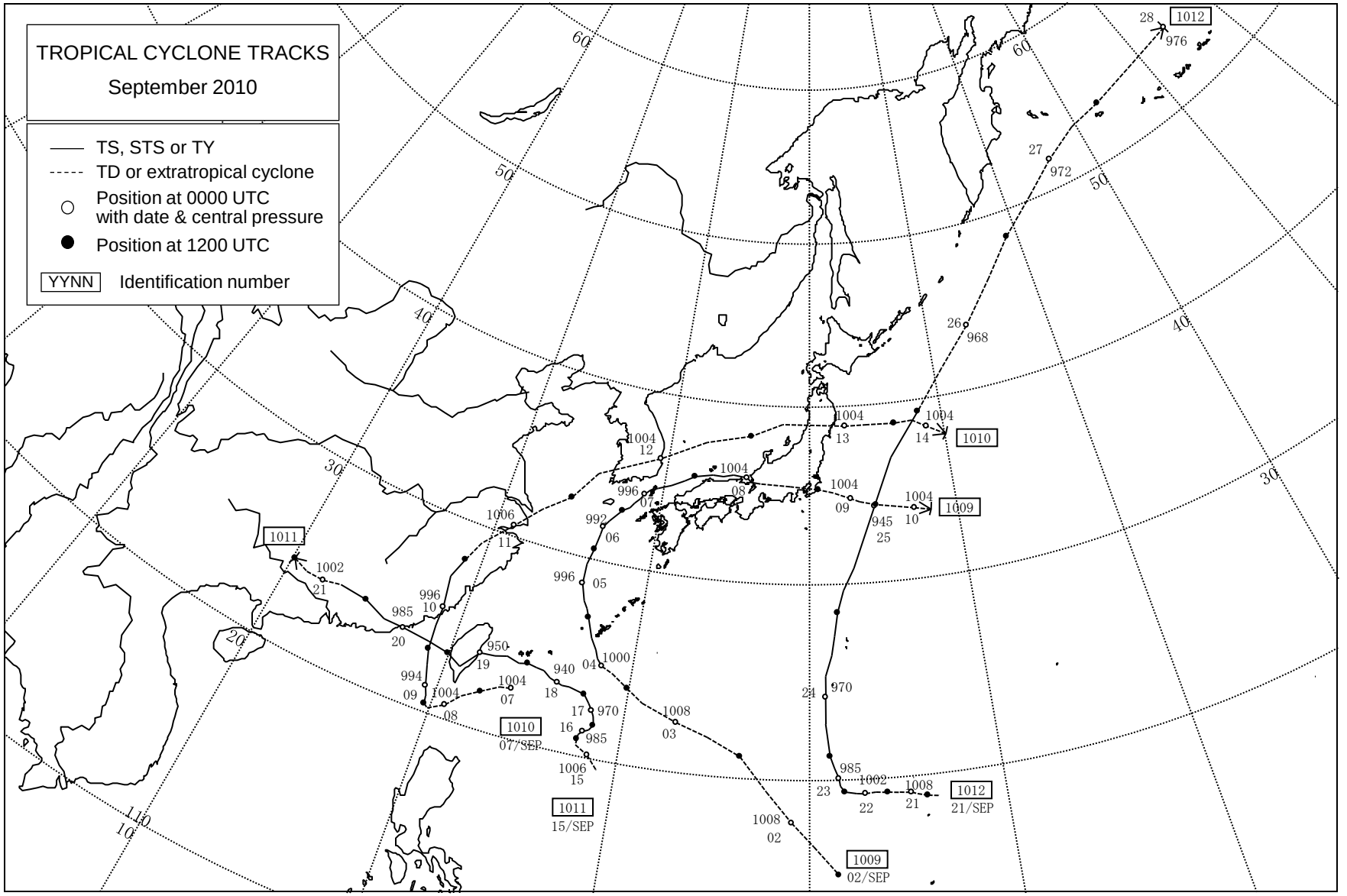
Appendix 2

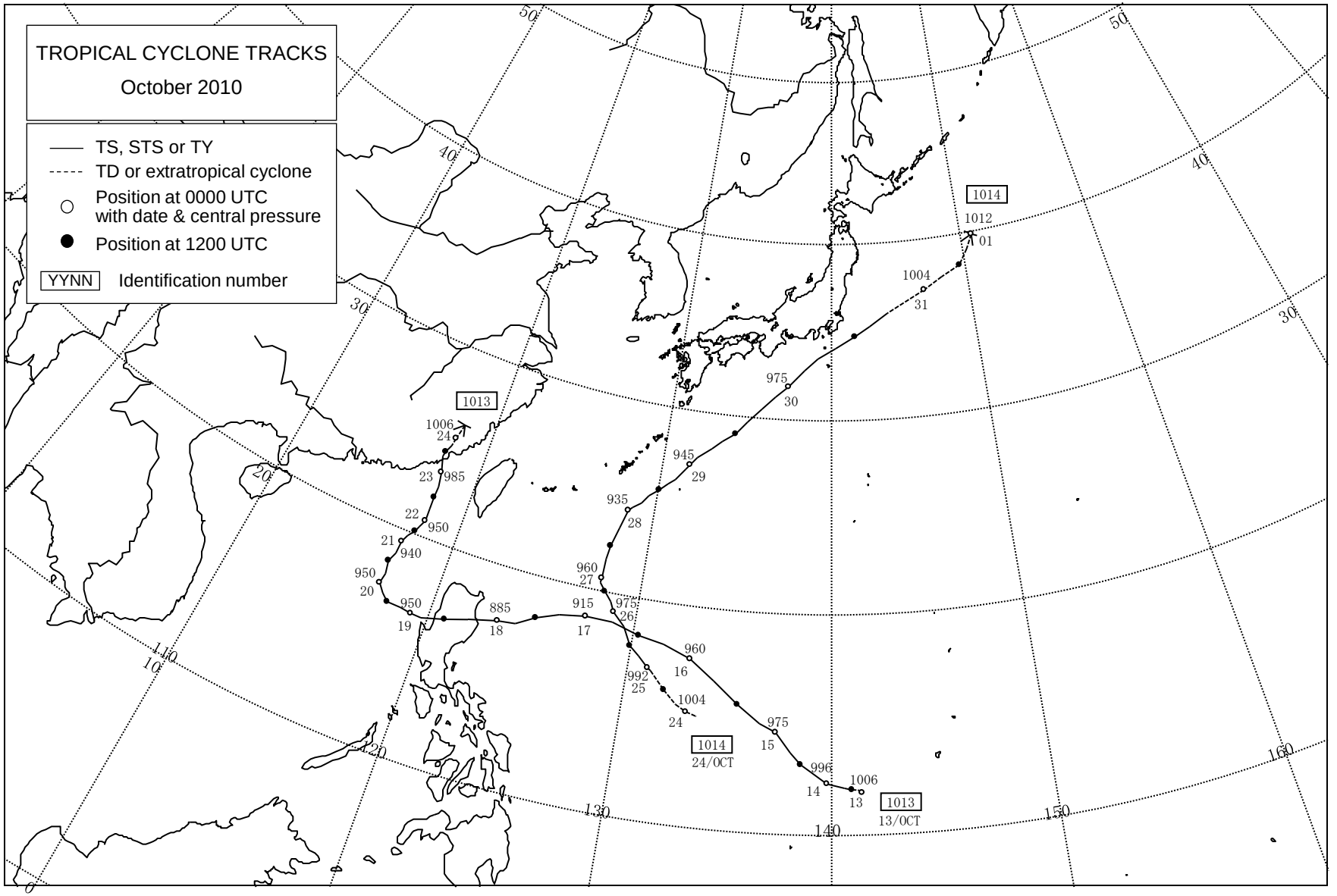
Monthly Tracks of Tropical Cyclones in 2010


TROPICAL CYCLONE TRACKS
March 2010
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN
Identification number
40
30
20
10
0
110
120
130
140
150
160
1001
26
1004
25
998
24
1000
23
1002
1001
23/MAR


TROPICAL CYCLONE TRACKS
July 2010
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1002
1000
18
1003
996
23
980
17
970
22
975
16
985
21
998
20
990
15
1004
19
1008
18
1003
18/JUL
985
14
975
13
1000
12
1002
12/JUL
50
40
30
20
10
0
110
120
130
140
150
160


TROPICAL CYCLONE TRACKS
August 2010
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
60
50
40
30
20
10
110
1007
984 06
994 05
1004
998 13
1004 03
1000 04
990 02
994 12
990 11
985 10
965 01
1005
1000 25
1006
1004 04
1002 03
1008
996 31
996 02
1000 30
1008
30/AUG
985 24
990 30
990 01
1000 29
31 985
994 23
1002 22
28 1004
1005
22/AUG
1006
28/AUG
990 09
960 31
998 08
1002 07
1004
07/AUG
994 30
1004 29
1007
29/AUG


TROPICAL CYCLONE TRACKS
September 2010
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
60
50
40
30
20
10
110
1011
1002
21
996
10
985
20
950
19
994
09
1004
07
1004
08
940
18
1000
04
970
17
1010
07/SEP
985
16
1006
15
1011
15/SEP
1008
03
1008
02
1009
02/SEP
1006
11
992
06
996
05
996
07
1004
08
1004
12
1004
13
1004
14
1010
1004
09
1004
10
1009
945
25
970
24
985
23
1002
22
1008
21
1012
21/SEP
1012
28
976
27
972
26
968


TROPICAL CYCLONE TRACKS
October 2010
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
1014
1012
01
1004
31
975
30
1013
1006
24
945
29
23
985
935
28
22
950
21
940
960
27
950
20
915
975
26
885
950
19
18
17
960
16
992
25
1004
24
975
15
1014
24/0CT
996
14
1006
13
1013
13/0CT
10
20
30
40
50
110
120
130
140
150
160

Appendix 3

Track and Intensity Analysis and Forecast Errors for Each Tropical Cyclone in 2010

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
TS Omais (1001)												
Mar 24/12	22	150					-2			5		
24/18	68	208					-4			5		
25/00	21											
25/06	55											
25/12	54											
25/18	0											
mean	37	179					-3			5		
sampl	6	2					2			2		

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
TY Conson (1002)												
Jul. 12/00	24	235	436	451	592	596	15	0	-5	-20	-5	0
12/06	0	233	424	445	600	625	10	-15	-10	-15	10	5
12/12	0	248	320	485	578	618	0	-22	-15	-5	20	10
12/18	0	271	390	484	553	597	-20	-32	-20	15	30	15
13/00	0	156	264	399	431		-20	-30	-20	15	25	15
13/06	11	141	273	436	491		-20	-25	-15	15	20	10
13/12	22	69	314	436	543		-17	-15	-15	15	10	15
13/18	70	155	362	411	418		-12	-10	-10	15	5	10
14/00	24	169	319	297			-10	-10	0	5	5	0
14/06	0	85	191	284			0	5	-10	-5	-10	5
14/12	0	173	258	354			10	10	-12	-15	-10	10
14/18	46	193	264	322			5	10	-11	-10	-10	10
15/00	0	168	247				5	0		-10	0	
15/06	54	115	209				10	-5		-15	0	
15/12	11	133	215				10	-2		-5	0	
15/18	11	59	38				10	-4		-5	5	
16/00	15	25					0			5		
16/06	0	74					-15			15		
16/12	15	91					-12			10		
16/18	0	90					-11			10		
17/00	46											
17/06	0											
17/12	0											
17/18	0											
mean	15	144	283	400	526	609	-3	-9	-12	1	6	9
sampl	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	=90	=120	T=24	=48	=72	T=24	=48	=72
TY Chanthu (1003)												
Jul. 19/12	22	35	39	185			-5	-5	0	5	-5	-10
19/18	67	116	105	330			0	0	-5	0	-5	0
20/00	31	148	146	429			0	5	-16	-5	-10	10
20/06	31	148	156				0	5		-10	-10	
20/12	54	130	122				0	10		-10	-20	
20/18	56	112	92				0	11		-5	-15	
21/00	31	52	91				5	0		-10	-10	
21/06	0	70					15			-20		
21/12	0	84					5			-15		
21/18	21	177					0			-5		
22/00	0	168					-11			5		
22/06	0											
22/12	21											
22/18	67											
23/00	0											
mean	27	113	107	315			1	4	-7	-6	-11	0
sampl	15	11	7	3			11	7	3	11	7	3

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
STS Dianmu (1004)												
Aug. 08/12	20	145	160	252	508		7	7	4	-10	-10	-10
08/18	0	102	168	424			7	7	2	-10	-10	-5
09/00	0	135	306	552			5	2	2	-5	-5	-5
09/06	0	15	282	419			0	0	2	0	0	-5
09/12	0	28	322	603			-5	-2	-2	5	0	5
09/18	0	47	247				-5	-4		5	5	
10/00	0	14	119				-10	-4		10	5	
10/06	33	76	260				-12	-4		10	0	
10/12	15	126	509				-12	-6		10	5	
10/18	14	118					-9			10		
11/00	0	214					-4			10		
11/06	22	97					-2			5		
11/12	0	266					-4			10		
11/18	14											
12/00	0											
12/06	0											
12/12	0											
mean	7	106	264	450	508		-3	-0	2	4	-1	-4
sampl	17	13	9	5	1		13	9	5	13	9	5

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
TS Mindulle (1005)												
Aug. 23/00	55	64					5			0		
23/06	34	49					5			0		
23/12	0	67					0			5		
23/18	42	116					-6			10		
24/00	0											
24/06	0											
24/12	0											
24/18	25											
mean	19	74					1			4		
sampl	8	4					4			4		

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
STS Lionrock (1006)												
Aug. 28/18	31	56	124	243	113		0	5	0	0	-5	0
29/00	33	15	98	207	65		6	5	-5	-5	-5	5
29/06	0	10	130	159			7	0	-5	-5	0	5
29/12	44	91	148	59			5	0	-10	-5	0	10
29/18	21	118	56	167			0	-5	-10	0	5	10
30/00	11	100	10	224			0	-5	-11	0	5	15
30/06	0	74	99				0	-5		0	5	
30/12	24	56	137				0	-5		0	5	
30/18	30	71	151				0	-5		0	5	
31/00	49	39	226				-5	-11		5	15	
31/06	53	70					-5			5		
31/12	57	49					-5			5		
31/18	43	38					-5			5		
01/00	23	84					-6			10		
01/06	39											
01/12	45											
01/18	46											
02/00	63											
mean	34	62	118	176	89	0	-1	-3	-7	1	3	8
sampl	18	14	10	6	2	0	14	10	6	14	10	6

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
TY Kompasu (1007)													
Aug.	29/18	56	161	341	780			20	20	-5	-25	-25	0
	30/00	22	23	189	763			25	15	-15	-30	-20	10
	30/06	0	87	264	875			15	5	-14	-20	-10	10
	30/12	0	119	253	704			10	5	-18	-15	-10	20
	30/18	0	118	316				0	-10		-5	5	
	31/00	0	146	480				-15	-20		10	15	
	31/06	0	156	537				-10	-14		10	10	
	31/12	0	214	585				0	-8		0	10	
	31/18	0	156					-10			0		
	01/00	0	193					-10			5		
	01/06	0	195					-9			5		
	01/12	0	215					-4			0		
	01/18	56											
	02/00	22											
	02/06	0											
	02/12	0											
	mean	10	149	371	780			1	-1	-13	-5	-3	10
	sampl	16	12	8	4			12	8	4	12	8	4

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
TS Namtheun (1008)													
Aug.	30/12	33											
	30/18	0											
	31/00	15											
	mean	16											
	sampl	3											

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
STS Malou (1009)													
Sep.	04/00	46	135	237	458	998		0	-2	-11	-5	-5	5
	04/06	67	180	211	524			-4	-7	-11	-5	0	5
	04/12	0	91	173	508			-4	-9	-11	0	0	5
	04/18	33	125	172	435			-2	-14	-20	-5	5	15
	05/00	67	101	154	469			-7	-16	-24	0	10	20
	05/06	126	149	288				-7	-16		0	10	
	05/12	97	173	457				-9	-16		0	10	
	05/18	111	150	362				-14	-15		5	10	
	06/00	88	140	337				-16	-19		10	15	
	06/06	38	165					-16			10		
	06/12	50	249					-16			10		
	06/18	39	273					-15			10		
	07/00	22	168					-10			5		
	07/06	0											
	07/12	0											
	07/18	18											
	08/00	11											
	mean	48	161	265	479	998		-9	-13	-15	3	6	10
	sampl	17	13	9	5	1		13	9	5	13	9	5

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
STS Meranti (1010)													
Sep.	08/18	85	215					11			-20		
	09/00	38	126					2			-5		
	09/06	22	49					2			-35		
	09/12	11											
	09/18	10											
	10/00	30											
	10/06	0											
	mean	28	130					5			-20		
	sampl	7	3					3			3		

Date/Time		Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
	(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
TY Fanapi (1011)													
Sep.	15/12	38	76	15	143	430	743	19	30	35	-20	-25	-25
	15/18	30	38	24	55	210		20	30	45	-20	-25	-35
	16/00	30	33	15	162	324		0	20	0	0	-10	0
	16/06	30	47	92	285	498		5	20	-20	-5	-10	15
	16/12	0	38	74	249	363		5	10	-5	0	-5	5
	16/18	0	31	45	188			5	20	15	-5	-15	-15
	17/00	22	0	88	99			10	10	13	-5	-5	-15
	17/06	0	73	172	129			10	10	12	-5	-10	-45
	17/12	0	35	98	45			0	5	6	0	-5	-40
	17/18	0	24	54				10	5		-10	-5	
	18/00	0	54	107				-10	-5		5	5	
	18/06	0	176	139				0	6		0	-5	
	18/12	0	117	74				0	2		0	-5	
	18/18	0	23					0			0		
	19/00	0	114					-5			5		
	19/06	20	24					4			-5		
	19/12	0	88					-2			0		
	19/18	31											
	20/00	33											
	20/06	20											
	20/12	84											
	mean	16	58	77	151	365	743	4	13	11	-4	-9	-17
	sampl	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	=90	=120	T=24	=48	=72	T=24	=48	=72
TY Malakas (1012)													
Sep.	22/00	70	53	226	815			-5	-5	5	0	0	0
	22/06	0	123	171	546			0	5	0	-10	-5	0
	22/12	0	129	145				0	10		-10	-10	
	22/18	47	83	214				0	15		-5	-10	
	23/00	62	114	349				0	15		-5	-5	
	23/06	47	177	449				5	0		-5	0	
	23/12	21	224					5			-10		
	23/18	0	107					15			-10		
	24/00	0	133					15			-5		
	24/06	0	66					5			0		
	24/12	0											
	24/18	0											
	25/00	0											
	25/06	18											
	mean	19	121	259	681			4	7	2	-6	-5	0
	sampl	14	10	6	2			10	6	2	10	6	2

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
TY Megi (1013)												
Oct. 13/12	33	73	125	218	275	321	5	15	25	-5	-15	-20
13/18	55	109	219	295	307	361	10	15	40	-10	-15	-30
14/00	98	187	342	366	254	318	10	10	40	-10	-10	-30
14/06	39	78	207	239	253	248	10	10	45	-10	-10	-30
14/12	22	119	217	236	284	224	10	15	55	-10	-10	-40
14/18	34	123	201	181	259	149	10	30	60	-10	-25	-45
15/00	0	70	134	169	465	502	0	30	55	0	-25	-40
15/06	0	123	190	269	457	372	0	35	30	-5	-25	-20
15/12	11	67	152	169	336	293	5	45	5	-5	-35	-10
15/18	0	75	146	225	144	159	20	55	0	-20	-40	-5
16/00	44	64	84	150	67	369	30	55	0	-25	-40	0
16/06	0	67	182	299	317	582	40	40	10	-30	-25	-5
16/12	0	57	111	231	400	582	45	10	0	-35	-10	0
16/18	11	70	86	323	438	528	50	0	-10	-30	-5	5
17/00	0	96	160	240	417	511	25	-5	-10	-10	5	5
17/06	0	109	120	168	368	481	40	-5	-10	-25	5	5
17/12	0	101	79	153	315	402	0	-10	0	-5	5	0
17/18	0	46	53	205	355	445	0	-10	0	-5	5	0
18/00	0	11	40	229	364	431	0	-10	5	0	5	-10
18/06	11	40	131	284	375	470	0	-10	-5	0	5	-5
18/12	34	35	149	260	358	357	0	-5	-5	0	0	-5
18/18	88	109	229	349	440		0	5	-5	5	0	5
19/00	54	93	229	316	379		-20	-20	-30	15	10	20
19/06	15	57	176	203	225		-25	-15	-30	20	5	25
19/12	15	79	191	182	132		-20	-15	-40	15	5	30
19/18	11	77	137	132			-20	-20	-50	15	15	40
20/00	15	133	167	176			-10	-20	-45	10	20	40
20/06	0	98	144	231			-5	-20	-47	5	25	50
20/12	0	31	91	157			0	-25	-50	0	20	50
20/18	33	10	83				-10	-30		10	20	
21/00	10	33	111				-15	-40		15	30	
21/06	0	33	145				-20	-47		20	40	
21/12	0	59	123				-25	-40		15	40	
21/18	0	35					-15			15		
22/00	0	63					-25			25		
22/06	0	90					-22			25		
22/12	0	38					-20			20		
22/18	0											
23/00	0											
23/06	0											
23/12	0											
mean	16	75	150	229	319	386	2	1	1	-1	-1	-1
sampl	41	37	33	29	25	21	37	33	29	37	33	29

Date/Time	Center Position (km)						Central Pressure (hPa)			Max. Wind (kt)		
(UTC)	T=00	=24	=48	=72	=90	=120	T=24	=48	=72	T=24	=48	=72
TY Chaba (1014)												
Oct. 24/18	39	25	109	114	108	259	10	20	30	-15	-20	-25
25/00	21	46	99	161	185	506	10	20	35	-15	-20	-25
25/06	0	107	138	145	327	742	0	15	35	-5	-15	-25
25/12	0	95	123	226	424	902	-5	10	20	0	-10	-20
25/18	11	71	167	325	605		-5	10	15	5	-10	-10
26/00	54	88	75	254	685		0	15	5	0	-10	0
26/06	22	56	144	416	880		0	20	-5	-5	-15	10
26/12	0	53	284	541	1095		10	20	0	-10	-20	5
26/18	10	151	322	657			10	20	0	-10	-10	10
27/00	0	158	440	739			5	5	-15	-5	0	10
27/06	10	115	442	685			15	-5	-20	-10	10	10
27/12	0	115	329	646			10	-10	-30	-5	15	15
27/18	0	114	444				10	-10		-5	10	
28/00	0	133	444				5	-15		0	10	
28/06	0	209	455				-5	-10		10	0	
28/12	0	149	500				-5	-15		5	0	
28/18	0	166					-10			10		
29/00	0	131					5			-10		
29/06	0	104					5			-15		
29/12	10	93					-5			-10		
29/18	0											
30/00	19											
30/06	9											
30/12	0											
mean	9	109	282	409	538	602	3	6	6	-4	-5	-4
sampl	24	20	16	12	8	4	20	16	12	20	16	12

Appendix 4

Monthly and Annual Frequencies of Tropical Cyclones

Monthly and annual frequencies of tropical cyclones that attained TS intensity or higher in the western North Pacific and the South China Sea for 1951 - 2010

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	5	5	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	1	3	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
Normal 1971-2000	0.5	0.1	0.4	0.8	1.0	1.7	4.2	5.4	5.0	3.9	2.5	1.3	26.7

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 YYGGggF UTC LaLa.LaF N LoLoLo.LoF E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
Ft1Ft1HF YYGGggF UTC LaLa.LaF N LoLoLo.LoF E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
GUST VgVgVg KT
MXWD VmVmVm KT
Ft2Ft2HF YYGGggF UTC LaLa.LaF N LoLoLo.LoF 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 YYGGggF UTC LaLa.LaF N LoLoLo.LoF E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
96HF YYGGggF UTC LaLa.LaF N LoLoLo.LoF E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
120HF YYGGggF UTC LaLa.LaF N LoLoLo.LoF E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT=

Notes:

a. Underlined parts are fixed.

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

Example:

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

(3) RSMC Guidance for Forecast (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) SAREP (TCNA20/21 RJTD)

TCNA i i RJTD YYGGgg
CCAA YYGGg 47644 name (common-No.) nt nt LaLaLa Qc LoLoLoLo 1At Wt at tm
2St St // (9ds ds fs fs)=

Notes:

a. Underlined is fixed.

b. Symbolic letters

i i	:	20 for the observation at 03, 09, 15 and 21 UTC 21 for the observation at 00, 06, 12 and 18 UTC
YYGGg	:	Time of observation submitting the data for analysis in UTC
nt nt	:	Serial number of the tropical cyclone in order of its formation in the year given in '01' - '99'
LaLaLa	:	Latitude given in 0.1°
Qc	:	Quadrant of the earth. 1: N/E, 2: S/E, 3: S/W and 4: N/W
LoLoLoLo	:	Longitude in 0.1°
At	:	Confidence 0: =<10km 1: =<20km 2: =<50km 3: =<100km 4: =<200km 5: =<300km /: unable to determine
Wt	:	Mean diameter (d: degree in latitude) of cloud system 0: d<1° 1: 1°=<d<2° 2: 2°=<d<3° 3: 3°=<d<4° 4: 4°=<d<5° 5: 5°=<d<6° 6: 6°=<d<7° 7: 7°=<d<8° 8: 8°=<d<9° 9: 9°=<d /: unable to determine
At	:	24-hour intensity inclination 0: further weakening 1: weakening 2: no change 3: intensifying 4: further intensifying 9: no former observation /: unable to determine
tm	:	Time interval (t: hour) for determination of movement 0: t<1 1: 1=<t<2 2: 2=<t<3 3: 3=<t<6 4: 6=<t<9 5: 9=<t<12 6: 12=<t<15 7: 15=<t<18 8: 18=<t<21 9: 21=<t<30 /: no (9dsdsfsfs) group

StSt	:	Intensity
		00: weakening 15, 20, 25 … 80: CI-number (in 0.1)
		99: under extratropical transformation //: unable to determine
dsds	:	Direction of movement (in 10°)
fsfs	:	Speed of movement (in knots)

Example:

TCNA21 RJTD 180000
CCAA 18000 47644 DAMREY(0001) 29149 11272 11334 275// 92811=

(5) 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.=

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

FKPQ i i RJTD YYGGgg	
TC ADVISORY	
DTG:	yyyymmdd/time Z
TCAC:	TOKYO
TC:	name
NR:	number
PSN:	N LaLa.LaLa E LoLoLo.LoLo
MOV:	direction SpSpSp KT
C:	PPPP HPA
MAX WIND:	WWW KT
FCST PSN +6HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo*
FCST MAX WIND +6HR:	WWW KT*
FCST PSN +12HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo
FCST MAX WIND +12HR:	WWW KT
FCST PSN +18HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo*
FCST MAX WIND +18HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo*
FCST PSN +24HR:	YY/GGgg Z N LaLa.LaLa E LoLoLo.LoLo
FCST MAX WIND +24HR:	WWW KT
RMK:	NIL =
NXT MSG:	yyyymmdd/time Z

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

Notes:

a. Underlined parts are fixed.

b. Abbreviations

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

c. Symbolic letters

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

Example:

FKPQ30 RJTD 271200
TC ADVISORY

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

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

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

:
:
DISSIPATION AT MMMDDTTUTC=

Notes:

a. Underlined parts are fixed.

b. [1)] REMARKS is given optionally.

c. Symbolic letters

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

Example:

AXPQ20 RJTD 020600

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

Appendix 6

Specifications of JMA NWP (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 (TL959L60) has about 20 km horizontal resolution and 60 vertical layers. Details on the GSM are found in Nakagawa (2009). TEPS (TL319L60), became operational in February 2008, has 11 members with approx. 60 km horizontal resolution and 60 vertical layers. A singular vector (SV) method is employed for the initial perturbation setup. 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), TL959L60	TEPS (Typhoon Ensemble Prediction System), TL319L60
Resolution	20 km, 60 layers (Top: 0.1hPa)	60 km, 60 layers (Top: 0.1hPa)
Area	Global	Global
Method for initial value	Global Data Assimilation System (4DVAR) Outer resolution: TL959L60 Inner resolution: T159L60 Window: Init-3h to Init + 3h	Unperturbed condition: Truncated GSM initial condition Initial perturbation: SV-based perturbation Ensemble size: 11 (10 perturbed members and 1 control member) SV target areas: 1 fixed (Dry SV / 20°N -60°N, 100 °E -180°E) + TC adapted (Moist SV / Max 3 TCs) (e.g. Fig 6.1)
Forecast time (and initials)	84h (00, 06, 18 UTC) 216h (12 UTC)	132h (00, 06, 12, 18 UTC)
Operational as from	21 November 2007	February 2008 (de facto from T0801)

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

- Improvement on the initial perturbation setup (May 2010)
- Introduction of a stochastic physics scheme (December 2010)

Global Data Assimilation Systems:

- Improvement on the position of TC bogus data (April 2010)
- Assimilation of clear sky radiance from GOES-13 (May 2010)
- Assimilation of atmospheric motion vector from GOES-13 (May 2010)
- Assimilation of atmospheric motion vector from MTSAT-2 (August 2010)
- Assimilation of GNSS radio occultation data from COSMIC (November 2010)

- Improvement on the assimilation of AMSU-A data in coastal areas (November 2010)

TEPS:

TEPS is an ensemble prediction system used mainly for TC track forecasts up to five days ahead. Initial perturbations are created by the combination of dry singular vectors (SVs) with one fixed target area (20°N -60°N, 100°E-180°E) and moist SVs with the TC adaptive target area (centered on the predicted typhoon in one-day forecasting up to three areas configured for different typhoons at one initial time). Figure 6.1 shows an example of SV target areas. At this initial time, there were three TCs in the area. Figure 6.2 shows an example of TEPS forecast tracks for MELOR (TY0918). In this case, the forecasted TC track of the control member was entering into the Sea of Japan, which turned to be false, while the ensemble mean and some members predicted tracks appropriately following the observed one. The details on TEPS are found in Yamaguchi and Komori (2009).

[References]

Nakagawa, M., 2009: Outline of the High Resolution Global Model at the Japan Meteorological Agency. RSMC Tokyo-Typhoon Center Technical Review, **11**, 1-13.

Yamaguchi, M. and T. Komori, 2009: Outline of the Typhoon Ensemble Prediction System at the Japan Meteorological Agency. RSMC Tokyo-Typhoon Center Technical Review, **11**, 14-24.

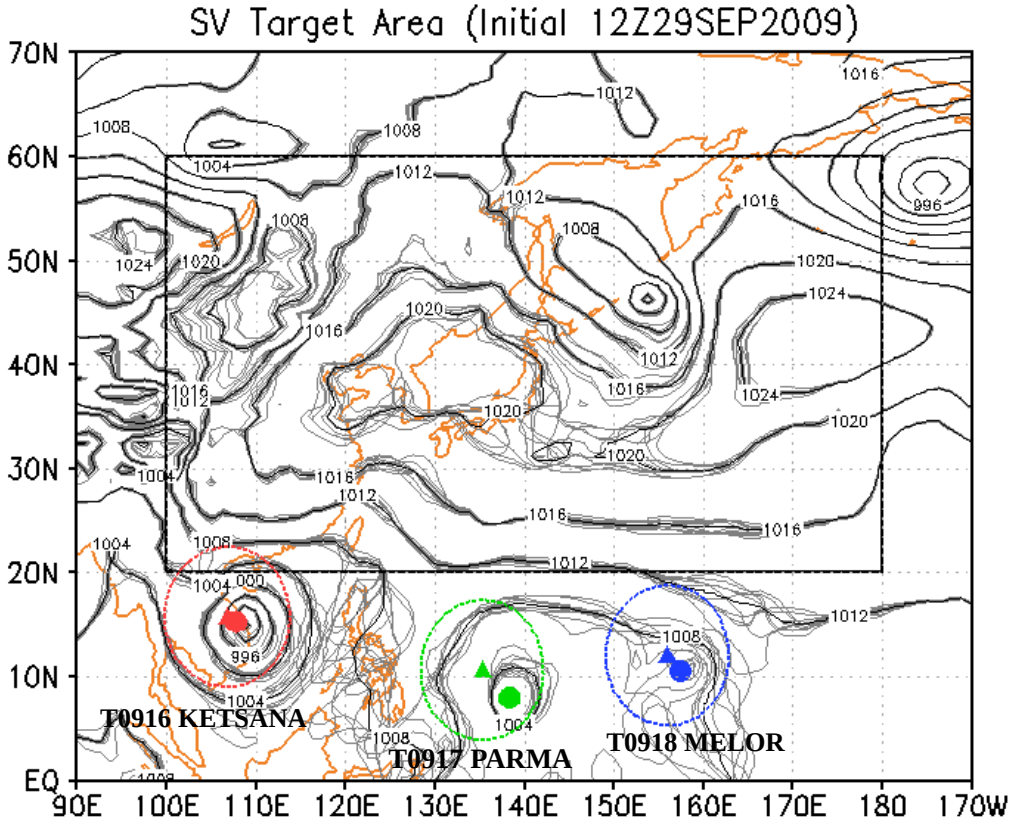


Figure 6.1 Example of SV target area of TEPS (Initial time: 12UTC 29 September 2009). Filled circles and triangles show TC central positions and operational 24-hour forecast positions. Gray contours show the initial sea level pressure of each member. The large thick rectangular shows fixed SV target area and dashed circles show adaptive target area of each TC. Adaptive areas are set around 24-hour forecast TC positions.

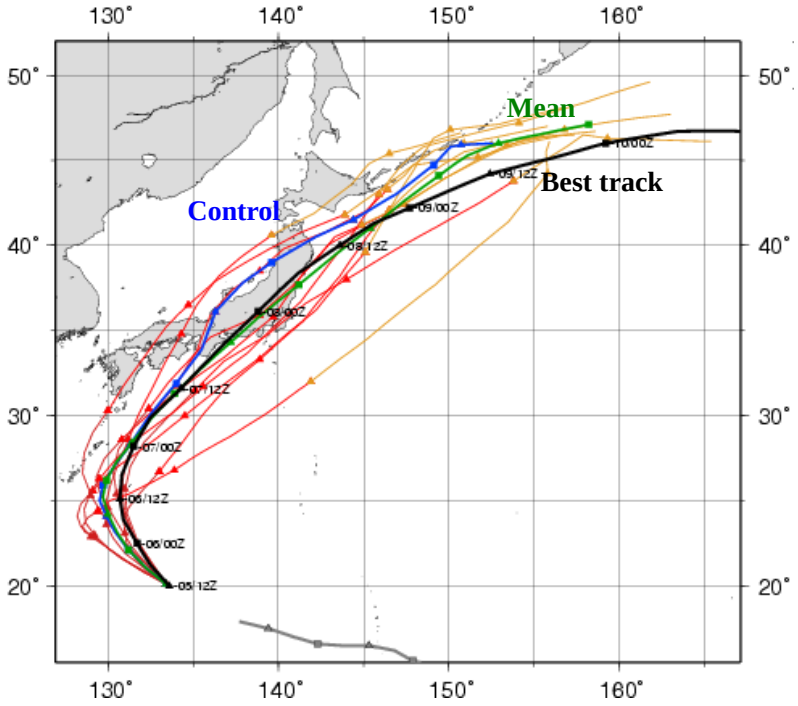


Figure 6.2 Example of TEPS forecast track (Initial time: 12UTC 5 October 2009). Black, blue, and green lines denote TC best track, forecast track of control member and ensemble mean respectively. Red (up to 96-hour) and yellow (up to 120-hour) lines show TC forecast tracks of all perturbed members.

Appendix 7

List of GPV products and data on the RSMC Data Serving System

Area	20S-60N, 80E-160W	20S-60N, 60E-160W
Resolution	2.5×2.5 degrees	1.25×1.25 degrees
Levels and elements	Surface (P, U, V, T, TTd, R) 850hPa (Z, U, V, T, TTd, ω) 700hPa (Z, U, V, T, TTd, ω) 500hPa (Z, U, V, T, TTd, ζ) 300hPa (Z, U, V, T) 250hPa (Z, U, V, T) 200hPa (Z, U, V, T) 150hPa (Z, U, V, T) 100hPa (Z, U, V, T)	Surface (P, U, V, T, TTd, R)** 1000hPa (Z, U, V, T, TTd) 925hPa (Z, U, V, T, TTd, ω) 850hPa (Z*, U*, V*,T*, TTd*, ω, ψ, χ) 700hPa (Z*, U*, V*,T*, TTd*, ω) 500hPa (Z*, U*, V*,T*, TTd*, ζ) 400hPa (Z, U, V, T, TTd) 300hPa (Z, U, V, T, TTd) 250hPa (Z, U, V, T) 200hPa (Z*, U*, V*, T*, ψ, χ) 150hPa (Z, U, V, T) 100hPa (Z, U, V, T) 70hPa (Z, U, V, T) 50hPa (Z, U, V, T) 30hPa (Z, U, V, T) 20hPa (Z, U, V, T) 10hPa (Z, U, V, T)
Forecast hours	For 00 and 12 UTC: 0, 6, 12, 18, 24, 30, 36, 48, 60 and 72 hours	For 00 and 12 UTC: 0 – 84 (every 6 hours) For 12 UTC only: * 96, 120, 144, 168 and 192 hours ** 90 – 192 (every 6 hours)
Frequency (initial times)	Twice a day (00 and 12 UTC)	Twice a day (00 and 12 UTC)

Area	Globe		Globe
Resolution	2.5×2.5 degrees		1.25×1.25 degrees
Levels and elements	Surface (P, R, U, V, T) 1000hPa (Z) 850hPa (Z, U, V, T, TTd) 700hPa (Z, U, V, T, TTd) 500hPa (Z,U,V, T) 300hPa (Z,U,V, T) 250hPa (Z,U,V, T)* 200hPa (Z,U,V, T) 100hPa (Z,U,V, T)* 70hPa (Z,U,V, T)* 50hPa (Z,U,V, T)* 30hPa (Z,U,V, T)*	Surface (P, U, V, T, TTd*) 1000hPa (Z, U, V, T, TTd*) 850hPa (Z, U, V, T, TTd) 700hPa (Z, U, V, T, TTd) 500hPa (Z, U, V, T, TTd*) 400hPa (Z, U, V, T, TTd*) 300hPa (Z, U, V, T, TTd*) 250hPa (Z, U, V, T) 200hPa (Z, U, V, T) 150hPa (Z, U, V, T) 100hPa (Z, U, V, T) 70hPa (Z, U, V, T) 50hPa (Z, U, V, T) 30hPa (Z, U, V, T) 20hPa (Z, U, V, T) 10hPa (Z, U, V, T)	Surface (P, U, V, T, RH, R) 1000hPa (Z, U, V, T, RH, ω) 925hPa (Z, U, V, T, RH, ω) 850hPa (Z, U, V, T, RH, ω, ψ, χ) 700hPa (Z, U, V, T, RH, ω) 600hPa (Z, U, V, T, RH, ω) 500hPa (Z, U, V, T, RH, ω, ζ) 400hPa (Z, U, V, T, RH, ω) 300hPa (Z, U, V, T, RH, ω) 250hPa (Z, U, V, T) 200hPa (Z, U, V, T, ψ, χ) 150hPa (Z, U, V, T) 100hPa (Z, U, V, T) 70hPa (Z, U, V, T) 50hPa (Z, U, V, T) 30hPa (Z, U, V, T) 20hPa (Z, U, V, T) 10hPa (Z, U, V, T)
Forecast hours	For 00 and 12 UTC: 24, 48 and 72 hours For 12 UTC only: 96 – 192 (every 24 hours) * 96 and 120 only	For 00 and 12 UTC: 0 hours (analysis) * 00UTC only	For 00 and 12 UTC: 0 – 84 (every 6 hours) For 12 UTC only: 96 – 192 (every 12 hours)
Frequency (initial times)	Twice a day (00 and 12 UTC)		Twice a day (00 and 12 UTC)

Area	Globe
Resolution	2.5×2.5 degrees
Levels and elements	Surface (P) 1000hPa (Z) 850hPa (T, U, V) 500hPa (Z) 250hPa (U, V) *Above GPVs consists of ensemble mean and standard deviation of ensemble forecast members.
Forecast hours	0 – 192 hours (every 12 hours)
Frequency (initial times)	Once a day (12 UTC)

Notes:

P:	pressure reduced to mean sea level	R:	total precipitation	RH:	relative humidity
T:	temperature	TTd:	dew point depression	U:	u-component of wind
V:	v-component of wind	Z:	geopotential height	ζ:	relative vorticity
χ:	velocity potential	ψ:	stream function	ω:	vertical velocity

Products/ Data	Satellite data	Typhoon Information	Global Wave Model	Observational data
Contents	MTSAT-1R data (GRIB) • High density atmospheric motion vector (VIS, IR, WV)	Tropical cyclone related information (BUFR) • tropical cyclone analysis data	• Significant wave height • Prevailing wave period • Prevailing wave direction (GRIB) Forecast hours: 0, 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72, 78, 84 (for 00 and 12 UTC); 96, 108, 120, 132, 144, 156, 168 ,180 and 192 hours (for 12 UTC)	(a) Surface data (SYNOP, SHIP) (b) Upper-air data (TEMP, parts A-D) (PILOT, parts A-D)
Frequency (initial times)	VIS: twice a day (00 and 06UTC) IR and WV: 4 times a day (00, 06, 12 and 18UTC)	4 times a day (00, 06, 12 and 18 UTC)	Twice a day (00 and 12 UTC)	(a) Mostly 4 times a day (b) Mostly twice a day

Appendix 8

User's Guide to the Attached DVD

Preface

This DVD contains all the texts, tables and charts of the RSMC Annual Report 2010 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 2010. This document is a brief user's guide to the DVD, which was mastered in ISO-9660 format.

Directory and File layout

```
[Root]
|------AdbeRdr920_en_US.exe (Adobe Reader Installer)
|------Readme.txt (brief explanation of the DVD)
|------TopMenu.exe (start menu setup program)
|------SATAIDmanual.pdf (user manual for the satellite image viewer)
|------Annual_Report
        |---Text (text of Annual Report 2010 in PDF)
        |---Figure (figures for MS PowerPoint)
        |---Table (tables for MS Excel)
        |---Appendix (appendices for MS Excel and PowerPoint)
|------Programs
        |---Gmslpd
                |--Gmslpd.exe (viewer; tropical cyclone version in English)
                |--Gsetup.exe (setup programs)
|------Satellite_Image_Data
        |---T1001 (hourly satellite image data)
        |---T1002 (hourly satellite image data)
                :
        |---T1014 (hourly satellite image data)
|------Andata
        |--Besttrack
                |--E_BST_2010.txt (best track data for 2010)
                |--E_BST_20103.txt (best track data for TCs generated in March 2010)
                        :
                |--E_BST_201010.txt (best track data for TCs generated in October 2010)
```

How to use the DVD

When the DVD runs, a start menu automatically appears displaying a panel with buttons marked *Annual Report 2010*, *MTSAT Satellite Image*, *About DVD* and *Close* as well as a file list box for a number of introductory documents. Click the button 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 ver. 3.1 or later

< Annual Report 2010 >

Annual Report 2010 is provided in two formats as PDF files and MS Word/Excel/PowerPoint files.

- PDF files:

Click the *Annual Report 2010* button to open the text in PDF. If you cannot open the PDF file, install Adobe Acrobat Reader using the installer (ar405eng.exe) in the file list box of the start menu window and try again. Adobe Acrobat Reader (or Adobe Acrobat) is required to view PDF files.

- MS Word/Excel/PowerPoint files:

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

< MTSAT Satellite Image >

- Installation of the program for displaying satellite images

Click the *MTSAT Satellite Image* button to run the setup program (Gsetup.exe) for the satellite image viewer. Follow the instructions, and the satellite image viewer *Gmslpd.exe* will be installed onto the computer's hard disk. A list of the tropical cyclones occurring in 2010 is displayed in the selection window of the satellite images for tropical cyclones.

- Displaying satellite images

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

Period : From the generation stage to the weakening stage of each tropical cyclone

Images	: Infrared images (00 to 23 UTC) Visible images (00 to 09 and 21 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	: 0.04 degrees in both latitude and longitude
Compression of file	: Compressed using the *compress.exe* command of Microsoft Windows

< About DVD >

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

< Close >

Click the *Close* button to close the start menu window.

< File list box >

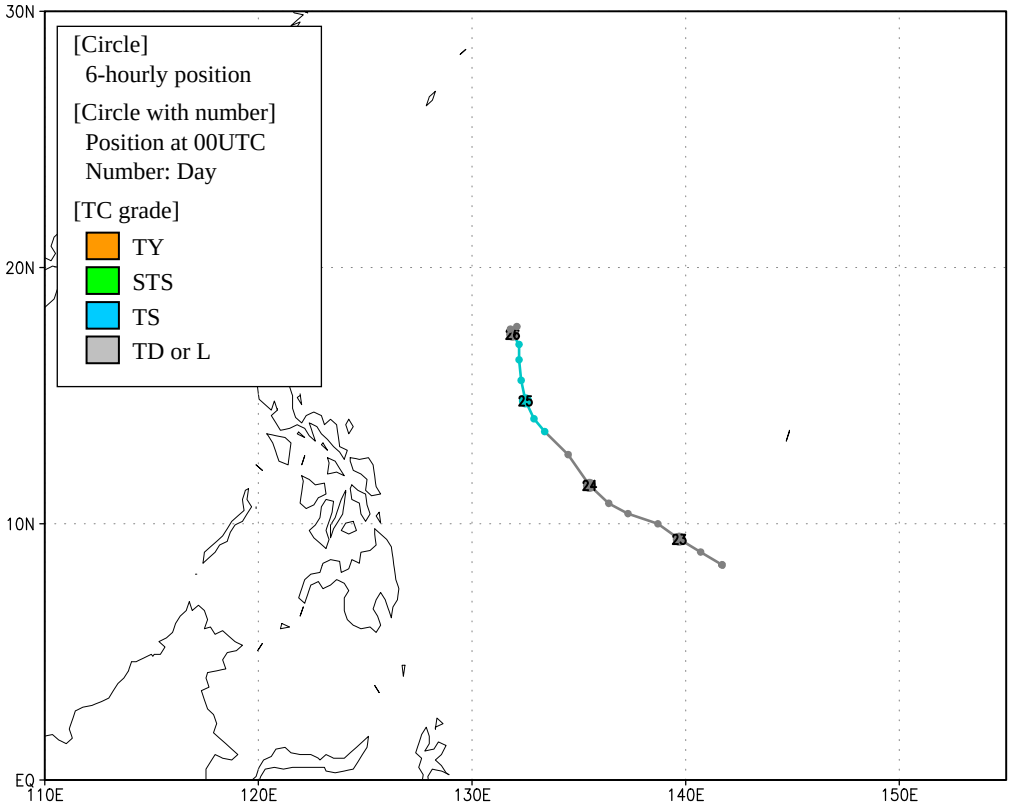
Document files can be opened from the file list box in the start menu window. Choose a file and click the *Open* button, or simply double-click the file name.

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

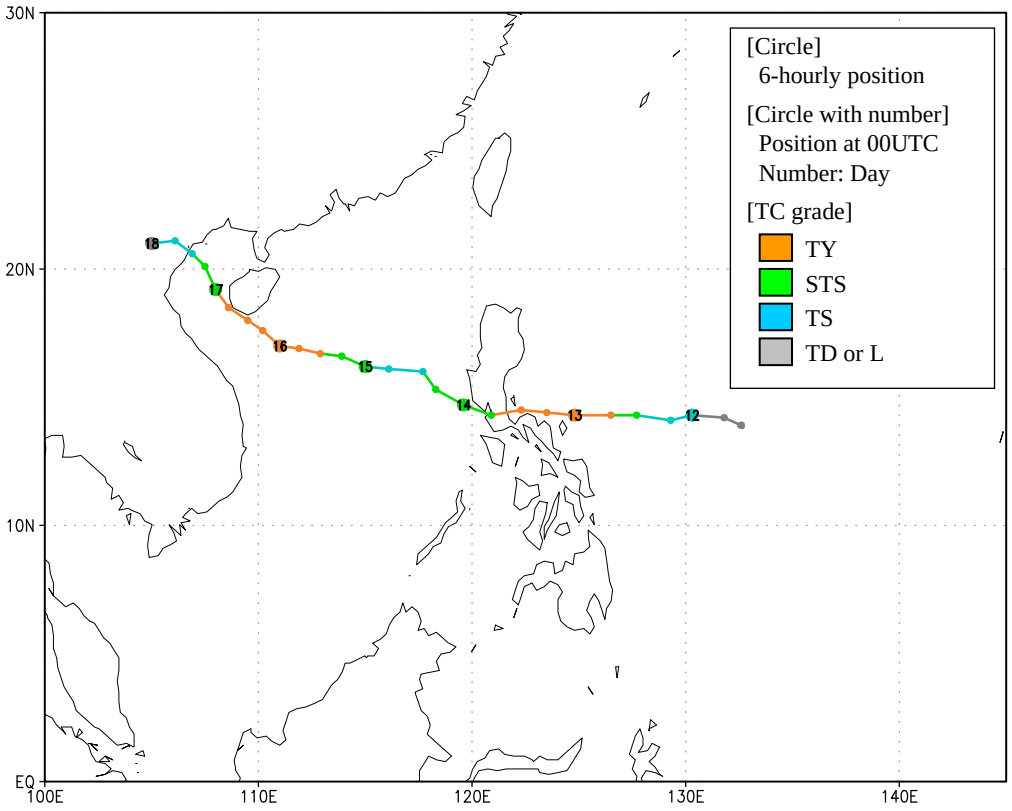
OMAIS (1001)

Omais formed as a tropical depression (TD) over the Caroline Islands at 12 UTC on 22 March 2010. Moving west-northwestward over the sea east of the Philippines, it was upgraded to tropical storm (TS) intensity reaching its peak intensity with maximum sustained winds of 35 kt and a central pressure of 998 hPa at 12 UTC on 24 March. Turning gradually north-northwestward, Omais was downgraded to TD intensity east of Luzon Island at 00 UTC on 26 March and remained almost stationary until it dissipated 18 hours later.



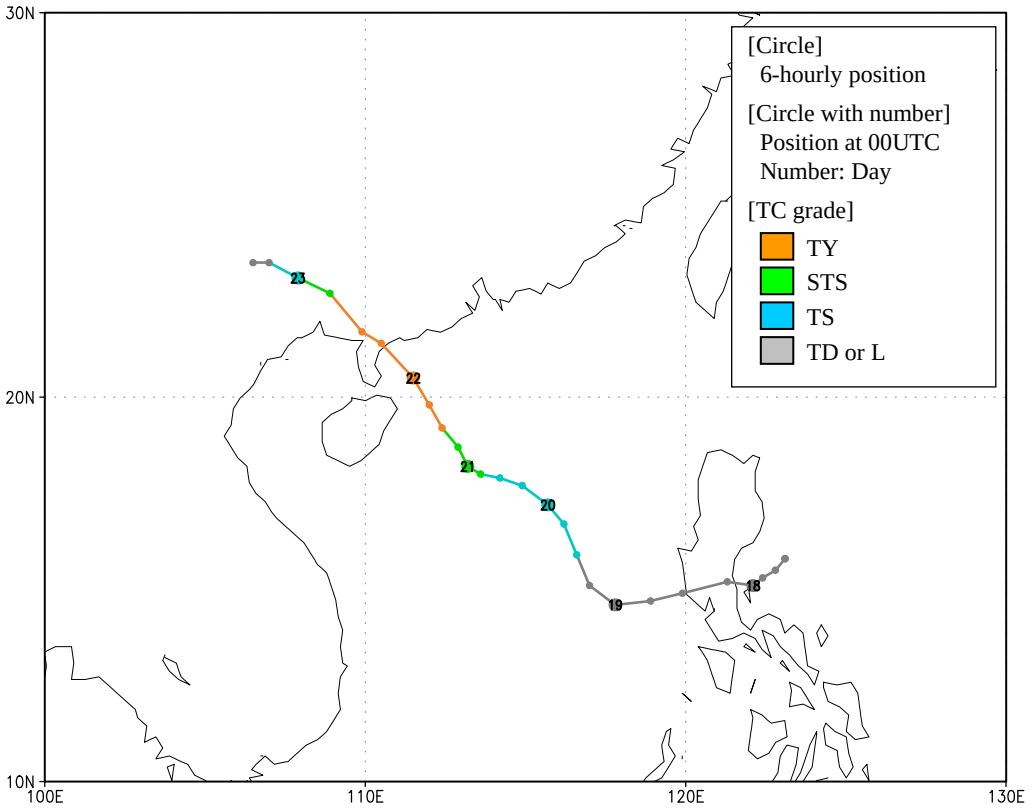
CONSON (1002)

Conson formed as a tropical depression (TD) over the sea east of the Philippines at 12 UTC on 11 July 2010. Moving westward with rapid development, it was upgraded to tropical storm (TS) intensity at 00 UTC and typhoon (TY) intensity at 18 UTC the next day. After it crossed Luzon Island, Conson was downgraded to TS intensity at 12 UTC on 14 July. Keeping its westward track in the South China Sea, it was again upgraded to TY intensity at 12 UTC on 15 July and reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 970 hPa south of Hainan Island 18 hours later. After it moved northwestward over the Gulf of Tonkin and reached the coast of Viet Nam, Conson weakened to TD intensity at 00 UTC on 18 July before dissipating 6 hours later.



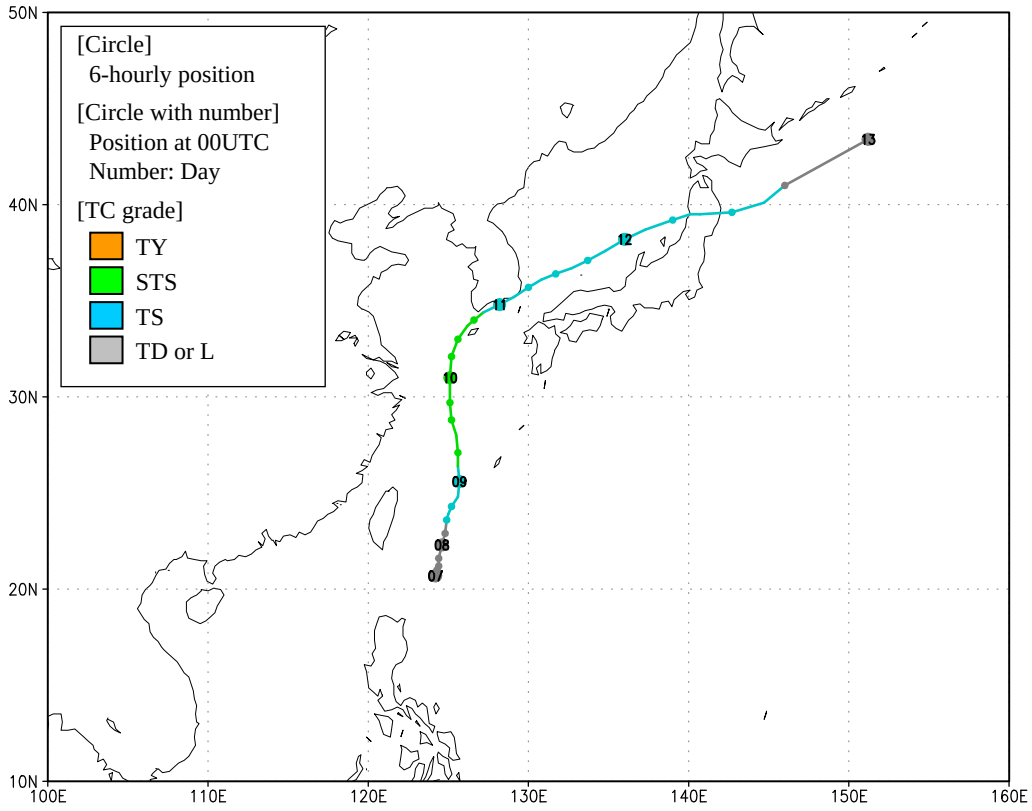
CHANTHU (1003)

Chanthu formed as a tropical depression (TD) off the eastern coast of Luzon Island at 06 UTC on 17 July 2010. It moved westward crossing the island and it was upgraded to tropical storm (TS) intensity in the South China Sea at 12 UTC on 19 July. Moving northwestward, Chanthu was upgraded to typhoon (TY) intensity east of Hainan Island at 12 UTC on 21 July and reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 970 hPa 12 hours later. Keeping its northwestward track, it was downgraded to severe tropical storm (STS) intensity at 18 UTC on 22 July after it reached the southern coast of China. Chanthu weakened to TD intensity at 06 UTC on 23 July and dissipated 12 hours later over the southern China.



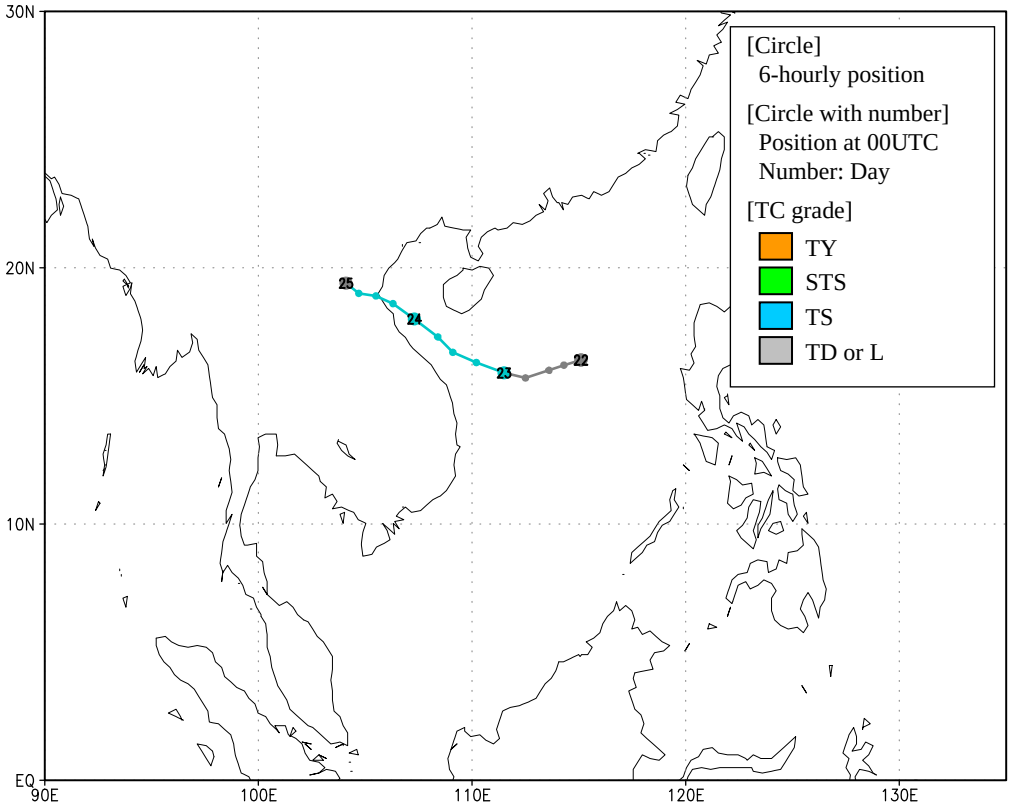
DIANMU (1004)

Dianmu formed as a tropical depression (TD) south of the Okinawa Islands at 00 UTC on 7 August 2010. Moving northward, it was upgraded to tropical storm (TS) intensity south of Miyakojima Island at 12 UTC the next day. After approaching the island around 6 hours later, it reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 985 hPa in the East China Sea at 03 UTC on 9 August. After turning to the east-northeast, it moved along the southern coast of the Korean Peninsula and was downgraded to TS intensity at 21 UTC the next day. Keeping its east-northeastward track, Dianmu made landfall in the northern part of Honshu around 08 UTC on 12 August with TS intensity. It transformed into an extratropical cyclone south of Hokkaido at 18 UTC that day and dissipated south of the Aleutian Islands 12 hours later.



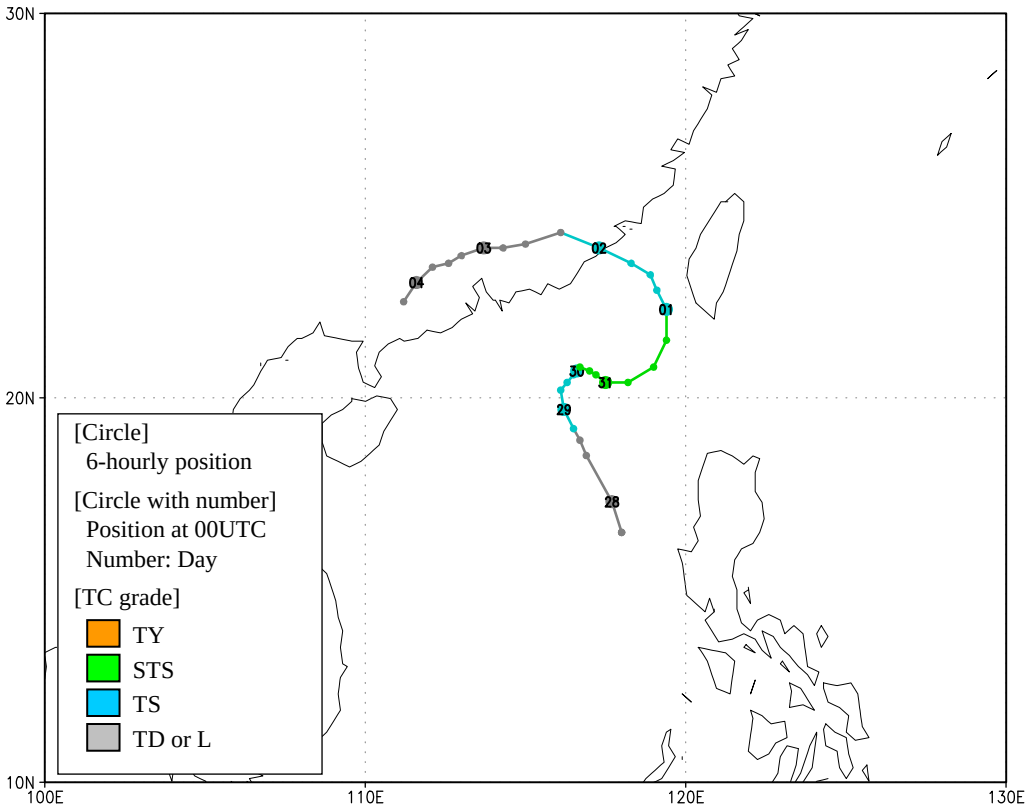
MINDULLE (1005)

Mindulle formed as a tropical depression (TD) in the South China Sea at 00 UTC on 22 August 2010. Moving west-southwestward, it was upgraded to tropical storm (TS) intensity 24 hours later. Turning gradually west-northwestward and moving into the Gulf of Tonkin, Mindulle reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 985 hPa at 00 UTC on 24 August. Soon after it hit Viet Nam, Mindulle was downgraded to TD intensity at 00 UTC on 25 August and dissipated around Laos 6 hours later.



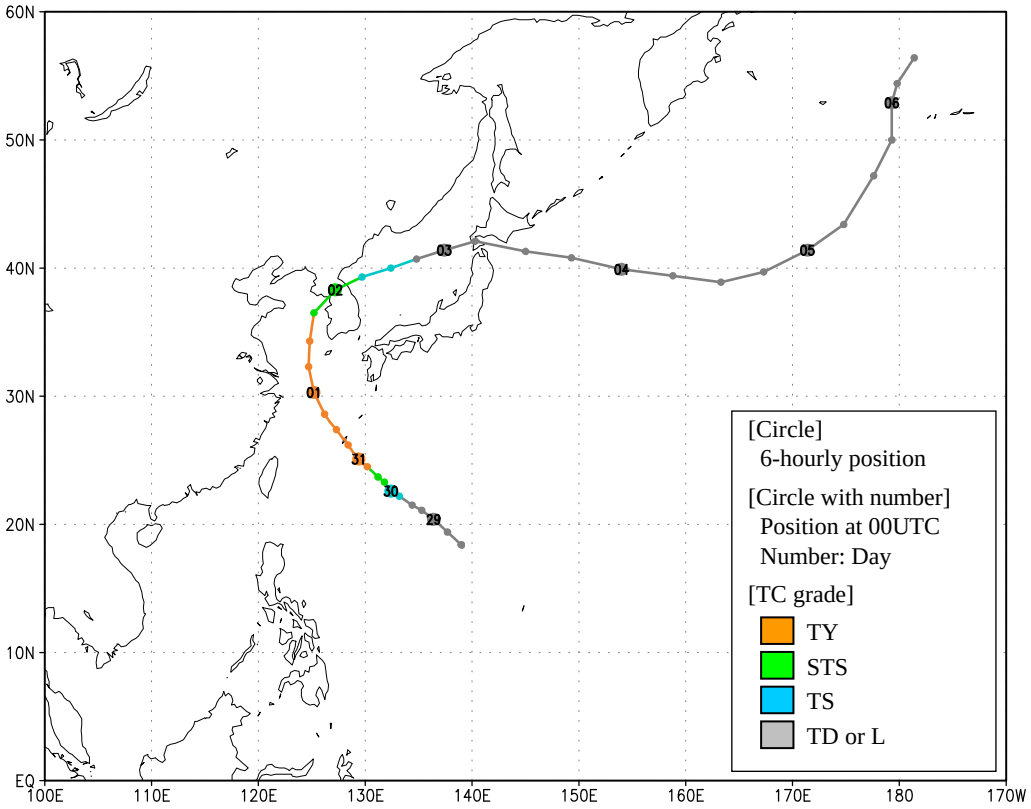
LIONROCK (1006)

Lionrock formed as a tropical depression (TD) west of Luzon Island in the South China Sea at 18 UTC on 27 August 2010. Moving northwestward it was upgraded to tropical storm (TS) intensity 24 hours later. After it turned gradually to the east, Lionrock passed around the Pratas Island and it was upgraded to severe tropical storm intensity (STS) at 06 UTC on 30 August. It turned gradually northwestward in the South China Sea, reached the coast of China, and then weakened to TD intensity at 06 UTC on 2 September. It dissipated in the China at 12 UTC on 4 September.



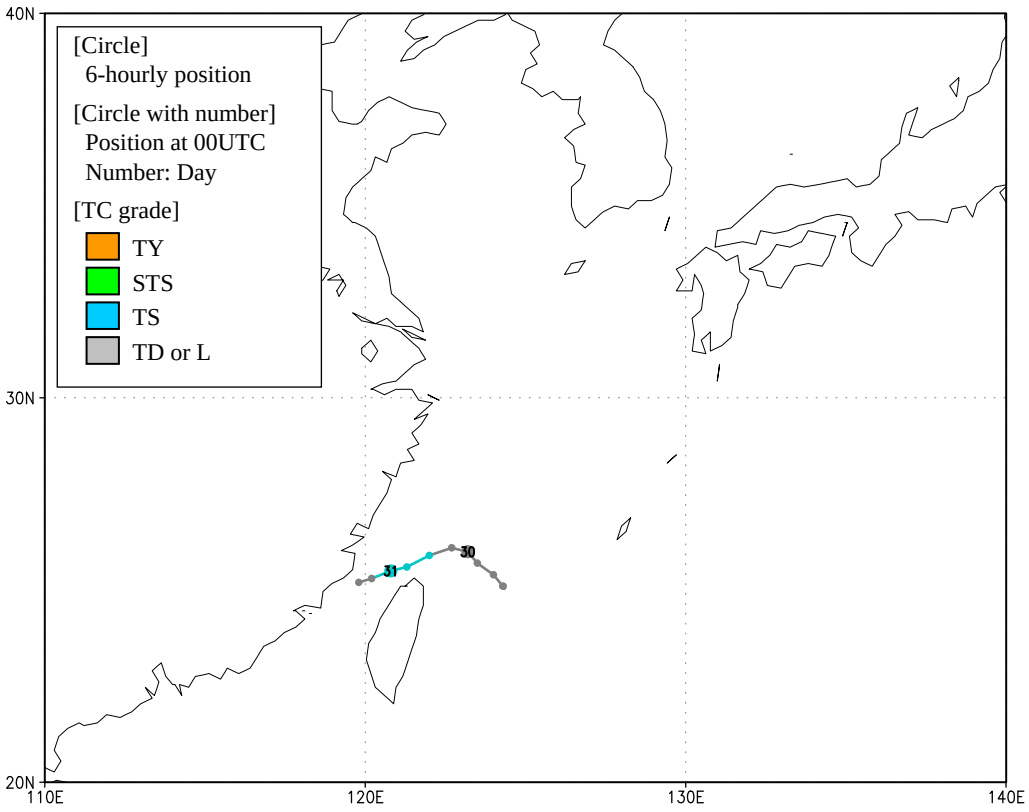
KOMPASU (1007)

Kompasu formed as a tropical depression (TD) southeast of Okinotorishima Island at 12 UTC on 28 August 2010. Moving northwestward, it was upgraded to tropical storm (TS) intensity northwest of the Island at 18 UTC on 29 August. Keeping its northwestward track, Kompasu was upgraded to typhoon (TY) intensity south of Minamidaitojima Island at 18 UTC on 30 August and reached its peak intensity with maximum sustained winds of 80 kt and a central pressure of 960 hPa 6 hours later. Holding its intensity, it crossed the northern part of Okinawa Island after 08 UTC on 31 August and entered the East China Sea. After turning eastward in the Yellow Sea and crossing the Korean Peninsula, Kompasu weakened to TD intensity in the Sea of Japan at 18 UTC on 2 September. It transformed into an extratropical cyclone southeast of Hokkaido at 12 UTC on 3 September after crossing Oshima Peninsula. Turning north-northeastward over the sea far east of Japan, it crossed longitude 180 degrees east in the Bering Sea before 12 UTC on 6 September.



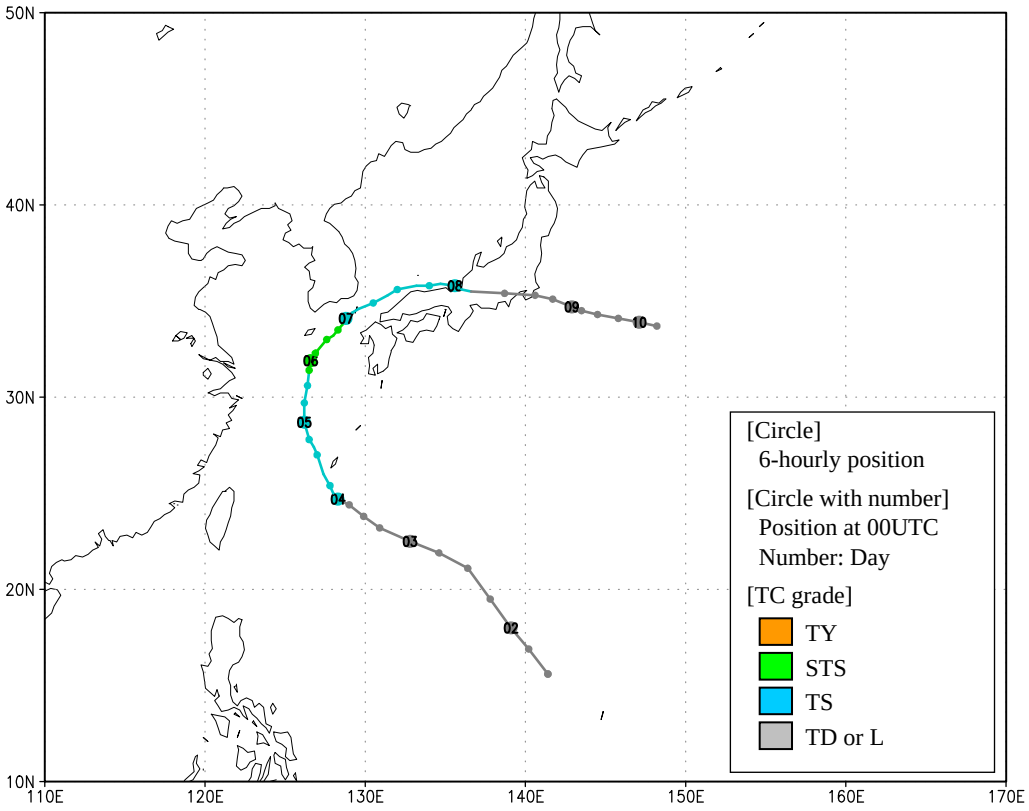
NAMTHEUN (1008)

Namtheun formed as a tropical depression (TD) north of Ishigakijima Island at 06 UTC on 29 August 2010. Moving northwestward then west-southwestward, it was upgraded to tropical storm (TS) intensity, reaching its peak with maximum sustained winds of 35 kt and a central pressure of 996 hPa north of Taiwan at 12 UTC the next day. Keeping its west-southwestward track, it weakened to TD intensity in the Taiwan Strait at 06 UTC on 31 August and dissipated 12 hours later.



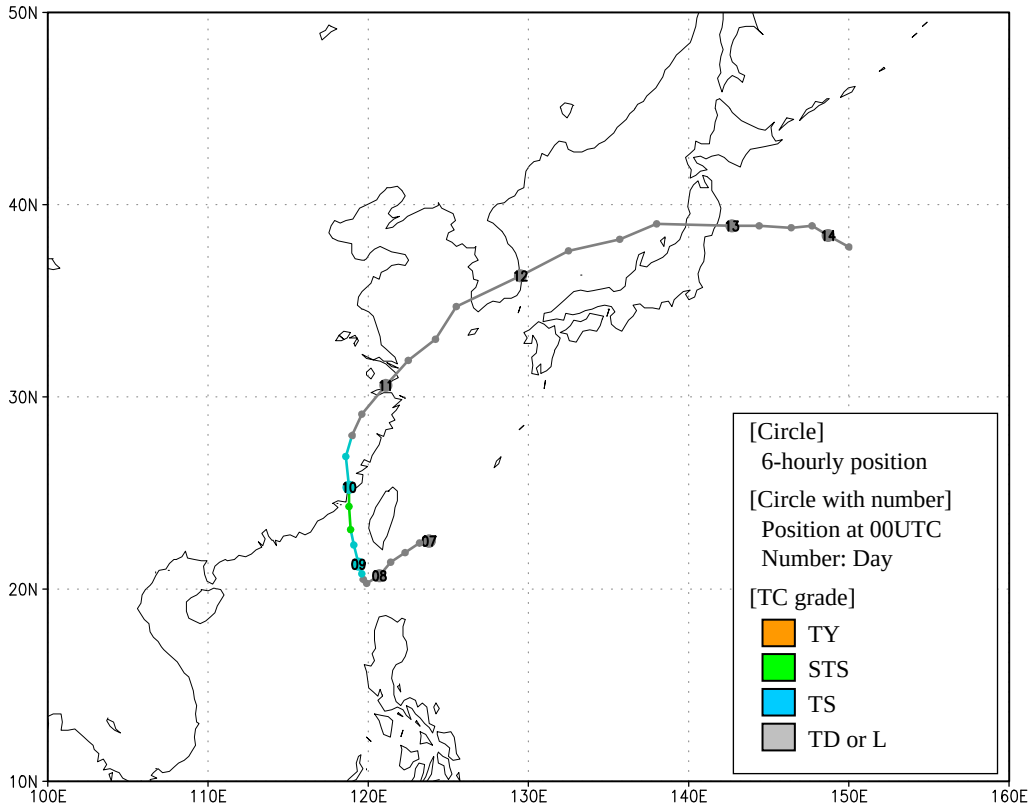
MALOU (1009)

Malou formed as a tropical depression (TD) west of Saipan Island at 12 UTC on 1 September. Moving northwestward, it was upgraded to tropical storm (TS) intensity south of Okinawa Island on 00 UTC on 4 September. During its recurvature, it reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 992 hPa in the East China Sea at 18 UTC on 5 September. Turning to the east, it crossed Tsushima Island early on 7 September and then made landfall in Japan just before weakening to tropical depression (TD) intensity at 03 UTC the next day. Malou moved east-southeastward in the eastern part of Japan early that day and then dissipated east of Japan at 12 UTC on 10 September.



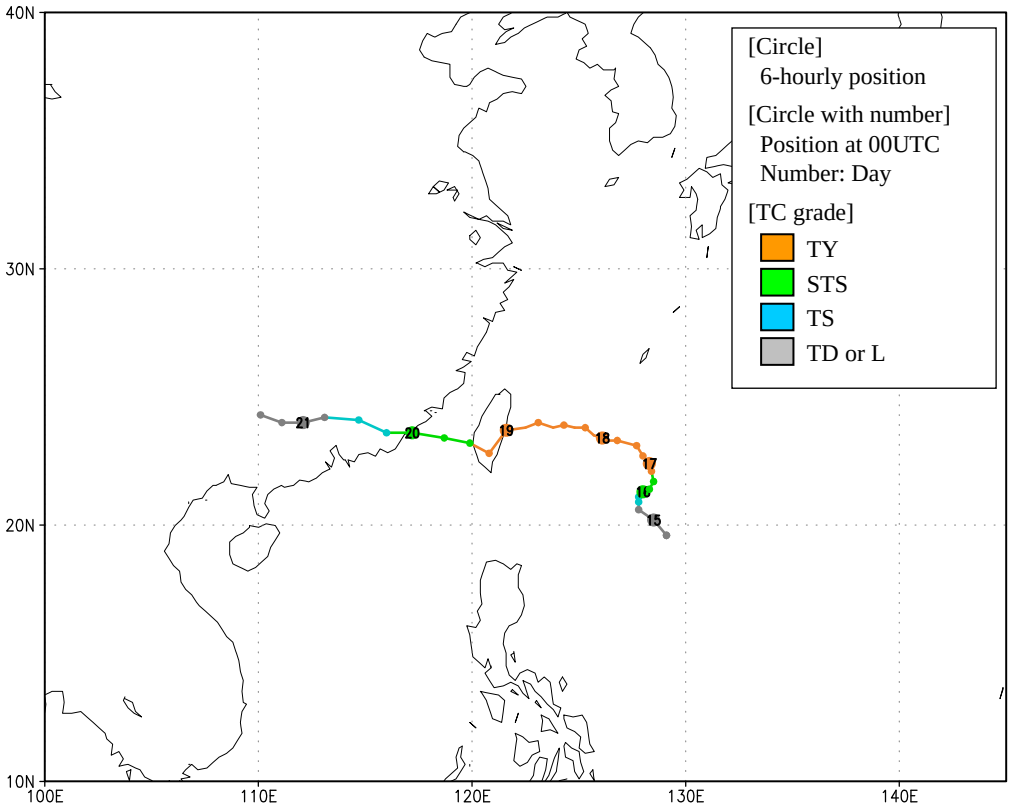
MERANTI (1010)

Meranti formed as a tropical depression (TD) south of Iriomotejima Island at 00 UTC on 7 September 2010. Moving southwestward and entering into the South China Sea, it was upgraded to tropical storm (TS) intensity at 18 UTC on 8 September. After turning sharply northward, it reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 985 hPa 24 hours later. It hit southern China and weakened to TD intensity at 12 UTC on 10 September. Accelerating northeastward, it passed the East China Sea on 11 September. Soon after crossing the Korean Peninsula, Meranti transformed into an extratropical cyclone at 00 UTC on 12 September. After moving eastward over the Sea of Japan and crossing Tohoku region of Japan, it dissipated east of Japan at 12 UTC on 14 September.



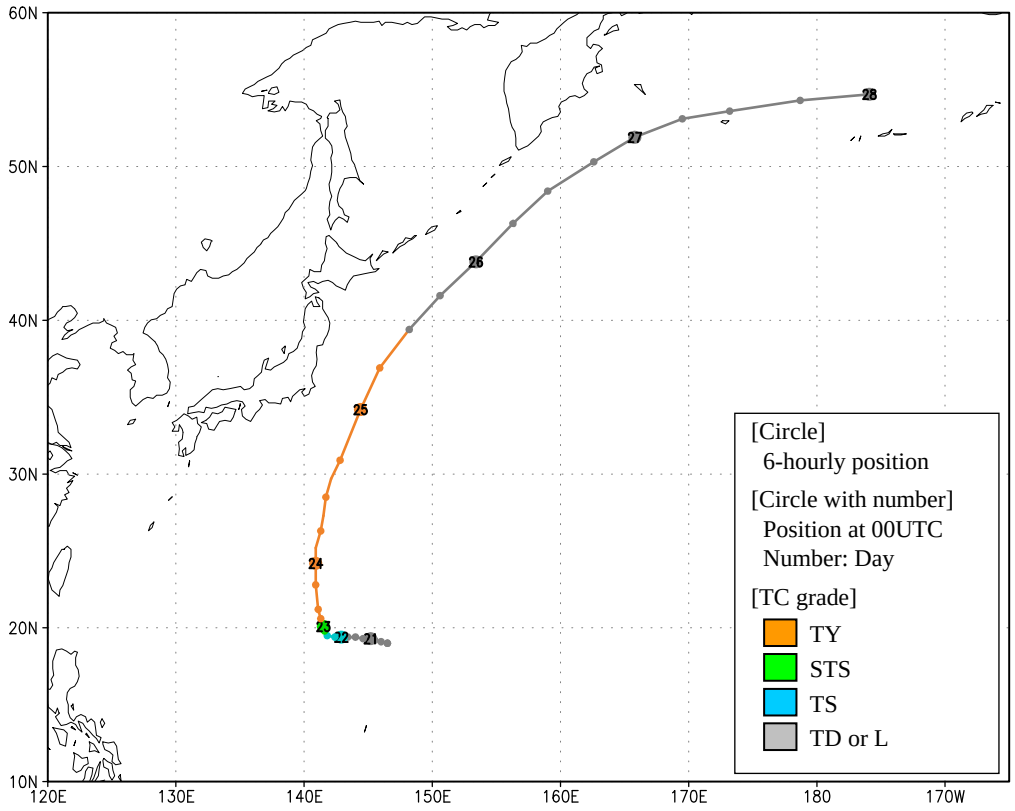
FANAPI (1011)

Fanapi formed as a tropical depression (TD) east of Luzon Island at 18 UTC on 14 September 2010. Moving northwestward, it was upgraded to tropical storm (TS) intensity south of Okinawa Island at 12 UTC the next day. Turning northward, it was upgraded to typhoon (TY) intensity over the same waters at 18 UTC on 16 September. Turning gradually westward, it reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 930 hPa south of Iriomotejima Island at 15 UTC on 18 September. Keeping its westward track, Fanapi was downgraded to severe tropical storm (STS) intensity at 12 UTC on 19 September just after crossing Taiwan Island. After crossing the Taiwan Strait and hitting southern China, it weakened to TD intensity north of Hong Kong at 18 UTC on 20 September and dissipated 24 hours later.



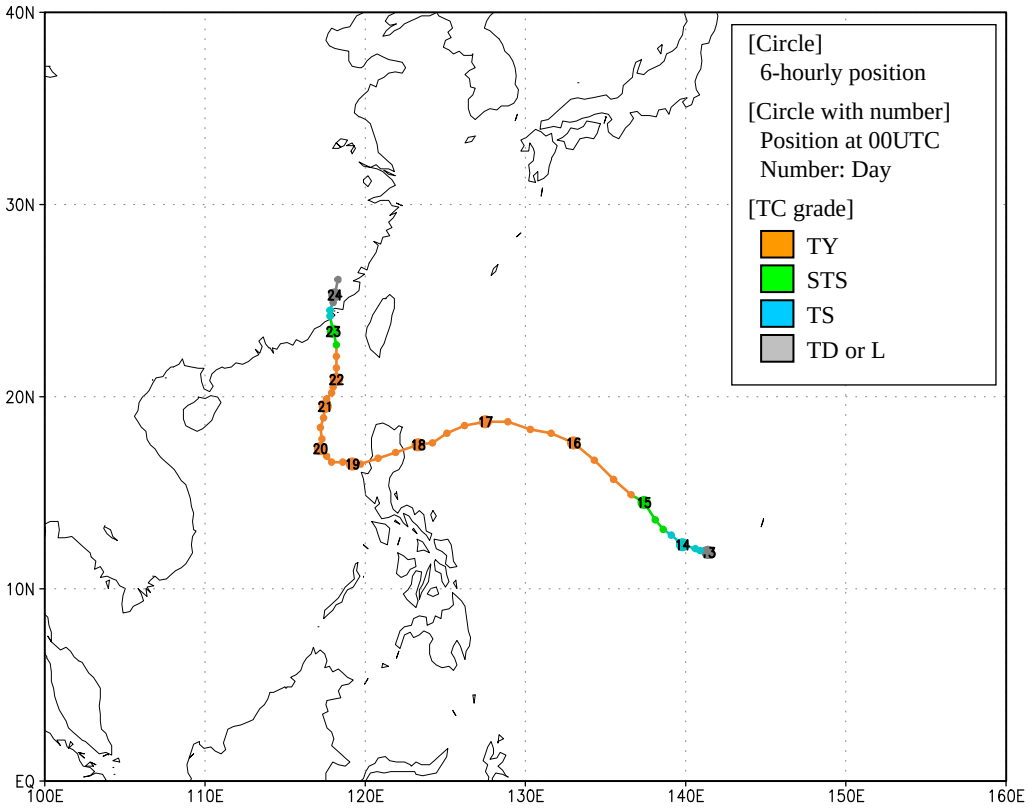
MALAKAS (1012)

Malakas formed as a tropical depression (TD) around the Mariana Islands at 06 UTC on 20 September 2010. Moving slowly westward, it was upgraded to tropical storm (TS) intensity west of the Mariana Islands at 00 UTC on 22 September. After turning to the north, it was upgraded to typhoon (TY) intensity at 06 UTC the next day. Keeping its northward track, it reached its peak intensity with maximum sustained winds of 85 kt and a central pressure of 945 hPa southeast of Hachijojima Island at 18 UTC on 24 September. Turning gradually to the northeast, Malakas transformed into an extratropical cyclone east of Japan at 12 UTC the next day. Turning to the east, it crossed longitude 180 degrees east over the Bering Sea before 00 UTC on 28 September.



MEGI (1013)

Megi, the strongest typhoon in recent years, formed as a tropical depression (TD) southwest of Guam at 00 UTC on 13 October 2010. Moving northwestward, it was upgraded to tropical storm (TS) intensity 12 hours later and to typhoon (TY) intensity at 06 UTC on 15 October. Megi turned gradually west-southwestward and developed rapidly reaching its peak intensity with maximum sustained winds of 125 kt and a central pressure of 885 hPa east of the Philippines at 18 UTC on 17 October. It weakened rapidly, although holding TY intensity, when it crossed Luzon Island on 18 October. Megi turned sharply northward over the South China Sea and moved slowly northward with slow development. It weakened to TD intensity at 18 UTC on 23 October soon after it reached the southern coast of Fujian Province of China. Megi dissipated over southern China at 12 UTC on 24 October.



CHABA (1014)

Chaba formed as a tropical depression (TD) east of the Philippines at 18 UTC on 23 October 2010. Moving northwestward, it was upgraded to tropical storm (TS) intensity 24 hours later. After it gradually turned to the northeast, Chaba reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 930 hPa south east of Okinawa Island at 06 UTC on 28 October. Accelerating and keeping its northeastward track over the sea south of the Japanese Islands, it transformed into an extratropical cyclone at 18 UTC on 30 October east of Kanto region and dissipated far east of Japan at 06 UTC on 1 November.