Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2022

Japan Meteorological Agency

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Introduction

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

The Center conducts the following operations on a routine basis:

(1) Preparation of information on the formation, movement and development of TCs and associated meteorological phenomena

(2) Preparation of information on synoptic-scale atmospheric situations that affect the behavior of TCs

(3) Provision of the above information to National Meteorological Services (NMSs), and in particular to United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)/WMO Typhoon Committee Members, in appropriate formats for operational processing

In addition to the routine services outlined above, the Center distributes a series of reports entitled *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center* as operational references for the NMSs concerned. The reports summarize the activities of the Center and review the TCs of the preceding year.

In this issue covering 2022, Chapter 1 outlines routine operations performed at the Center and its operational products, while Chapter 2 reports on its major activities in 2022. Chapter 3 describes atmospheric and oceanic conditions in the tropics and notes the highlights of TC activity in 2022. Chapter 4 presents verification statistics relating to operational forecasts (i.e., official forecasts), results from JMA's numerical weather prediction (NWP) models and other guidance models, Atmospheric Motion Vector (AMV) based Sea-surface Wind (ASWind) data, TC central pressure estimates based on satellite microwave observations and storm surge predictions. Best-track data for 2022 TCs of tropical storm (TS) intensity or higher are shown in table and chart form in the appendices.

Chapter 1
Operations at the RSMC Tokyo - Typhoon Center in 2022

The Center's area of responsibility covers the western North Pacific and the South China Sea (0° – 60°N, 100° – 180°E) including marginal seas and adjacent land areas (Figure 1.1). The Center carries out analysis and forecasting in relation to TCs in the area and also provides the relevant NMSs with RSMC products via the Global Telecommunication System (GTS), the Aeronautical Fixed Telecommunication Network (AFTN), the Internet and other media.

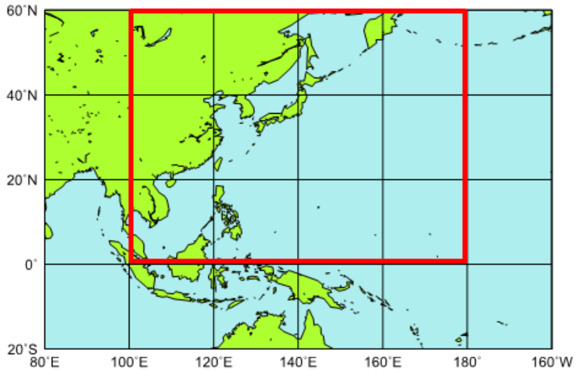


Figure 1.1
Area of responsibility of the RSMC Tokyo - Typhoon Center

1.1 Analysis

TC analysis is performed eight times a day at 00, 03, 06, 09, 12, 15, 18 and 21 UTC, and begins with determination of the TC's center position. Cloud imagery from Himawari-8/9 and microwave imagery from various polar orbiting satellites are the principal sources for this determination, especially for TCs migrating over data-sparse ocean areas. Information on the TC's direction and speed of movement is extracted primarily from six-hourly displacement vectors of the center position.

The maximum sustained wind speed in the vicinity of the TC's center is determined mainly from the Current Intensity (CI) number, which is derived from satellite imagery using the Dvorak method. The central pressure of the TC is then determined from the maximum sustained wind speed with the assumption of a certain pressure profile around the TC. The radii of circles representing winds with speeds exceeding 30 and 50 knots are determined mainly from surface observation, Advanced Scatterometer (ASCAT) observation and ASWind data derived from satellite images in the vicinity of the TC. The size of the central dense overcast area of the TC as observed in satellite imagery is also referenced to determine the radius of 50-knot wind speed circles.

1.2 Forecast

The Center issues TC track forecasts with probability circles, as well as intensity forecasts for tropical depressions (TDs) expected to reach tropical storm (TS) intensity within 24 hours and for TCs with TS intensity or higher up to 120 hours ahead. As a primary basis for TC track forecasts, JMA implements NWP using the Global Spectral Model (GSM) and the Global Ensemble Prediction System (GEPS). The GSM (TL959, upgraded on 30 March 2021) has a horizontal resolution of approximately 20 km and 128 vertical layers, while GEPS (Tq479; upgraded on 30 March 2022) has 51 members with a horizontal resolution of approximately 27 km and the same number of vertical layers. GEPS horizontal resolution was enhanced from 40 to 27 km in 2022. Further details and recent model improvements are detailed in Appendix 7. Since 2015 the Center has mainly employed a consensus method for TC track forecasts. This approach involves taking the mean of predicted TC positions from multiple deterministic models, including the GSM and other NWP centers' models.

A probability circle shows the range into which the center of a TC is expected to move with 70% probability at each validation time. The radius for all forecast times up to 120 hours is determined by the multiple ensemble method, which is solely according to the confidence level based on the cumulative ensemble spread calculated using multiple ensemble prediction systems (EPSs) consisting of European Centre for Medium-Range Weather Forecasts (ECMWF), National Centers for Environmental Prediction (NCEP) and United Kingdom Met Office (UKMO) global EPSs in addition to GEPS.

In relation to TC intensity, the Center began providing TC intensity forecasts with extended lead times of up to 120 hours in March 2019, based on several tropical cyclone intensity forecast guidance products including the one based on the Statistical Hurricane Intensity Prediction Scheme (SHIPS). The new scheme was developed by JMA and Meteorological Research Institute (MRI) of JMA and is known as TIFS (Typhoon Intensity Forecasting scheme based on SHIPS).

1.3 Provision of RSMC Products

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

- a TC of TS intensity or higher exists in the Center's area of responsibility
- a TD is expected to reach or exceed TS intensity in the area within 24 hours

RSMC products are issued while any TC of TS intensity or higher or any TD expected to reach or exceed TS intensity within 24 hours exists in the Center's area of responsibility. Appendix 6 denotes the code forms of the bulletins.

(1) RSMC Tropical Cyclone Advisory for Three-day Forecasts (WTPQ20-25 RJTD: via GTS)
The RSMC Tropical Cyclone Advisory for Three-day Forecasts is issued eight times a day after observations made at 00, 03, 06, 09, 12, 15, 18 and 21 UTC, and reports the following elements in analysis, and in 24-, 48- and 72-hour forecasts for TCs:

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

** This Advisory was terminated in September 2022.*

<u>RSMC Tropical Cyclone Advisory</u> (WTPQ50-55 RJTD: via GTS)

The RSMC Tropical Cyclone Advisory is issued eight times a day after observations made at 00, 03 06, 09, 12, 15, 18 and 21 UTC, and reports the following elements in analysis and in 24-, 48-, 72-, 96- and 120-hour forecasts for TCs:

Analysis	Center position Accuracy of center position determination Direction and speed of movement Central pressure Maximum sustained wind speed (10-minute average) Maximum gust wind speed Radii of wind areas over 50 and 30 knots
24-, 48- 72-, 96- and 120-hour Forecasts[1]	Center position and radius of probability circle Direction and speed of movement Central pressure Maximum sustained wind speed (10-minute average) Maximum gust wind speed

(2) <u>RSMC Guidance for Forecast by GSM</u> (FXPQ20-25 RJTD: via GTS)

The RSMC Guidance for Forecast by GSM reports the results of predictions made by the GSM; which is run four times a day with initial analyses at 00, 06, 12 and 18 UTC. The guidance presents six-hourly GSM predictions for TCs up to 132 hours ahead and reports the following elements:

NWP prediction (T = 006 to 132)	Center position Central pressure* Maximum sustained wind speed*

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

(3) <u>RSMC Guidance for Forecast by GEPS</u> (FXPQ30-35 RJTD: via GTS)

The RSMC Guidance for Forecast by GEPS reports the results of predictions made by the GEPS; which is run four times a day with initial analyses at 00, 06, 12 and 18 UTC. The guidance presents the ensemble mean of GEPS six-hourly predictions up to 132 hours ahead and reports the following elements:

NWP prediction (T = 006 to 132)	Center position Central pressure* Maximum sustained wind speed*

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

(4) <u>SAREP</u> (IUCC10 RJTD: via GTS)

The SAREP in BUFR format reports the results of TC analysis including intensity information (i.e., the CI number) based on the Dvorak method. It is issued shortly after observations made for TCs with TS intensity or higher at 00, 03, 06, 09, 12, 15, 18 and 21 UTC (TDs expected to reach TS intensity or

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

higher within 24 hours at 00, 06, 12 and 18), and reports the following elements:

Himawari-8/9 imagery analysis	Center position
	Accuracy of center position determination
	Direction and speed of movement
	Mean diameter of overcast cloud
	Apparent past 24-hour change in intensity**
	Dvorak Intensity (CI, T, DT, MET, PT number) **
	Cloud pattern type of the DT number**
	Trend of past 24-hour change**
	Cloud pattern type of the PT number**
	Type of the final T-number**

*** Reported only at 00, 06, 12 and 18 UTC*

BUFR/CREX templates for translation into table-driven code forms are provided on the WMO website at https://community.wmo.int/activity-areas/wis/wis-manuals. The SAREP is provided in text format on the Numerical Typhoon Prediction (NTP) website (see 1.7).

(5) RSMC Prognostic Reasoning (WTPQ30-35 RJTD: via GTS)
The RSMC Prognostic Reasoning report provides brief reasoning for TC analysis and forecasts, and is issued at 00, 06, 12 and 18 UTC following the issuance of the RSMC Tropical Cyclone Advisory. The bulletin provides general comments on current positioning, intensity and related changes, synoptic situations such as those of the subtropical high and atmospheric/oceanographic fields, reasoning behind TC track and intensity forecasts (including details of methodology and guidance models), and relevant remarks in plain language.

(6) RSMC Tropical Cyclone Best Track (AXPQ20 RJTD: via GTS)
The RSMC Tropical Cyclone Best Track report provides post-analysis data on TCs of TS intensity or higher. It reports the center position, the central pressure and the maximum sustained wind speed. The best track for each TC is usually finalized three months after the termination of related issuance of the above RSMC bulletins.

(7) Tropical Cyclone Advisory for SIGMET (FKPQ30-35 RJTD: via AFTN, and IWXXM 3.0 format: via AMHS)
As a Tropical Cyclone Advisory Centre (TCAC) within the framework of the International Civil Aviation Organization (ICAO), the Center provides Tropical Cyclone Advisory (TCA) for SIGMET to Meteorological Watch Offices (MWOs) in order to support their preparations of SIGMET information on TCs. These advisories include the following elements in analysis and in 6-, 12-, 18- and 24-hour forecasts:

Analysis	Center position
	Observed CB cloud
	Direction and speed of movement
	Changes in intensity
	Central pressure
	Maximum sustained wind speed (10-minute average)
Forecast	Center position
	Maximum sustained wind speed (10-minute average)

1.4 Tropical Cyclone Advisory for SIGMET

The Center provides text-format and graphical TCAs in its role as the ICAO TCAC. These include the horizontal extent of cumulonimbus cloud and cloud top height associated with TCs potentially affecting aviation safety, in addition to text-format TCA information. Both text-format and graphical TCAs and related specifications are provided online for users via linkage from the NTP website (see 1.7), and graphical TCAs are also provided to World Area Forecast Centres (WAFCs).

In November 2020, TCAs in IWXXM 3.0 format were introduced and shared on the TCAC Tokyo website, followed by transmission via Air Traffic Services (ATS) Message Handling Services (AMHS) in March 2022. The IWXXM format is detailed in Guidelines for the Implementation of OPMET Data Exchange Using IWXXM, Third Edition (May 2019), ICAO.

1.5 WIS Global Information System Center Tokyo Server

As designated at the Sixteenth WMO Congress in June 2011, the Center introduced Data Collection or Production Centre (DCPC) service under the Global Information System Centre (GISC) Tokyo for the WMO Information System (WIS) in August 2011. It provides NWP products such as data on predicted fields in grid-point-value (GPV) form and observational values through WIS Data Discovery, Access and Retrieval (DAR) via a GISC Tokyo server (https://www.wis-jma.go.jp/). GSM products with resolution of 0.5 and 0.25 degrees (surface layer) and JMA SATAID (SATellite Animation and Interactive Diagnosis; https://www.wis-jma.go.jp/cms/sataid/) Service are also available from the server through WIS DAR. All products available via the new server are listed in Appendix 8.

1.6 RSMC Tokyo - Typhoon Center Website

The RSMC Tokyo - Typhoon Center Website provides TC advisories on a real-time basis and a wide variety of products including TC analysis archives, technical reviews and annual reports on the Center's activities at https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm. Since 12 November 2012, the website provides experimental TC advisory information in Common Alert Protocol (CAP) format.

1.7 Numerical Typhoon Prediction Website

Since 1 October 2004, the Center has operated the Numerical Typhoon Prediction (NTP) website to assist the NMSs of Typhoon Committee Members in improving their TC forecasting and warning services. The site provides TC track predictions and weather maps of deterministic global NWP models from nine centers (Bureau of Meteorology (BoM, Australia), China Meteorological Administration (CMA, China), Canadian Meteorological Centre (CMC, Canada), Deutscher Wetterdienst (DWD, Germany), ECMWF, Korea Meteorological Administration (KMA, Republic of Korea), NCEP (USA), UKMO (UK) and JMA), ensemble TC track predictions of global EPSs from four centers (ECMWF, NCEP, UKMO and JMA) and a wide variety of products including the results of the Center's TC analysis, upper-air analysis, ocean analysis, storm surge and ocean wave forecasting. All products available on the website are listed in Appendix 9.

1.8 TC Communication platform

The Center's TC communication platform (developed and maintained since July 2019) supports enhanced interaction between operational forecasters and the Center, as well as sharing of advance-notice updates. Full-scale operation of the platform was started during the 2021 typhoon season and related discussions have helped to clarify TC status and forecasts. All services provided on the platform are listed in Appendix 9.

Chapter 2
Major Activities of the RSMC Tokyo - Typhoon Center in 2022

2.1 Provision of RSMC Products

The Center provides operational products for TC forecasting to NMSs via the GTS, the AFTN and other networks. Monthly and annual totals of products issued in 2022 are listed in Table 2.1.

Table 2.1 Monthly and annual totals of products issued by the RSMC Tokyo - Typhoon Center in 2022

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
IUCC10	0	0	0	91	0	11	92	152	305	122	35	16	824
WTPQ20-25	0	0	0	104	0	18	102	183	301	0	0	0	708
WTPQ30-35	0	0	0	51	0	9	49	91	165	70	18	11	464
WTPQ50-55	0	0	0	104	0	18	102	183	335	141	39	23	945
FXPQ20-25	0	0	0	51	0	9	49	89	164	68	18	11	459
FXPQ30-35	0	0	0	49	0	9	49	88	162	68	18	11	454
FKPQ30-35	0	0	0	51	0	9	49	89	164	68	18	11	459
AXPQ20	4	2	0	0	0	0	2	0	0	3	8	3	22

Notes:

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

*WTPQ20-25 was terminated in September 2022.

2.2 Publications

In April 2022, the 24th issue of the RSMC Technical Review was issued with the following area of focus:

1. JMA's Wave Ensemble System and Related Development

In December 2022, the Center published the *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2021*. Both publications are available on the Center's website at https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm.

2.3 Typhoon Committee Attachment Training

The Center has organized ESCAP/WMO Typhoon Committee Attachment Training courses every fiscal year since 2001 with the support of the WMO Tropical Cyclone Programme and the Typhoon Committee in order to advance the TC analysis and forecasting capacity of Committee Members.

In 2022, preparations were made for the 22nd event to be held from 11 to 13 January 2023. Amid the COVID-19 pandemic, the course was held virtually (as in March 2021 and January 2022) with 51 attendees from eight Typhoon Committee Members (China, Hong Kong China, Macao China, Malaysia, the Philippines, the Republic of Korea, Thailand and the United States of America), along with one invited lecturer.

The 2023 training course was enhanced with hands-on training materials for self-study and with interactive exercises on satellite analysis techniques/Dvorak analysis. RSMC-Tokyo highlighted the purposes of the course as set out under Category 2 Unit of the Tropical Cyclone Forecast Competency in the Typhoon Committee Region specifications of the Typhoon Committee Operational Manual (TOM).

RSMC-Tokyo is committed to improving forecasting competence, and thereby the capacity of Meteorological Services in the Typhoon Committee region, via training to meet various regional needs, including basic application, state-of-the-art tropical cyclone forecasting and monitoring techniques/methodologies.

2.4 Monitoring of Observational Data Availability

The Center carried out regular monitoring of information exchanges for enhanced TC observation in accordance with the standard procedures stipulated in Section 6.2, Chapter 6 of *The Typhoon Committee Operational Manual (TOM) - Meteorological Component (WMO/TD-No. 196)*. Monitoring for the period from 1 January to 31 December 2022, was conducted for two TCs:

1. Sever Tropical Storm (STS) Ma-on (2209), from 00 UTC 22 August to 23 UTC 26 August 2022
2. Typhoon (TY) Muifa (2212), from 00 UTC 11 September to 23 UTC 15 September 2022

The results were distributed to all Typhoon Committee Members in March 2022, and are also available on the WIS GISC Tokyo server at https://www.wis-jma.go.jp/monitoring/data/monitoring/.

2.5 Other Activities in 2022

2.5.1 Services Introduced in 2022

Upgrade of tropical cyclone heat potential (TCHP) products

In association with 2020 upgrades made to ocean data assimilation (including higher resolution and adoption of four-dimensional variational data assimilation (4D-Var)), high-resolution TCHP products based on improved MOVE/MRI.COM-JPN data were made available on the NTP website in March 2022.

2.5.2 Upgrades of Numerical Typhoon Prediction Website

The changes outlined below were made to the NTP website in 2022.

(1) Upgrade of tropical cyclone heat potential (TCHP) products (Section 2.5.1 (1))

(2) Upgrade of the storm surge watch scheme (SSWS) model and updating of related products
In association with the SSWS model upgrade, SSWS products on the NTP website were updated in August 2022. The changes included higher resolution for coastal areas, expansion of the forecast area, extension of the forecast range and addition of probabilistic products based on comprehensive use of whole ensemble members.

Chapter 3
Summary of the 2022 Typhoon Season

In 2022, 25 TCs of TS intensity or higher formed over the western North Pacific and the South China Sea. This total is almost same as the climatological normal[2] frequency of 25.1. Among these 25 TCs, 10 reached TY intensity, 3 reached severe tropical storm (STS) intensity and 12 reached TS intensity (Table 3.1).

Table 3.1 List of tropical cyclones reaching TS intensity or higher in 2022

Tropical Cyclone			Duration (UTC) (TS or higher)	Minimum Central Pressure (UTC)	lat(N)	long(E)	(hPa)	Max Wind (kt)
TY	Malakas	(2201)	080000 Apr - 151200 Apr	131800	19.8	137.5	945	90
TS	Megi	(2202)	091800 Apr - 110000 Apr	100000	10.8	125.7	996	40
TY	Chaba	(2203)	300000 Jun - 030600 Jul	020000	20.6	111.7	965	70
TS	Aere	(2204)	301800 Jun - 050000 Jul	020600	25.9	129.5	994	45
TS	Songda	(2205)	281200 Jul - 311800 Jul	310000	33.5	123.1	996	40
TS	Trases	(2206)	310000 Jul - 011200 Aug	310000	25.7	127.9	998	35
TS	Mulan	(2207)	090600 Aug - 110000 Aug	091200	18.3	112.8	994	35
TS	Meari	(2208)	111200 Aug - 141200 Aug	140600	41.0	146.9	996	40
STS	Ma-on	(2209)	211800 Aug - 260000 Aug	231800	19.0	118.8	985	55
TY	Tokage	(2210)	220000 Aug - 251800 Aug	231200	31.6	149.1	970	75
TY	Hinnamnor	(2211)	280600 Aug - 061200 Sep	301200	26.6	133.6	920	105
TY	Muifa	(2212)	071800 Sep - 160000 Sep	110000	22.6	124.4	950	85
TY	Merbok	(2213)	111200 Sep - 150600 Sep	141200	31.9	161.9	965	70
TY	Nanmadol	(2214)	131800 Sep - 191800 Sep	161800	25.5	133.8	910	105
TS	Talas	(2215)	220000 Sep - 231200 Sep	230000	30.7	134.8	1000	35
TY	Noru	(2216)	221800 Sep - 281200 Sep	250000	15.0	123.6	940	95
STS	Kulap	(2217)	260000 Sep - 291200 Sep	290600	42.0	159.0	965	60
TY	Roke	(2218)	281200 Sep - 011800 Oct	300000	28.2	136.0	975	70
TS	Sonca	(2219)	140000 Oct - 150000 Oct	140000	14.1	111.9	998	35
TY	Nesat	(2220)	150600 Oct - 200000 Oct	171200	19.0	115.5	965	75
TS	Haitang	(2221)	180000 Oct - 191200 Oct	180000	28.7	158.6	1004	35
STS	Nalgae	(2222)	270000 Oct - 021800 Nov	310600	17.1	116.5	975	60
TS	Banyan	(2223)	301800 Oct - 010000 Nov	301800	8.1	135.2	1002	40
TS	Yamaneko	(2224)	121200 Nov - 140600 Nov	121200	21.1	165.5	1004	35
TS	Pakhar	(2225)	111200 Dec - 121200 Dec	111800	19.0	128.1	998	40

3.1 Atmospheric and Oceanographic Conditions in the Tropics

The La Niña event that started in autumn of 2021 persisted throughout boreal spring 2022, resulting in negative SST anomalies in the equatorial Pacific east of 170°E in boreal winter 2022 (December 2021 – February 2022). In association, tropical convection was enhanced from the Philippines to the area north of New Guinea. In spring, tropical convection was enhanced over the area from southwestern India to the Philippines, corresponding closely to the La Niña event that persisted throughout boreal summer (June –

[2] The base period for the climatological normal is 1991 – 2020. The normal was updated in early 2021 based on 30-year data.

August). Positive SST anomalies were observed west of 150°E, and remarkably negative anomalies were observed in the central part of the Pacific (Figure 3.1 (a)). Positive SST anomalies were observed in the eastern part of the tropical Indian Ocean and negative anomalies in the western part, indicating a negative Indian Ocean Dipole (IOD) event. Tropical convection was enhanced from the northern Arabian Sea to the area near Pakistan and from the southeastern tropical Indian Ocean to southern Indonesia (Figure 3.1 (b)). In the lower troposphere of the tropical region, anti-cyclonic circulation anomalies straddling the equator were seen over the western and central tropical Pacific (Figure 3.1 (c)). Circulation anomalies in the tropical Pacific corresponded closely with inactive cumulus convection activity over the western equatorial Pacific, possibly due to the La Niña event that persisted throughout boreal autumn (September – November). Remarkably positive SST anomalies were observed west of 150°E, and remarkably negative anomalies were observed in central and eastern parts of the Pacific. Positive SST anomalies were observed in the eastern part of the tropical Indian Ocean, and a negative IOD event persisted. Tropical convective activity was stronger than normal near Indonesia and weaker in the western and central equatorial Indian Ocean and the western and central equatorial Pacific. Circulation anomalies from the Indian Ocean to the tropical Pacific corresponded closely with active cumulus convection near Indonesia and inactive cumulus convection over the western equatorial Pacific, possibly due to the negative IOD event and the La Niña event.

2022 atmospheric and oceanographic charts (including monthly mean streamlines at 850 and 200 hPa, OLRs[3] with related anomalies, and monthly mean SSTs with related anomalies for the western North Pacific and the South China Sea are provided on the Tokyo Climate Center website at https://ds.data.jma.go.jp/tcc/tcc/products/clisys/figures/db_hist_mon_tcc.html and https://ds.data.jma.go.jp/tcc/tcc/products/elnino/ocean/index_tcc.html.

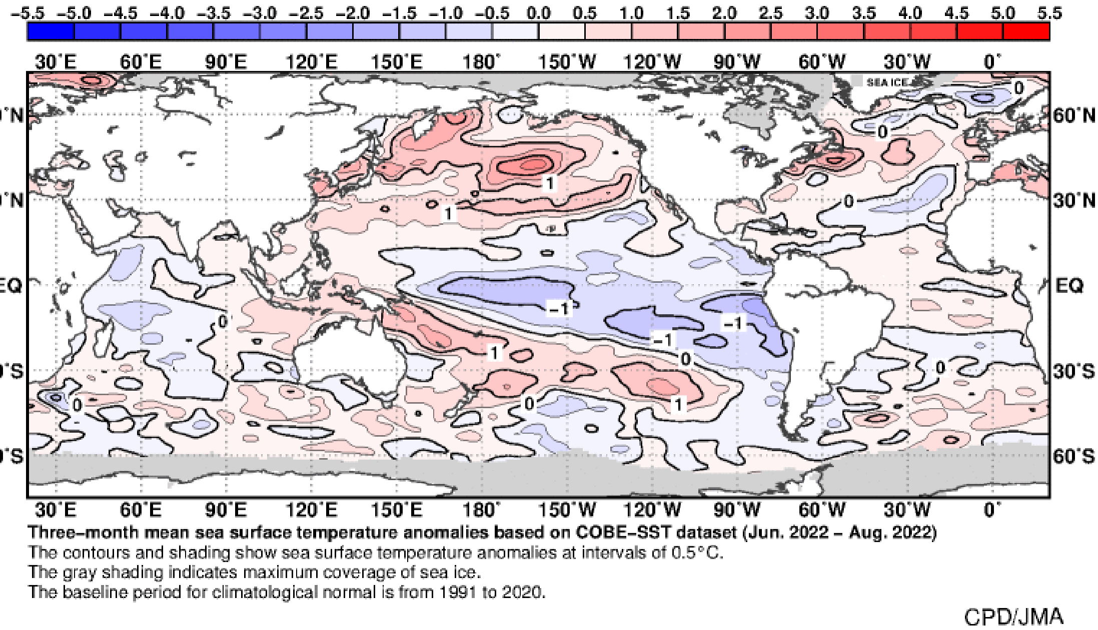
3.2 Tropical Cyclones in 2022

A total of 25 named TCs formed over the western North Pacific and the South China Sea in 2022, which was same as the climatological normal. Monthly and its normal numbers of named TC formation are shown in Figure 3.2, and the tracks of the 25 TCs are shown in Figure 3.3. Figure 3.4 shows the genesis points of the 25 TCs (dots) and related frequency distribution for past years (1951 – 2021).

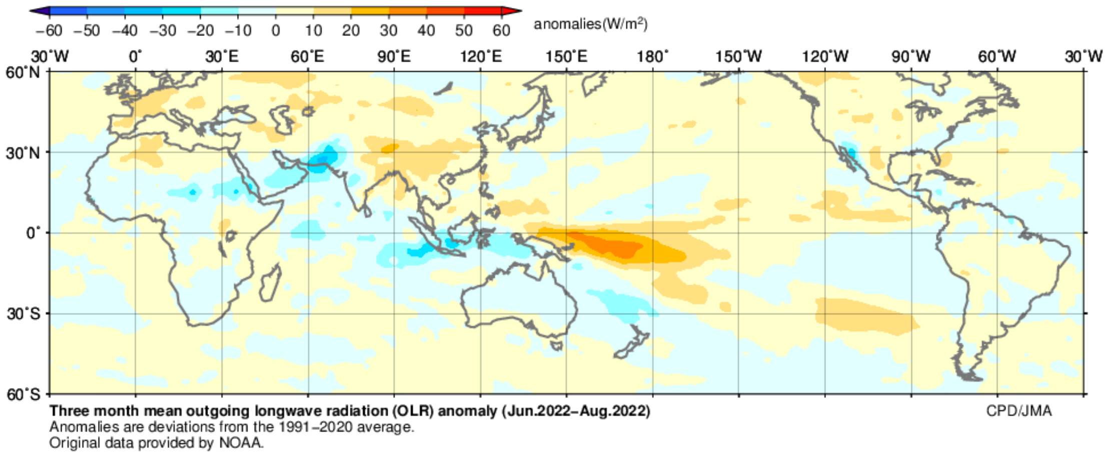
The 2022 typhoon season started in April with Malakas (2201), which originally formed as a TD over the sea around the Chuuk Islands. A total of 12 typhoons formed during the peak period from August to September (above the average of 10.7), while 6 formed from January to July (below the average of 7.8). This lower frequency may be attributable to enhanced low-level anti-cyclonic circulation over the area where TCs generally form, in association with the persistent La Niña event (see also 3.1). The negative phase of the Indian Ocean Dipole (IOD) may also have contributed to suppressed convection, particularly from June to July.

[3] OLR data were calculated using information provided by the Climate Prediction Center/NOAA at https://www.cpc.ncep.noaa.gov/products/global_precip/html/wpage.olr.html.

(a)



(b)



(c)

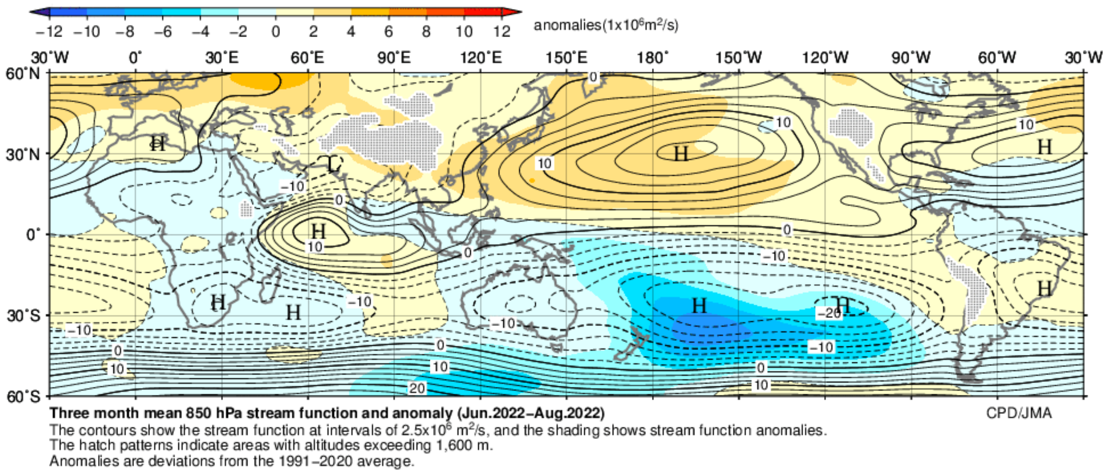


Figure 3.1 Three-month mean (a) sea surface temperature (SST) anomaly, (b) outgoing longwave radiation (OLR) anomaly, (c) 850-hPa stream function and related anomaly in boreal summer (June - August)
The base period for the normal is 1991 – 2020. (a) The contour interval is 0.5°C. Sea ice coverage areas are shaded in gray. (b) Negative (cold color) and positive (warm color) OLR anomalies show enhanced and suppressed convection, respectively, compared to the normal. Original data provided by NOAA. (c) The contour interval is 2.5 x 10^6 m^2 per s. “H” and “L” denote high- and low-pressure systems, respectively.

The mean genesis point of named TCs was 19.3˚N and 135.8˚E, which deviated northward from that of the 30-year average[4] (16.3˚N and 135.9˚E) (see Figure 3.4). The mean genesis point of named TCs formed in summer (June to August) was 21.8˚N and 132.1˚E, with northwestward deviation from that of the 30-year summer average (18.5˚N and 134.2˚E), and that of named TCs formed in autumn (September to November) was 19.4˚N and 139.1˚E, with north-westward deviation from that of the 30-year autumn average (16.2˚N and 137.0˚E). The clear northward shift of the mean genesis point throughout the year is partly attributable to the persistent La Niña event and to the intrusion of high potential vorticity from higher latitudes over the area from the central Pacific to the sea south of Japan.

The mean duration of TCs sustaining TS intensity or higher was 3.7 days, shorter than that of the 30-year average (5.2 days). The mean duration of TCs sustaining TS intensity or higher formed in summer was 3.8 days, shorter than that of the 30-year average (5.0 days), and the mean duration of TCs sustaining TS intensity or higher formed in autumn was 3.8 days, shorter than that of the 30-year average (5.4 days).

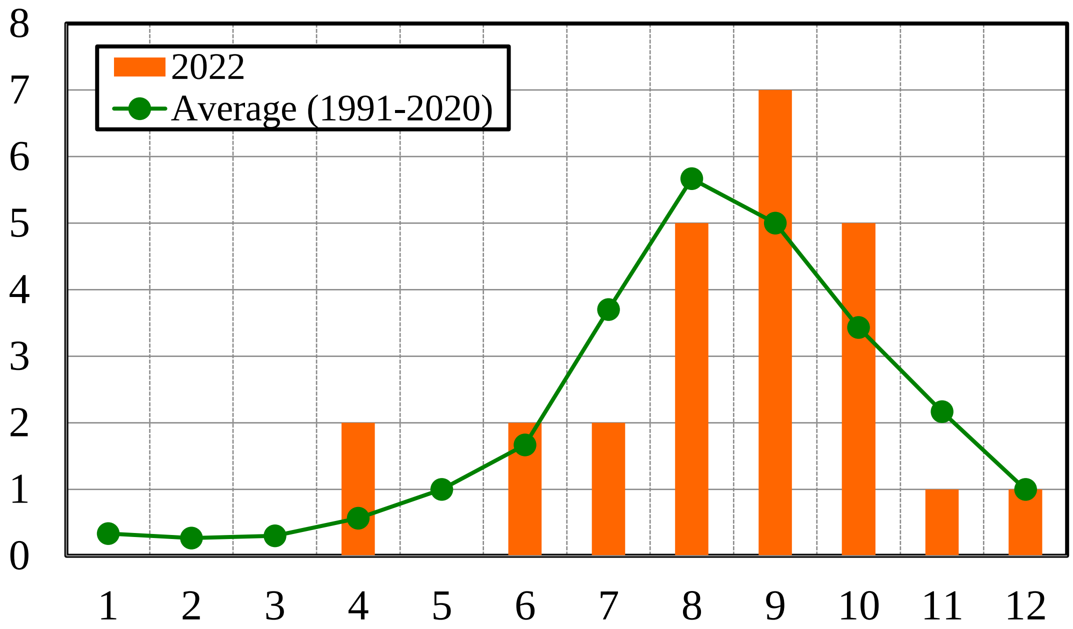


Figure 3.2 Monthly number of named TC formation for 2022 compared to the climatological normal

[4] The 30-year averaging period is from 1991 to 2020

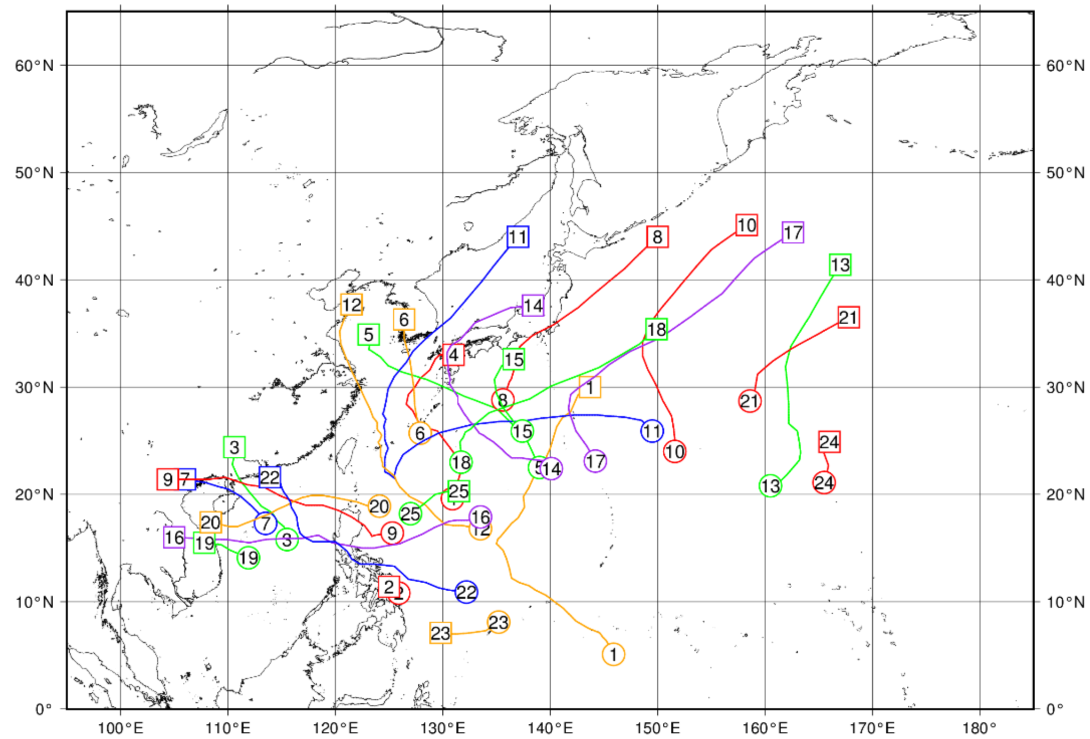


Figure 3.3 Tracks of the 25 named TCs that formed in 2022. TC tracks for those with an intensity of TS or higher are shown.

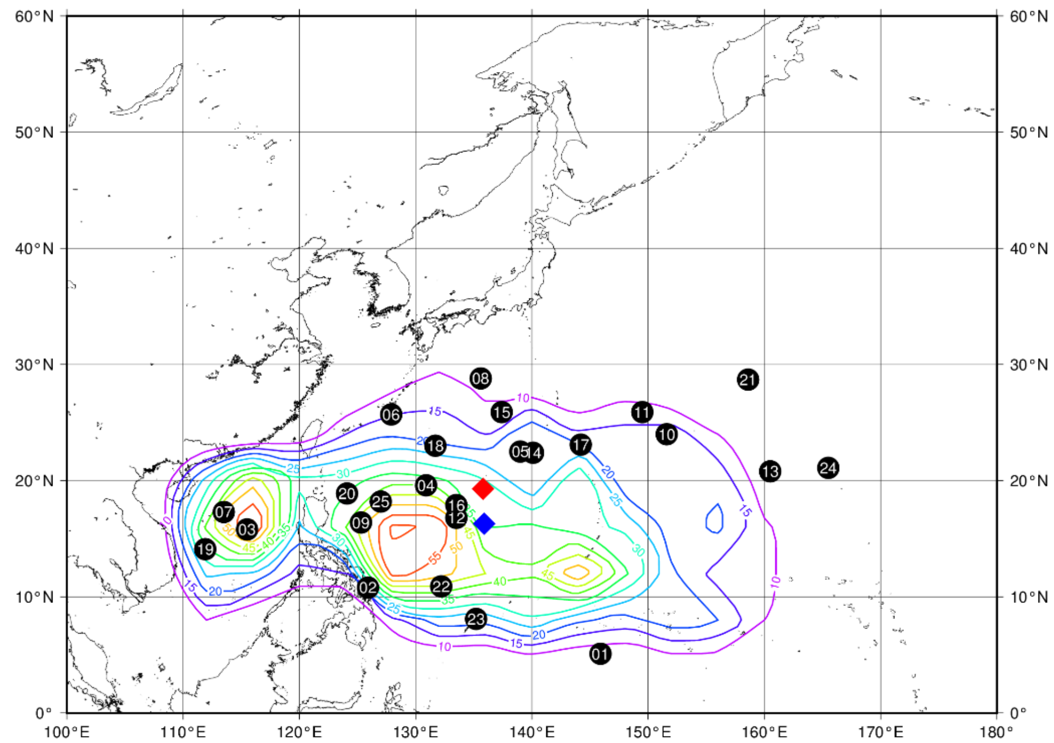


Figure 3.4 Genesis points of the 25 named TCs forming in 2022 (dots) and related frequency distribution for 1951 - 2021 (lines). Red and blue diamonds show the mean genesis points of TCs forming in 2022 and the 30-year average period (1991 – 2020), respectively.

Chapter 4
Verification of Forecasts and Other Products in 2022

4.1 Verification of Operational Forecasts for TCs with TS Intensity or Higher

Operational forecasts for the 25 TCs of TS intensity or higher that formed in 2022 were verified using RSMC TC best track data[5]. The verified elements were forecasts of the center position, central pressure and maximum sustained wind speed (up to five days ahead). In addition to forecast errors, improvement ratios of forecast errors to climatological model were also evaluated to assess operational forecast skill. Forecasts issued at 00, 06, 12 and 18 UTC were included in verification for TCs classified in best-track data as TS, STS or TY at both initial and forecast valid times. The position and intensity errors of such operational forecasts are shown in bold face in Appendix 3. (Those for TD before upgrading into TS intensity or higher are indicated in italic face in Appendix 3.)

4.1.1 Center Position

Figure 4.1 shows annual mean errors in TC track forecasts covering periods of 24 hours (since 1982), 48 hours (since 1989), 72 hours (since 1997), 96 hours and 120 hours (since 2009). It can be seen that operational TC track forecasts have steadily improved since 1982, although year-to-year fluctuations are seen due in part to differences in TC characteristics. The improvement observed since 2015 is partially attributed to the introduction of the consensus method using four global numerical models of ECMWF, JMA, NCEP and UKMO for operational forecasts in that year. The errors in 2022 were 72, 124, 172, 195 and 267 km for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively. 72- and 96-hour forecast errors in 2022 were the lowest on record.

The annual mean improvement ratios in relation to the climatology and persistence model (CLIPER)[6] for TC track prediction since 2011 are shown in Figure 4.2 to support evaluation of the operational forecast skill. The values are defined as

$$\frac{\text{Mean Position Error (CLIPER)} - \text{Mean Position Error (Operational)}}{\text{Mean Position Error (CLIPER)}}$$

and positive/negative values indicate that the operational forecasts were better/worse than the CLIPER predictions. Although there are year-to-year fluctuations, it can be seen that operational forecasts have steadily improved in the long run. The annual mean improvement ratios for 24-, 48-, 72-, 96- and 120-hour forecasts in 2022 were 61% (51% in 2021), 69% (62%), 73% (66%), 77% (68%) and 74% (71%), respectively.

The details of errors including improvement ratios to CLIPER for each named TC that formed in 2022 are summarized in Table 4.1. Forecasts for Ma-on (2209) and Roke (2218) were characterized by large errors. Those in forecasts for Ma-on (2209) are attributable to the fact that guidance models predict more west-northwestern tracks than reality. Those in forecasts for Roke (2218) are attributable to the fact that guidance models indicate complex tracks over the sea south of Japan, which results in slow bias in the post-curvature

[5] Maximum sustained wind of TD is not described in best track data or operational forecast. Therefore, maximum sustained wind of TD was treated as 30 kt for convenience in verification in 4.1.

[6] The Center operates the CLIPER model based on Aberson (1998), Neumann (1972) and Merrill (1980). The model outputs no information on current atmospheric status, but best-track data such as TC center position/central pressure/movement and dates are referenced. Multiple regression coefficients for the model were generated from best-track data between 1980 and 2010.

stage (See. Fig. 4.4). Meanwhile, forecasts for Malakas (2201), Tokage (2210) and Nesat (2220) showed relatively small errors.

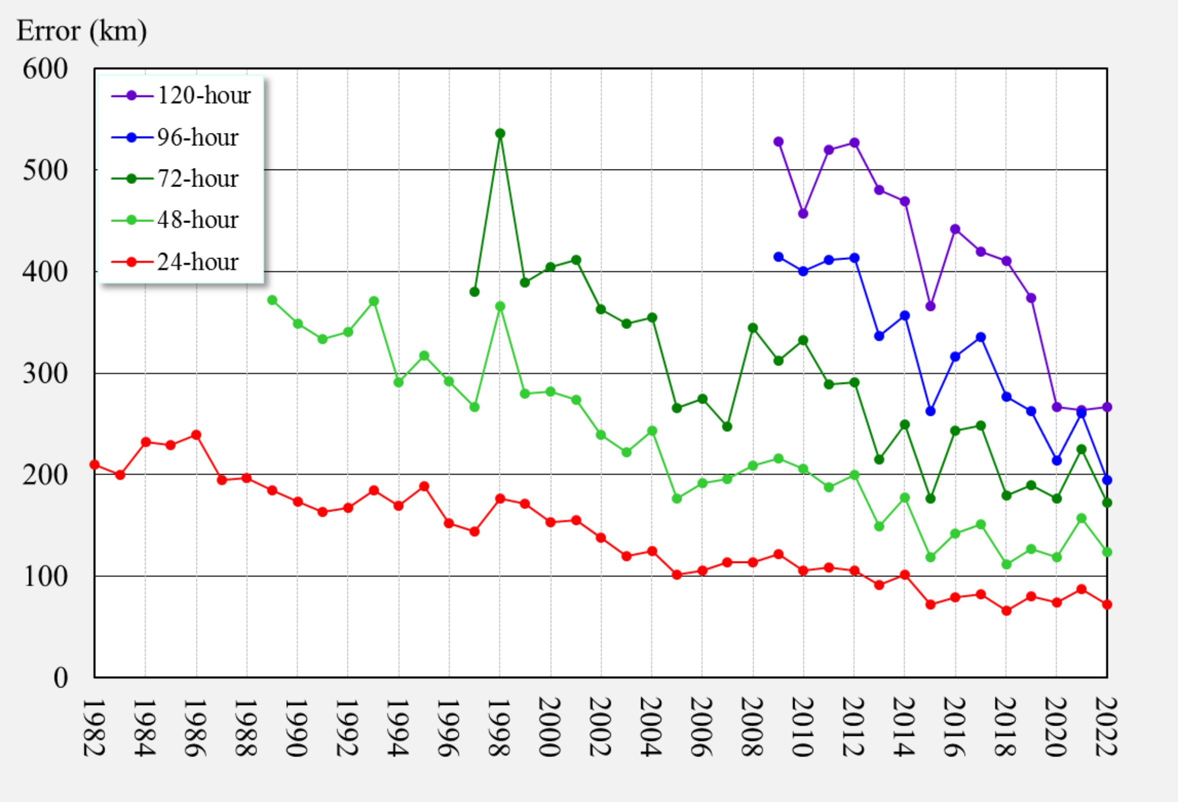


Figure 4.1 Annual mean position errors in 24-, 48-, 72-, 96- and 120-hour operational track forecasts

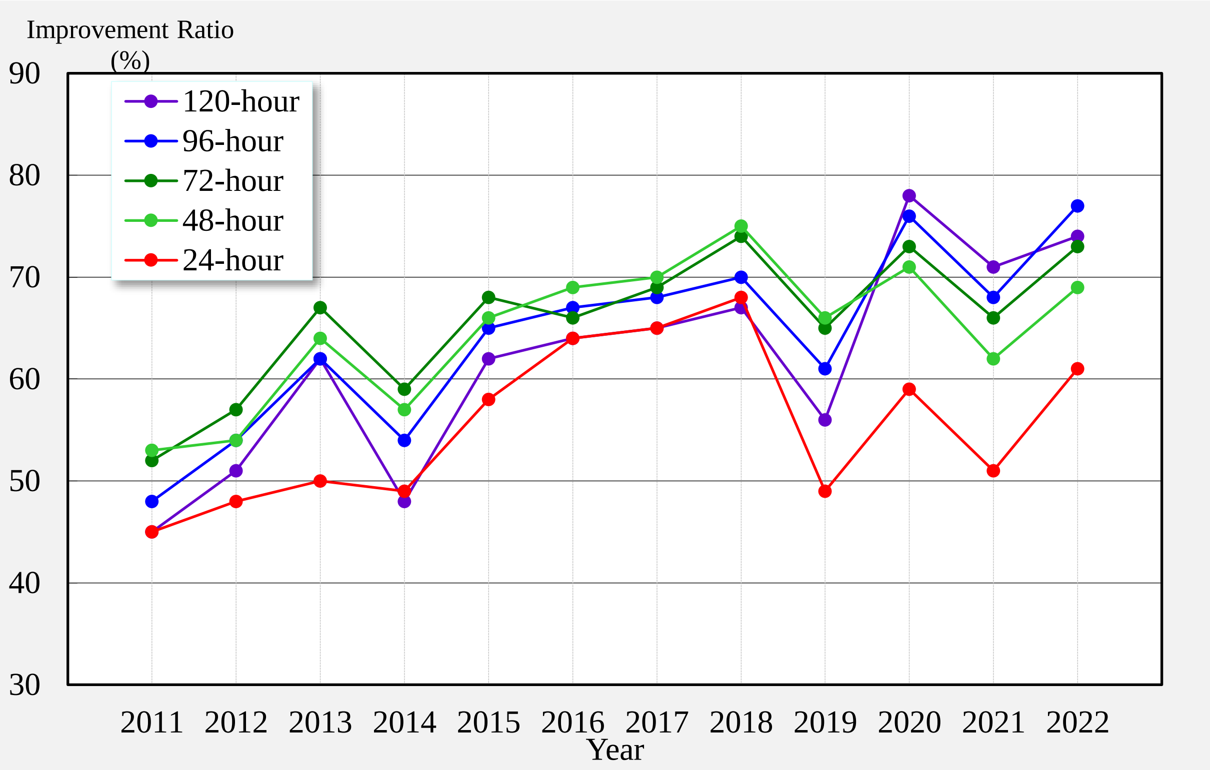


Figure 4.2 Annual mean improvement ratios in 24-, 48-, 72-, 96- and 120-hour operational track forecasts.

Table 4.1 Mean position errors of 24-, 48-, 72-, 96- and 120-hour operational forecasts for each named TC that formed in 2022. S.D., Impr. and Num. represent the standard deviation of operational forecast position errors, improvement ratio (see the equation in 4.1.1 for detail) and number of samples, respectively.

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
			Mean (km)	S.D. (km)	Num.	Impr. (%)	Mean (km)	S.D. (km)	Num.	Impr. (%)	Mean (km)	S.D. (km)	Num.	Impr. (%)	Mean (km)	S.D. (km)	Num.	Impr. (%)	Mean (km)	S.D. (km)	Num.	Impr. (%)
TY	Malakas	(2201)	59	28	26	67	79	52	22	76	107	45	18	79	141	60	14	80	156	99	10	83
TS	Megi	(2202)	99	0	1	43	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Chaba	(2203)	52	25	9	58	81	39	5	69	188	0	1	63	-	-	0	-	-	-	0	-
TS	Aere	(2204)	50	29	13	81	95	59	9	83	107	68	5	88	168	0	1		-	-	0	-
TS	Songda	(2205)	85	41	9	81	149	109	5	86	236	0	1	81	-	-	0	-	-	-	0	-
TS	Trases	(2206)	81	0	1	77	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Mulan	(2207)	152	38	3	51	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Meari	(2208)	42	17	8	84	56	31	4	92	-	-	0	-	-	-	0	-	-	-	0	-
STS	Ma-on	(2209)	102	37	13	57	220	31	9	57	362	51	5	56	616	0	1	33	-	-	0	-
TY	Tokage	(2210)	31	19	11	82	46	15	7	86	76	26	3	84	-	-	0	-	-	-	0	-
TY	Hinnamnor	(2211)	58	51	33	73	133	117	29	77	227	233	25	78	224	241	20	83	240	182	16	85
TY	Muifa	(2212)	69	70	29	54	123	118	25	64	155	90	21	67	213	84	17	62	296	135	13	50
TY	Merbok	(2213)	48	17	11	75	125	36	7	66	214	48	3	68	-	-	0	-	-	-	0	-
TY	Nanmadol	(2214)	75	19	20	45	119	27	16	65	116	46	12	82	89	60	8	90	203	92	4	84
TS	Talas	(2215)	97	9	2	50	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Noru	(2216)	90	44	19	35	144	78	15	54	164	91	11	69	189	115	7	80	378	32	3	73
STS	Kulap	(2217)	86	50	10	54	111	44	6	62	261	10	2	65	-	-	0	-	-	-	0	-
TY	Roke	(2218)	199	43	9	-39	527	53	5	-50	1061	0	1	-102	-	-	0	-	-	-	0	-
TS	Sonca	(2219)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Nesat	(2220)	37	22	15	72	54	40	11	84	91	51	7	85	120	57	3	87	-	-	0	-
TS	Haitang	(2221)	115	0	1	51	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Nalgae	(2222)	81	47	23	43	111	70	19	62	161	79	15	62	249	75	11	42	422	91	7	10
TS	Banyan	(2223)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Yamaneko	(2224)	105	53	3	19	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Pakhar	(2225)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
Annual Mean (Total)			72	52	269	61	124	108	194	69	172	155	130	73	195	152	82	77	267	158	53	74

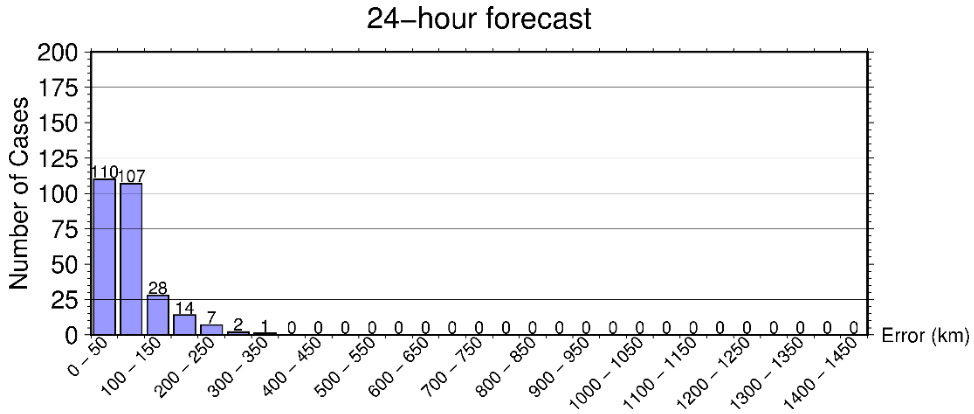


Figure 4.3 Histogram of 24-hour forecast position errors in 2022. (Histograms for 48-, 72-, 96- and 120-hour forecasts are available in the Appendix 5)).

Figure 4.3 shows a histogram of 24-hour forecast position errors (histograms for 48-, 72-, 96- and 120-hour forecasts are available in Appendix 5). About 91% (85% in 2021) of 24-hour forecasts, 94% (86%) of 48-hour forecasts, 95% (89%) of 72-hour forecasts, 96% (91%) of 96-hour forecasts and 96% (89%) of 120-hour forecasts had errors of less than 150, 300, 450, 500 and 600 km, respectively.

Figure 4.4 shows frequency distributions of 48-hour forecast position errors in longitudinal/latitudinal direction and cross-track/along-track direction (Scatter diagrams of 24-, 72-, 96- and 120-hour forecasts are available in Appendix 5.). While mean position biases are relatively small, a clear slow bias for Roke (2218) after recurvature is seen.

Table 4.2 presents the mean hitting ratios and radii of 70% probability circles[7] provided in operational forecasts for each named TC that formed in 2022. The term hitting ratio here is used to describe the ratio of the number of 70% probability circles within which the actual TC center fell to the total number of circles. The annual mean radius of circles provided in 24-hour position forecasts was 89 km (93 km in 2021), and their hitting ratio was 73% (67%). The corresponding values for 48-hour forecasts were 159 km (168 km in 2021) and 72% (72%), those for 72-hour forecasts were 258 km (266 km in 2021) and 85% (74%), those for 96-hour forecasts were 385 km (386 km in 2021) and 95% (86%), and those for 120-hour forecasts were 564 km (533 km in 2021) and 94% (93%).

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

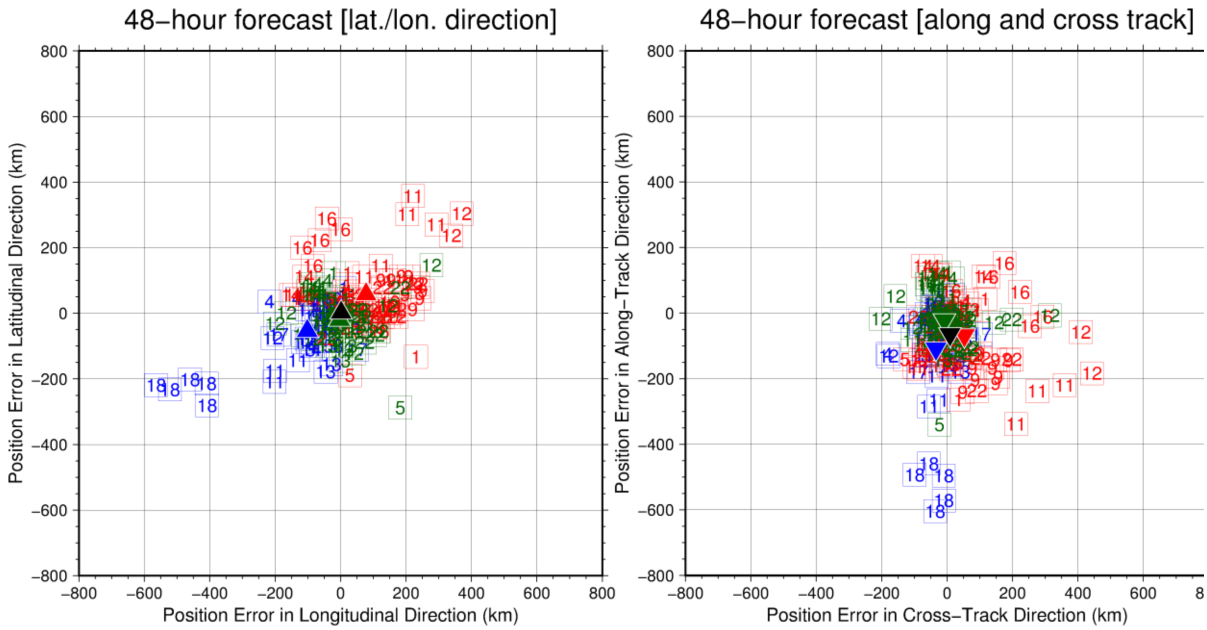


Figure 4.4 Scatter diagrams of 48-hour forecast position errors in longitudinal/latitudinal direction (left) and cross-/along-track direction (right) in 2022. (Scatter diagrams of 24-, 72-, 96- and 120-hour forecasts are available in Appendix 5.) Red, green and blue squares with TC numbers denote biases for each initial time in the stages before, during and after recurvature, respectively. Red, green and blue triangles indicate mean biases in the stages before, during and after recurvature, respectively. Black triangles indicate mean bias for all initial time.

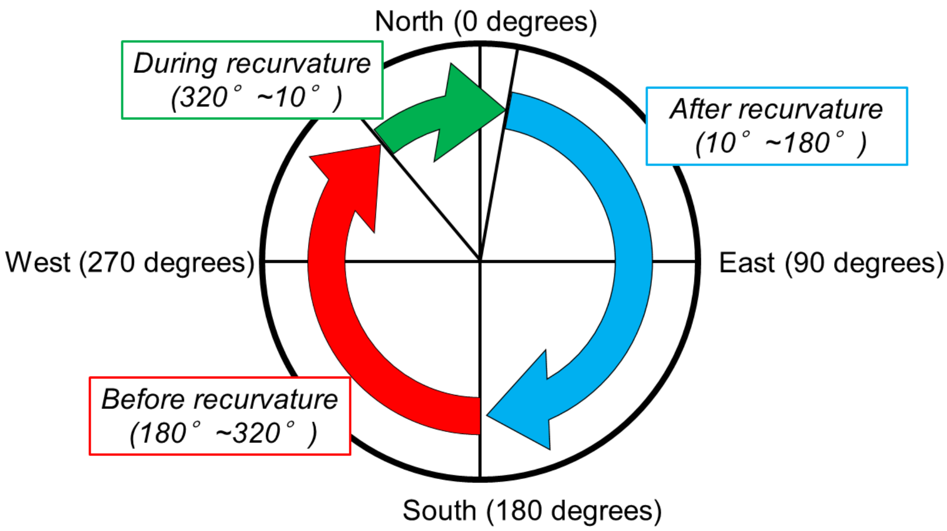


Figure 4.5 Definition of the stages before, during and after recurvature based on TC direction as calculated from positions at individual prediction times and those observed six hours prior.

Table 4.2 Mean hitting ratios (%) and radii (km) of 70% probability circles provided in 24-, 48-, 72-, 96- and 120-hour operational forecasts for each named TC that formed in 2022. Num. represents number of samples.

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast			96-hour Forecast			120-hour Forecast		
			Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)
TY	Malakas	(2201)	92	26	86	95	22	165	100	18	265	100	14	390	100	10	556
TS	Megi	(2202)	100	1	148	-	0	-	-	0	-	-	0	-	-	0	-
TY	Chaba	(2203)	78	9	89	100	5	167	100	1	259	-	0	-	-	0	-
TS	Aere	(2204)	100	13	104	89	9	186	100	5	319	100	1	519	-	0	-
TS	Songda	(2205)	78	9	115	80	5	220	100	1	370	-	0	-	-	0	-
TS	Trases	(2206)	100	1	120	-	0	-	-	0	-	-	0	-	-	0	-
TS	Mulan	(2207)	0	3	93	-	0	-	-	0	-	-	0	-	-	0	-
TS	Meari	(2208)	100	8	100	100	4	185	-	0	-	-	0	-	-	0	-
STS	Ma-on	(2209)	54	13	95	22	9	179	0	5	304	0	1	519	-	0	-
TY	Tokage	(2210)	100	11	101	100	7	177	100	3	340	-	0	-	-	0	-
TY	Hinnamnor	(2211)	85	33	79	62	29	143	76	25	246	85	20	376	94	16	551
TY	Muifa	(2212)	79	29	87	80	25	152	86	21	249	100	17	373	92	13	534
TY	Merbok	(2213)	82	11	88	71	7	172	67	3	333	-	0	-	-	0	-
TY	Nanmadol	(2214)	35	20	68	56	16	125	100	12	213	100	8	350	100	4	519
TS	Talas	(2215)	100	2	148	-	0	-	-	0	-	-	0	-	-	0	-
TY	Noru	(2216)	58	19	88	47	15	160	100	11	263	100	7	389	100	3	654
STS	Kulap	(2217)	50	10	85	83	6	162	50	2	259	-	0	-	-	0	-
TY	Roke	(2218)	11	9	99	0	5	200	0	1	333	-	0	-	-	0	-
TS	Sonca	(2219)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TY	Nesat	(2220)	100	15	69	100	11	121	100	7	201	100	3	315	-	0	-
TS	Haitang	(2221)	0	1	93	-	0	-	-	0	-	-	0	-	-	0	-
STS	Nalgae	(2222)	70	23	91	74	19	163	87	15	264	100	11	431	86	7	651
TS	Banyan	(2223)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TS	Yamaneko	(2224)	33	3	106	-	0	-	-	0	-	-	0	-	-	0	-
TS	Pakhar	(2225)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
Annual Mean (Total)			73	269	89	72	194	159	85	130	258	95	82	385	94	53	564

4.1.2 Central Pressure and Maximum Wind Speed

Figure 4.6 shows annual means of root mean square errors (RMSEs) for TC central pressure and maximum wind speed forecasts covering periods of 24 hours, 48 hours (since 2001), 72 hours (since 2003) 96 hours and 120 hours (since 2019). The values for maximum wind speed forecasts for individual TCs are available in Appendix 5).

Operational TC intensity forecasts have improved recently after a long period with no notable enhancement, although year-to-year fluctuations exist. The annual RMSEs of central pressure for 24-, 48-, 72- 96- and 120-hour forecasts were 13.7 hPa (11.9 hPa in 2021), 19.4 hPa (15.9 hPa), 21.3 hPa (18.0 hPa), 19.4 hPa (19.0 hPa) and 15.5 hPa (17.9 hPa), respectively. The corresponding values for maximum wind speed were 6.3 m/s (5.0 m/s in 2021), 8.7 m/s (6.5 m/s), 8.7 m/s (6.9 m/s), 7.7 m/s (7.6 m/s) and 6.0 m/s (8.2 m/s), respectively.

Figure 4.7 shows annual mean improvement ratios for Central Pressure and Maximum Wind Speed forecasts in relation to a guidance model based on climatology and persistence (Statistical Hurricane Intensity Forecast; SHIFOR[8]) to highlight operational forecast skill. The values are defined as

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

with positive/negative values indicating better/worse operational forecasts than SHIFOR predictions. The values for maximum wind speed forecasts are available in Appendix 5. It can be seen that operational TC intensity forecasts have improved recently, with minimal year-to-year fluctuations. The annual mean improvement ratios of central pressure for 24-, 48-, 72-, 96- and 120-hour forecasts were 7% (15% in 2021), 7% (25%), 9% (26%), 12% (24%) and 25% (17%), respectively. The corresponding values of maximum wind were -3% (11% in 2021), 6% (27%), 19% (37%), 35% (38%) and 50% (33%), respectively.

The details of errors in operational central pressure forecasts, including improvement ratios to SHIFOR for each named TC that formed in 202, are summarized in Table 4.3. The data for maximum wind speed forecasts are available in Appendix 5. Forecasts for Hinnamnor (2211), Nanmadol (2214) and Noru (2116) were characterized by large errors attributed to the difficulty of estimation for rapid intensification.

Figure 4.8 shows a histogram of maximum wind speed errors for 24-hour forecasts (Histograms for 48-, 72-, 96- and 120-hour forecasts are also available in Appendix 5). Approximately 58% (67% in 2021) of 24-hour forecasts had errors of less than ±3.75 m/s, with figures of ±6.25 m/s for 64% (72%) of 48-hour forecasts, ±6.25 m/s for 65% (69%) of 72-hour forecasts, ±8.75 m/s for 77% (80%) of 96-hour forecasts and ±8.75 m/s for 91% (76%) of 120-hour forecasts.

[8] The Center operates the SHIFOR model based on Jarvinen and Neumann (1979). The explanatory variables include TC analysis data (center position, central pressure and maximum sustained wind, and related temporal variation from best-track data) and date. Multiple regression coefficients for the model were generated from best-track data for named TCs forming between 1977 and 2010.

[Reference]
Aberson, S. D., 1998. Five-Day Tropical Cyclone Track Forecasts in the North Atlantic Basin, *Weather and Forecasting*, **13**, 1005-1015.
Jarvinen, B. R. and C. J. Neumann, 1979: Statistical forecasts of tropical cyclone intensity, *NOAA Tech. Memo. NWS NHC-10*, 22 pp.
Neumann, C. J., 1972: An alternate to the Hurran (hurricane analog) tropical cyclone forecasting system. *NOAA Tech. Memo. NWS SR 62*, 23 pp.
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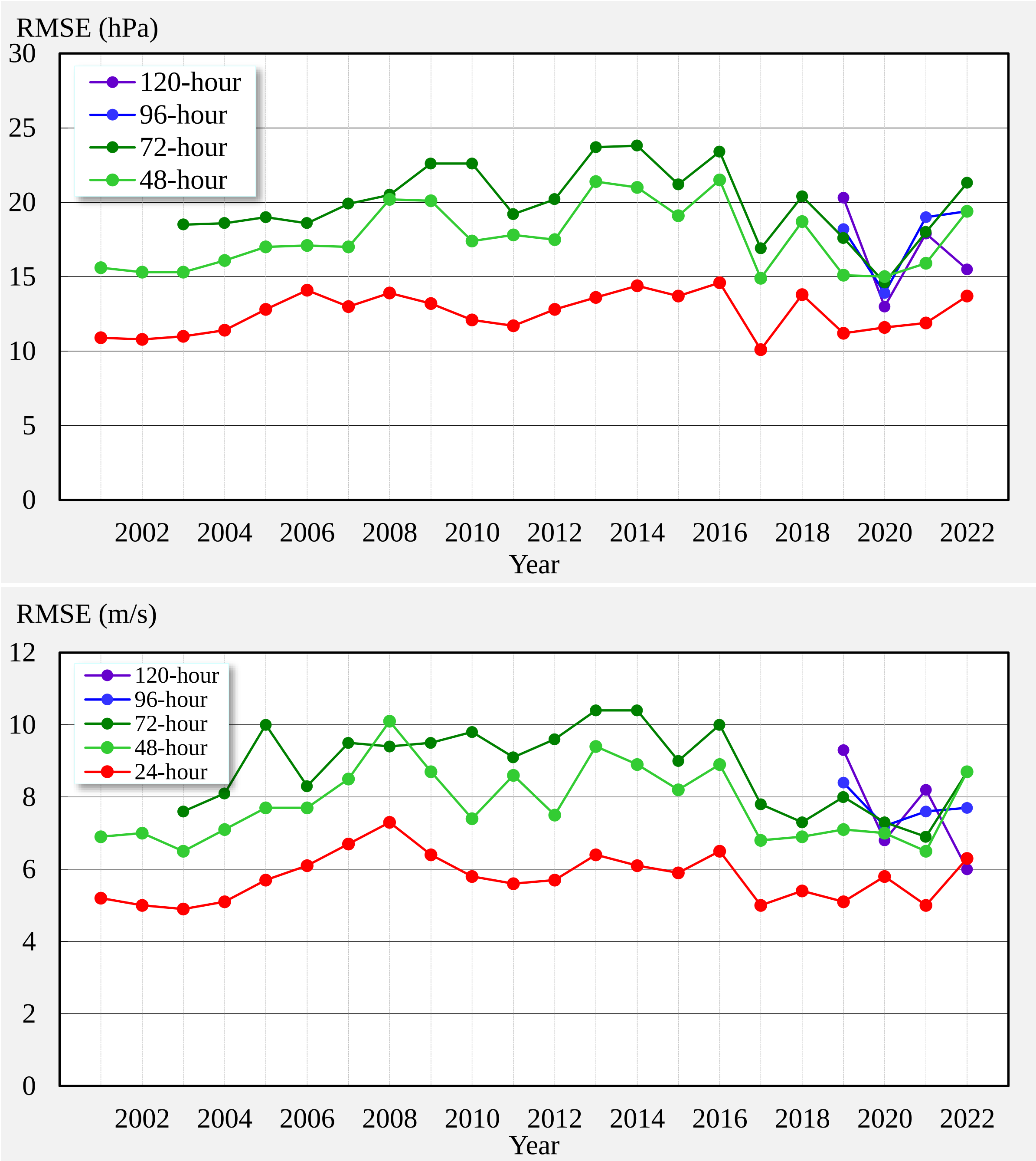
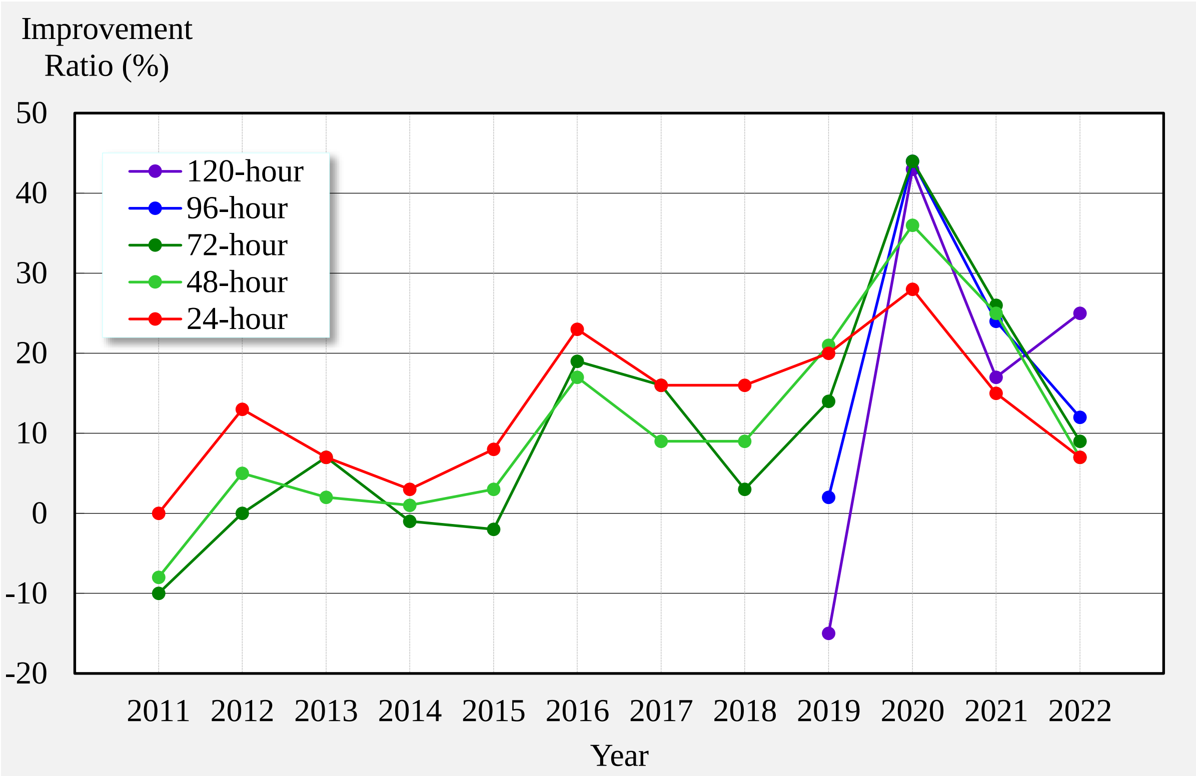


Figure 4.6 Annual RMSEs in 24-, 48, 72-, 96- and 120-hour operational central pressure (top) and maximum wind speed (bottom) forecasts



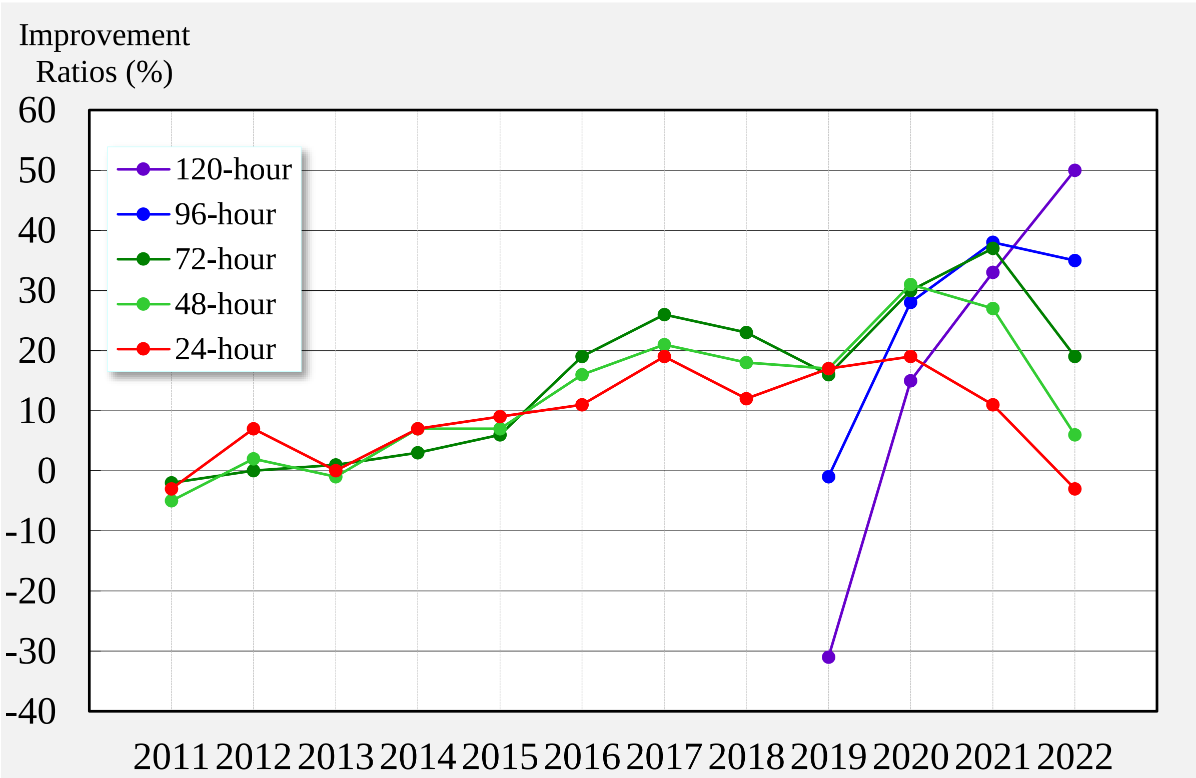


Figure 4.7 Annual mean improvement ratios in 24-, 48, 72-, 96- and 120-hour operational central pressure (top) and maximum wind speed (bottom) forecasts

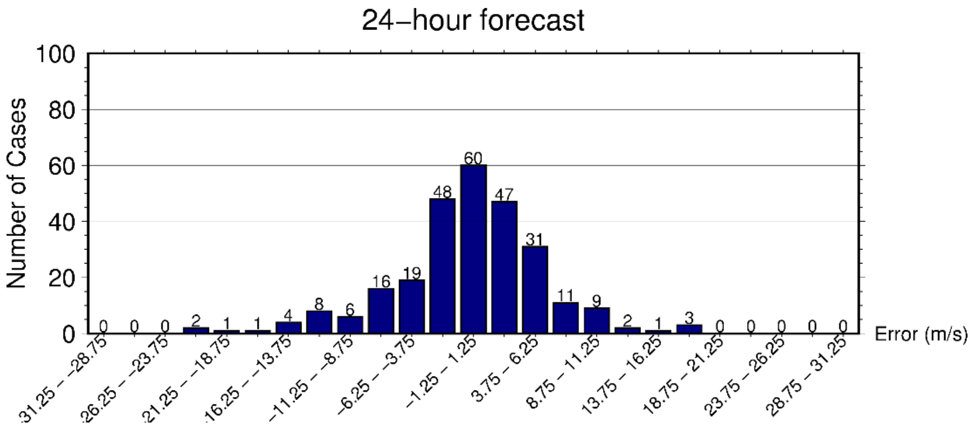


Figure 4.8 Histogram of 24-hour forecast maximum wind speed errors in 2022. (Histograms for 48-, 72-, 96- and 120-hour forecasts are also available at Appendix 5).

Table 4.3 Mean errors of 24-, 48-, 72-, 96- and 120-hour operational central pressure forecasts for each named TC that formed in 2022. Impr. and Num. represent improvement ratio of RMSEs (see the equation in 4.1.2 for detail) and number of samples, respectively.

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
			Error (hPa)	RMSE (hPa)	Num.	Impr. (%)	Error (hPa)	RMSE (hPa)	Num.	Impr. (%)	Error (hPa)	RMSE (hPa)	Num.	Impr. (%)	Error (hPa)	RMSE (hPa)	Num.	Impr. (%)	Error (hPa)	RMSE (hPa)	Num.	Impr. (%)
TY	Malakas	(2201)	-3.3	9.1	26	21	-4.9	11.3	22	29	-3.9	13.2	18	29	3.6	7.8	14	42	9.5	11.3	10	-54
TS	Megi	(2202)	0.0	0.0	1	100	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Chaba	(2203)	2.8	6.5	9	53	7.8	11.3	5	22	0.0	0.0	1	100	-	-	0	-	-	-	0	-
TS	Aere	(2204)	-1.5	3.2	13	49	-3.1	4.2	9	74	-4.8	5.5	5	76	2.0	2.0	1		-	-	0	-
TS	Songda	(2205)	3.8	4.3	9	-23	4.8	5.1	5	52	4.0	4.0	1	83	-	-	0	-	-	-	0	-
TS	Trases	(2206)	0.0	0.0	1	100	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Mulan	(2207)	0.7	1.2	3	91	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Meari	(2208)	2.3	2.3	8	2	4.0	4.0	4	11	-	-	0	-	-	-	0	-	-	-	0	-
STS	Ma-on	(2209)	1.3	4.9	13	48	2.8	6.3	9	66	4.4	5.3	5	81	2.0	2.0	1	94	-	-	0	-
TY	Tokage	(2210)	6.4	11.6	11	-17	9.7	17.8	7	-73	8.0	10.7	3	31	-	-	0	-	-	-	0	-
TY	Hinnamnor	(2211)	-5.9	23.6	33	-29	-3.1	29.9	29	-9	-6.1	31.2	25	-7	-9.2	27.3	20	10	-9.9	20.4	16	34
TY	Muifa	(2212)	3.3	10.2	29	16	4.9	12.2	25	12	3.6	13.5	21	-42	2.7	10.5	17	0	3.9	14.0	13	-26
TY	Merbok	(2213)	3.5	6.8	11	-23	13.9	14.6	7	-112	21.7	22.2	3	-266	-	-	0	-	-	-	0	-
TY	Nanmadol	(2214)	2.5	25.9	20	-28	16.6	36.1	16	6	27.9	40.2	12	7	20.0	29.6	8	1	1.3	5.6	4	-9
TS	Talas	(2215)	0.0	0.0	2	100	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Noru	(2216)	6.4	18.1	19	39	15.6	27.5	15	-34	8.2	18.8	11	-11	23.7	26.8	7	-59	17.0	18.5	3	-27
STS	Kulap	(2217)	8.5	8.8	10	4	14.0	14.3	6	-5	22.5	22.6	2	-207	-	-	0	-	-	-	0	-
TY	Roke	(2218)	0.0	14.6	9	-20	-1.6	10.5	5	4	2.0	2.0	1	86	-	-	0	-	-	-	0	-
TS	Sonca	(2219)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Nesat	(2220)	-2.7	6.3	15	60	2.9	9.5	11	54	1.1	9.1	7	44	-12.0	12.5	3	48	-	-	0	-
TS	Haitang	(2221)	2.0	2.0	1	71	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Nalgae	(2222)	-3.9	7.3	23	37	-5.9	6.7	19	66	-5.6	6.6	15	68	-3.2	7.5	11	66	-7.9	12.9	7	51
TS	Banyan	(2223)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Yamaneko	(2224)	-2.7	2.8	3	75	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Pakhar	(2225)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
Annual Mean (Total)			0.5	13.7	269	7	3.4	19.4	194	7	2.6	21.3	130	9	2.1	19.4	82	12	-0.2	15.5	53	25

4.2 Verification of Timing of First-issued Operational Forecasts for Individual Named TCs

The Center issues TC track forecasts with probability circles and intensity values when a TC of TS intensity or higher is present or expected within 24 hours in its area of responsibility. Accordingly, initial forecasts for individual TCs are also used as 24-hour genesis forecasts in addition to track and intensity forecasts.

Table 4.4 shows differences between initial times of initial forecasts and upgrade times in best-track data/real-time provisional analysis data for individual named TCs. Differences tend to be less than the ideal of 24 hours.

Table 4.4 Lead times of operational forecasting for upgrade to TS intensity or higher. "First forecast," "Upgrade (Best/Prov.)" and "Lead time (Best/Prov.)" are the initial time of the first forecast for individual named TCs, the time when the TC was upgraded to TS intensity or higher in best-track data/provisional analysis, and the time difference between the two, respectively.

Tropical Cyclone			First Forecast	Upgrade (Best)	Upgrade (Prov.)	Lead Time (Best)	Lead Time (Prov.)
TY	Malakas	(2201)	0600UTC 06 Apr	0000UTC 08 Apr	0000UTC 08 Apr	42 h	42 h
TS	Megi	(2202)	0000UTC 09 Apr	1800UTC 09 Apr	0000UTC 10 Apr	18 h	24 h
TY	Chaba	(2203)	0000UTC 29 Jun	0000UTC 30 Jun	0000UTC 30 Jun	24 h	24 h
TS	Aere	(2204)	1800UTC 30 Jun	1800UTC 30 Jun	0000UTC 01 Jul	0 h	6 h
TS	Songda	(2205)	1200UTC 26 Jul	1200UTC 28 Jul	1200UTC 28 Jul	48 h	48 h
TS	Trases	(2206)	0300UTC 31 Jul	0000UTC 31 Jul	0300UTC 31 Jul	-3 h	0 h
TS	Mulan	(2207)	0600UTC 08 Aug	0600UTC 09 Aug	0600UTC 09 Aug	24 h	24 h
TS	Meari	(2208)	0000UTC 10 Aug	1200UTC 11 Aug	1800UTC 11 Aug	36 h	42 h
STS	Ma-on	(2209)	0600UTC 21 Aug	1800UTC 21 Aug	0300UTC 22 Aug	12 h	21 h
TY	Tokage	(2210)	1800UTC 21 Aug	0000UTC 22 Aug	0300UTC 22 Aug	6 h	9 h
TY	Hinnamnor	(2211)	0000UTC 28 Aug	0600UTC 28 Aug	0600UTC 28 Aug	6 h	6 h
TY	Muifa	(2212)	0600UTC 07 Sep	1800UTC 07 Sep	0000UTC 08 Sep	12 h	18 h
TY	Merbok	(2213)	0600UTC 11 Sep	1200UTC 11 Sep	0000UTC 12 Sep	6 h	18 h
TY	Nanmadol	(2214)	1800UTC 12 Sep	1800UTC 13 Sep	1800UTC 13 Sep	24 h	24 h
TS	Talas	(2215)	1800UTC 21 Sep	0000UTC 22 Sep	0000UTC 23 Sep	6 h	30 h
TY	Noru	(2216)	0600UTC 22 Sep	1800UTC 22 Sep	0600UTC 23 Sep	12 h	24 h
STS	Kulap	(2217)	0600UTC 25 Sep	0000UTC 26 Sep	0000UTC 26 Sep	18 h	18 h
TY	Roke	(2218)	0000UTC 28 Sep	1200UTC 28 Sep	1200UTC 28 Sep	12 h	12 h
TS	Sonca	(2219)	0000UTC 13 Oct	0000UTC 14 Oct	0600UTC 14 Oct	24 h	30 h
TY	Nesat	(2220)	1200UTC 14 Oct	0600UTC 15 Oct	0600UTC 15 Oct	18 h	18 h
TS	Haitang	(2221)	0600UTC 18 Oct	0000UTC 18 Oct	0600UTC 18 Oct	-6 h	0 h
STS	Nalgae	(2222)	0000UTC 26 Oct	0000UTC 27 Oct	0000UTC 27 Oct	24 h	24 h
TS	Banyan	(2223)	0300UTC 31 Oct	1800UTC 30 Oct	0300UTC 31 Oct	-9 h	0 h
TS	Yamaneko	(2224)	1800UTC 11 Nov	1200UTC 12 Nov	1200UTC 12 Nov	18 h	18 h
TS	Pakhar	(2225)	0000UTC 10 Dec	1200UTC 11 Dec	1200UTC 11 Dec	36 h	36 h

4.3 Verification of Numerical Models (GSM, GEPS)

GSM and GEPS provide primary information for use by JMA forecasters in making operational TC track and intensity forecasts. The details of GSM and GEPS and information on recent related improvements are given in Appendix 7. GSM and GEPS predictions were verified with RSMC TC best track data and predictions using the persistency (PER) method. All TC forecast verifications were conducted for both systems.

4.3.1 GSM Prediction

1) Center Position

GSM annual mean position errors observed since 1997 are presented in Figure 4.9. In 2022, the annual mean errors for 30-, 54-, 78-, 102- and 126-hour[9] predictions were 96 km (120 km in 2021), 156km (232 km), 232km (330 km), 266km (394 km) and 340km (445 km), respectively. The mean position errors of 18-, 30-, 42-, 54-, 66-, 78-, 90-, 102-, 114- and 126-hour predictions for each named TC are given in Table 4.5.

Table 4.6 shows relative GSM performance compared with results obtained using the PER method[10]. In this comparison, TCs were classified into the three life stages of before, during and after recurvature. The definition of the stages is based on the direction of movement of each TC at individual prediction times (Figure 4.5). The table indicates that GSM results outperformed those of the PER method throughout the forecast period beyond 18 hours from the initial time, and that the ratios of error reduction for the GSM compared to the PER method were about 59% (51% in 2021), 70% (58%), 76% (58%), 77% (62%), 81% (67%) and 81% (70%) for 18-, 30-, 54-, 78-, 102- and 126-hour predictions, respectively.

About 83% (73% in 2021) of 30-hour predictions (histograms showing the position errors of 30-, 54-, 78-, 102- and 126-hour predictions are shown in Appendix 5) had errors of less than 150 km, while 91% (75%) of 54-hour predictions had errors of less than 300 km, and 89% (79%) of 78-hour predictions had errors of less than 450 km.

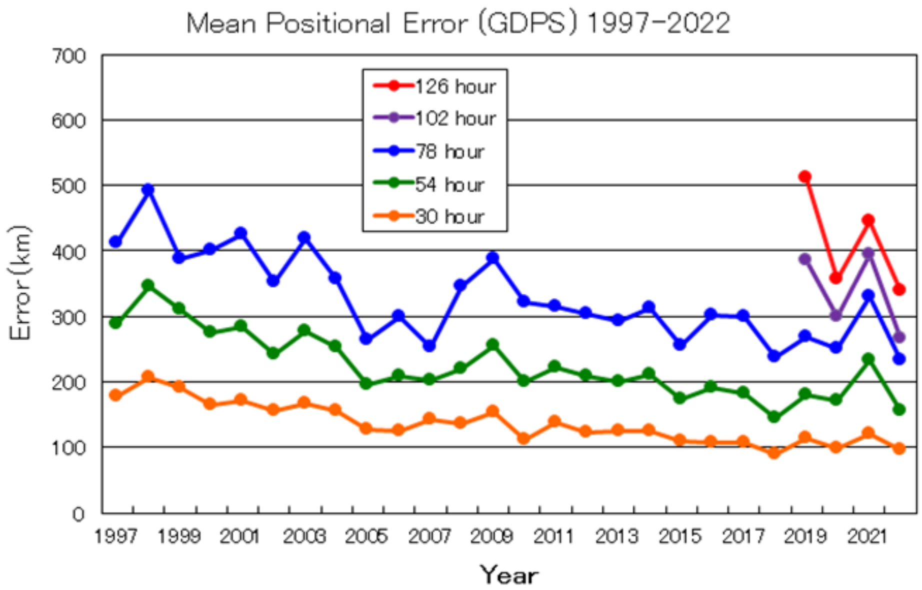


Figure 4.9 GSM annual mean position errors since 1997

[9] 30-, 54-, 78-, 102- and 126-hour GSM predictions are used as primary information by forecasters creating 24-, 48-, 72-, 96- and 120-hour operational forecasts, respectively.
[10] The PER method is based on the assumption that a TC holds the same movement throughout the forecast period, and linear extrapolation for the latest 12-hour track of the TC is applied to create TC track forecasts. Position errors with the PER method are used to evaluate the relative performance of operational forecasts and model predictions.

Table 4.5 GSM mean position errors (km) for each named TC that formed in 2022. The number of samples is given in parentheses.

Tropical Cyclone			T=18		T=30		T=42		T=54		T=66		T=78		T=90		T=102		T=114		T=126	
TY	2201	MALAKAS	70.4	(34)	80.7	(32)	87.2	(30)	90.3	(28)	97.2	(26)	125.7	(24)	126.4	(22)	164.3	(20)	214.4	(18)	248	(16)
TS	2202	MEGI	54.1	(10)	86.4	(8)	115.7	(6)	128.1	(3)	218.3	(1)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2203	CHABA	68.2	(14)	64.1	(12)	67.6	(10)	63.6	(8)	79.7	(6)	115.9	(4)	180	(2)	-	(-)	-	(-)	-	(-)
TS	2204	AERE	42.6	(14)	60.8	(12)	89.5	(10)	117.3	(8)	158.4	(6)	237.5	(4)	285.6	(2)	-	(-)	-	(-)	-	(-)
TS	2205	SONGDA	142	(13)	142.2	(8)	151.4	(5)	119.4	(2)	279.6	(1)	300.4	(1)	391	(1)	379.1	(1)	-	(-)	-	(-)
TS	2206	TRASES	153.9	(5)	127.7	(3)	312.8	(1)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2207	MULAN	69.5	(8)	62.5	(6)	67.9	(4)	57.2	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2208	MEARI	65.2	(15)	66.2	(13)	110	(11)	130.7	(7)	150.9	(4)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
STS	2209	MA-ON	77.3	(16)	106.2	(14)	156.5	(12)	249	(10)	346.9	(8)	457	(6)	616.9	(4)	817.5	(2)	-	(-)	-	(-)
TY	2210	TOKAGE	57.9	(13)	68.5	(11)	87.9	(9)	152.3	(7)	285	(5)	235.5	(3)	249.3	(1)	-	(-)	-	(-)	-	(-)
TY	2211	HINNAMNOR	45.7	(35)	73.9	(33)	117	(30)	144.1	(28)	176.5	(26)	194.6	(24)	189.2	(22)	195.9	(20)	236.3	(18)	281.4	(16)
TY	2212	MUIFA	68.8	(32)	107.1	(30)	152.7	(28)	195.5	(26)	244.8	(24)	303.7	(22)	363.4	(20)	414.2	(18)	446.9	(16)	452.9	(14)
TY	2213	MERBOK	54.7	(13)	61.8	(11)	59.4	(9)	107.3	(7)	147.8	(5)	149.1	(3)	98	(1)	-	(-)	-	(-)	-	(-)
TY	2214	NANMADOL	58.7	(26)	97.8	(24)	126.8	(22)	151.9	(20)	173.9	(18)	251.4	(16)	311.7	(13)	296.4	(11)	341.1	(10)	185	(7)
TS	2215	TALAS	118.2	(8)	157.9	(6)	172	(4)	196.9	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2216	NORU	62	(22)	82.3	(20)	102.5	(18)	130.5	(16)	155.1	(14)	157.7	(12)	132.1	(10)	127	(8)	198.5	(6)	218.1	(4)
STS	2217	KULAP	72.5	(13)	93.6	(11)	130.7	(9)	212.4	(7)	307.2	(5)	502.1	(3)	618	(1)	-	(-)	-	(-)	-	(-)
TY	2218	ROKE	95.4	(12)	192.4	(10)	343	(8)	551.1	(6)	920.4	(4)	1326.4	(2)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2219	SONCA	45.1	(4)	96.8	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2220	NESAT	49	(20)	71.4	(18)	88	(16)	98.4	(14)	118.3	(12)	172.8	(10)	220.9	(8)	269.1	(6)	294	(4)	377.8	(2)
TS	2221	HAITANG	131.1	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
STS	2222	NALGAE	87	(29)	98	(27)	107.5	(25)	135.9	(23)	158.6	(21)	195.8	(19)	231.9	(17)	283.9	(15)	381.2	(13)	548.4	(11)
TS	2223	BANYAN	106.9	(6)	143.6	(4)	154	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2224	YAMANEKO	122.6	(7)	215.3	(5)	322.6	(3)	304.8	(1)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2225	PAKHAR	123.6	(8)	237.1	(6)	424.3	(4)	611.4	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
All	Annual	Mean	72.6	(379)	95.7	(326)	125.8	(276)	155.9	(227)	192.1	(186)	232	(153)	242.3	(124)	265.6	(101)	305.8	(85)	339.5	(70)

Table 4.6 Mean position errors (km) of GSM and PER method predictions for the 25 named TCs that formed in 2022 in the stages before, during and after recurvature. The number of samples is given in parentheses. IMPROV is the ratio of error reductions in GSM results to those observed using the PER method.

TIM	MODEL	Before		During		After		All	
T=18	GSM	76.0	(170)	66.7	(113)	73.3	(96)	72.6	(379)
	PER	166.7	(170)	153.2	(113)	218.8	(96)	175.8	(379)
	IMPROV	54.4	%	56.4	%	66.5	%	58.7	%
T=30	GSM	96.7	(142)	85.5	(100)	106.2	(84)	95.7	(326)
	PER	294.3	(142)	282.0	(100)	395.0	(84)	316.5	(326)
	IMPROV	67.2	%	69.7	%	73.1	%	69.8	%
T=42	GSM	125.4	(119)	109.3	(83)	145.1	(74)	125.8	(276)
	PER	428.2	(119)	431.8	(83)	608.2	(74)	477.5	(276)
	IMPROV	70.7	%	74.7	%	76.1	%	73.6	%
T=54	GSM	158.1	(99)	119.3	(65)	190.4	(63)	155.9	(227)
	PER	550.4	(99)	625.5	(65)	839.7	(63)	652.2	(227)
	IMPROV	71.3	%	80.9	%	77.3	%	76.1	%
T=66	GSM	202.3	(77)	144.0	(57)	229.6	(52)	192.1	(186)
	PER	693.6	(77)	798.9	(57)	1030.	(52)	820.0	(186)
	IMPROV	70.8	%	82.0	%	77.7	%	76.6	%
T=78	GSM	245.1	(60)	179.6	(52)	279.5	(41)	232.0	(153)
	PER	869.2	(60)	959.2	(52)	1199.	(41)	988.4	(153)
	IMPROV	71.8	%	81.3	%	76.7	%	76.5	%
T=90	GSM	262.9	(46)	234.7	(47)	223.4	(31)	242.3	(124)
	PER	1008.	(46)	1223.	(47)	1297.	(31)	1162.	(124)
	IMPROV	73.9	%	80.8	%	82.8	%	79.1	%
T=102	GSM	262.3	(30)	295.3	(45)	218.0	(26)	265.6	(101)
	PER	1054.	(30)	1439.	(45)	1602.	(26)	1367.	(101)
	IMPROV	75.1	%	79.5	%	86.4	%	80.6	%
T=114	GSM	240.1	(17)	343.2	(42)	288.4	(26)	305.8	(85)
	PER	1430.	(17)	1472.	(42)	2020.	(26)	1631.	(85)
	IMPROV	83.2	%	76.7	%	85.7	%	81.3	%
T=126	GSM	276.2	(10)	397.4	(35)	283.8	(25)	339.5	(70)
	PER	1488.	(10)	1673.	(35)	2094.	(25)	1797.	(70)
	IMPROV	81.4	%	76.2	%	86.5	%	81.1	%

2) Central Pressure and Maximum Wind Speed

The mean errors of 30-, 54-, 78-, 102- and 126-hour GSM central pressure predictions in 2022 were +6.7 hPa (+7.6 hPa in 2021), +8.8 hPa (+8.3 hPa), +9.5 hPa (+9.4 hPa), +7.3 hPa (+8.6 hPa) and +5.3 hPa (+7.1 hPa), respectively. Their root mean square errors (RMSEs) were 15.7 hPa (20.2 hPa in 2021) for 30-hour predictions, 19.9 hPa (22.1 hPa) for 54-hour predictions, 22.1 hPa (24.6 hPa) for 78-hour predictions, 24.2 hPa (24.0 hPa) for 102-hour predictions and 20.4 hPa (23.4 hPa) for 126-hour predictions. The biases in 30-, 54-, 78-, 102- and 126-hour maximum wind speed predictions were –6.0 m/s (-6.2 m/s in 2021) with an RMSE of 9.8 m/s (10.1 m/s), -7.1 m/s (-6.5 m/s) with a RMSE of 12.2 m/s (10.9 m/s), -7.2 m/s (-7.0 m/s) with a RMSE of 12.7 m/s (11.7 m/s), -5.9 m/s (-7.1 m/s) with a RMSE of 13.2 m/s (11.6 m/s) and -5.9 m/s (-7.6 m/s) with a RMSE of 11.5 m/s (12.7 m/s), respectively.

Figure 4.10 shows histograms of central pressure errors and maximum wind speed errors in 30-hour GSM predictions. It can be seen that the GSM has a small positive bias in central pressure prediction (left) and tends to underestimate the wind speed of TCs (right). This underestimation occurs because the model's horizontal resolution in 2022 (about 20 km) is not fine enough to produce the TC core structure, especially when the TC is intense and small.

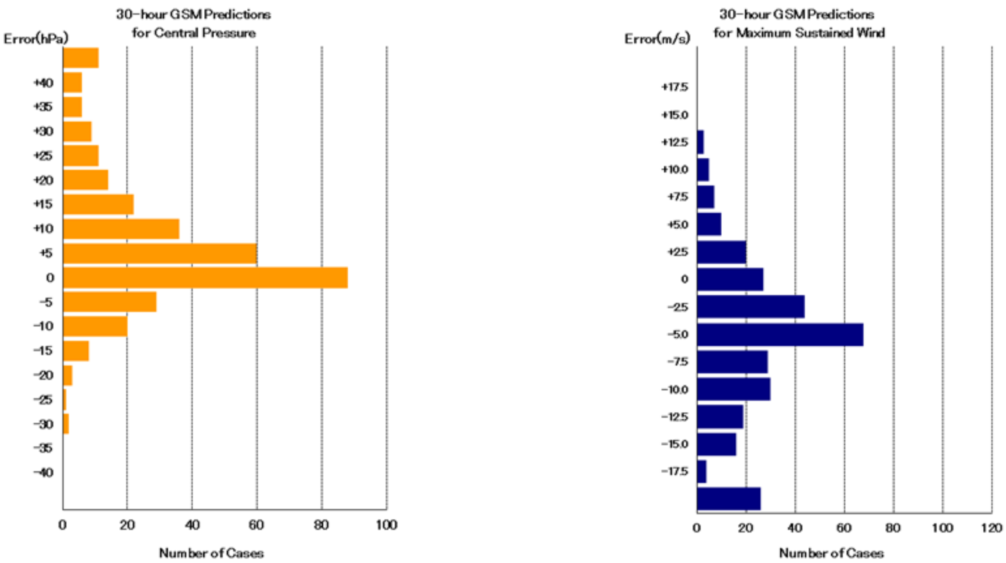


Figure 4.10 Error distribution of GSM 30-hour intensity predictions in 2022. The figure on the left shows error distribution for central pressure, while the one on the right shows that for maximum wind speed (the error distributions of 54-, 78-, 102- and 126-hour predictions are shown at the Appendix 5).

4.3.2 GEPS Prediction

1) Ensemble Mean Center Position

GEPS took over the role of the Typhoon Ensemble Prediction System (TEPS), and has been providing ensemble forecasts for TCs since January 2017. GEPS and TEPS annual mean position errors observed since 2008 are presented in Figure 4.11. In 2022, the mean position errors of GEPS ensemble mean forecasts for 30-, 54-, 78-, 102- and 126-hour predictions for each named TC are given in Table 4.7. The annual means of ensemble mean position errors for 30-, 54-, 78-, 102- and 126-hour predictions were 107 km (96 km with the GSM), 175 km (156 km), 243 km (232 km), 279 km (266 km) and 335 km (340 km), respectively.

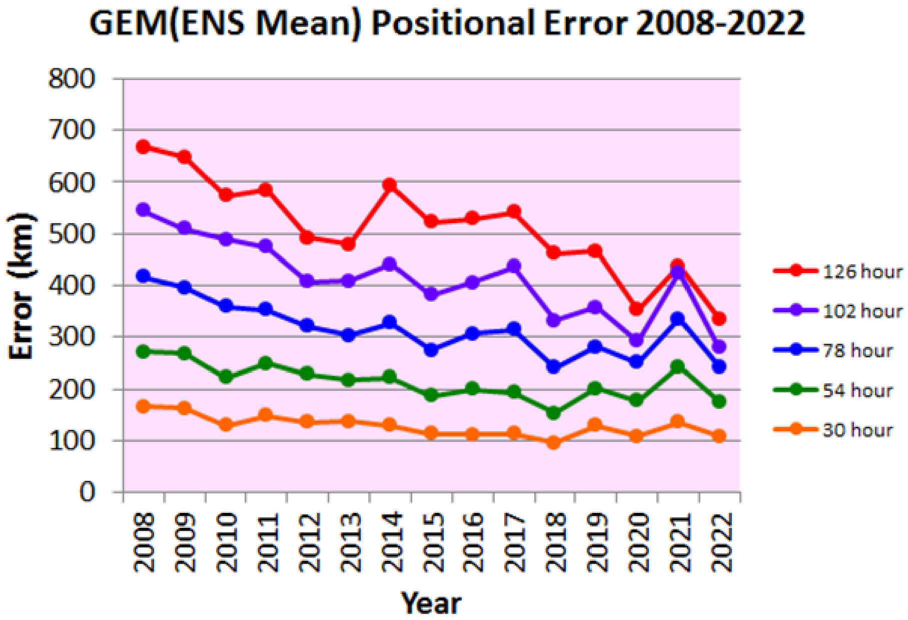


Figure 4.11 GEPS and TEPS annual mean position errors since 2008

2) Spread-Skill Relationship

Although position errors of GEPS ensemble mean forecasts were larger than those of the GSM in short-range forecasts, GEPS provides useful information on the reliability of TC track forecasts with its ensemble spread. Figure 4.12 shows the relationship between 6-hourly cumulative ensemble spreads in TC position forecasts and ensemble mean forecast position errors in 126-hour prediction. In an ideal EPS with a large number of samples, significant positional errors are observed when the ensemble spread is large. However, no clear correlation is seen from the figure. One of the reason why it is considered non-ideal is that the number of samples is not enough.

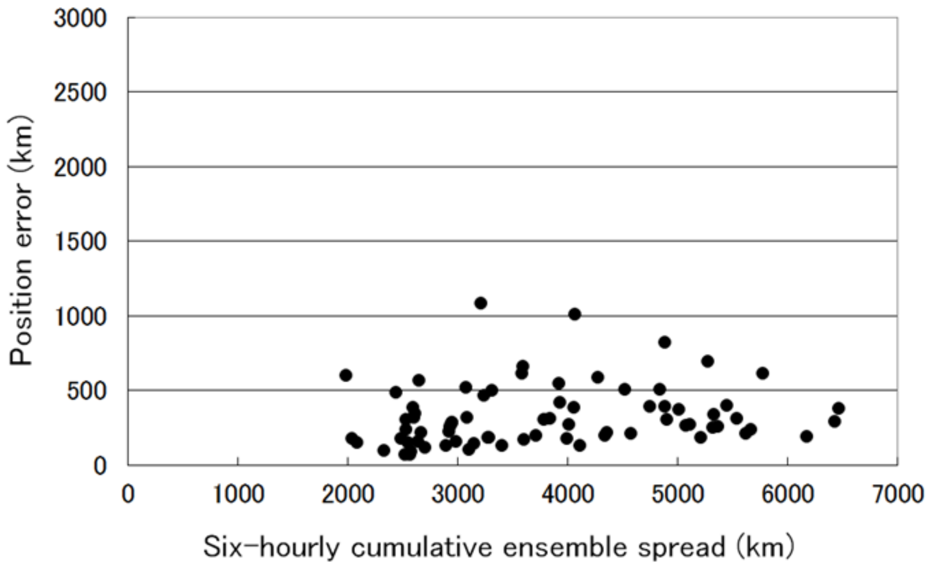


Figure 4.12 Relationship between six-hourly cumulative ensemble spread in TC position forecasts (km) and ensemble mean forecast position errors (km) in 126-hour predictions in 2022.

Table 4.7 Mean position errors (km) of GEPS ensemble mean forecasts for each named TC that formed in 2022. The number of samples is given in parentheses.

Tropical Cyclone			**T=18**		**T=30**		**T=42**		**T=54**		**T=66**		**T=78**		**T=90**		**T=102**		**T=114**		**T=126**	
TY	2201	MALAKAS	70.4	(34)	93.8	(32)	113	(30)	123.5	(28)	127.9	(26)	145.1	(24)	162.2	(22)	211.2	(20)	276.4	(18)	323.5	(16)
TS	2202	MEGI	79.5	(10)	109.8	(8)	162.6	(4)	190.4	(3)	225.5	(1)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2203	CHABA	64.9	(14)	64.2	(12)	67.8	(10)	65.5	(8)	81.4	(6)	108	(4)	173.9	(2)	-	(-)	-	(-)	-	(-)
TS	2204	AERE	43.6	(14)	53.2	(12)	87.6	(10)	116.5	(8)	148.7	(6)	208.4	(4)	250.4	(2)	-	(-)	-	(-)	-	(-)
TS	2205	SONGDA	122.6	(13)	146.5	(10)	146.5	(7)	121.5	(3)	201	(1)	125.5	(1)	176.7	(1)	-	(-)	-	(-)	-	(-)
TS	2206	TRASES	109	(5)	155.4	(3)	329.2	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2207	MULAN	55.9	(8)	66.2	(6)	64	(4)	67.2	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2208	MEARI	60.8	(15)	69	(13)	80.6	(10)	86.3	(4)	67.3	(1)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
STS	2209	MA-ON	86.4	(16)	115.2	(14)	180.9	(12)	277.1	(10)	394.7	(8)	493.5	(6)	642.9	(4)	749.7	(2)	-	(-)	-	(-)
TY	2210	TOKAGE	52.9	(13)	63.6	(11)	82.6	(9)	127.2	(7)	214.4	(5)	159.5	(3)	228.5	(1)	-	(-)	-	(-)	-	(-)
TY	2211	HINNAMNO R	44.5	(35)	74.6	(33)	120.7	(30)	156.1	(28)	187.9	(26)	208.3	(24)	212.6	(22)	227	(20)	279.9	(18)	333.3	(16)
TY	2212	MUIFA	70.8	(32)	108	(30)	146.8	(28)	187.1	(26)	234.7	(24)	297.9	(22)	349	(20)	401.9	(18)	439.9	(16)	453.7	(14)
TY	2213	MERBOK	56.9	(13)	69.2	(11)	75.7	(9)	129.2	(7)	191.5	(5)	249.8	(3)	222.6	(1)	-	(-)	-	(-)	-	(-)
TY	2214	NANMADOL	61.6	(26)	105.1	(24)	128.4	(22)	155.9	(20)	176.1	(18)	238.5	(16)	291.6	(14)	292.9	(12)	227.4	(10)	170.7	(8)
TS	2215	TALAS	121.3	(8)	192.3	(6)	254.1	(4)	293.2	(1)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2216	NORU	64.1	(22)	98.1	(20)	130.8	(18)	160.7	(16)	171.3	(14)	175.1	(12)	162	(10)	176.1	(8)	176.2	(5)	186.2	(3)
STS	2217	KULAP	83.9	(13)	114.7	(11)	179.8	(9)	287.4	(7)	395	(5)	536.9	(3)	684.7	(1)	-	(-)	-	(-)	-	(-)
TY	2218	ROKE	135.2	(12)	291.2	(10)	519.4	(8)	785.5	(6)	1141.5	(4)	1518.2	(2)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2219	SONCA	85.8	(4)	168.1	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2220	NESAT	56.4	(20)	84.2	(18)	110.9	(16)	132.7	(14)	162.4	(12)	220.3	(10)	294.5	(8)	375.7	(6)	477.5	(4)	573.5	(2)
TS	2221	HAITANG	117.1	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
STS	2222	NALGAE	96.1	(29)	110.1	(27)	113.9	(25)	142.7	(23)	169.5	(21)	195.9	(19)	217.2	(17)	234.4	(15)	261.1	(13)	321.2	(11)
TS	2223	BANYAN	111.8	(6)	166.7	(3)	203.8	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2224	YAMANEKO	168.5	(7)	251.9	(5)	327.7	(3)	321.5	(1)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2225	PAKHAR	165.9	(8)	241.3	(6)	350.8	(4)	505.3	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
All	Annual	Mean	77	(379)	107.4	(327)	141.5	(276)	175.5	(224)	210.5	(183)	242.5	(153)	253.7	(125)	279.1	(101)	303.7	(84)	335.2	(70)

To add reliability information to TC track forecasts, JMA has introduced a reliability index in which the categories A, B and C represent the highest, middle and lowest levels of reliability, respectively. The index is based on the six-hourly cumulative ensemble spread at each forecast time. The category levels were set from the results of the pre-operational running of GEPS so that the category frequencies are 40%, 40% and 20%, respectively. Table 4.8 shows ensemble mean forecast errors classified with the reliability index. Theoretically, mean position errors with higher reliability should be smaller than those with lower reliability throughout forecast times with sufficient samples in an ideal EPS. The table shows that GEPS provides appropriate reliability information on 2022 TC track forecasts.

Table 4.8 Ensemble mean forecast position errors (km) in 2022 classified with six-hourly cumulative ensemble spread at each forecast time. The number of samples is given in parentheses.

Time	Reliability Index					
	A		B		C	
T=30	73	(110)	101	(148)	162	(91)
T=54	140	(119)	212	(86)	212	(40)
T=78	200	(90)	297	(47)	268	(28)
T=102	210	(59)	383	(34)	268	(18)
T=126	284	(41)	366	(30)	363	(4)

4.4 Verification for Other Guidance Models

4.4.1 Verification by WGNE

The Center utilizes other guidance models in addition to JMA's NWP models for operational TC track and intensity forecasting, including global deterministic NWP models from seven other centers ((BOM, CMC, DWD, ECMWF, KMA, NCEP and UKMO). These models (as well as the Meteo France (FRN) model, the Naval Research Laboratory (NRL) model and National Centre for Medium Range Weather Forecasting (NCMRWF) model) are verified under the framework of WGNE (the Working Group on Numerical Experimentation), which is a collaborative working group for development of Earth system models (design, implementation, error diagnosis and model revision) across the full range of temporal and spatial scales. JMA works on inter-comparison of these models under the framework. Figures 4.13 and 4.14 show the results of the verification for center positions and 72-hour intensity forecasts by WGNE.

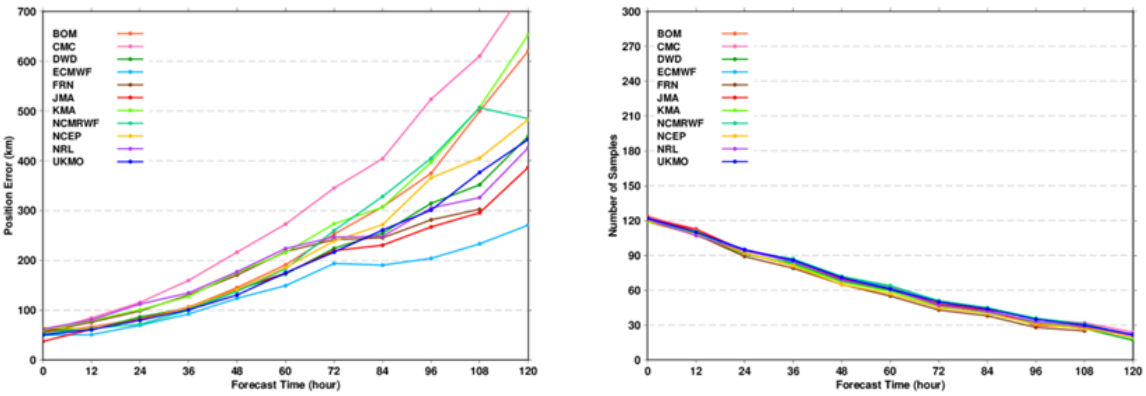


Figure 4.13 (Left) Positional errors for 2022 named TCs. The tropical depression (TD) stage and the extra-tropical cyclone (L) stage of targeted TCs is also included in this verification. (Right) Sample numbers.

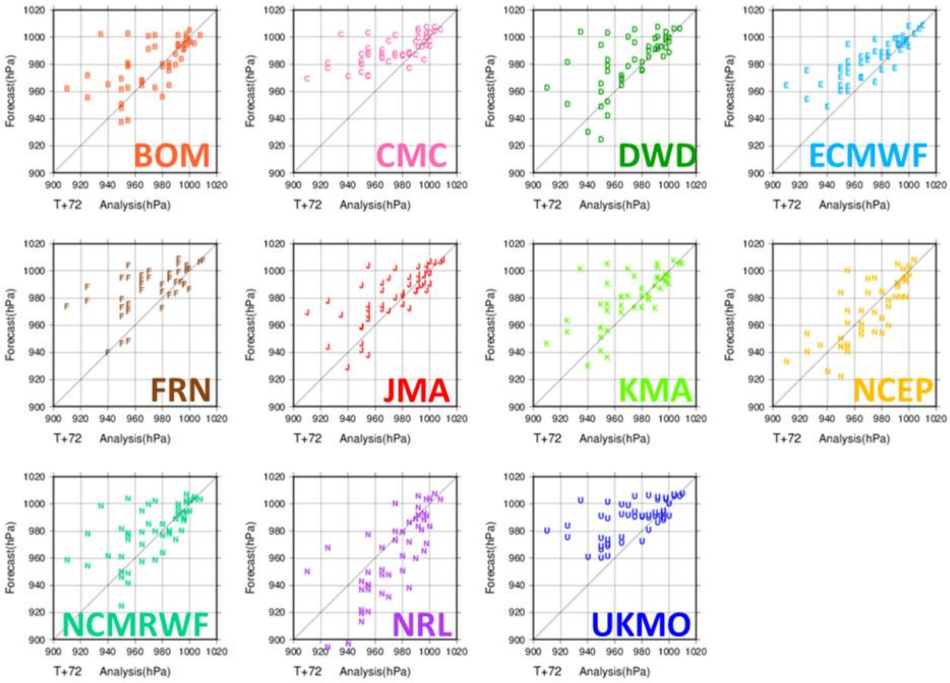


Figure 4.14 Scatter diagrams of 72-hour TC center pressure forecasts from 11 deterministic models for 2022. The tropical depression (TD) stage and the extra-tropical cyclone (L) stage of targeted TCs is also included in this verification.

4.4.2 Verification of Intensity Guidance Models

Table 4.9 shows mean central pressure and maximum wind speed errors in TIFS and LGEM (Logistic Growth Equation Model) intensity guidance and related consensus. This section describes verification of the latest guidance data available for each initial time of real-time operation conducted for RSMC operational forecasting.

Table 4.9 Mean error and RMSE of central pressure (top) and maximum wind speed (bottom) forecasts from intensity guidance models produced by the Center in 2022. Num. represents number of samples.

Prediction		24-hour Forecast			48-hour Forecast			72-hour Forecast			96-hour Forecast			120-hour Forecast		
		Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.	Error (hPa)	RMSE (hPa)	Num.
Intensity guidance model	TIFS	0.5	11.9	264	0.3	16.3	188	-1.4	17.4	126	-4.1	16.7	80	-5.8	12.5	52
	LGEM	2.3	12.8	264	1.7	17.6	188	-2.6	20.5	126	-7.5	20.0	80	-	-	0
Consensus method	TIFS&LGEM	1.4	12.0	264	1.0	16.6	188	-2.0	18.6	126	-5.8	17.4	80	-	-	0

Prediction		24-hour Forecast			48-hour Forecast			72-hour Forecast			96-hour Forecast			120-hour Forecast		
		Error (m/s)	RMSE (m/s)	Num.	Error (m/s)	RMSE (m/s)	Num.	Error (m/s)	RMSE (m/s)	Num.	Error (m/s)	RMSE (m/s)	Num.	Error (m/s)	RMSE (m/s)	Num.
Intensity guidance model	TIFS	-1.4	5.7	264	-1.6	7.4	188	-0.8	7.3	126	-0.2	7.3	80	0.1	5.1	52
	LGEM	-1.5	6.0	264	-1.3	7.7	188	0.1	8.0	126	1.6	7.3	80	-	-	0
Consensus method	TIFS&LGEM	-1.5	5.7	264	-1.4	7.4	188	-0.3	7.4	126	0.7	6.9	80	-	-	0

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

JMA produces Atmospheric Motion Vectors (AMVs) using successive satellite imagery from the Himawari-8/9 geostationary satellite. These are derived from the Full-disk observation conducted every 10 minutes and Region 3 tropical cyclone observation conducted over an area of 1,000 square kilometers every 2.5 – 5 minutes. Since July 2017, JMA has used the AMV-based Sea-surface Winds (ASWinds) product based on low-level AMVs (assigned below 700 hPa level) to estimate sea-surface winds in the vicinity of TCs. The ASWinds are derived at intervals of 10 – 30 minutes with frequent and wide-ranging wind distribution information. Figure 4.15 shows the distributions of ASWind derived using the Full-disk and Region 3 observations by Himawari-8 for TY Hinnamnor (2211). The wide-area coverage and high temporal resolution of ASWinds data are also expected to support real-time determination of 30-kt wind radii for TC areas where low-level clouds appear in Himawari-8/9 imagery together with surface wind observations from satellite microwave scatterometers such as the ASCAT units on board MetOp polar-orbiting satellites (referred to here as “ASCAT winds”).

JMA verifies the quality of ASWinds data from Visible (B03: 0.64 μm), Short-wave Infrared (B07: 3.9 μm), and Infrared (B13: 10.4 μm) with respect to ASCAT wind data in the vicinity of 25 TCs occurring in 2022 (Table 4.10). Wind speed biases in ASWinds data from Full-disk and Region 3 observation are small at -0.7 to -0.5 m/s, and -02 m/s, respectively. Vector differences in ASWinds from Region 3 observation are slightly larger than those from Full-disk observation, which suggests that the use of high-frequency Region-3 observation data supports tracking to determine the movement of low-level cloud associated with mesoscale phenomena.

The mean distribution of ASWinds data from Full-disk and Region-3 observation (Figure 4.16) for 2022 suggests that the representation of Region-3 ASWinds is higher than that of Full-disk ASWinds, particularly near TC centers. This is attributed to the higher temporal frequency of Region-3 imagery.

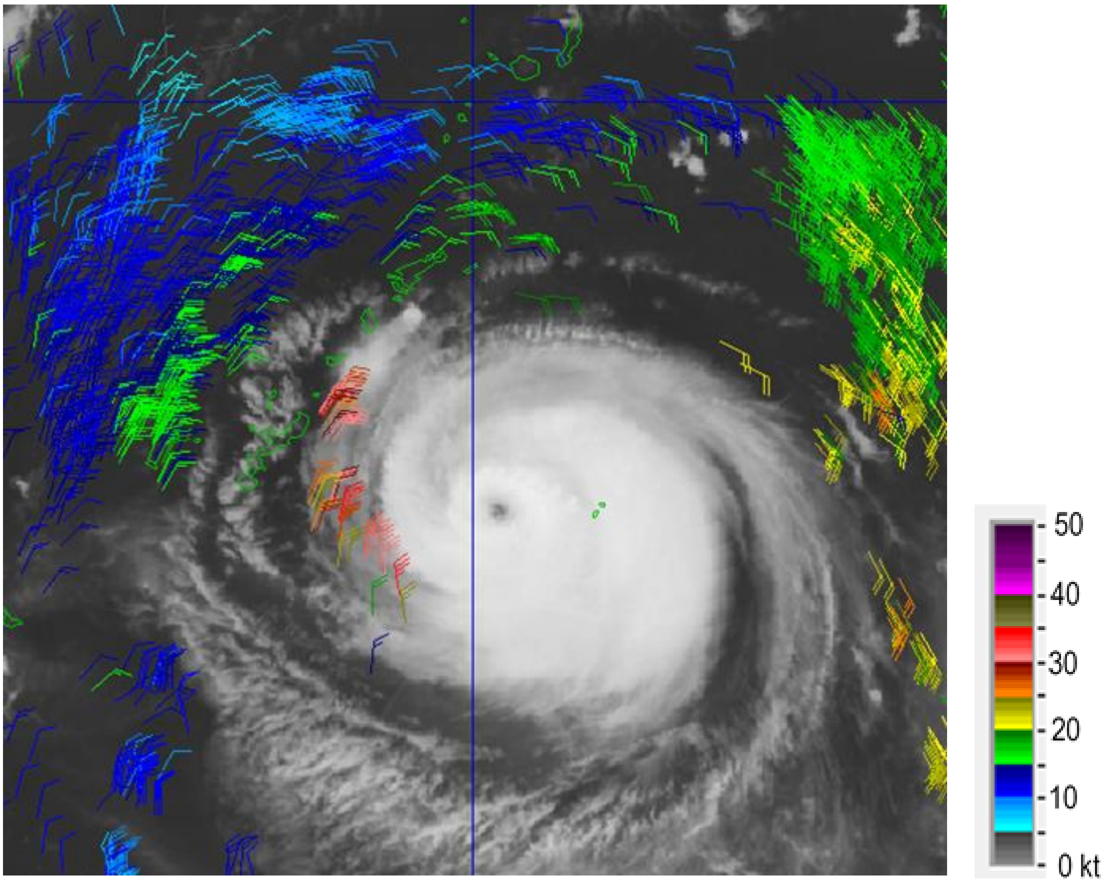


Figure 4.15 ASWinds derived from a series of Himawari-8 Full-disk and Region 3 Infrared (B13) and Short-wave Infrared (B07) images for TY Hinnamnor (2211) at 2354 UTC on 30 August 2022.

Table 4.10 Vector Differences (VDs) and biases of ASWinds (0.85 < QI) with reference to ASCAT winds within a square of 20 degrees centered at the TC center for 25 TCs in 2022.

(a) ASWind (Full-disk)

	Number of collocations	Vector Difference [m/s]	Bias [m/s]
B03 (VIS)	281623	1.8	-0.5
B07 (SWIR)	256129	2.0	-0.7
B13 (IR)	260637	1.9	-0.7

(b) ASWind (Region 3)

	Number of collocations	Vector Difference [m/s]	Bias [m/s]
B03 (VIS)	618968	2.3	-0.2
B07 (SWIR)	630450	2.7	-0.2
B13 (IR)	492705	2.8	-0.2

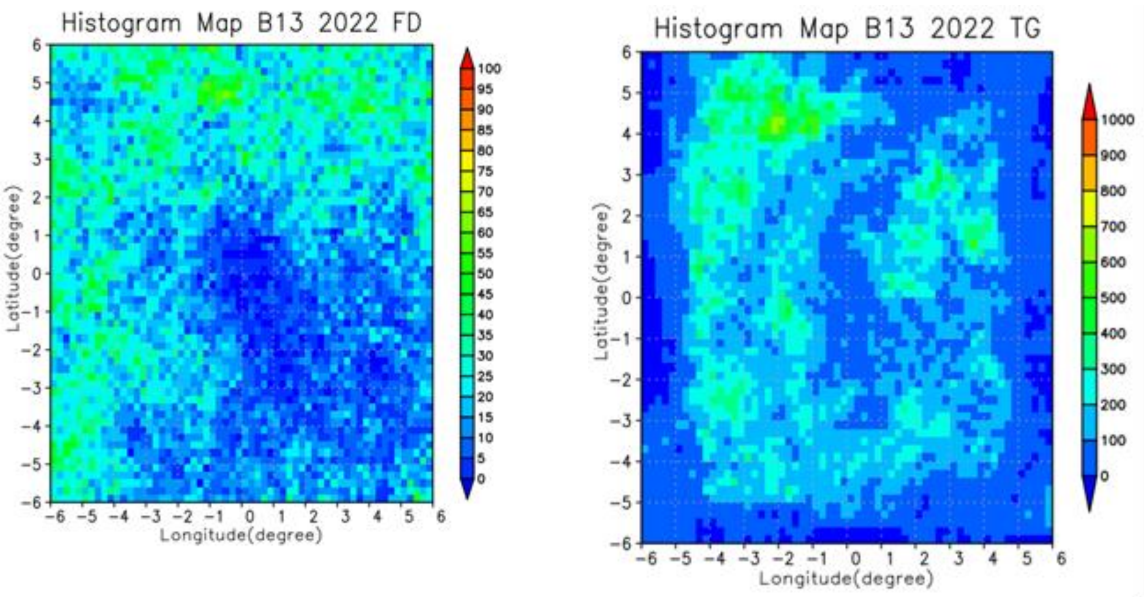


Figure 4.16 Spatial distributions of Full-disk (left) and Region 3 (right) ASWind data derived from Infrared (B13) images within a square of 12 degrees centered at TC center for 25 TCs in 2022.

4.6 Verification of TC Central Pressure Estimates Based on Satellite Microwave Observations

JMA uses TC central pressure (Minimum Sea Level Pressure, or MSLP) estimates based on TC warm core intensity (i.e., the maximum temperature anomaly near the TC center) from microwave sounders on board polar-orbiting satellites as reference for JMA operational TC analysis. The Advanced Microwave Sounding Unit-A (AMSU-A) of the NOAA and MetOp series of polar-orbiting satellites has been used for MSLP estimation since 2013. JMA also began to use data from the Advanced Technology Microwave Sounder (ATMS) on board the Suomi-NPP and JPSS-1 (NOAA-20) satellites in 2015. The higher spatial resolution of ATMS observation (32 km at the sub-satellite point) as compared to AMSU-A (48 km) enables more accurate determination of warm core intensity. Figure 4.17 shows the MSLP estimates based on AMSU-A and ATMS observations (referred to here as AMSU/ATMS estimates) together with MSLP estimates based on the Dvorak technique (Dvorak estimates) and a product based on consensus between AMSU/ATMS MSLP estimates and Dvorak MSLP estimates (CONSENSUS) for TY Nanmadol (2214).

Table 4.11 shows the results of AMSU and ATMS estimate verification with respect to JMA best-track data for 2015 - 2022 together with Dvorak TC intensity estimates and CONSENSUS. The biases and root mean square errors (RMSEs) of AMSU estimates are -5.5 to 2.7 hPa and 10.0 to 14.0 hPa, respectively (Table 4.11a). It should be noted that the RMSE of CONSENSUS between AMSU estimates and Dvorak estimates is consistently smaller than that for AMSU and Dvorak estimates over a period of eight years, which is attributed to the benefits of independent information from the satellite microwave observation. The RMSE for ATMS estimates is smaller than that for AMSU (Table 4.11b), which indicates that the higher resolution of ATMS observation as compared to AMSU leads to more accurate determination of TC warm core intensity. As with the AMSU estimate result, the RMSEs of CONSENSUS between ATMS and Dvorak estimates are smaller than those of ATMS and Dvorak estimates. The superiority of CONSENSUS to individual estimates is seen in bias comparison.

Use of AMSU/ATMS estimates via CONSENSUS is expected to support JMA's operational TC intensity analysis, particularly when in-situ observation data are scarce and operational TC intensity analysis depends largely on the Dvorak estimates.

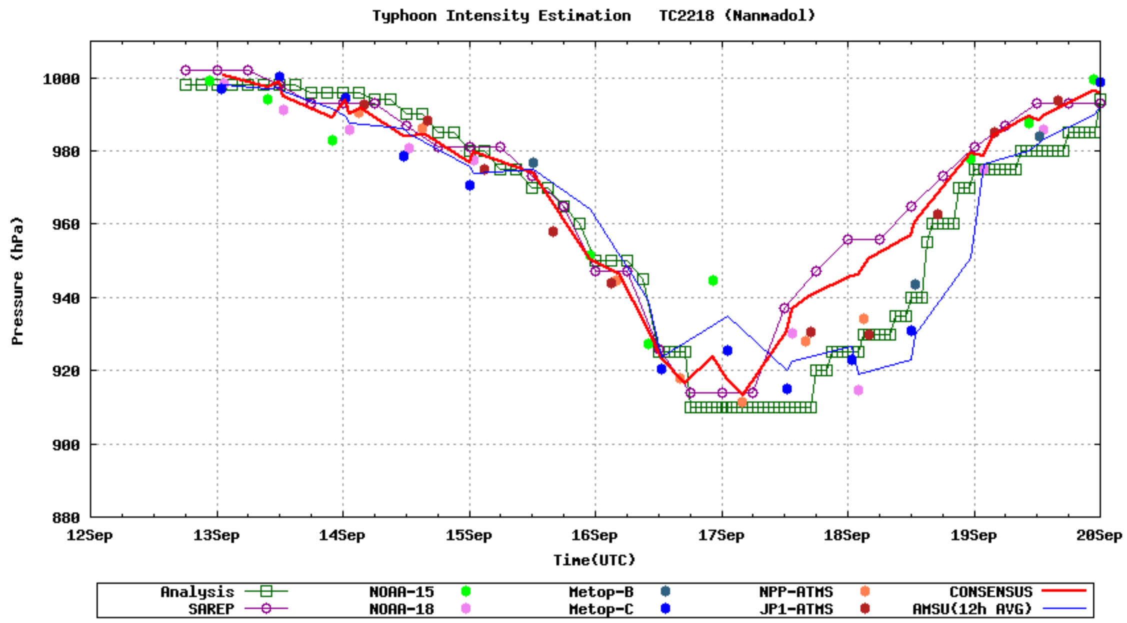


Figure 4.17 Time-series representation of Dvorak MSLP estimates, microwave-based MSLP estimates (AMSU and ATMS), CONSENSUS between Dvorak and AMSU/ATMS estimates and JMA analysis for TY Nanmadol (2214) on the Numerical Typhoon Prediction (NTP) website

Table 4.11 (a) Bias and RMSE of Dvorak MSLP estimates, AMSU MSLP estimates and CONSENSUS between Dvorak and AMSU estimates with respect to the best-track data for the previous eight years (2015 - 2022); (b) as per (a) but for ATMS estimates

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

Year		2015	2016	2017	2018	2019	2020	2021	2022
BIAS	AMSU	1.3	2.7	-2.9	-3.1	-2.5	-5.5	-2.9	-1.9
	Dvorak	0.1	-2.1	-2.0	-0.4	-2.9	-2.8	-2.1	-1.8
	Consensus	**0.3**	**-0.8**	**-2.6**	**-1.5**	**-3.2**	**-4.0**	**-2.8**	**-2.2**
RMSE (hPa)	AMSU	12.8	13.8	10.0	12.4	11.7	14.0	13.1	11.3
	Dvorak	7.5	9.6	7.2	7.0	9.2	8.4	7.9	6.5
	Consensus	**6.8**	**8.2**	**6.7**	**6.7**	**7.6**	**7.9**	**6.6**	**6.3**
Number of Data		819	595	569	680	645	478	703	473

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

Year		2015	2016	2017	2018	2019	2020	2021	2022
BIAS	ATMS	3.0	4.1	1.8	0.9	1.9	0.9	1.7	1.1
	Dvorak	-0.5	-1.4	-2.0	-0.9	-3.7	-3.6	-2.1	-2.7
	Consensus	**0.8**	**0.3**	**-0.7**	**-0.3**	**-1.9**	**-1.8**	**-0.9**	**-1.2**
RMSE (hPa)	ATMS	11.9	13.0	8.7	11.4	9.9	9.0	10.9	8.1
	Dvorak	7.8	8.5	7.9	7.9	9.7	9.6	8.5	8.0
	Consensus	**6.1**	**7.1**	**6.3**	**7.0**	**7.1**	**6.0**	**6.0**	**5.7**
Number of Data		229	190	193	224	244	148	159	116

4.7 Verification of Storm Surge Prediction

Storm surge predictions have been provided since 2011 via the Numerical Typhoon Prediction (NTP) website to Typhoon Committee Members within the framework of the Storm Surge Watch Scheme (SSWS). The Asia-area storm surge ensemble prediction system has been operational and probabilistic forecast products have been provided since August 2022, with a forecast period extended to 132 hours. For details of the system and the new SSWS forecast products, refer to Hasegawa et al. (2023) on the NTP website. Verification of deterministic storm surge predictions was conducted on data from 10 stations (Table 4.12) for which sea level observation information is provided on the University of Hawaii Sea Level Center (UHSLC) database website (http://uhslc.soest.hawaii.edu/data/?fd) and the Global Sea Level Observing System (GLOSS) website (http://www.ioc-sealevelmonitoring.org/index.php) for all named TCs that formed in 2022. Hourly hindcast data (from FT = -5 to FT = 0) and forecast data (from FT = 1 to FT = 132) were compared with observation data. Ensemble predictions were also verified with information including data from the Busan tide station (Korea) for TY Hinnamnor (2211).

Table 4.12 Stations used for verification

	Station	Abbreviation	Member	Data Source
1	Quarry Bay	QB	Hong Kong	UHSLC
2	Shek Pik	SP	Hong Kong	GLOSS
3	Langkawi	LK	Malaysia	UHSLC
4	Legaspi Port	LG	Philippines	UHSLC
5	Manila South Harbor	ML	Philippines	UHSLC
6	Subic Bay	SB	Philippines	UHSLC
7	Busan	BS	Republic of Korea	GLOSS
8	Apra Harbor	AP	U.S.A.	UHSLC
9	Qui Nhon	QN	Viet Nam	UHSLC
10	Vung Tau	VT	Viet Nam	UHSLC

Table 4.13 Storm surges exceeding 0.5 m observed at the 10 stations for each named TC that formed in 2022

Station	Named TC	Storm surge [m]
SP	Ma-on (2209)	0.66
BS	Hinnamnor (2211)	0.96
SP	Nesat (2220)	0.63
QB	Nesat (2220)	0.61
QB	Nalgae (2222)	0.61
SP	Nalgae (2222)	0.54

4.7.1 Deterministic Prediction

Storm surges exceeding 1 meter in height were not observed in any of 10 stations in 2022 (Table 4.13). Figure 4.18 shows scatter diagrams of modeled storm surges (hindcast and forecast) against observation data. Verification results for 2022 (Figure 4.18) indicate that deterministic predictions overestimated storm surges caused by TY Ma-on among others. However, those for TY Hinnamnor were predicted well as described in the Case Study section below.

The verification results shown in Figure 4.18 may be insufficient to evaluate model accuracy for TCs, given that there were sparse observation data for verification and remarkable storm surges were not observed at most stations. Accordingly, additional verification was conducted using data from stations in Japan, where sufficient observation data are available, and TCs frequently approach or make landfall in Japan. Although the characteristics of model forecasts may vary by region, the system is considered to have comparable accuracy at storm surge watch scheme stations.

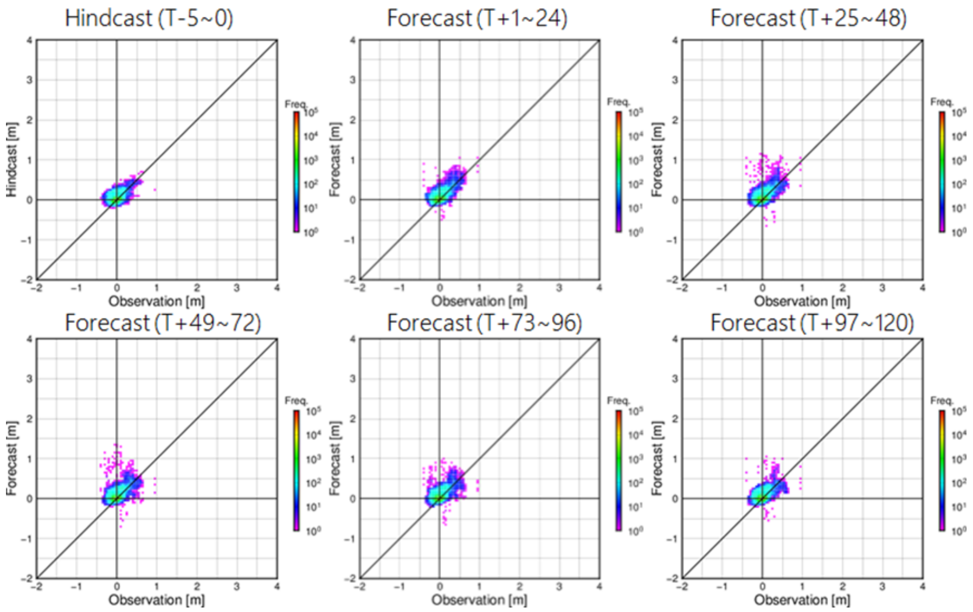


Figure 4.18 Scatter diagrams of modeled storm surges against observation data from 10 stations for all the named TCs that formed in 2022 (top left: hindcast; others: forecast)

Figure 4.19 shows scatter diagrams of modeled storm surges (forecast) against observation data from around 200 stations (operated by JMA, the Ports and Harbours Bureau, the Japan Coast Guard, and the Geospatial Information Authority of Japan) in Japan. The verification period is from January to December 2022, and cases of TCs are extracted. Eleven named TCs approached the country, with the three making landfall. The diagrams indicate that forecasts for Japan compare well with observed storm surges, although some predictions exhibit significant errors (e.g., TY Nanmadol (2214)). Naturally, prediction errors increase with lead time. For the third day in particular, the data show extreme overestimation, mainly because of TC track errors and typhoon bogusing, which expresses wind and pressure fields based on simple parametric TC modeling with no changes in TC structure and wind reduction associated with land topography. The lower overestimation from the fourth day onward is mainly associated with the lower number of official TC forecasts than in the previous period, which means typhoon bogusing was utilized less thereafter.

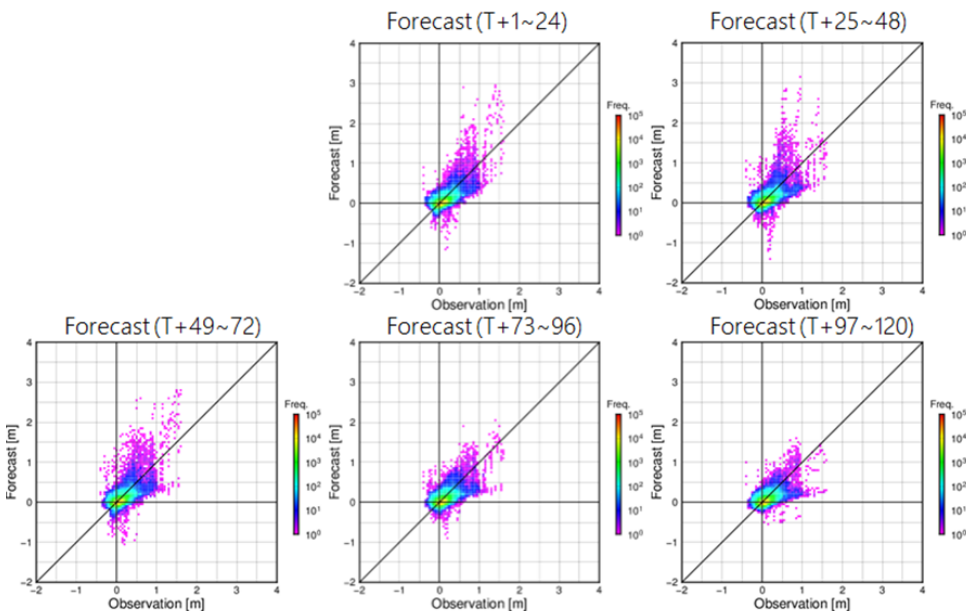


Figure 4.19 Scatter diagrams of modeled storm surges (forecast) against observation data from around 200 stations (operated by JMA, the Port Authority, the Japan Coast Guard, and the Geospatial Information Authority of Japan) in Japan for TCs in 2022. All plots are three-hourly maximum values.

4.7.2 Verification of Ensemble Prediction

Threat scores from ensemble prediction in Japan for TCs in 2022 (Figure 4.20; statistical period: as per deterministic forecast verification) generally peak in the probability range from 20 to 40%. The effects of specific typhoons is significant due to the relatively low number of remarkable storm surges in 2022. Although prediction accuracy decreases with forecast period length, the system maintains scores of around 0.15 up to five days ahead.

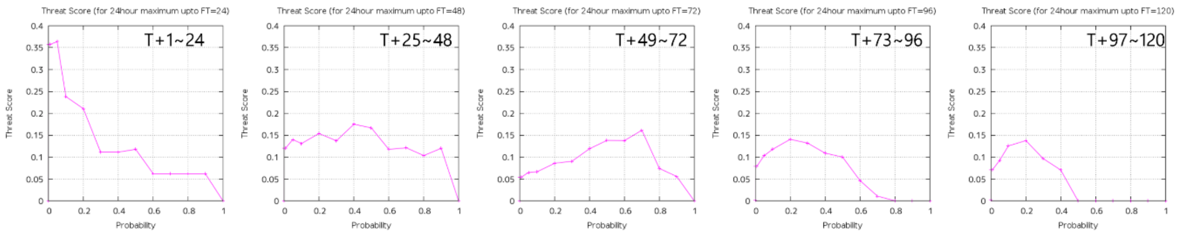


Figure 4.20 Threat scores of the ensemble prediction system for each probability against storm surges exceeding 100 cm at around 200 stations in Japan in 2022.

4.7.3 Case Study

TY Hinnamnor (2211) moved north over the East China Sea in September 2022, developing to a maximum wind speed of 45 m/s and a minimum pressure of 940 hPa. Figure 4.21 shows the analysis track and all predicted tracks (official forecast and 51 tracks calculated using GEPS) for the 72-hour period before the storm surge peak in Busan. The typhoon actually passed very close to Busan, but the official forecast and most ensemble members with the initial time (00 UTC on 3 September 2022) had predicted passage north of this area. Tracks and passage times over Korea were not uniformly predicted, highlighting uncertainties in TC track forecasting. The maximum storm surge for Busan in the official forecast was 0.92 m (Figure 4.24), while the corresponding maximum storm tide was 0.93 m. For this station, the peak storm tide was underestimated in all members, while the peak storm surge was predicted well in many members compared to the observation (observed maximum storm tide: 1.38 m above mean sea level; maximum storm surge: 0.96 m).

The ensemble system predicted a probability of storm surges exceeding 1 meter in height along the southern coast of Korea, while the ensemble spreads exhibited high uncertainty around this area (Figure 4.22). For Busan, the maximum probability of predicted storm surges exceeding 1 meter in height was around 15% (Figure 4.23). The station observed no such tides, but some members generally captured the peak storm surge and tide well (Figure 4.24).

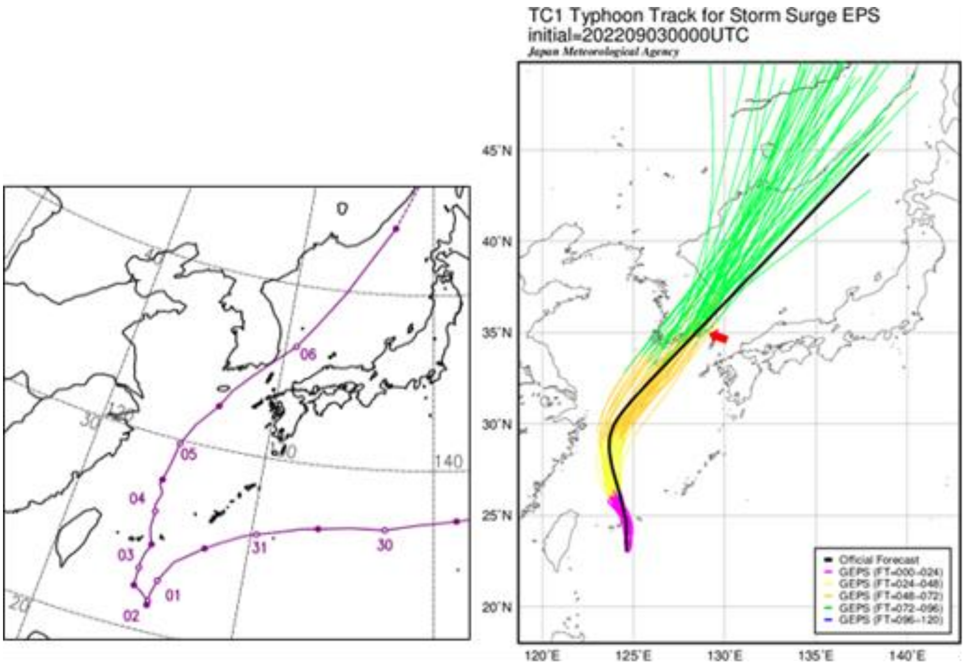


Figure 4.21 Analysis track (left) and predicted tracks (right) for TY Hinnamnor. In the figure on the right, colored lines show the 51 tracks from GEPS members and the bold black line shows the official forecast. The red arrow shows the location of Busan.

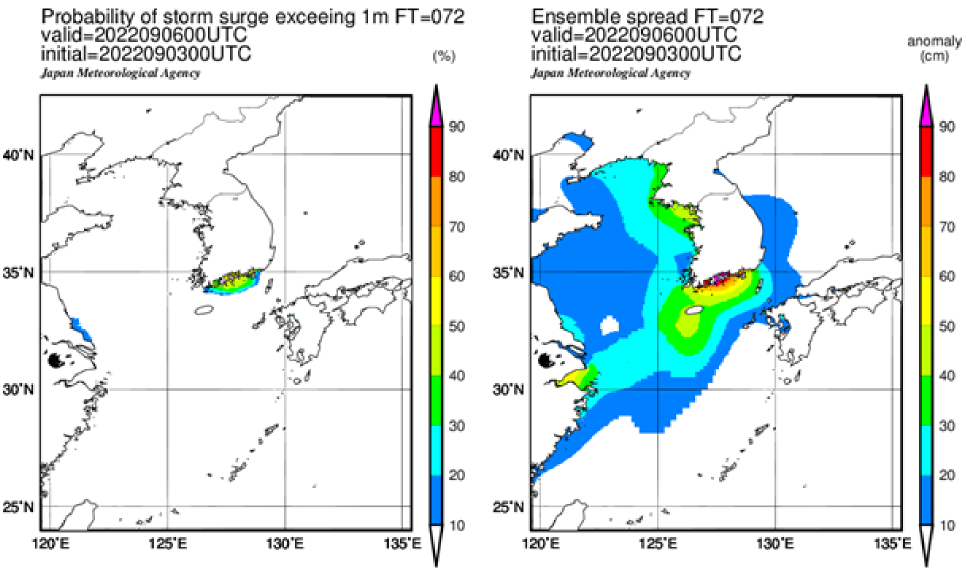


Figure 4.22 Probabilities of storm surges exceeding 1 meter (left) and ensemble spread (right).

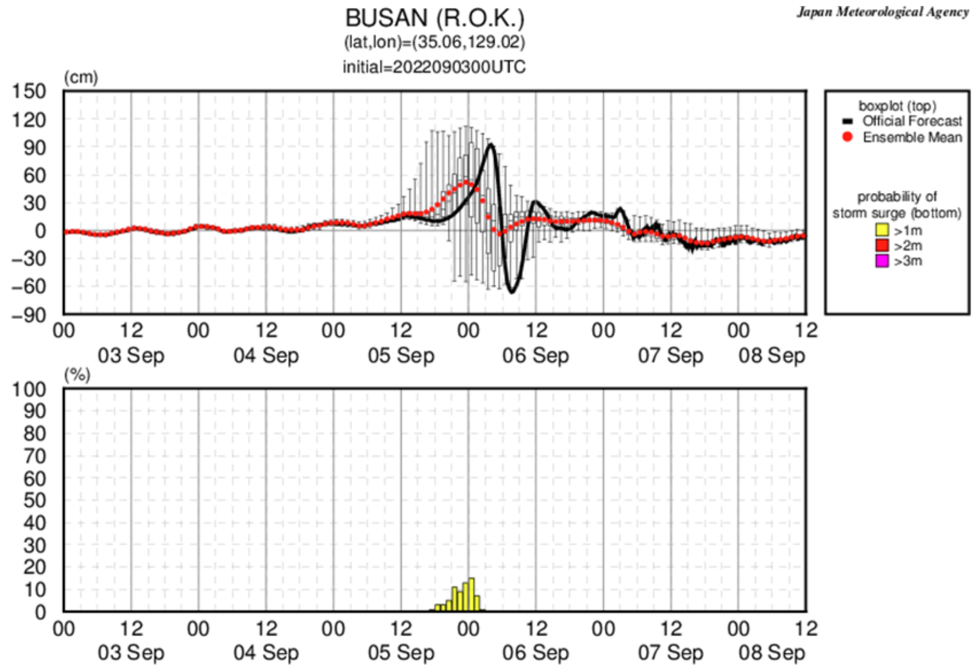


Figure 4.23 Time-series representation of storm surge boxplots (top), storm surge probability bars (bottom) for Busan.

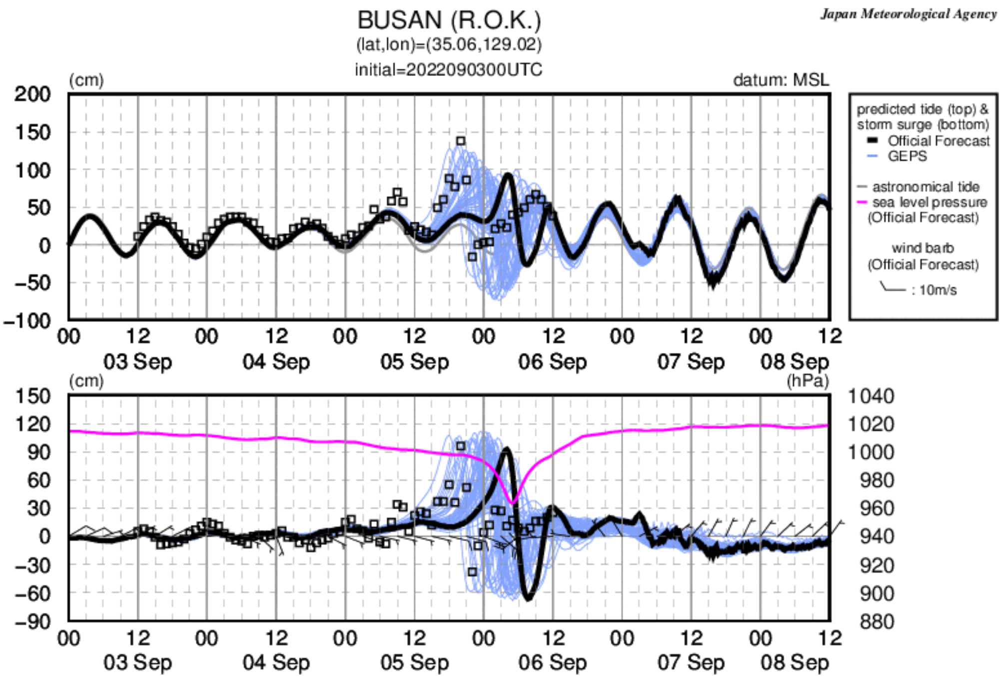


Figure 4.24 Time-series representation of storm tide and astronomical tide (top), storm surge, sea level pressure and surface wind (bottom) for Busan. Squares show hourly observation values.

[Reference]

Hasegawa. H., N. Kohno, and H. Hayashibara, 2012: JMA's Storm Surge Prediction for the WMO Storm Surge Watch Scheme (SSWS). *RSMC Tokyo-Typhoon Center Technical Review*, **14**, 13-24.

Hasegawa. H., N. Kohno, M. Higaki, and M. Itoh, 2017: Upgrade of JMA's Storm Surge Prediction for WMO Storm Surge Watch Scheme (SSWS). *RSMC Tokyo-Typhoon Center Technical Review*, **19**, 26-34.

Hasegawa. H., J. Sugano, T. Fukuura and M. Higaki, 2023: Upgrade of JMA's Storm Surge Prediction for WMO Storm Surge Watch Scheme (SSWS) in 2022. *RSMC Tokyo-Typhoon Center Technical Review*, **25**, 1-14.

Appendices

Appendix 1
RSMC Tropical Cyclone Best Track Data in 2022

TY MALAKAS (2201)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Apr.	06/06	3.4	150.2	1004	-	-	TD
	06/12	3.5	149.6	1006	-	0.0	TD
	06/18	3.5	149.1	1004	-	0.5	TD
	07/00	3.8	148.4	1006	-	1.0	TD
	07/06	4.0	147.7	1004	-	1.0	TD
	07/12	4.1	147.1	1004	-	1.5	TD
	07/18	4.5	146.3	1002	-	2.0	TD
	08/00	5.1	145.9	1000	35	2.5	TS
	08/06	5.6	145.7	998	35	2.5	TS
	08/12	6.4	145.2	998	35	2.5	TS
	08/18	6.7	144.9	996	40	2.5	TS
	09/00	7.1	144.6	996	40	2.5	TS
	09/06	7.5	143.6	996	40	2.5	TS
	09/12	8.2	142.4	996	40	2.5	TS
	09/18	9.4	141.2	996	40	2.5	TS
	10/00	10.6	139.6	994	45	3.0	TS
	10/06	11.1	138.6	992	45	3.0	TS
	10/12	11.5	138.0	990	50	3.0	STS
	10/18	11.8	137.1	990	50	3.5	STS
	11/00	12.2	136.4	990	50	3.5	STS
	11/06	13.1	136.2	990	50	3.5	STS
	11/12	14.1	135.9	985	55	3.5	STS
	11/18	14.8	135.6	980	60	4.0	STS
	12/00	15.4	135.0	975	65	4.0	TY
	12/06	15.8	135.1	970	70	4.5	TY
	12/12	16.1	135.4	955	80	4.5	TY
	12/18	16.7	135.9	955	80	4.5	TY
	13/00	17.3	136.4	955	80	4.5	TY
	13/06	17.8	137.0	950	85	5.5	TY
	13/12	18.8	137.6	950	85	5.5	TY
	13/18	19.8	137.5	945	90	6.0	TY
	14/00	20.6	138.0	945	90	6.0	TY
	14/06	21.7	138.5	945	90	6.0	TY
	14/12	22.6	139.0	950	85	5.5	TY
	14/15	23.2	139.5	950	85	-	TY
	14/18	24.3	140.0	955	80	5.0	TY
	14/21	25.3	140.3	955	80	-	TY
	15/00	26.3	140.6	960	75	4.5	TY
	15/03	27.1	141.1	965	70	-	TY
	15/06	27.7	141.9	970	65	4.0	TY
	15/09	29.3	142.6	970	65	-	TY
	15/12	30.0	143.7	972	-	-	L
	15/18	32.0	146.0	972	-	-	L
	16/00	34.7	149.3	976	-	-	L
	16/06	37.8	152.1	976	-	-	L
	16/12	41.5	155.2	976	-	-	L
	16/18	44.9	158.7	972	-	-	L
	17/00	46.4	160.7	966	-	-	L
	17/06	48.9	165.8	966	-	-	L
	17/12	50.9	172.3	968	-	-	L
	17/18	52.6	178.7	968	-	-	L
	18/00	53.1	183.5	970	-	-	Out

TS MEGI (2202)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Apr.	08/18	10.3	127.4	1002	-	-	TD
	09/00	10.8	127.4	1002	-	0.0	TD
	09/06	10.9	126.9	1000	-	0.5	TD
	09/12	11.2	126.3	1002	-	1.0	TD
	09/18	10.8	125.9	998	35	1.5	TS
	10/00	10.8	125.7	996	40	2.0	TS
	10/06	10.9	125.4	998	35	2.0	TS
	10/12	11.0	125.2	1000	35	2.0	TS
	10/18	11.2	125.1	1000	35	2.0	TS
	11/00	11.4	125.0	1002	-	1.5	TD
	11/06	11.4	125.0	1000	-	1.5	TD
	11/12	11.4	125.0	1002	-	1.5	TD
	11/18	11.4	125.0	1002	-	1.5	TD
	12/00	11.4	125.0	1004	-	1.5	TD
	12/06						Dissip.

TY CHABA (2203)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Jun.	28/18	14.6	116.5	998	-	0.5	TD
	29/00	15.0	116.3	998	-	1.0	TD
	29/06	15.5	116.2	998	-	1.5	TD
	29/12	15.6	116.0	998	-	1.5	TD
	29/18	15.6	115.7	998	-	1.5	TD
	30/00	15.8	115.5	994	35	2.0	TS
	30/06	16.1	115.6	992	40	2.5	TS
	30/12	17.0	115.2	990	45	2.5	TS
	30/18	17.5	114.6	985	50	3.0	STS
Jul.	01/00	18.3	114.1	980	55	3.5	STS
	01/06	18.9	113.1	980	55	3.5	STS
	01/12	19.5	112.6	975	60	3.5	STS
	01/18	20.2	112.0	970	65	4.0	TY
	02/00	20.6	111.7	965	70	5.0	TY
	02/06	21.2	111.2	965	70	5.0	TY
	02/12	21.9	110.8	980	50	5.0	STS
	02/18	22.8	110.4	985	45	4.5	TS
	03/00	23.6	110.6	990	35	4.0	TS
	03/06	24.4	110.6	994	-	3.5	TD
	03/12	24.8	110.8	994	-	-	TD
	03/18	25.3	111.2	996	-	-	TD
	04/00	26.1	111.7	996	-	-	TD
	04/06	27.1	112.0	996	-	-	TD
	04/12	27.7	112.6	996	-	-	TD
	04/18	28.6	113.4	996	-	-	TD
	05/00	29.8	113.9	996	-	-	TD
	05/06	30.8	114.5	996	-	-	TD
	05/12	31.8	115.1	996	-	-	TD
	05/18	32.8	115.6	994	-	-	L
	06/00	34.2	116.9	996	-	-	L
	06/06	35.4	117.9	996	-	-	L
	06/12	37.1	119.5	996	-	-	L
	06/18	38.7	120.8	996	-	-	L
	07/00	38.8	121.9	998	-	-	L
	07/06	38.8	122.8	998	-	-	L
	07/12	39.0	124.0	1000	-	-	L
	07/18	39.1	124.8	1000	-	-	L
	08/00						Dissip.

TS AERE (2204)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Jun.	30/12	19.1	131.0	1004	-	1.5	TD
	30/18	19.6	130.9	1000	35	2.0	TS
Jul.	01/00	20.1	131.0	998	40	2.5	TS
	01/06	20.9	131.3	998	40	2.5	TS
	01/12	22.2	131.7	998	40	2.5	TS
	01/18	23.5	131.3	998	40	2.5	TS
	02/00	24.7	130.4	998	40	2.5	TS
	02/06	25.9	129.5	994	45	2.5	TS
	02/12	26.3	128.1	994	45	2.5	TS
	02/14	26.4	127.9	994	45	-	TS
	02/18	27.2	127.5	996	40	2.5	TS
	03/00	27.8	127.2	998	35	2.0	TS
	03/06	28.1	126.9	998	35	2.0	TS
	03/12	28.4	126.6	998	35	2.0	TS
	03/18	29.3	126.8	998	35	2.0	TS
	04/00	30.0	127.4	998	35	2.0	TS
	04/06	30.8	127.9	998	35	2.0	TS
	04/12	31.6	128.8	998	35	2.0	TS
	04/18	32.6	129.3	1000	35	2.0	TS
	04/20	33.0	129.7	1000	35	-	TS
	05/00	33.0	131.0	1002	-	1.5	L
	05/06	34.3	133.3	1004	-	1.5	L
	05/12	34.7	135.1	1006	-	-	L
	05/18	34.0	138.8	1002	-	-	L
	06/00	34.4	140.9	1002	-	-	L
	06/06	34.1	142.0	1002	-	-	L
	06/12	34.1	142.8	1000	-	-	L
	06/18	33.9	143.9	1000	-	-	L
	07/00	33.8	145.2	998	-	-	L
	07/06	34.1	145.7	996	-	-	L
	07/12	34.3	146.1	996	-	-	L
	07/18	34.7	146.0	996	-	-	L
	08/00	34.5	144.8	996	-	-	L
	08/06	34.5	144.8	996	-	-	L
	08/12	34.5	144.4	996	-	-	L
	08/18	34.8	144.5	996	-	-	L
	09/00	35.9	144.8	998	-	-	L
	09/06	37.5	144.7	998	-	-	L
	09/12	39.2	143.7	1000	-	-	L
	09/18	39.8	143.3	1000	-	-	L
	10/00	40.8	143.2	1002	-	-	L
	10/06	41.2	142.7	1004	-	-	L
	10/12	41.5	143.0	1008	-	-	L
	10/18						Dissip.

TS SONGDA (2205)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Jul.	26/12	14.9	143.3	1006	-	1.0	TD
	26/18	15.0	143.0	1004	-	1.5	TD
	27/00	15.3	142.6	1004	-	2.0	TD
	27/06	16.0	141.9	1004	-	2.0	TD
	27/12	17.4	141.0	1004	-	2.0	TD
	27/18	18.4	140.8	1002	-	2.0	TD
	28/00	19.4	140.3	1002	-	2.0	TD
	28/06	20.6	139.9	1002	-	2.0	TD
	28/12	22.5	139.0	1002	35	2.0	TS
	28/18	25.3	137.7	1002	35	2.0	TS
	29/00	28.0	135.0	1002	35	2.0	TS
	29/06	29.1	132.1	1002	35	2.5	TS
	29/12	30.1	129.9	1000	40	2.5	TS
	29/18	30.7	128.5	1000	35	2.5	TS
	30/00	31.4	126.2	1000	35	2.5	TS
	30/06	32.0	124.9	998	35	2.5	TS
	30/12	32.8	124.2	998	35	2.5	TS
	30/18	33.4	123.3	998	35	2.5	TS
	31/00	33.5	123.1	996	35	2.5	TS
	31/06	33.9	123.2	996	35	2.0	TS
	31/12	34.5	123.1	996	35	2.0	TS
	31/18	34.9	123.1	998	-	1.5	TD
Aug.	01/00	35.2	123.2	1000	-	-	TD
	01/06	35.3	123.3	1000	-	-	TD
	01/12						Dissip.

TS TRASES (2206)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Jul.	29/12	20.3	128.7	1002	-	0.0	TD
	29/18	20.6	127.9	1002	-	0.5	TD
	30/00	21.1	127.2	1000	-	1.0	TD
	30/06	21.7	127.2	998	-	1.0	TD
	30/12	22.6	127.7	998	-	1.5	TD
	30/18	23.7	127.9	998	-	1.5	TD
	31/00	25.7	127.9	998	35	1.5	TS
	31/06	27.1	127.6	998	35	2.0	TS
	31/12	28.2	127.4	998	35	2.0	TS
	31/18	30.0	127.3	998	35	2.5	TS
Aug.	01/00	32.7	126.9	998	35	2.5	TS
	01/06	34.5	126.4	1000	35	2.5	TS
	01/12	36.3	126.4	1004	-	2.0	TD
	01/18	37.9	125.8	1004	-	-	TD
	02/00						Dissip.

TS MULAN (2207)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Aug.	08/00	16.3	110.1	1002	−	−	TD
	08/06	15.3	111.1	1000	−	−	TD
	08/12	15.3	111.5	1000	−	0.5	TD
	08/18	15.5	112.0	998	−	0.5	TD
	09/00	16.0	112.8	998	−	1.0	TD
	09/06	17.3	113.5	996	35	1.5	TS
	09/12	18.3	112.8	994	35	1.5	TS
	09/18	19.0	112.1	994	35	2.0	TS
	10/00	19.8	111.2	996	35	2.0	TS
	10/06	20.5	110.0	996	35	2.0	TS
	10/12	20.7	109.2	996	35	2.0	TS
	10/18	21.1	107.9	996	35	2.0	TS
	11/00	21.4	106.0	998	−	1.5	TD
	11/06	21.5	104.1	1000	−	−	TD
	11/12						Dissip.

TS MEARI (2208)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Aug.	08/18	23.9	148.8	1008	-	1.0	TD
	09/00	24.1	146.3	1008	-	1.0	TD
	09/06	24.6	144.5	1008	-	1.0	TD
	09/12	24.9	142.8	1008	-	1.5	TD
	09/18	25.1	141.6	1006	-	2.0	TD
	10/00	26.0	140.3	1008	-	2.0	TD
	10/06	26.9	139.5	1006	-	2.0	TD
	10/12	27.6	138.5	1008	-	2.0	TD
	10/18	28.2	137.6	1006	-	2.0	TD
	11/00	28.8	136.3	1006	-	2.0	TD
	11/06	28.8	135.9	1004	-	2.0	TD
	11/12	28.8	135.6	1002	35	2.0	TS
	11/18	29.6	135.9	1002	35	2.0	TS
	12/00	30.5	136.2	1002	35	2.0	TS
	12/06	30.8	136.4	1002	35	2.0	TS
	12/12	31.9	136.7	1000	40	2.0	TS
	12/18	32.8	136.7	1000	40	2.0	TS
	13/00	33.8	137.2	998	40	2.5	TS
	13/05	34.5	138.0	998	40	-	TS
	13/06	34.7	138.2	998	40	2.0	TS
	13/08	35.0	138.7	998	40	-	TS
	13/12	35.8	140.3	998	40	2.0	TS
	13/18	37.4	142.6	998	40	2.0	TS
	14/00	39.2	144.7	998	40	2.0	TS
	14/06	41.0	146.9	996	40	2.0	TS
	14/12	44.0	150.0	994	-	-	L
	14/18	46.8	151.5	992	-	-	L
	15/00	49.8	152.2	988	-	-	L
	15/06	51.9	152.6	988	-	-	L
	15/12	53.2	153.9	988	-	-	L
	15/18	55.0	155.1	988	-	-	L
	16/00	57.8	155.7	990	-	-	L
	16/06	59.1	157.4	990	-	-	L
	16/12	59.9	157.2	992	-	-	L
	16/18	60.1	156.0	994	-	-	Out

STS MA-ON (2209)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Aug.	21/00	17.6	127.8	1004	-	1.0	TD
	21/06	17.2	127.2	1000	-	1.5	TD
	21/12	17.0	126.4	1000	-	1.5	TD
	21/18	16.4	125.3	998	35	1.5	TS
	22/00	16.3	124.4	996	40	1.5	TS
	22/06	16.2	123.7	994	40	2.0	TS
	22/12	16.1	123.4	992	45	2.5	TS
	22/18	16.3	123.3	990	50	3.0	STS
	23/00	17.1	122.7	990	50	3.0	STS
	23/06	17.9	121.5	990	50	3.0	STS
	23/12	18.5	120.3	990	50	3.0	STS
	23/18	19.0	118.8	985	55	3.5	STS
	24/00	19.0	117.2	985	55	3.5	STS
	24/06	19.4	116.0	985	55	3.5	STS
	24/12	19.9	114.8	985	55	3.5	STS
	24/18	20.7	113.3	985	55	3.5	STS
	25/00	20.9	111.8	985	55	3.5	STS
	25/06	21.6	109.7	990	50	3.0	STS
	25/12	21.4	108.3	992	45	2.5	TS
	25/18	21.4	106.4	996	35	2.5	TS
	26/00	21.4	104.4	1000	-	-	TD
	26/06						Dissip.

TY TOKAGE (2210)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Aug.	21/06	22.0	151.0	1002	-	0.5	TD
	21/12	22.3	151.2	1002	-	1.0	TD
	21/18	22.9	151.5	1002	-	1.5	TD
	22/00	24.0	151.6	1000	35	2.0	TS
	22/06	25.1	151.6	998	40	2.5	TS
	22/12	26.1	151.5	994	45	3.0	TS
	22/18	27.3	151.3	992	50	3.5	STS
	23/00	28.7	150.5	990	55	3.5	STS
	23/06	30.3	149.8	980	65	4.5	TY
	23/12	31.6	149.1	970	75	5.0	TY
	23/18	32.9	148.6	970	75	5.0	TY
	24/00	34.2	148.6	970	75	5.0	TY
	24/06	35.2	149.0	970	75	5.0	TY
	24/12	36.2	149.5	975	70	4.5	TY
	24/18	37.3	150.3	975	70	4.5	TY
	25/00	38.6	151.4	980	65	4.0	TY
	25/06	40.4	152.9	990	55	3.5	STS
	25/12	42.8	155.0	992	50	3.0	STS
	25/18	45.1	158.3	996	-	2.5	L
	26/00	47.0	160.6	1002	-	-	L
	26/06	48.7	165.2	1006	-	-	L
	26/12	50.1	170.9	1010	-	-	L
	26/18	50.6	177.3	1012	-	-	L
	27/00	50.7	184.1	1014	-	-	Out

TY HINNAMNOR (2211)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Aug.	27/18	23.8	151.1	1008	-	1.5	TD
	28/00	24.9	150.3	1008	-	2.0	TD
	28/06	25.9	149.5	1004	35	2.5	TS
	28/12	26.9	148.5	1002	40	3.0	TS
	28/18	27.2	146.9	996	55	4.0	STS
	29/00	27.3	145.3	980	70	4.5	TY
	29/03	27.4	144.4	980	70	-	TY
	29/06	27.4	143.2	975	75	5.0	TY
	29/09	27.4	142.3	970	80	-	TY
	29/12	27.3	141.3	965	85	5.5	TY
	29/15	27.2	140.3	955	85	-	TY
	29/18	27.1	139.2	950	90	6.0	TY
	30/00	26.8	137.3	940	95	6.0	TY
	30/06	26.8	135.4	935	100	7.0	TY
	30/12	26.6	133.6	920	105	7.0	TY
	30/15	26.5	132.7	920	105	-	TY
	30/18	26.3	131.9	920	105	7.0	TY
	30/21	26.1	131.1	920	105	-	TY
	31/00	25.9	130.3	935	100	6.0	TY
	31/03	25.7	129.6	935	100	-	TY
	31/06	25.4	129.0	935	100	6.5	TY
	31/09	25.1	128.4	935	100	-	TY
	31/12	24.7	127.7	935	100	6.5	TY
	31/18	23.7	126.3	935	100	6.5	TY
Sep.	01/00	22.6	125.7	925	100	6.5	TY
	01/06	21.8	125.5	925	100	6.5	TY
	01/12	21.3	125.5	925	100	6.5	TY
	01/18	21.3	125.5	935	90	5.5	TY
	02/00	21.5	125.5	940	80	5.0	TY
	02/06	21.9	125.0	945	75	4.5	TY
	02/12	22.1	124.6	950	75	4.5	TY
	02/18	22.5	124.6	955	75	4.5	TY
	02/21	22.7	124.6	960	75	-	TY
	03/00	23.0	124.6	960	75	4.5	TY
	03/03	23.3	124.6	960	75	-	TY
	03/06	23.8	124.7	960	75	4.5	TY
	03/09	24.0	124.8	960	75	-	TY
	03/12	24.3	124.9	950	80	4.5	TY
	03/15	24.8	124.7	950	80	-	TY
	03/18	25.1	124.6	950	80	5.0	TY
	03/21	25.5	124.6	950	80	-	TY
	04/00	26.0	124.6	945	85	5.5	TY
	04/03	26.3	124.5	945	85	-	TY
	04/06	27.0	124.7	940	90	6.0	TY
	04/09	27.5	124.4	940	90	-	TY
	04/12	27.7	124.5	940	90	6.0	TY
	04/18	28.6	124.7	940	90	6.0	TY
	05/00	29.8	124.9	945	85	5.5	TY
	05/03	30.2	125.1	945	85	-	TY
	05/06	31.0	125.5	950	80	5.5	TY
	05/09	31.6	126.0	950	80	-	TY
	05/12	32.3	126.6	955	75	5.5	TY
	05/15	33.3	127.2	960	75	-	TY
	05/18	34.2	128.1	965	70	5.0	TY
	05/21	35.1	129.1	965	70	-	TY
	06/00	36.4	130.7	970	65	4.5	TY
	06/03	37.8	131.9	970	65	-	TY
	06/06	39.8	133.6	975	60	4.0	STS
	06/12	44.0	137.0	980	-	3.5	L
	06/18	47.5	139.4	982	-	-	L
	07/00	52.6	138.4	978	-	-	L
	07/06	54.8	139.1	968	-	-	L
	07/12	55.8	139.1	970	-	-	L
	07/18	56.7	140.8	972	-	-	L
	08/00	58.0	142.9	976	-	-	L
	08/06	58.2	145.0	978	-	-	L
	08/12	58.9	147.0	984	-	-	L
	08/18	59.9	149.2	990	-	-	L
	09/00	61.7	149.9	992	-	-	Out

TY MUIFA (2212)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	03/18	25.6	146.6	1006	-	0.0	TD
	04/00	25.8	146.0	1008	-	0.5	TD
	04/06	25.5	145.3	1006	-	0.5	TD
	04/12	25.3	144.5	1006	-	0.0	TD
	04/18	24.8	143.2	1006	-	0.0	TD
	05/00	24.4	141.7	1006	-	0.5	TD
	05/06	24.1	140.3	1004	-	1.0	TD
	05/12	24.0	139.3	1006	-	1.0	TD
	05/18	23.5	137.9	1004	-	1.0	TD
	06/00	22.6	137.4	1006	-	0.5	TD
	06/06	21.4	136.8	1004	-	1.0	TD
	06/12	19.6	136.5	1006	-	0.5	TD
	06/18	18.2	136.0	1004	-	0.5	TD
	07/00	17.2	135.7	1004	-	0.5	TD
	07/06	17.1	135.5	1002	-	1.0	TD
	07/12	17.0	134.8	1004	-	1.5	TD
	07/18	16.8	133.5	1000	35	1.5	TS
	08/00	16.9	132.9	998	40	2.0	TS
	08/06	17.1	131.8	998	40	2.5	TS
	08/12	17.1	131.0	998	40	2.5	TS
	08/18	17.2	130.2	994	45	3.0	TS
	09/00	18.0	129.3	994	45	3.0	TS
	09/06	19.0	128.4	990	50	3.0	STS
	09/12	19.4	127.7	985	55	3.5	STS
	09/18	19.8	126.9	980	60	4.0	STS
	10/00	20.7	126.0	970	70	4.5	TY
	10/06	21.2	125.7	970	70	4.5	TY
	10/12	21.7	125.5	965	75	5.0	TY
	10/18	22.2	124.9	960	80	5.0	TY
	11/00	22.6	124.4	950	85	5.5	TY
	11/03	22.7	124.4	950	85	-	TY
	11/06	22.9	124.4	950	85	5.5	TY
	11/09	23.2	124.3	950	85	-	TY
	11/12	23.4	124.3	955	80	5.5	TY
	11/15	23.5	124.2	955	80	-	TY
	11/18	23.7	124.2	965	75	5.5	TY
	11/21	23.9	124.2	965	75	-	TY
	12/00	24.0	124.2	965	75	5.5	TY
	12/03	24.5	124.2	965	75	-	TY
	12/06	24.8	124.0	965	75	5.0	TY
	12/09	24.8	124.0	965	75	-	TY
	12/12	24.9	124.0	965	75	5.0	TY
	12/15	25.0	124.1	965	75	-	TY
	12/18	25.2	124.2	965	75	5.0	TY
	12/21	25.5	124.3	965	75	-	TY
	13/00	25.7	124.2	955	80	5.0	TY
	13/03	25.9	124.0	955	80	-	TY
	13/06	26.1	123.9	955	80	4.5	TY
	13/12	26.7	123.9	955	80	4.5	TY
	13/18	27.2	123.5	955	80	4.5	TY
	14/00	28.0	123.2	955	80	4.5	TY
	14/06	28.8	122.8	955	80	4.5	TY
	14/12	29.9	122.3	965	75	4.5	TY
	14/18	31.3	121.6	975	65	4.0	TY
	15/00	32.7	121.0	985	50	4.0	STS
	15/06	34.0	120.5	990	45	3.5	TS
	15/12	35.2	120.4	992	40	3.0	TS
	15/18	36.3	120.8	992	40	2.5	TS
	16/00	37.7	121.5	994	-	2.5	L
	16/06	39.1	122.8	994	-	-	L
	16/12	41.4	124.6	1000	-	-	L
	16/18	42.9	127.0	1004	-	-	L
	17/00	43.6	129.0	1006	-	-	L
	17/06						Dissip.

TY MERBOK (2213)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	10/12	20.6	158.0	1006	-	0.5	TD
	10/18	20.7	158.5	1004	-	1.0	TD
	11/00	20.7	159.2	1004	-	1.5	TD
	11/06	20.8	159.8	1002	-	2.0	TD
	11/12	20.8	160.5	1000	35	2.0	TS
	11/18	21.1	161.0	998	40	2.5	TS
	12/00	21.2	161.4	994	45	2.5	TS
	12/06	21.8	162.0	992	50	3.0	STS
	12/12	22.6	162.7	990	50	3.0	STS
	12/18	23.2	163.2	985	55	3.5	STS
	13/00	23.9	163.3	985	55	3.5	STS
	13/06	24.8	163.2	985	55	3.5	STS
	13/12	25.9	163.0	980	60	3.5	STS
	13/18	26.6	162.2	975	65	4.0	TY
	14/00	28.3	162.2	975	65	4.0	TY
	14/06	30.0	162.1	970	70	4.5	TY
	14/12	31.9	161.9	965	70	4.5	TY
	14/18	33.8	162.4	965	70	4.5	TY
	15/00	36.5	164.1	965	65	4.0	TY
	15/06	41.4	167.0	960	-	4.0	L
	15/12	45.0	167.7	956	-	3.5	L
	15/18	48.5	169.9	954	-	3.0	L
	16/00	51.4	172.9	952	-	-	L
	16/06	54.9	175.8	948	-	-	L
	16/12	56.5	177.5	940	-	-	L
	16/18	58.7	181.4	942	-	-	Out

TY NANMADOL (2214)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	12/12	22.3	138.7	1000	-	1.5	TD
	12/18	22.4	138.2	998	-	1.5	TD
	13/00	22.0	138.3	998	-	1.5	TD
	13/06	22.0	138.9	998	-	1.5	TD
	13/12	22.2	139.6	998	-	2.0	TD
	13/18	22.4	140.1	996	35	2.5	TS
	14/00	22.5	140.6	996	35	2.5	TS
	14/06	22.8	140.8	996	35	2.5	TS
	14/12	22.8	140.3	994	40	2.5	TS
	14/18	23.1	139.7	990	45	3.0	TS
	15/00	23.2	138.7	985	50	3.5	STS
	15/06	23.3	137.9	980	55	3.5	STS
	15/12	23.4	137.3	970	65	4.5	TY
	15/18	23.4	136.4	960	75	5.0	TY
	16/00	23.8	135.9	945	85	5.5	TY
	16/06	24.2	135.5	935	90	6.0	TY
	16/12	24.9	134.7	925	95	6.0	TY
	16/15	25.2	134.2	920	100	-	TY
	16/18	25.5	133.8	910	105	6.5	TY
	16/21	25.7	133.4	910	105	-	TY
	17/00	26.1	133.1	910	105	6.5	TY
	17/03	26.5	132.8	910	105	-	TY
	17/06	26.8	132.5	910	105	6.5	TY
	17/09	27.1	132.3	910	105	-	TY
	17/12	27.5	132.0	910	105	6.5	TY
	17/15	28.0	131.7	915	100	-	TY
	17/18	28.5	131.4	920	95	6.0	TY
	17/21	29.1	131.4	925	95	-	TY
	18/00	29.7	131.0	930	90	5.0	TY
	18/03	30.2	130.7	930	90	-	TY
	18/04	30.3	130.6	930	90	-	TY
	18/06	30.7	130.7	930	90	5.0	TY
	18/08	31.1	130.6	940	85	-	TY
	18/09	31.3	130.6	940	85	-	TY
	18/10	31.5	130.5	940	85	-	TY
	18/12	31.9	130.5	955	75	4.5	TY
	18/15	32.7	130.4	960	70	-	TY
	18/18	33.2	130.4	965	70	4.0	TY
	18/21	33.6	130.6	970	65	-	TY
	19/00	33.9	130.8	975	60	3.5	STS
	19/03	34.4	131.6	975	60	-	STS
	19/06	35.3	132.4	975	60	3.5	STS
	19/09	36.0	133.0	980	55	-	STS
	19/12	36.6	134.4	980	55	3.0	STS
	19/15	37.4	136.3	985	55	-	STS
	19/18	37.6	138.4	988	-	3.0	L
	20/00	39.0	143.0	994	-	-	L
	20/06						Dissip.

TS TALAS (2215)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	20/18	21.1	140.9	1006	-	0.5	TD
	21/00	22.4	141.4	1006	-	1.0	TD
	21/06	23.9	141.2	1006	-	1.5	TD
	21/12	24.4	139.7	1004	-	2.0	TD
	21/18	25.1	138.4	1004	-	2.0	TD
	22/00	25.9	137.4	1002	35	2.0	TS
	22/06	26.9	136.5	1002	35	2.0	TS
	22/12	28.1	135.6	1002	35	2.0	TS
	22/18	29.4	135.0	1002	35	2.0	TS
	23/00	30.7	134.8	1000	35	2.0	TS
	23/06	32.0	135.5	1000	35	2.0	TS
	23/12	32.6	136.6	1004	-	2.0	TD
	23/18	33.2	137.4	1004	-	2.0	TD
	24/00	33.7	138.2	1006	-	1.5	L
	24/06	34.4	139.2	1006	-	-	L
	24/12	34.4	139.9	1010	-	-	L
	24/18	34.5	141.3	1010	-	-	L
	25/00	35.1	142.5	1012	-	-	L
	25/06	35.6	143.0	1012	-	-	L
	25/12	35.9	143.3	1014	-	-	L
	25/18	36.6	143.5	1014	-	-	L
	26/00	37.2	144.1	1014	-	-	L
	26/06	37.9	144.8	1012	-	-	L
	26/12	38.1	145.6	1012	-	-	L
	26/18	38.1	146.0	1012	-	-	L
	27/00	38.9	147.9	1012	-	-	L
	27/06	39.1	148.1	1010	-	-	L
	27/12	39.5	148.1	1012	-	-	L
	27/18						Dissip.

TY NORU (2216)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	21/06	17.4	133.0	1004	-	0.0	TD
	21/12	17.6	133.7	1006	-	0.5	TD
	21/18	17.7	134.2	1004	-	1.0	TD
	22/00	17.7	134.4	1004	-	1.0	TD
	22/06	17.9	134.4	1002	-	1.5	TD
	22/12	18.0	134.1	1002	-	2.0	TD
	22/18	17.9	133.5	1000	35	2.0	TS
	23/00	17.6	132.4	1000	35	2.0	TS
	23/06	17.6	131.3	998	40	2.5	TS
	23/12	17.5	130.6	994	45	3.0	TS
	23/18	16.9	129.2	992	50	3.5	STS
	24/00	16.3	128.1	985	60	4.0	STS
	24/06	15.8	126.9	975	70	4.5	TY
	24/12	15.4	126.0	960	80	5.0	TY
	24/18	15.2	124.7	950	90	6.0	TY
	25/00	15.0	123.6	940	95	6.5	TY
	25/06	15.0	122.5	940	95	6.5	TY
	25/12	15.2	121.4	955	85	6.0	TY
	25/18	15.5	119.7	970	75	5.5	TY
	26/00	16.2	118.4	975	70	5.0	TY
	26/06	15.9	116.9	980	65	4.5	TY
	26/12	15.9	115.5	970	70	4.0	TY
	26/18	15.8	113.5	965	75	5.0	TY
	27/00	15.5	112.0	950	85	5.5	TY
	27/06	15.6	111.2	950	85	5.5	TY
	27/12	15.8	109.9	950	85	5.5	TY
	27/18	15.8	108.8	965	75	5.0	TY
	28/00	15.9	107.9	980	55	4.5	STS
	28/06	15.9	107.3	990	45	4.0	TS
	28/12	16.0	105.0	996	-	3.5	TD
	28/18	16.0	104.9	996	-	-	TD
	29/00	16.0	103.9	998	-	-	TD
	29/06	16.0	103.3	1000	-	-	TD
	29/12						Dissip.

STS KULAP (2217)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	25/00	19.9	147.3	1006	-	0.0	TD
	25/06	20.6	146.0	1004	-	0.5	TD
	25/12	21.0	145.2	1004	-	1.0	TD
	25/18	22.1	144.8	1002	-	1.5	TD
	26/00	23.1	144.2	998	35	2.0	TS
	26/06	24.5	143.4	996	35	2.0	TS
	26/12	25.9	142.4	994	40	2.5	TS
	26/18	27.0	142.0	990	50	3.0	STS
	26/21	27.6	141.8	990	50	-	STS
	27/00	28.0	141.7	990	50	3.0	STS
	27/06	29.3	141.9	990	50	3.0	STS
	27/12	29.9	142.6	990	50	3.0	STS
	27/18	31.0	144.2	980	55	3.5	STS
	28/00	32.1	145.5	975	60	3.5	STS
	28/06	33.3	147.4	975	60	3.5	STS
	28/12	34.6	150.3	975	60	3.5	STS
	28/18	36.5	153.0	970	60	3.5	STS
	29/00	38.7	156.0	970	55	3.0	STS
	29/06	42.0	159.0	965	55	2.5	STS
	29/12	44.4	162.6	960	-	-	L
	29/18	48.1	167.1	956	-	-	L
	30/00	52.1	170.1	950	-	-	L
	30/06	54.9	171.3	940	-	-	L
	30/12	55.5	173.6	944	-	-	L
	30/18	56.5	177.2	950	-	-	L
Oct.	01/00	57.5	178.8	956	-	-	L
	01/06	57.6	179.7	960	-	-	L
	01/12	57.4	181.0	968	-	-	Out

TY ROKE (2218)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	28/00	21.1	132.5	1004	-	1.0	TD
	28/06	21.6	132.1	1002	-	1.5	TD
	28/12	23.0	131.7	1000	35	2.0	TS
	28/18	23.8	131.7	998	40	2.5	TS
	29/00	24.9	131.6	994	45	3.0	TS
	29/03	25.3	131.9	992	50	-	STS
	29/06	25.8	132.1	990	55	3.5	STS
	29/09	26.1	132.6	985	60	-	STS
	29/12	26.6	133.1	980	65	4.0	TY
	29/18	27.6	134.3	980	65	4.0	TY
	30/00	28.2	136.0	975	70	4.0	TY
	30/06	28.9	138.1	975	70	4.0	TY
	30/12	30.1	140.1	980	65	4.0	TY
	30/18	31.1	142.7	990	55	3.5	STS
Oct.	01/00	31.8	144.5	992	50	3.5	STS
	01/06	33.0	146.6	992	50	3.5	STS
	01/12	34.0	148.3	992	50	3.5	STS
	01/18	35.4	149.9	992	-	3.5	L
	02/00	36.6	152.1	992	-	-	L
	02/06	37.0	154.6	992	-	-	L
	02/12	37.3	155.8	996	-	-	L
	02/18	37.3	157.5	996	-	-	L
	03/00	37.0	158.1	1000	-	-	L
	03/06	37.2	158.1	1000	-	-	L
	03/12	37.3	158.3	1000	-	-	L
	03/18	37.4	158.2	1000	-	-	L
	04/00	37.4	158.3	1000	-	-	L
	04/06	37.8	159.4	1002	-	-	L
	04/12	38.6	160.8	1004	-	-	L
	04/18	39.3	162.1	1006	-	-	L
	05/00	39.9	163.8	1010	-	-	L
	05/06	41.1	165.9	1012	-	-	L
	05/12						Dissip.

TS SONCA (2219)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Oct.	13/06	12.8	113.9	1000	-	1.0	TD
	13/12	13.6	113.8	1000	-	1.0	TD
	13/18	13.9	112.8	1000	-	1.5	TD
	14/00	14.1	111.9	998	35	2.0	TS
	14/06	14.3	111.4	998	35	2.0	TS
	14/12	14.8	110.2	998	35	2.0	TS
	14/18	15.3	109.4	998	35	2.0	TS
	15/00	15.5	107.8	1004	-	1.5	TD
	15/06						Dissip.

TY NESAT (2220)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Oct.	14/12	18.9	128.2	998	-	1.0	TD
	14/18	19.0	126.4	998	-	1.5	TD
	15/00	19.0	125.0	998	-	1.5	TD
	15/06	18.9	124.1	996	35	2.0	TS
	15/12	18.9	123.1	994	40	2.5	TS
	15/18	19.3	122.0	985	50	3.0	STS
	16/00	19.5	121.0	985	50	3.0	STS
	16/06	19.7	120.0	985	55	3.5	STS
	16/12	19.9	118.8	985	55	3.5	STS
	16/18	19.9	117.8	985	55	3.5	STS
	17/00	19.7	116.9	975	65	4.0	TY
	17/06	19.4	116.2	970	70	4.5	TY
	17/12	19.0	115.5	965	75	5.0	TY
	17/18	18.6	114.6	965	75	5.0	TY
	18/00	18.2	113.9	965	75	5.0	TY
	18/06	17.9	113.1	965	75	5.0	TY
	18/12	17.6	112.4	970	70	4.5	TY
	18/18	17.3	111.6	975	65	4.5	TY
	19/00	17.0	110.9	990	55	4.0	STS
	19/06	17.0	110.1	992	50	3.5	STS
	19/12	17.2	109.3	1000	40	2.5	TS
	19/18	17.2	108.8	1004	35	2.5	TS
	20/00	17.4	108.4	1008	-	2.5	TD
	20/06	17.7	108.2	1008	-	2.0	TD
	20/12						Dissip.

TS HAITANG (2221)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Oct.	17/00	27.0	156.4	1006	-	0.0	TD
	17/06	26.8	157.7	1006	-	0.5	TD
	17/12	27.8	158.0	1008	-	1.0	TD
	17/18	28.2	158.2	1008	-	1.5	TD
	18/00	28.7	158.6	1004	35	2.0	TS
	18/06	29.4	159.0	1004	35	2.0	TS
	18/12	31.2	159.3	1004	35	2.0	TS
	18/18	32.4	160.7	1004	35	2.0	TS
	19/00	33.6	162.5	1004	35	2.0	TS
	19/06	34.8	164.7	1004	35	2.0	TS
	19/12	36.5	167.8	1008	-	2.0	L
	19/18	38.2	171.0	1008	-	-	L
	20/00	39.5	175.1	1008	-	-	L
	20/06	40.3	178.3	1010	-	-	L
	20/12	41.3	182.5	1012	-	-	Out

STS NALGAE (2222)

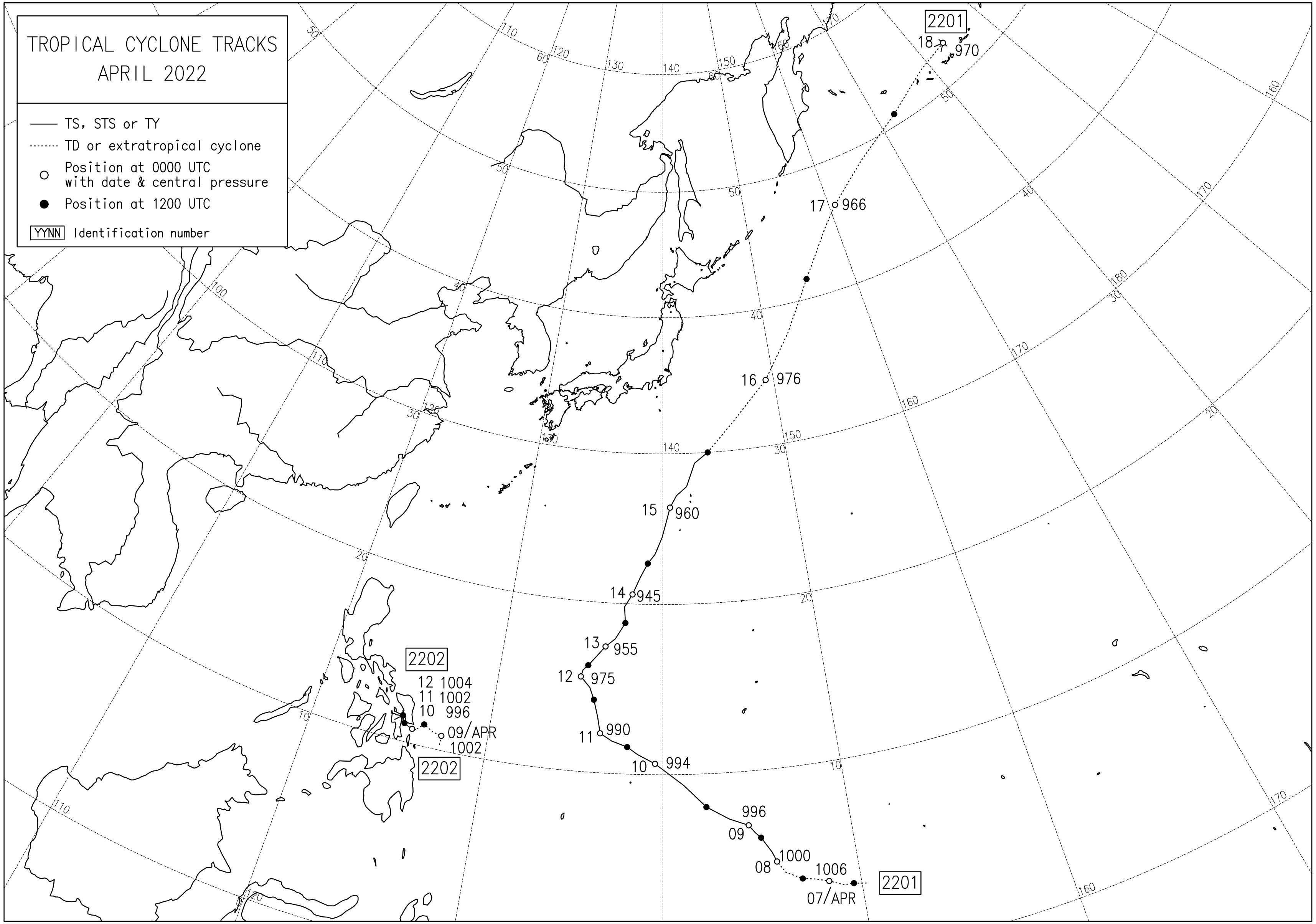
Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Oct.	26/00	10.1	134.9	1004	-	0.0	TD
	26/06	10.3	134.3	1002	-	0.0	TD
	26/12	10.6	133.7	1004	-	0.5	TD
	26/18	10.8	132.9	1000	-	1.0	TD
	27/00	10.9	132.2	998	35	1.5	TS
	27/06	11.0	131.3	996	35	1.5	TS
	27/12	11.1	130.5	996	35	1.5	TS
	27/18	11.3	129.6	992	40	2.0	TS
	28/00	11.8	128.4	992	40	2.0	TS
	28/06	12.1	126.8	990	45	2.5	TS
	28/12	13.3	125.5	990	45	2.5	TS
	28/18	13.5	123.7	985	50	3.0	STS
	29/00	13.5	122.3	985	50	3.0	STS
	29/06	14.0	121.5	985	50	3.0	STS
	29/12	14.7	121.1	985	50	3.0	STS
	29/18	15.6	120.0	990	45	3.0	TS
	30/00	15.6	118.7	990	45	3.0	TS
	30/06	15.6	117.9	990	45	2.5	TS
	30/12	15.9	117.3	990	45	2.5	TS
	30/18	16.1	117.0	985	50	3.0	STS
	31/00	16.4	116.7	980	55	3.0	STS
	31/06	17.1	116.5	975	60	3.0	STS
	31/12	17.9	116.4	975	60	3.5	STS
	31/18	18.3	116.2	975	60	3.5	STS
Nov.	01/00	18.8	115.9	975	60	4.0	STS
	01/06	19.3	115.8	975	60	4.0	STS
	01/12	19.8	115.5	980	55	4.0	STS
	01/18	20.2	115.2	990	50	4.0	STS
	02/00	20.6	115.0	994	45	3.5	TS
	02/06	21.0	114.9	996	40	3.5	TS
	02/12	21.4	114.3	1000	35	3.0	TS
	02/18	21.6	113.9	1004	-	2.5	TD
	03/00	21.9	113.4	1010	-	2.0	TD
	03/06						Dissip.

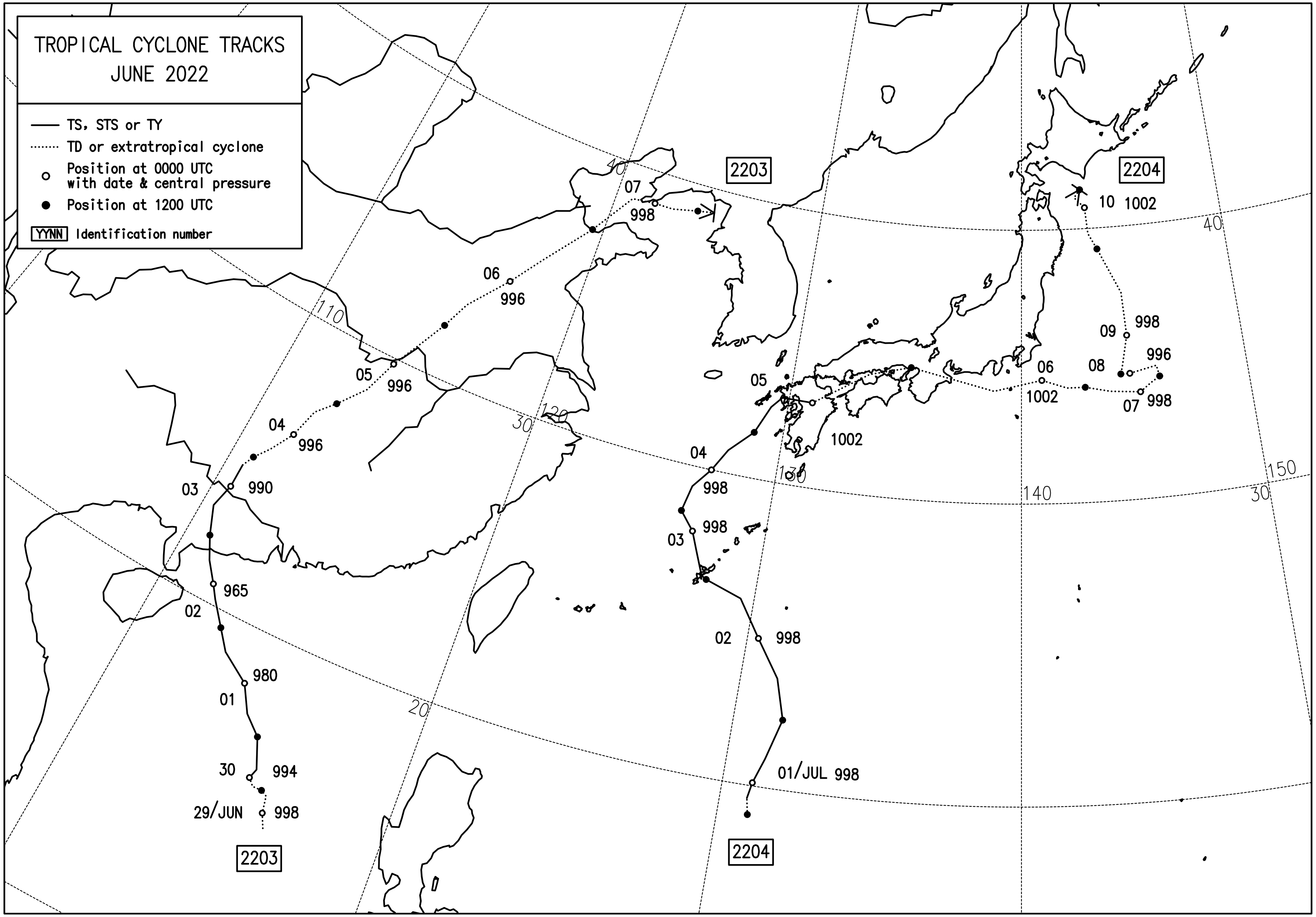
Date/Time		Center Position		Central pressure	Max Wind	CI num.	Grade
	(UTC)	Lat (N)	Lon (E)	(hPa)	(kt)		
TS BANYAN (2223)							
Oct.	28/06	6.8	140.4	1004	-	-	TD
	28/12	7.7	140.3	1006	-	-	TD
	28/18	8.2	140.0	1006	-	-	TD
	29/00	8.3	139.8	1008	-	0.0	TD
	29/06	8.5	139.8	1004	-	0.5	TD
	29/12	8.8	139.3	1008	-	1.0	TD
	29/18	9.0	138.7	1004	-	1.5	TD
	30/00	9.0	138.2	1004	-	1.5	TD
	30/06	9.1	136.9	1004	-	1.5	TD
	30/12	8.6	136.0	1004	-	2.0	TD
	30/18	8.1	135.2	1002	35	2.0	TS
	31/00	7.3	134.0	1002	40	2.5	TS
	31/06	7.1	132.6	1002	35	2.5	TS
	31/12	7.0	131.4	1004	35	2.5	TS
	31/18	7.0	130.4	1004	35	2.0	TS
Nov.	01/00	7.1	129.8	1006	-	2.0	TD
	01/06	7.1	129.5	1006	-	-	TD
	01/12	7.2	129.1	1008	-	-	TD
	01/18	7.6	128.9	1006	-	-	TD
	02/00	7.6	128.4	1010	-	-	TD
	02/06	7.3	128.0	1008	-	-	TD
	02/12	7.0	127.5	1010	-	-	TD
	02/18	6.9	127.4	1008	-	-	TD
	03/00	6.7	127.4	1010	-	-	TD
	03/06						Dissip.

Date/Time		Center Position		Central pressure	Max Wind	CI num.	Grade
	(UTC)	Lat (N)	Lon (E)	(hPa)	(kt)		
TS YAMANEKO (2224)							
Nov.	11/12	19.8	167.3	1012	-	0.5	TD
	11/18	20.1	166.4	1010	-	1.0	TD
	12/00	20.3	165.7	1010	-	1.5	TD
	12/06	20.6	165.5	1008	-	1.5	TD
	12/12	21.1	165.5	1004	35	2.0	TS
	12/18	21.5	165.6	1004	35	2.0	TS
	13/00	21.9	165.8	1004	35	2.0	TS
	13/06	22.1	165.8	1004	35	2.0	TS
	13/12	22.2	165.8	1004	35	2.0	TS
	13/18	22.7	165.9	1004	35	2.0	TS
	14/00	23.8	165.5	1004	35	2.0	TS
	14/06	24.9	166.0	1006	-	2.0	TD
	14/12	26.1	166.7	1008	-	-	TD
	14/18	28.8	168.2	1006	-	-	TD
	15/00						Dissip.

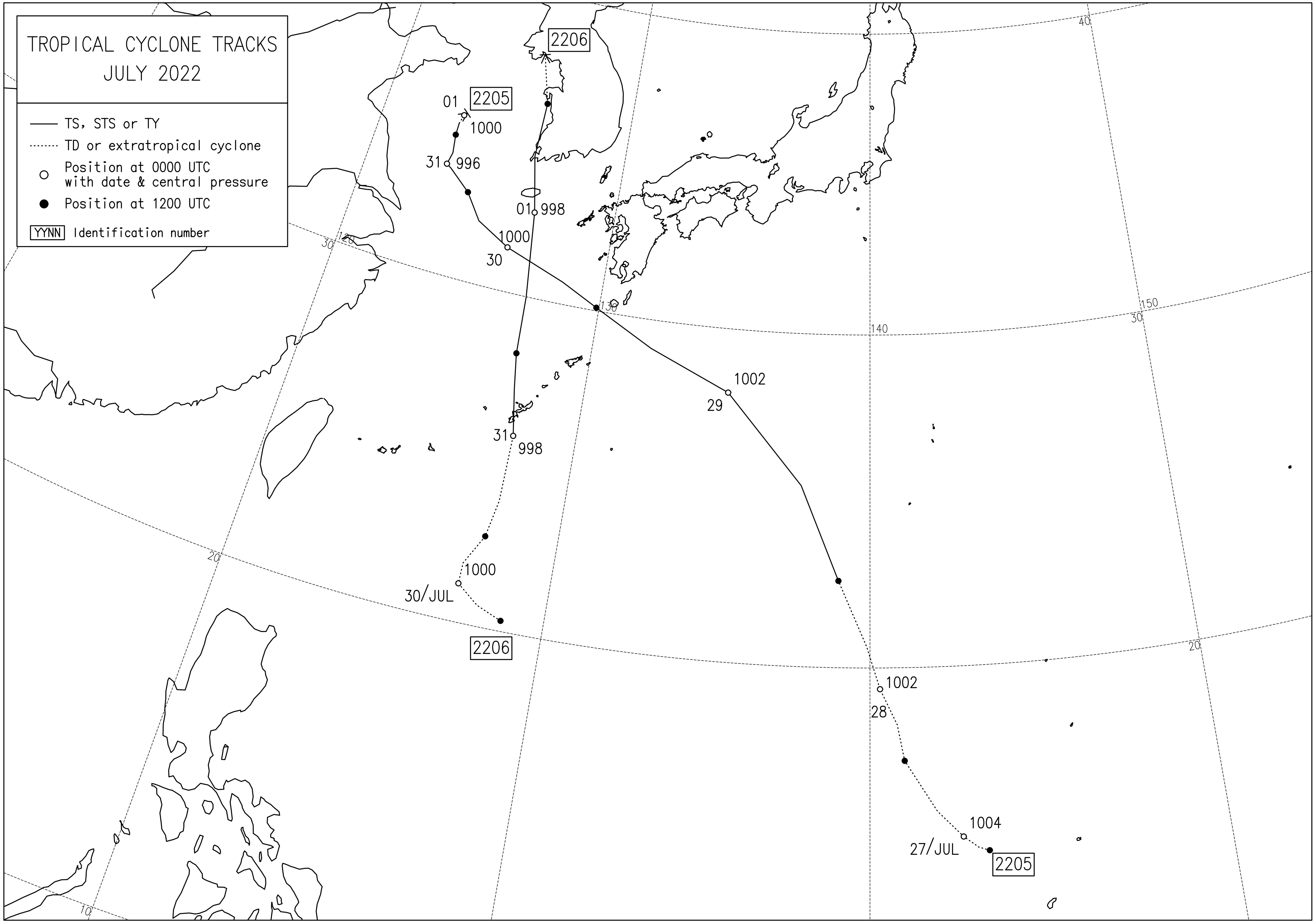
Date/Time		Center Position		Central pressure	Max Wind	CI num.	Grade
	(UTC)	Lat (N)	Lon (E)	(hPa)	(kt)		
TS PAKHAR (2225)							
Dec.	10/00	14.0	124.7	1004	-	1.0	TD
	10/06	14.8	124.1	1002	-	1.0	TD
	10/12	15.8	124.2	1004	-	1.5	TD
	10/18	16.3	124.6	1004	-	1.5	TD
	11/00	16.9	125.2	1004	-	1.5	TD
	11/06	17.5	126.1	1002	-	1.5	TD
	11/12	18.2	127.0	1000	35	2.0	TS
	11/18	19.0	128.1	998	40	2.5	TS
	12/00	20.0	129.3	998	40	2.5	TS
	12/06	20.4	131.0	1002	35	-	TS
	12/12	20.3	131.5	1006	-	-	L
	12/18						Dissip.

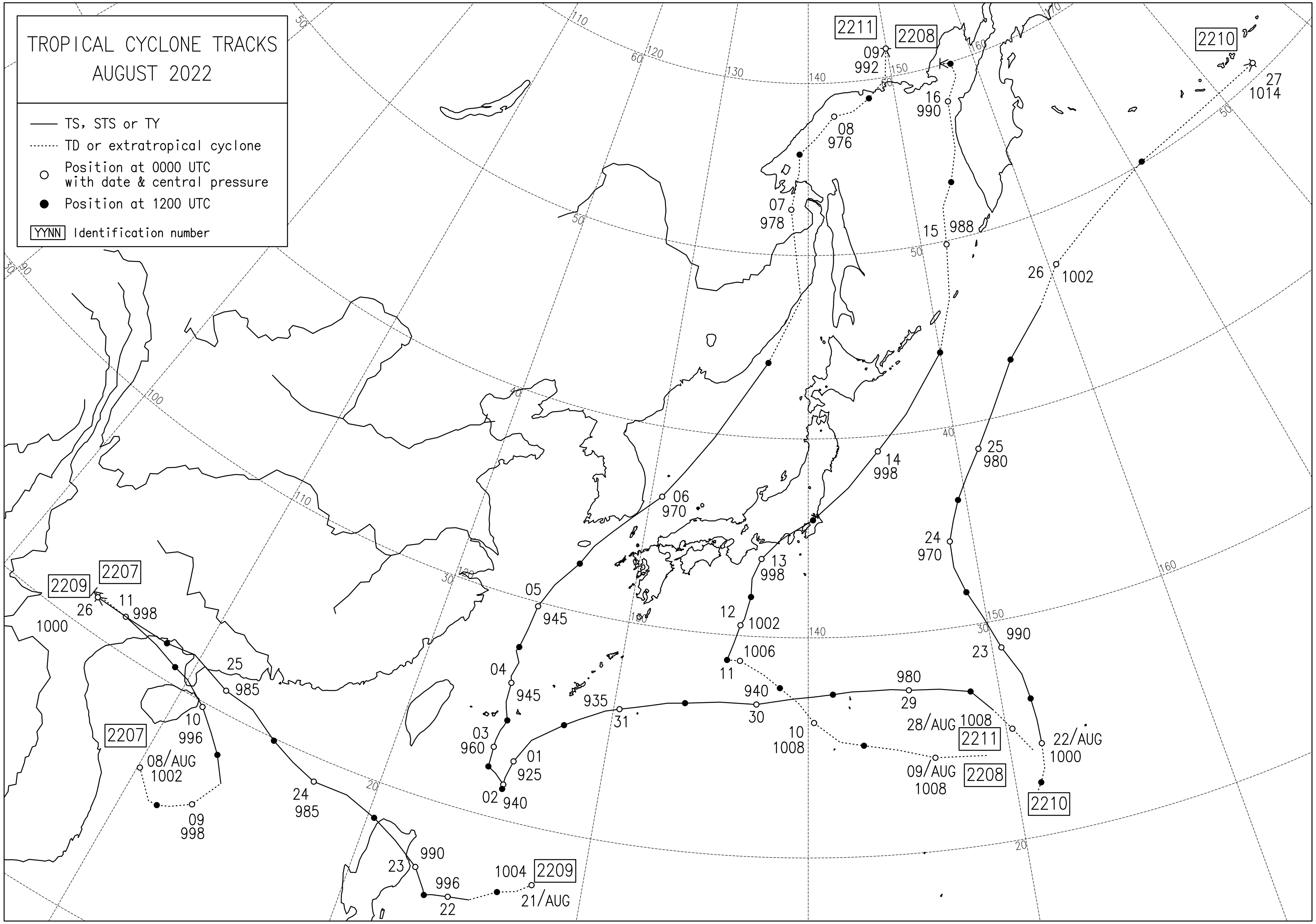
Appendix 2
Monthly Tracks of Tropical Cyclones in 2022

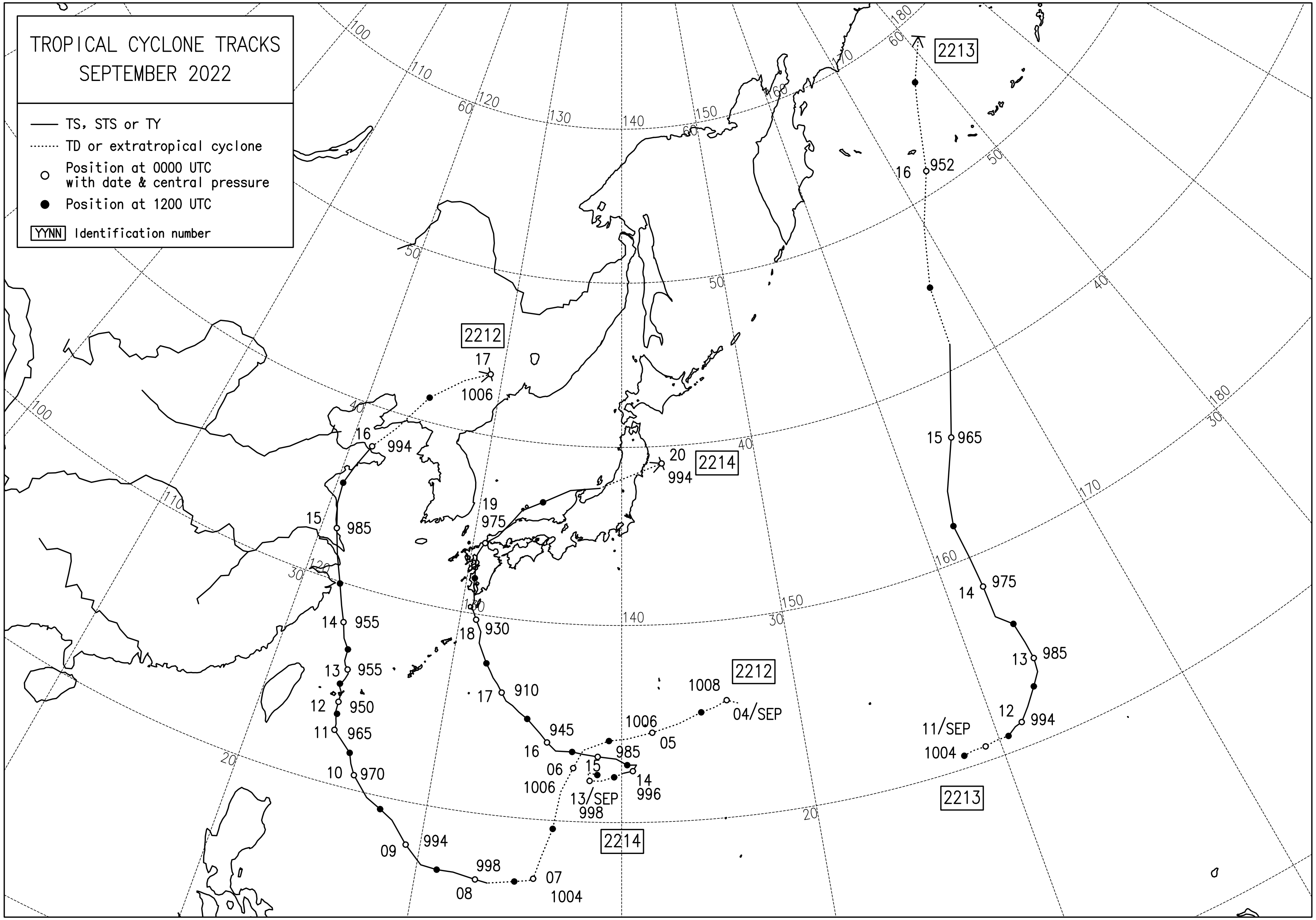

TROPICAL CYCLONE TRACKS
APRIL 2022
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2201
18 970
17 966
16 976
15 960
14 945
13 955
12 975
11 990
10 994
09 996
08 1000
07/APR 1006
2201
2202
12 1004
11 1002
10 996
09/APR 1002
2202

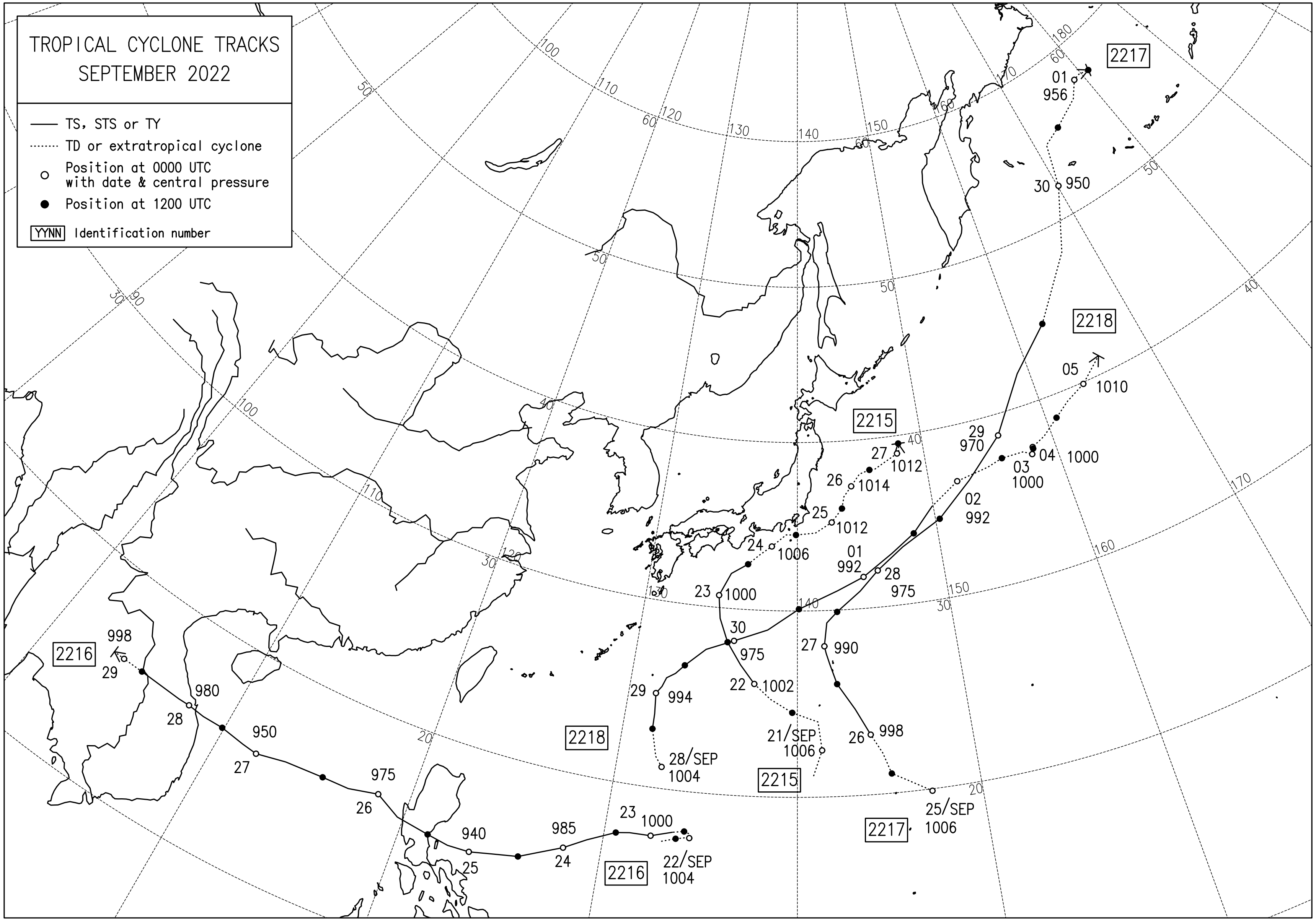


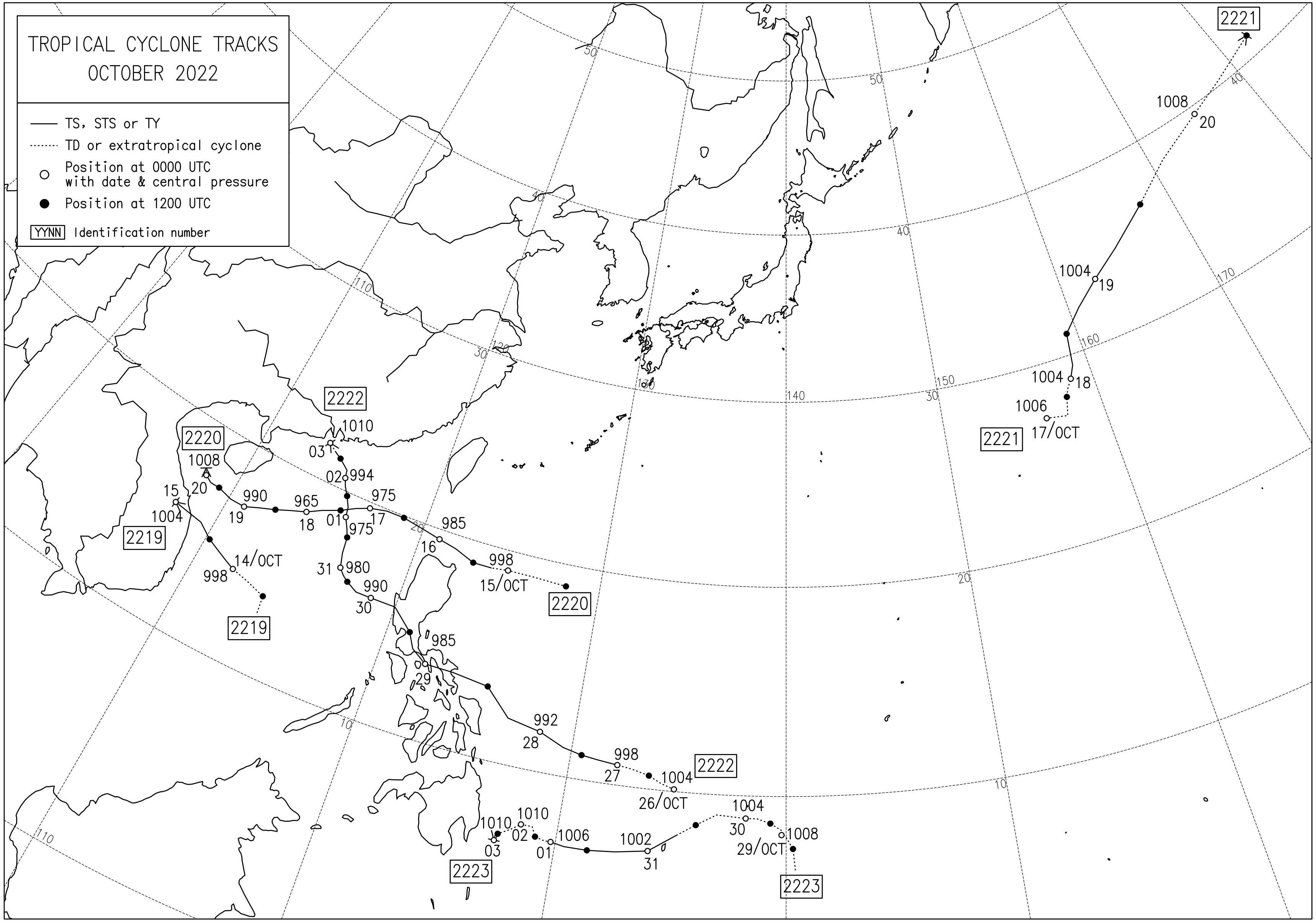
TROPICAL CYCLONE TRACKS
JUNE 2022
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
2203
29/JUN 998
30 994
01 980
02 965
03 990
04 996
05 996
06 996
07 998
2204
01/JUL 998
02 998
03 998
04 998
05 1002
06 1002
07 998
08 996
09 998
10 1002


TROPICAL CYCLONE TRACKS
JULY 2022
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2206
2205
01
1000
31
996
01
998
1000
30
1002
29
31
998
1000
30/JUL
2206
1002
28
1004
27/JUL
2205
40
30
20
10
140
150

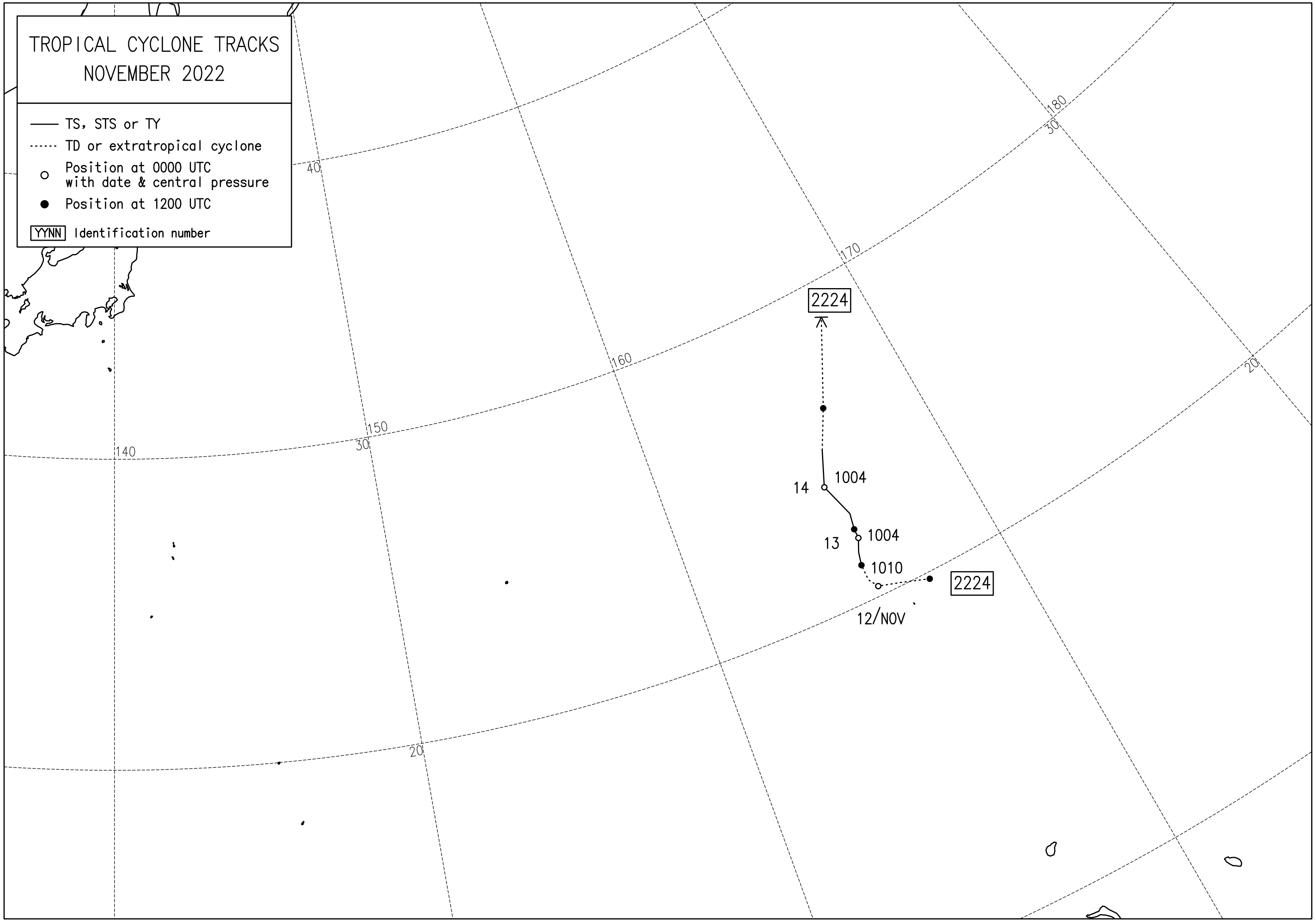

TROPICAL CYCLONE TRACKS
AUGUST 2022
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2207
2208
2209
2210
2211
08/AUG
1002
09
998
10
996
11
998
09/AUG
1008
10
1008
11
1006
12
1002
13
998
14
998
15
988
16
990
21/AUG
1004
22
996
23
990
24
985
25
985
26
1000
22/AUG
1000
23
990
24
970
25
980
26
1002
27
1014
28/AUG
1008
29
980
30
940
31
935
01
925
02
940
03
960
04
945
05
945
06
970
07
978
08
976
09
992

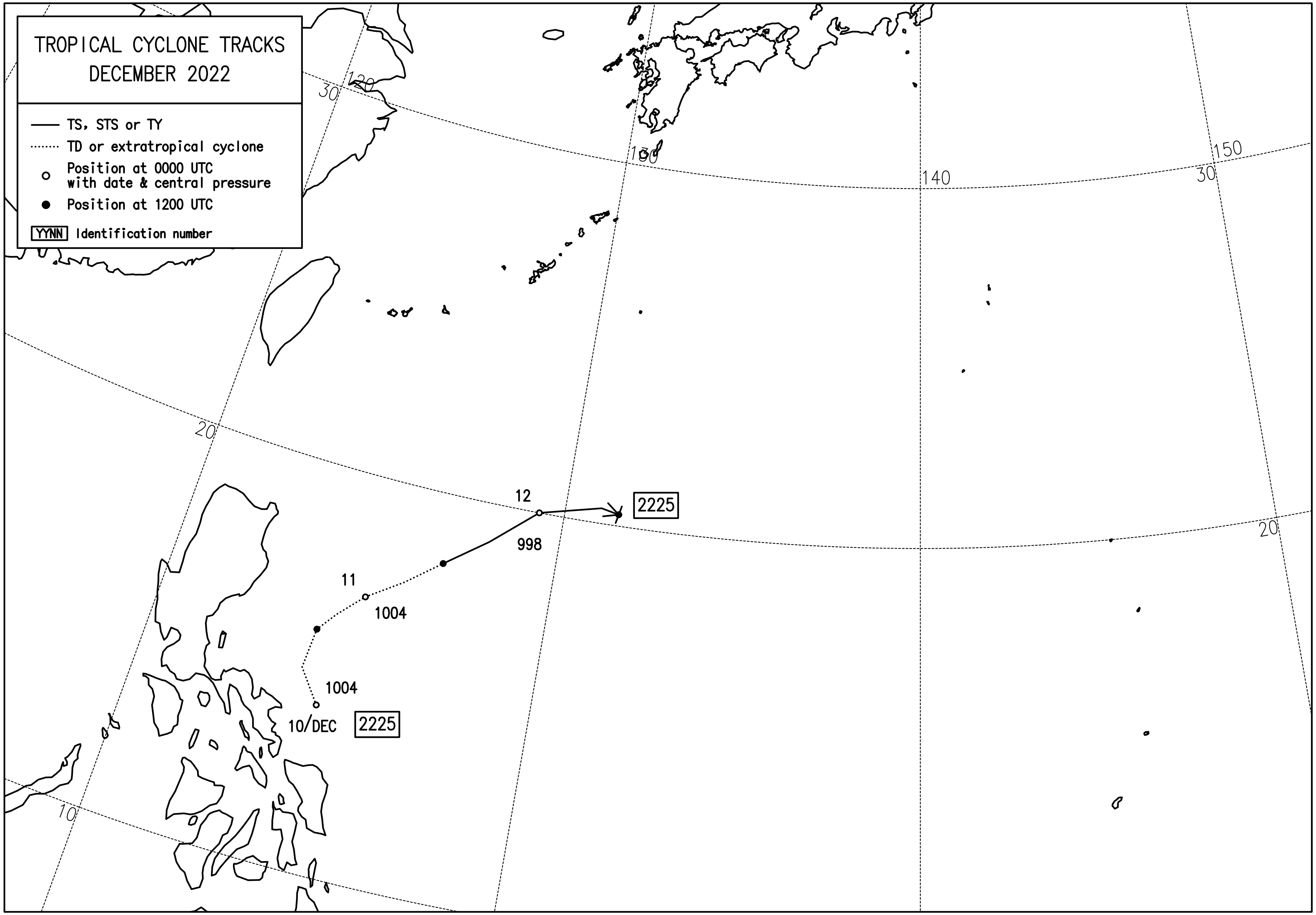

TROPICAL CYCLONE TRACKS
SEPTEMBER 2022
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
2212
2213
2214
04/SEP
11/SEP
13/SEP


TROPICAL CYCLONE TRACKS
SEPTEMBER 2022
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
2215
21/SEP 1006
22 1002
23 1000
24 1006
25 1012
26 1014
27 1012
2216
22/SEP 1004
23 1000
24 985
25 940
26 975
27 950
28 980
29 998
2217
25/SEP 1006
26 998
27 990
28 975
29 970
30 950
01 956
2218
28/SEP 1004
29 994
30 975
01 992
02 992
03 1000
04 1000
05 1010



TROPICAL CYCLONE TRACKS
OCTOBER 2022
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2219
14/OCT
998
15
1004
2219
2220
15/OCT
998
16
985
17
975
18
965
19
990
20
1008
2220
2221
17/OCT
1006
18
1004
19
1004
20
1008
2221
2222
26/OCT
1004
27
998
28
992
29
985
30
990
31
980
01
975
02
994
03
1010
2222
2223
29/OCT
1008
30
1004
31
1002
01
1006
02
1010
03
1010
2223


TROPICAL CYCLONE TRACKS
NOVEMBER 2022
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2224
14
1004
13
1004
1010
12/NOV
2224
140
150
160
170
180
40
30
20


TROPICAL CYCLONE TRACKS
DECEMBER 2022
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
120
130
140
150
30
20
10
12
998
11
1004
1004
10/DEC
2225
2225

Appendix 3
Errors of Track and Intensity Forecasts for Each Tropical Cyclone in 2022

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0[‡]	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)[†] T=24	=48	=72	=96	=120
Malakas(2201)																			
Apr.	06/06	TD	TD	192	65	140	55	164	225	-4	0	-2	0	2	5	5	5	5	0
	06/12	TD	TD	148	31	133	47	199	70	-4	0	-2	2	7	5	5	5	0	-5
	06/18	TD	TD	130	11	159	165	199	123	-2	2	-4	-5	-5	5	0	10	10	10
	07/00	TD	TD	0	35	90	159	217	99	0	2	-2	-5	0	0	0	5	10	5
	07/06	TD	TD	0	35	47	201	132	116	2	2	0	-5	5	0	0	5	10	0
	07/12	TD	TD	0	68	70	165	117	94	2	2	2	0	20	0	0	0	5	-10
	07/18	TD	TD	46	116	159	252	154	112	4	2	2	5	20	-5	0	0	0	-10
	08/00	TS	TS	68	81	266	239	171	94	2	0	0	5	20	0	0	5	0	-10
	08/06	TS	TS	99	65	153	137	100	254	-4	-2	-10	0	15	5	5	10	0	-10
	08/12	TS	TS	94	46	68	117	95	157	-6	-15	-30	-5	0	10	15	25	5	0
	08/18	TS	TS	55	16	92	68	92	67	-6	-15	-25	-5	5	10	15	20	5	-5
	09/00	TS	TS	0	99	124	81	91	35	-4	-20	-25	-5	10	5	20	20	5	-10
	09/06	TS	TS	0	93	124	79	112	56	-2	-20	-20	0	10	5	20	15	0	-10
	09/12	TS	TS	0	84	85	81	114	79	-5	-20	-5	0	15	5	20	5	0	-10
	09/18	TS	TS	0	92	55	57	57	216	-10	-15	-5	10	10	10	15	5	-10	-5
	10/00	TS	TS	74	79	34	81	129	330	-10	-5	0	10	10	15	10	5	-10	-5
	10/06	TS	TS	60	101	48	134	135	270	-20	-20	5	20	0	20	15	-5	-15	5
	10/12	STS	STS	25	87	55	158	180		-20	-5	0	10		20	5	-5	-10	
	10/18	STS	STS	0	78	64	119	256		-15	-5	5	5		15	5	-10	-5	
	11/00	STS	STS	47	15	74	127	265		-10	-5	5	5		10	5	-10	-5	
	11/06	STS	STS	46	24	91	114	178		-5	0	15	0		5	0	-15	0	
	11/12	STS	STS	35	35	85	53			10	0	10			-5	0	-10		
	11/18	STS	STS	24	35	24	114			10	5	5			-5	-5	-5		
	12/00	TY	TY	24	46	30	124			-5	5	5			5	-10	-5		
	12/06	TY	TY	11	70	46	46			0	15	0			0	-15	0		
	12/12	TY	TY	11	77	79				-10	10				5	-10			
	12/18	TY	TY	0	39	20				-5	5				0	-5			
	13/00	TY	TY	0	49	67				5	5				-5	-5			
	13/06	TY	TY	0	46	59				10	-5				-10	5			
	13/12	TY	TY	0	33					10					-10				
	13/18	TY	TY	0	0					5					-5				
	14/00	TY	TY	25	83					5					-5				
	14/06	TY	TY	25	49					-5					0				
	14/12	TY	TY	0															
	14/18	TY	TY	88															
	15/00	TY	TY	55															
	15/06	TY	TY	23															
Initial: TS/STS/TY			**mean**	30	59	79	107	141	156	-3	-5	-4	4	10	4	5	3	-3	-6
Valid: TS/STS/TY			**sample**	30	26	22	18	14	10	26	22	18	14	10	26	22	18	14	10
Initial: TD(before upg.)			*mean*	74	52	114	149	169	120	0	1	-1	-1	7	1	1	4	6	-1
Valid: TD/TS/STS/TY			*sample*	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0[‡]	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)[†] T=24	=48	=72	=96	=120
									Megi(2202)										
Apr.	09/00	TD	TD	*35*	*153*	*236*	*295*			*4*	*-2*	*-4*			*-5*	*5*	*5*		
	09/06	TD	TD	*25*	*186*	*244*				*2*	*0*				*0*	*5*			
	09/12	TD	TD	*47*	*111*	*208*				*0*	*-2*				*0*	*5*			
	09/18	TS	TD	**0**	**99**					**0**					**0**				
	10/00	TS	TS	**11**															
	10/06	TS	TS	**31**															
	10/12	TS	TS	**22**															
	10/18	TS	TS	**44**															
	11/00	TD	TS																
	11/06	TD	TS																
	11/12	TD	TS																
	11/18	TD	TS																
	12/00	TD	TS																
Initial: TS/STS/TY			**mean**	**22**	**99**	**--**	**--**	**--**	**--**	**0**	**--**	**--**	**--**	**--**	**0**	**--**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**5**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
Initial: TD(before upg.)			*mean*	*35*	*150*	*229*	*295*	*--*	*--*	*2*	*-1*	*-4*	*--*	*--*	*-2*	*5*	*5*	*--*	*--*
Valid: TD/TS/STS/TY			*sample*	*3*	*3*	*3*	*1*	*0*	*0*	*3*	*3*	*1*	*0*	*0*	*3*	*3*	*1*	*0*	*0*

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
									Chaba(2203)										
Jun.	29/00	TD	TD	*25*	*201*	*84*	*81*	*226*	*463*	*4*	*18*	*31*	*6*	*2*	*0*	*-20*	*-30*	*5*	*5*
	29/06	TD	TD	*11*	*124*	*67*	*91*	*342*	*653*	*6*	*18*	*31*	*2*	*2*	*-5*	*-20*	*-30*	*10*	*5*
	29/12	TD	TD	*56*	*126*	*31*	*100*	*335*	*633*	*6*	*19*	*14*	*2*	*0*	*-10*	*-20*	*-10*	*5*	*5*
	29/18	TD	TD	*88*	*90*	*84*	*157*	*314*	*655*	*11*	*24*	*9*	*0*	*2*	*-15*	*-25*	*-5*	*5*	*0*
	30/00	TS	TS	**150**	**57**	**33**	**188**			**10**	**20**	**0**			**-15**	**-25**	**5**		
	30/06	TS	TS	**64**	**31**	**49**				**5**	**15**				**-10**	**-20**			
	30/12	TS	TS	**0**	**24**	**79**				**10**	**0**				**-10**	**5**			
	30/18	STS	STS	**21**	**102**	**102**				**5**	**0**				**-5**	**5**			
Jul.	01/00	STS	STS	**22**	**47**	**144**				**0**	**4**				**0**	**5**			
	01/06	STS	STS	**11**	**33**					**0**					**0**				
	01/12	STS	STS	**15**	**30**					**-10**					**10**				
	01/18	TY	STS	**0**	**64**					**5**					**-5**				
	02/00	TY	TY	**0**	**84**					**0**					**0**				
	02/06	TY	TY	**10**															
	02/12	STS	STS	**0**															
	02/18	TS	TS	**22**															
	03/00	TS	TS	**10**															
	03/06	TD	TD																
Initial: TS/STS/TY			**mean**	**25**	**52**	**81**	**188**	**--**	**--**	**3**	**8**	**0**	**--**	**--**	**-4**	**-6**	**5**	**--**	**--**
Valid: TS/STS/TY			**sample**	**13**	**9**	**5**	**1**	**0**	**0**	**9**	**5**	**1**	**0**	**0**	**9**	**5**	**1**	**0**	**0**
Initial: TD(before upg.)			*mean*	*45*	*135*	*67*	*107*	*304*	*601*	*7*	*20*	*21*	*3*	*2*	*-8*	*-21*	*-19*	*6*	*4*
Valid: TD/TS/STS/TY			*sample*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
Aere(2204)																			
Jun.	30/18	TS	TD	**33**	**94**	**108**	**217**	**168**		**0**	**0**	**0**	**2**		**-5**	**0**	**0**	**-5**	
Jul.	01/00	TS	TS	**10**	**52**	**30**	**145**			**4**	**2**	**-4**			**-5**	**5**	**10**		
	01/06	TS	TS	**10**	**67**	**35**	**35**			**4**	**-6**	**-6**			**-5**	**10**	**10**		
	01/12	TS	TS	**10**	**15**	**70**	**97**			**0**	**-6**	**-6**			**0**	**10**	**10**		
	01/18	TS	TS	**11**	**24**	**35**	**44**			**-2**	**-6**	**-8**			**5**	**10**	**10**		
	02/00	TS	TS	**11**	**63**	**84**				**-6**	**-6**				**10**	**10**			
	02/06	TS	TS	**15**	**77**	**141**				**-4**	**-2**				**10**	**5**			
	02/12	TS	TS	**0**	**92**	**220**				**-4**	**-2**				**10**	**5**			
	02/18	TS	TS	**15**	**10**	**131**				**-2**	**-2**				**5**	**0**			
	03/00	TS	TS	**0**	**10**					**-2**					**5**				
	03/06	TS	TS	**0**	**22**					**-2**					**0**				
	03/12	TS	TS	**22**	**67**					**-2**					**0**				
	03/18	TS	TS	**11**	**57**					**-4**					**0**				
	04/00	TS	TS	**36**															
	04/06	TS	TS	**10**															
	04/12	TS	TS	**22**															
	04/18	TS	TS	**9**															
Initial: TS/STS/TY			**mean**	**13**	**50**	**95**	**107**	**168**	**--**	**-2**	**-3**	**-5**	**2**	**--**	**2**	**6**	**8**	**-5**	**--**
Valid: TS/STS/TY			**sample**	**17**	**13**	**9**	**5**	**1**	**0**	**13**	**9**	**5**	**1**	**0**	**13**	**9**	**5**	**1**	**0**
Initial: TD(before upg.)			*mean*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Valid: TD/TS/STS/TY			*sample*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
									Songda(2205)										
Jul.	26/12	TD	TD	*68*	*168*	*158*	*281*	*427*	*484*	*-2*	*-2*	*0*	*2*	*4*	*5*	*5*	*-5*	*0*	*0*
	26/18	TD	TD	*178*	*145*	*152*	*247*	*438*	*535*	*0*	*-2*	*0*	*2*	*2*	*5*	*5*	*0*	*0*	*5*
	27/00	TD	TD	*113*	*167*	*181*	*208*	*280*	*412*	*0*	*-2*	*0*	*4*	*0*	*5*	*5*	*0*	*0*	*5*
	27/06	TD	TD	*22*	*241*	*135*	*211*	*189*	*236*	*0*	*-2*	*0*	*2*	*0*	*5*	*5*	*5*	*5*	*5*
	27/12	TD	TD	*35*	*181*	*160*	*267*	*312*		*0*	*-2*	*0*	*4*		*0*	*0*	*5*	*0*	
	27/18	TD	TD	*57*	*191*	*179*	*204*	*196*		*-4*	*-8*	*-6*	*0*		*5*	*10*	*10*	*5*	
	28/00	TD	TD	*74*	*175*	*169*	*124*	*158*		*-4*	*-8*	*0*	*-2*		*5*	*10*	*5*	*5*	
	28/06	TD	TD	*31*	*89*	*144*	*81*	*48*		*-4*	*-6*	*2*	*-2*		*5*	*10*	*0*	*5*	
	28/12	TS	TS	**0**	**165**	**341**	**236**			**0**	**2**	**4**			**0**	**5**	**0**		
	28/18	TS	TS	**0**	**131**	**191**				**2**	**4**				**0**	**0**			
	29/00	TS	TS	**49**	**83**	**52**				**2**	**6**				**0**	**-5**			
	29/06	TS	TS	**0**	**24**	**107**				**4**	**6**				**0**	**-5**			
	29/12	TS	TS	**59**	**101**	**52**				**4**	**6**				**0**	**-5**			
	29/18	TS	TS	**35**	**91**					**4**					**0**				
	30/00	TS	TS	**0**	**45**					**6**					**0**				
	30/06	TS	TS	**0**	**56**					**6**					**-5**				
	30/12	TS	TS	**15**	**72**					**6**					**-5**				
	30/18	TS	TS	**22**															
	31/00	TS	TS	**0**															
	31/06	TS	TS	**24**															
	31/12	TS	TS	**0**															
	31/18	TD	TD																
Initial: TS/STS/TY			**mean**	**16**	**85**	**149**	**236**	**--**	**--**	**4**	**5**	**4**	**--**	**--**	**-1**	**-2**	**0**	**--**	**--**
Valid: TS/STS/TY			**sample**	**13**	**9**	**5**	**1**	**0**	**0**	**9**	**5**	**1**	**0**	**0**	**9**	**5**	**1**	**0**	**0**
Initial: TD(before upg.)			*mean*	*72*	*170*	*160*	*203*	*256*	*417*	*-2*	*-4*	*-1*	*1*	*2*	*4*	*6*	*3*	*3*	*4*
Valid: TD/TS/STS/TY			*sample*	*8*	*8*	*8*	*8*	*8*	*4*	*8*	*8*	*8*	*8*	*4*	*8*	*8*	*8*	*8*	*4*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time		Grade		Center Position (km)						Central Pressure (hPa)					Max. Wind (kt)[†]				
	(UTC)	Best	Prov.	T=0[‡]	=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120
								Trases(2206)											
Jul.	31/06	TS	TS	**0**	**81**					**0**					**-5**				
	31/12	TS	TS	**20**															
	31/18	TS	TS	**97**															
Aug.	01/00	TS	TS	**22**															
	01/06	TS	TS	**0**															
	01/12	TD	TD																
Initial: TS/STS/TY			**mean**	**28**	**81**	**--**	**--**	**--**	**--**	**0**	**--**	**--**	**--**	**--**	**-5**	**--**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**5**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
Initial: TD(before upg.)			*mean*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Valid: TD/TS/STS/TY			*sample*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Grade Prov.	Center Position (km) T=0[‡]	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)[†] T=24	=48	=72	=96	=120
								Mulan(2207)											
Aug.	08/06	TD	TD	*33*	*94*	*38*	*290*			*0*	*0*	*-2*			*0*	*0*	*5*		
	08/12	TD	TD	*89*	*109*	*54*				*2*	*0*				*0*	*0*			
	08/18	TD	TD	*11*	*74*	*86*				*2*	*0*				*0*	*0*			
	09/00	TD	TD	*76*	*62*	*190*				*0*	*-2*				*0*	*5*			
	09/06	TS	TS	**11**	**125**					**0**					**0**				
	09/12	TS	TS	**24**	**125**					**0**					**0**				
	09/18	TS	TS	**31**	**205**					**2**					**0**				
	10/00	TS	TS	**74**															
	10/06	TS	TS	**71**															
	10/12	TS	TS	**24**															
	10/18	TS	TS	**0**															
	11/00	TD	TD																
Initial: TS/STS/TY			**mean**	**33**	**152**	**--**	**--**	**--**	**--**	**1**	**--**	**--**	**--**	**--**	**0**	**--**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**7**	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**
Initial: TD(before upg.)			*mean*	*52*	*85*	*92*	*290*	*--*	*--*	*1*	*-1*	*-2*	*--*	*--*	*0*	*1*	*5*	*--*	*--*
Valid: TD/TS/STS/TY			*sample*	*4*	*4*	*4*	*1*	*0*	*0*	*4*	*4*	*1*	*0*	*0*	*4*	*4*	*1*	*0*	*0*

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

Date/Time (UTC)	Grade Best	Grade Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
						Meari(2208)												
Aug. 10/00	TD	TD	*56*	*81*	*97*	*247*	*237*		*-2*	*0*	*0*	*-6*		*5*	*0*	*0*	*5*	
10/06	TD	TD	*52*	*69*	*149*	*357*	*240*		*0*	*0*	*2*	*0*		*5*	*0*	*-5*	*0*	
10/12	TD	TD	*68*	*81*	*83*	*255*			*2*	*2*	*2*			*0*	*-5*	*-5*		
10/18	TD	TD	*33*	*73*	*110*	*133*			*2*	*2*	*2*			*0*	*-5*	*-5*		
11/00	TD	TD	*41*	*83*	*129*	*92*			*2*	*4*	*0*			*0*	*-5*	*0*		
11/06	TD	TD	*37*	*123*	*80*	*28*			*0*	*4*	*2*			*0*	*-5*	*0*		
11/12	TS	TD	**69**	**48**	**45**				**2**	**4**				**-5**	**-5**			
11/18	TS	TS	**0**	**22**	**63**				**2**	**4**				**-5**	**-5**			
12/00	TS	TS	**33**	**36**	**14**				**4**	**4**				**-5**	**-5**			
12/06	TS	TS	**10**	**69**	**100**				**2**	**4**				**0**	**0**			
12/12	TS	TS	**0**	**58**					**2**					**0**				
12/18	TS	TS	**11**	**54**					**2**					**0**				
13/00	TS	TS	**0**	**14**					**2**					**0**				
13/06	TS	TS	**0**	**37**					**2**					**0**				
13/12	TS	TS	**0**															
13/18	TS	TS	**0**															
14/00	TS	TS	**0**															
14/06	TS	TS	**34**															
Initial: TS/STS/TY		**mean**	**13**	**42**	**56**	**--**	**--**	**--**	**2**	**4**	**--**	**--**	**--**	**-2**	**-4**	**--**	**--**	**--**
Valid: TS/STS/TY		**sample**	**12**	**8**	**4**	**0**	**0**	**0**	**8**	**4**	**0**	**0**	**0**	**8**	**4**	**0**	**0**	**0**
Initial: TD(before upg.)		*mean*	*48*	*85*	*108*	*185*	*239*	--	*1*	*2*	*1*	*-3*	--	*2*	*-3*	*-3*	*3*	--
Valid: TD/TS/STS/TY		*sample*	*6*	*6*	*6*	*6*	*2*	*0*	*6*	*6*	*6*	*2*	*0*	*6*	*6*	*6*	*2*	*0*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
									Ma-on(2209)										
Aug.	21/06	TD	TD	*0*	*163*	*170*	*412*	*731*		*4*	*8*	*11*	*6*		*-5*	*-15*	*-15*	*-10*	
	21/12	TD	TD	*11*	*144*	*232*	*433*	*705*		*6*	*8*	*7*	*4*		*-10*	*-15*	*-10*	*-5*	
	21/18	TS	TD	**15**	**125**	**221**	**390**	**616**		**8**	**11**	**7**	**2**		**-15**	**-15**	**-10**	**0**	
	22/00	TS	TD	**11**	**69**	**246**	**373**			**8**	**11**	**7**			**-15**	**-15**	**-10**		
	22/06	TS	TS	**0**	**101**	**260**	**417**			**6**	**7**	**0**			**-10**	**-10**	**0**		
	22/12	TS	TS	**15**	**92**	**236**	**267**			**2**	**5**	**6**			**-5**	**-5**	**-10**		
	22/18	STS	STS	**15**	**97**	**205**	**364**			**5**	**0**	**2**			**-5**	**0**	**0**		
	23/00	STS	STS	**39**	**157**	**217**				**0**	**-5**				**0**	**5**			
	23/06	STS	STS	**11**	**190**	**250**				**-5**	**0**				**5**	**0**			
	23/12	STS	STS	**0**	**133**	**184**				**-5**	**0**				**5**	**0**			
	23/18	STS	STS	**15**	**74**	**159**				**-5**	**-4**				**5**	**10**			
	24/00	STS	STS	**21**	**71**					**-5**					**5**				
	24/06	STS	STS	**11**	**63**					**2**					**-5**				
	24/12	STS	STS	**0**	**83**					**4**					**-5**				
	24/18	STS	STS	**30**	**76**					**2**					**0**				
	25/00	STS	STS	**30**															
	25/06	STS	TS	**0**															
	25/12	TS	TS	**21**															
	25/18	TS	TS	**0**															
	26/00	TD	TD																
Initial: TS/STS/TY			**mean**	**14**	**102**	**220**	**362**	**616**	**--**	**1**	**3**	**4**	**2**	**--**	**-3**	**-3**	**-6**	**0**	**--**
Valid: TS/STS/TY			**sample**	**17**	**13**	**9**	**5**	**1**	**0**	**13**	**9**	**5**	**1**	**0**	**13**	**9**	**5**	**1**	**0**
Initial: TD(before upg.)			*mean*	*5*	*154*	*201*	*423*	*718*	--	*5*	*8*	*9*	*5*	--	*-8*	*-15*	*-13*	*-8*	--
Valid: TD/TS/STS/TY			*sample*	*2*	*2*	*2*	*2*	*2*	*0*	*2*	*2*	*2*	*2*	*0*	*2*	*2*	*2*	*2*	*0*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Grade Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
								Tokage(2210)											
Aug.	21/18	TD	TD	*53*	*104*	*67*	*11*			*8*	*30*	*23*			*-15*	*-40*	*-30*		
	22/00	TS	TD	**80**	**60**	**48**	**48**			**10**	**30**	**18**			**-20**	**-40**	**-25**		
	22/06	TS	TS	**0**	**38**	**49**	**70**			**20**	**28**	**4**			**-30**	**-35**	**-10**		
	22/12	TS	TS	**11**	**72**	**52**	**111**			**22**	**17**	**2**			**-25**	**-20**	**-5**		
	22/18	STS	STS	**37**	**15**	**49**				**15**	**10**				**-15**	**-10**			
	23/00	STS	STS	**11**	**24**	**69**				**10**	**0**				**-10**	**0**			
	23/06	TY	STS	**24**	**11**	**44**				**10**	**-10**				**-10**	**10**			
	23/12	TY	TY	**11**	**14**	**14**				**0**	**-7**				**0**	**10**			
	23/18	TY	TY	**0**	**27**					**-5**					**5**				
	24/00	TY	TY	**11**	**45**					**-5**					**5**				
	24/06	TY	TY	**11**	**20**					**-5**					**5**				
	24/12	TY	TY	**0**	**16**					**-2**					**5**				
	24/18	TY	TY	**11**															
	25/00	TY	TY	**24**															
	25/06	STS	STS	**52**															
	25/12	STS	STS	**14**															
Initial: TS/STS/TY			**mean**	**20**	**31**	**46**	**76**	**--**	**--**	**6**	**10**	**8**	**--**	**--**	**-8**	**-12**	**-13**	**--**	**--**
Valid: TS/STS/TY			**sample**	**15**	**11**	**7**	**3**	**0**	**0**	**11**	**7**	**3**	**0**	**0**	**11**	**7**	**3**	**0**	**0**
Initial: TD(before upg.)			*mean*	*53*	*104*	*67*	*11*	*--*	*--*	*8*	*30*	*23*	*--*	*--*	*-15*	*-40*	*-30*	*--*	*--*
Valid: TD/TS/STS/TY			*sample*	*1*	*1*	*1*	*1*	*0*	*0*	*1*	*1*	*1*	*0*	*0*	*1*	*1*	*1*	*0*	*0*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time		Grade		Center Position (km)						Central Pressure (hPa)					Max. Wind (kt)[†]				
	(UTC)	Best	Prov.	T=0[‡]	=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120
Hinnamnor(2211)																			
Aug.	28/00	TD	TD	*0*	*67*	*521*	*931*			*24*	*64*	*71*			*-35*	*-60*	*-70*		
	28/06	TS	TS	0	89	421	781			29	69	71			-40	-65	-70		
	28/12	TS	TS	0	142	364	664	958	776	33	74	57	67	42	-45	-60	-50	-50	-25
	28/18	STS	TS	10	289	398	758	814	560	44	72	55	50	25	-45	-55	-45	-30	-10
	29/00	TY	STS	0	35	161	334	249	302	35	35	30	10	-20	-30	-30	-20	5	15
	29/06	TY	TY	0	15	113	219	123	112	30	15	15	-10	-25	-25	-15	-10	20	20
	29/12	TY	TY	0	30	133	184	178	166	35	15	25	-15	-15	-20	-10	-10	20	15
	29/18	TY	TY	0	54	164	133	112	81	30	15	5	-20	-15	-15	-10	5	20	15
	30/00	TY	TY	0	81	192	123	130	110	5	15	-5	-35	-20	-5	-5	20	25	15
	30/06	TY	TY	0	83	190	161	188	198	-15	-5	-20	-35	-5	5	5	25	25	5
	30/12	TY	TY	10	60	133	122	97	80	-20	-10	-35	-35	-15	10	10	30	25	10
	30/18	TY	TY	0	90	59	56	32	116	-20	-20	-40	-35	-15	10	20	30	25	10
	31/00	TY	TY	11	69	44	42	67	163	-10	-25	-45	-30	-20	10	30	30	20	15
	31/06	TY	TY	0	35	33	35	104	241	-10	-30	-35	-5	0	10	35	25	5	5
	31/12	TY	TY	0	25	11	45	149	301	-5	-15	-25	-5	-10	5	20	20	5	10
	31/18	TY	TY	0	30	43	42	59	143	-15	-20	-25	-5	-20	15	20	20	5	15
Sep.	01/00	TY	TY	0	33	52	46	77	176	-25	-25	-20	-5	-20	30	20	15	5	15
	01/06	TY	TY	0	22	15	30	38	323	-30	-25	-15	-10	-25	35	20	10	10	20
	01/12	TY	TY	0	15	20	74	123		-35	-15	-15	-15		35	15	10	15	
	01/18	TY	TY	0	22	15	127	240		-30	-15	-15	-15		25	15	10	15	
	02/00	TY	TY	0	24	32	146	367		-35	-20	-25	-20		20	10	15	15	
	02/06	TY	TY	0	24	24	80	378		-35	-20	-15	-15		20	10	10	15	
	02/12	TY	TY	23	23	20	137			-25	-20	-10			15	10	10		
	02/18	TY	TY	0	24	63	249			-15	-15	-20			10	5	15		
	03/00	TY	TY	0	30	134	467			-10	-20	-20			5	10	15		
	03/06	TY	TY	0	54	145	633			-5	-25	-25			0	15	20		
	03/12	TY	TY	0	30	130				-5	-20				0	15			
	03/18	TY	TY	0	41	194				5	-20				-5	15			
	04/00	TY	TY	0	51	267				-10	-25				5	15			
	04/06	TY	TY	0	53	290				-15	-10				10	10			
	04/12	TY	TY	0	61					-20					15				
	04/18	TY	TY	0	78					-20					15				
	05/00	TY	TY	0	133					-20					15				
	05/06	TY	TY	0	69					-10					10				
	05/12	TY	TY	0															
	05/18	TY	TY	0															
	06/00	TY	TY	21															
	06/06	STS	TY	0															
Initial: TS/STS/TY			**mean**	2	58	133	227	224	240	-6	-3	-6	-9	-10	3	3	5	10	9
Valid: TS/STS/TY			**sample**	37	33	29	25	20	16	33	29	25	20	16	33	29	25	20	16
Initial: TD(before upg.)			*mean*	*0*	*67*	*521*	*931*	*--*	*--*	*24*	*64*	*71*	*--*	*--*	*-35*	*-60*	*-70*	*--*	*--*
Valid: TD/TS/STS/TY			*sample*	*1*	*1*	*1*	*1*	*0*	*0*	*1*	*1*	*1*	*0*	*0*	*1*	*1*	*1*	*0*	*0*

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

Date/Time		Grade		Center Position (km)						Central Pressure (hPa)					Max. Wind (kt)†				
	(UTC)	Best	Prov.	T=0‡	=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120
Muifa(2212)																			
Sep.	07/06	TD	TD	*85*	*216*	*378*	*417*	*338*	*254*	*2*	*2*	*15*	*25*	*10*	*-5*	*0*	*-10*	*-15*	*-5*
	07/12	TD	TD	*72*	*276*	*401*	*403*	*321*	*285*	*2*	*7*	*20*	*20*	*10*	*-5*	*-5*	*-15*	*-10*	*-5*
	07/18	TS	TD	39	330	479	410	349	335	6	12	25	10	10	-10	-10	-20	-5	-5
	08/00	TS	TS	55	208	413	309	254	190	4	22	35	10	20	-5	-20	-25	-5	-10
	08/06	TS	TS	0	200	314	190	152	164	4	15	25	5	15	-5	-10	-15	0	-5
	08/12	TS	TS	21	107	146	125	108	124	7	20	15	0	10	-5	-15	-10	0	-5
	08/18	TS	TS	15	105	63	44	164	248	10	20	0	0	15	-5	-15	0	0	-10
	09/00	TS	TS	77	105	38	68	171	267	10	20	0	10	15	-10	-15	0	-5	-10
	09/06	STS	TS	39	73	22	129	193	375	15	20	0	15	20	-15	-15	0	-10	-15
	09/12	STS	STS	21	23	78	141	267	528	5	0	-10	10	5	-5	0	5	-10	-10
	09/18	STS	STS	15	0	53	114	235	516	10	-10	-5	10	-5	-10	5	0	-10	0
	10/00	TY	TY	22	15	42	102	201	471	20	-10	5	15	-15	-15	5	-5	-15	15
	10/06	TY	TY	15	31	69	75	116	286	5	-15	5	10	-20	-5	10	-5	-10	20
	10/12	TY	TY	0	30	52	46	59	147	0	-15	5	5	-12	0	10	-5	-10	15
	10/18	TY	TY	0	31	45	87	193	191	-15	-10	10	0	-7	10	5	-10	-5	10
	11/00	TY	TY	0	32	59	126	293		-15	10	10	-10		10	-5	-10	10	
	11/06	TY	TY	0	24	11	140	301		-15	10	10	-15		10	-5	-10	15	
	11/12	TY	TY	0	22	129	295	379		-15	-5	-5	-17		10	0	0	20	
	11/18	TY	TY	0	10	53	221	190		-15	5	-10	-12		5	-5	5	15	
	12/00	TY	TY	0	10	74	158			0	5	-15			0	-5	15		
	12/06	TY	TY	10	55	59	135			10	10	-15			-5	-5	15		
	12/12	TY	TY	0	15	53	110			10	5	-2			-5	-5	10		
	12/18	TY	TY	20	46	112	225			15	5	-7			-10	-5	10		
	13/00	TY	TY	0	33	115				10	-5				-5	10			
	13/06	TY	TY	0	59	166				15	6				-10	-10			
	13/12	TY	TY	10	81	203				5	4				-5	-5			
	13/18	TY	TY	0	58	221				0	4				0	-5			
	14/00	TY	TY	24	99					5					0				
	14/06	TY	TY	15	75					0					5				
	14/12	TY	TY	15	59					4					0				
	14/18	TY	TY	0	52					2					0				
	15/00	STS	STS	0															
	15/06	TS	TS	0															
	15/12	TS	TS	14															
	15/18	TS	TS	21															
Initial: TS/STS/TY			**mean**	14	69	123	155	213	296	3	5	4	3	4	-3	-4	-3	-1	-1
Valid: TS/STS/TY			**sample**	33	29	25	21	17	13	29	25	21	17	13	29	25	21	17	13
Initial: TD(before upg.)			*mean*	*78*	*246*	*389*	*410*	*330*	*269*	*2*	*5*	*18*	*23*	*10*	*-5*	*-3*	*-13*	*-13*	*-5*
Valid: TD/TS/STS/TY			*sample*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time		Grade		Center Position (km)						Central Pressure (hPa)					Max. Wind (kt)[†]				
	(UTC)	Best	Prov.	T=0[‡]	=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120
								Merbok(2213)											
Sep.	11/06	TD	TD	*11*	*84*	*69*	*118*			*6*	*7*	*10*			*-15*	*-10*	*-10*		
	11/12	TS	TD	**21**	**62**	**108**	**197**			**8**	**16**	**25**			**-15**	**-20**	**-20**		
	11/18	TS	TD	**11**	**41**	**68**	**165**			**13**	**21**	**25**			**-20**	**-25**	**-20**		
	12/00	TS	TS	**10**	**42**	**102**	**279**			**11**	**15**	**15**			**-15**	**-15**	**-5**		
	12/06	STS	TS	**0**	**22**	**112**				**7**	**15**				**-10**	**-15**			
	12/12	STS	STS	**11**	**69**	**145**				**5**	**15**				**-5**	**-10**			
	12/18	STS	STS	**31**	**23**	**158**				**-5**	**5**				**5**	**0**			
	13/00	STS	STS	**0**	**46**	**184**				**-5**	**10**				**5**	**0**			
	13/06	STS	STS	**10**	**48**					**0**					**0**				
	13/12	STS	STS	**0**	**56**					**5**					**-5**				
	13/18	TY	TY	**11**	**44**					**0**					**0**				
	14/00	TY	TY	**44**	**78**					**0**					**5**				
	14/06	TY	TY	**15**															
	14/12	TY	TY	**11**															
	14/18	TY	TY	**29**															
	15/00	TY	TY	**11**															
Initial: TS/STS/TY			**mean**	**14**	**48**	**125**	**214**	**--**	**--**	**4**	**14**	**22**	**--**	**--**	**-5**	**-12**	**-15**	**--**	**--**
Valid: TS/STS/TY			**sample**	**15**	**11**	**7**	**3**	**0**	**0**	**11**	**7**	**3**	**0**	**0**	**11**	**7**	**3**	**0**	**0**
Initial: TD(before upg.)			*mean*	*11*	*84*	*69*	*118*	*--*	*--*	*6*	*7*	*10*	*--*	*--*	*-15*	*-10*	*-10*	*--*	*--*
Valid: TD/TS/STS/TY			*sample*	*1*	*1*	*1*	*1*	*0*	*0*	*1*	*1*	*1*	*0*	*0*	*1*	*1*	*1*	*0*	*0*

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

Date/Time		Grade		Center Position (km)						Central Pressure (hPa)					Max. Wind (kt)†				
	(UTC)	Best	Prov.	T=0‡	=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120
Nanmadol(2214)																			
Sep.	12/18	TD	TD	*30*	*129*	*135*	*255*	*276*	*187*	*0*	*4*	*30*	*75*	*65*	*0*	*-5*	*-30*	*-55*	*-45*
	13/00	TD	TD	*0*	*167*	*150*	*301*	*307*	*213*	*0*	*9*	*40*	*65*	*45*	*0*	*-10*	*-35*	*-45*	*-30*
	13/06	TD	TD	*0*	*160*	*138*	*263*	*213*	*134*	*0*	*14*	*50*	*65*	*45*	*0*	*-15*	*-40*	*-45*	*-30*
	13/12	TD	TD	*0*	*114*	*158*	*198*	*171*	*220*	*2*	*24*	*60*	*65*	*20*	*-5*	*-25*	*-45*	*-45*	*-15*
	13/18	TS	TS	**0**	**91**	**158**	**170**	**166**	**287**	**4**	**25**	**65**	**55**	**10**	**-5**	**-25**	**-45**	**-35**	**-10**
	14/00	TS	TS	**0**	**60**	**153**	**185**	**199**	**293**	**5**	**35**	**65**	**45**	**0**	**-5**	**-30**	**-45**	**-30**	**0**
	14/06	TS	TS	**57**	**88**	**162**	**145**	**97**	**158**	**5**	**40**	**60**	**40**	**0**	**-5**	**-30**	**-40**	**-25**	**0**
	14/12	TS	TS	**59**	**105**	**129**	**144**	**85**	**75**	**15**	**50**	**60**	**15**	**-5**	**-15**	**-35**	**-40**	**-10**	**5**
	14/18	TS	STS	**0**	**99**	**119**	**126**	**39**		**20**	**55**	**45**	**10**		**-20**	**-40**	**-30**	**-10**	
	15/00	STS	STS	**52**	**90**	**120**	**120**	**52**		**30**	**50**	**30**	**0**		**-25**	**-35**	**-20**	**0**	
	15/06	STS	STS	**0**	**107**	**126**	**163**	**14**		**30**	**45**	**25**	**0**		**-20**	**-30**	**-15**	**-5**	
	15/12	TY	TY	**0**	**78**	**105**	**94**	**56**		**30**	**40**	**0**	**-5**		**-20**	**-25**	**0**	**0**	
	15/18	TY	TY	**0**	**67**	**88**	**56**			**40**	**30**	**-10**			**-25**	**-15**	**5**		
	16/00	TY	TY	**15**	**82**	**95**	**33**			**30**	**20**	**0**			**-15**	**-5**	**5**		
	16/06	TY	TY	**0**	**60**	**124**	**64**			**30**	**10**	**5**			**-15**	**0**	**0**		
	16/12	TY	TY	**0**	**66**	**108**	**89**			**15**	**-10**	**-10**			**-10**	**10**	**10**		
	16/18	TY	TY	**0**	**51**	**60**				**-10**	**-20**				**10**	**15**			
	17/00	TY	TY	**11**	**40**	**85**				**-20**	**-45**				**15**	**30**			
	17/06	TY	TY	**11**	**66**	**134**				**-10**	**-30**				**10**	**25**			
	17/12	TY	TY	**0**	**66**	**143**				**-35**	**-30**				**25**	**25**			
	17/18	TY	TY	**0**	**64**					**-35**					**20**				
	18/00	TY	TY	**0**	**43**					**-45**					**35**				
	18/06	TY	TY	**0**	**78**					**-30**					**20**				
	18/12	TY	TY	**0**	**90**					**-20**					**15**				
	18/18	TY	TY	**0**															
	19/00	STS	STS	**0**															
	19/06	STS	STS	**0**															
	19/12	STS	STS	**58**															
Initial: TS/STS/TY			**mean**	**11**	**75**	**119**	**116**	**89**	**203**	**3**	**17**	**28**	**20**	**1**	**-2**	**-10**	**-18**	**-14**	**-1**
Valid: TS/STS/TY			**sample**	**24**	**20**	**16**	**12**	**8**	**4**	**20**	**16**	**12**	**8**	**4**	**20**	**16**	**12**	**8**	**4**
Initial: TD(before upg.)			*mean*	*8*	*142*	*145*	*254*	*242*	*189*	*1*	*13*	*45*	*68*	*44*	*-1*	*-14*	*-38*	*-48*	*-30*
Valid: TD/TS/STS/TY			*sample*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time (UTC)	Grade Best	Grade Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
Talas(2215)																		
Sep. 21/18	TD	TD	*0*	*73*	*111*				*-2*	*-4*				*0*	*5*			
22/00	TS	TD	**0**	**88**					**0**					**0**				
22/06	TS	TD	**0**	**106**					**0**					**0**				
22/12	TS	TD	**0**															
22/18	TS	TD	**15**															
23/00	TS	TS	**0**															
23/06	TS	TS	**38**															
23/12	TD	TS																
23/18	TD	TS																
Initial: TS/STS/TY		**mean**	**9**	**97**	**--**	**--**	**--**	**--**	**0**	**--**	**--**	**--**	**--**	**0**	**--**	**--**	**--**	**--**
Valid: TS/STS/TY		**sample**	**6**	**2**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**
Initial: TD(before upg.)		*mean*	*0*	*73*	*111*	--	--	--	*-2*	*-4*	--	--	--	*0*	*5*	--	--	--
Valid: TD/TS/STS/TY		*sample*	*1*	*1*	*1*	*0*	*0*	*0*	*1*	*1*	*0*	*0*	*0*	*1*	*1*	*0*	*0*	*0*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
									Noru(2216)										
Sep.	22/06	TD	TD	*21*	*181*	*208*	*201*	*231*	*329*	*2*	*23*	*54*	*14*	*44*	*-5*	*-30*	*-50*	*-20*	*-40*
	22/12	TD	TD	*21*	*108*	*250*	*321*	*315*	*317*	*6*	*38*	*39*	*22*	*42*	*-10*	*-40*	*-40*	*-20*	*-35*
	22/18	TS	TD	**11**	**169**	**256**	**326**	**323**	**355**	**8**	**48**	**24**	**27**	**27**	**-15**	**-50**	**-30**	**-25**	**-25**
	23/00	TS	TD	**24**	**175**	**292**	**315**	**346**	**423**	**15**	**58**	**19**	**42**	**14**	**-25**	**-55**	**-25**	**-35**	**-10**
	23/06	TS	TS	**11**	**168**	**231**	**246**	**256**	**356**	**23**	**52**	**12**	**30**	**10**	**-30**	**-45**	**-15**	**-20**	**-10**
	23/12	TS	TS	**0**	**137**	**232**	**207**	**183**		**30**	**39**	**20**	**30**		**-25**	**-40**	**-15**	**-20**	
	23/18	STS	TS	**53**	**119**	**168**	**108**	**122**		**40**	**22**	**15**	**25**		**-35**	**-25**	**-10**	**-20**	
	24/00	STS	STS	**15**	**68**	**69**	**68**	**53**		**40**	**15**	**25**	**10**		**-30**	**-15**	**-15**	**0**	
	24/06	TY	STS	**0**	**44**	**55**	**58**	**40**		**20**	**0**	**15**	**2**		**-15**	**-5**	**-10**	**0**	
	24/12	TY	TY	**11**	**39**	**65**	**87**			**5**	**5**	**15**			**-5**	**-5**	**-10**		
	24/18	TY	TY	**11**	**97**	**151**	**130**			**5**	**5**	**-10**			**-10**	**-5**	**5**		
	25/00	TY	TY	**0**	**65**	**154**	**120**			**-10**	**15**	**-25**			**5**	**-10**	**25**		
	25/06	TY	TY	**0**	**82**	**96**	**143**			**-15**	**5**	**-20**			**10**	**-5**	**20**		
	25/12	TY	TY	**0**	**65**	**130**				**0**	**5**				**0**	**-5**			
	25/18	TY	TY	**11**	**97**	**129**				**-10**	**-15**				**5**	**10**			
	26/00	TY	TY	**0**	**97**	**116**				**0**	**-10**				**0**	**15**			
	26/06	TY	TY	**0**	**34**	**11**				**0**	**-10**				**0**	**15**			
	26/12	TY	TY	**15**	**92**					**5**					**0**				
	26/18	TY	TY	**15**	**64**					**-10**					**10**				
	27/00	TY	TY	**11**	**34**					**-15**					**20**				
	27/06	TY	TY	**11**	**58**					**-10**					**15**				
	27/12	TY	TY	**11**															
	27/18	TY	TY	**33**															
	28/00	STS	STS	**32**															
	28/06	TS	TS	**0**															
	28/12	TD	TD																
Initial: TS/STS/TY			**mean**	**12**	**90**	**144**	**164**	**189**	**378**	**6**	**16**	**8**	**24**	**17**	**-7**	**-15**	**-7**	**-17**	**-15**
Valid: TS/STS/TY			**sample**	**23**	**19**	**15**	**11**	**7**	**3**	**19**	**15**	**11**	**7**	**3**	**19**	**15**	**11**	**7**	**3**
Initial: TD(before upg.)			*mean*	*21*	*144*	*229*	*261*	*273*	*323*	*4*	*31*	*47*	*18*	*43*	*-8*	*-35*	*-45*	*-20*	*-38*
Valid: TD/TS/STS/TY			*sample*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time		Grade		Center Position (km)						Central Pressure (hPa)					Max. Wind (kt)†				
	(UTC)	Best	Prov.	T=0‡	=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120
									Kulap(2217)										
Sep.	25/06	TD	TD	*88*	*129*	*250*	*158*	*327*		*4*	*6*	*21*	*29*		*0*	*-10*	*-20*	*-15*	
	25/12	TD	TD	*0*	*156*	*221*	*227*			*6*	*6*	*17*			*-5*	*-10*	*-15*		
	25/18	TD	TD	*52*	*133*	*251*	*259*			*10*	*12*	*20*			*-15*	*-10*	*-10*		
	26/00	TS	TS	**69**	**162**	**200**	**270**			**8**	**17**	**20**			**-10**	**-15**	**-5**		
	26/06	TS	TS	**39**	**161**	**103**	**251**			**8**	**17**	**25**			**-10**	**-15**	**-5**		
	26/12	TS	TS	**0**	**115**	**83**				**4**	**15**				**-5**	**-10**			
	26/18	STS	STS	**0**	**115**	**91**				**10**	**15**				**0**	**0**			
	27/00	STS	STS	**15**	**48**	**66**				**10**	**10**				**0**	**10**			
	27/06	STS	STS	**78**	**14**	**122**				**10**	**10**				**0**	**10**			
	27/12	STS	STS	**24**	**62**					**10**					**0**				
	27/18	STS	STS	**35**	**38**					**10**					**0**				
	28/00	STS	STS	**38**	**42**					**10**					**5**				
	28/06	STS	STS	**52**	**98**					**5**					**10**				
	28/12	STS	STS	**11**															
	28/18	STS	STS	**0**															
	29/00	STS	STS	**21**															
	29/06	STS	LOW	**0**															
Initial: TS/STS/TY			**mean**	**27**	**86**	**111**	**261**	**--**	**--**	**9**	**14**	**23**	**--**	**--**	**-1**	**-3**	**-5**	**--**	**--**
Valid: TS/STS/TY			**sample**	**14**	**10**	**6**	**2**	**0**	**0**	**10**	**6**	**2**	**0**	**0**	**10**	**6**	**2**	**0**	**0**
Initial: TD(before upg.)			*mean*	*47*	*140*	*241*	*215*	*327*	*--*	*7*	*8*	*19*	*29*	*--*	*-7*	*-10*	*-15*	*-15*	*--*
Valid: TD/TS/STS/TY			*sample*	*3*	*3*	*3*	*3*	*1*	*0*	*3*	*3*	*3*	*1*	*0*	*3*	*3*	*3*	*1*	*0*

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0[‡]	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)[†] T=24	=48	=72	=96	=120
									Roke(2218)										
Sep.	28/00	TD	TD	*0*	*78*	*288*	*779*			*8*	*27*	*10*			*-10*	*-35*	*-15*		
	28/06	TD	TD	*30*	*83*	*341*	*852*			*10*	*23*	*6*			*-20*	*-30*	*-10*		
	28/12	TS	TS	**0**	**119**	**503**	**1061**			**18**	**14**	**2**			**-25**	**-20**	**-5**		
	28/18	TS	TS	**0**	**163**	**605**				**18**	**4**				**-25**	**-10**			
	29/00	TS	TS	**0**	**184**	**571**				**15**	**-2**				**-15**	**5**			
	29/06	STS	STS	**15**	**200**	**462**				**10**	**-7**				**-10**	**10**			
	29/12	TY	TY	**0**	**192**	**495**				**-10**	**-17**				**10**	**20**			
	29/18	TY	TY	**0**	**205**					**-20**					**20**				
	30/00	TY	TY	**0**	**228**					**-17**					**20**				
	30/06	TY	TY	**10**	**284**					**-12**					**15**				
	30/12	TY	STS	**22**	**215**					**-2**					**5**				
	30/18	STS	STS	**0**															
Oct.	01/00	STS	STS	**15**															
	01/06	STS	STS	**0**															
	01/12	STS	STS	**0**															
Initial: TS/STS/TY			**mean**	**5**	**199**	**527**	**1061**	**--**	**--**	**0**	**-2**	**2**	**--**	**--**	**-1**	**1**	**-5**	**--**	**--**
Valid: TS/STS/TY			**sample**	**13**	**9**	**5**	**1**	**0**	**0**	**9**	**5**	**1**	**0**	**0**	**9**	**5**	**1**	**0**	**0**
Initial: TD(before upg.)			*mean*	*15*	*81*	*315*	*815*	*--*	*--*	*9*	*25*	*8*	*--*	*--*	*-15*	*-33*	*-13*	*--*	*--*
Valid: TD/TS/STS/TY			*sample*	*2*	*2*	*2*	*2*	*0*	*0*	*2*	*2*	*2*	*0*	*0*	*2*	*2*	*2*	*0*	*0*

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0[‡]	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)[†] T=24	=48	=72	=96	=120
								Sonca(2219)											
Oct.	13/06	TD	TD	*16*	*54*					*0*					*0*				
	13/12	TD	TD	*11*	*11*					*0*					*0*				
	13/18	TD	TD	*49*	*92*					*0*					*0*				
	14/00	TS	TD	**45**															
	14/06	TS	TS	**11**															
	14/12	TS	TS	**22**															
	14/18	TS	TS	**0**															
	15/00	TD	TD																
Initial: TS/STS/TY			**mean**	**19**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial: TD(before upg.)			*mean*	*25*	*52*	--	--	--	--	*0*	--	--	--	--	*0*	--	--	--	--
Valid: TD/TS/STS/TY			*sample*	*3*	*3*	*0*	*0*	*0*	*0*	*3*	*0*	*0*	*0*	*0*	*3*	*0*	*0*	*0*	*0*

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
									Nesat(2220)										
Oct.	14/12	TD	TD	*119*	*116*	*188*	*291*	*394*	*419*	*2*	*9*	*25*	*20*	*-10*	*-5*	*-15*	*-30*	*-25*	*5*
	14/18	TD	TD	*124*	*110*	*199*	*290*	*375*	*351*	*9*	*5*	*15*	*5*	*-24*	*-15*	*-15*	*-25*	*-15*	*15*
	15/00	TD	TD	*168*	*116*	*199*	*301*	*332*	*227*	*11*	*15*	*20*	*-5*	*-18*	*-15*	*-20*	*-20*	*0*	*20*
	15/06	TS	TS	**25**	**87**	**147**	**192**	**186**		**9**	**22**	**20**	**-7**		**-15**	**-25**	**-20**	**5**	
	15/12	TS	TS	**15**	**80**	**116**	**138**	**127**		**0**	**10**	**5**	**-15**		**-5**	**-10**	**-5**	**15**	
	15/18	STS	TS	**33**	**31**	**54**	**65**	**46**		**0**	**10**	**5**	**-14**		**0**	**-10**	**-5**	**15**	
	16/00	STS	STS	**33**	**42**	**54**	**54**			**-5**	**5**	**-5**			**5**	**0**	**5**		
	16/06	STS	STS	**11**	**48**	**48**	**57**			**0**	**5**	**-7**			**0**	**0**	**10**		
	16/12	STS	STS	**10**	**48**	**34**	**39**			**5**	**-5**	**-6**			**-5**	**5**	**5**		
	16/18	STS	STS	**10**	**22**	**22**	**91**			**0**	**5**	**-4**			**0**	**0**	**0**		
	17/00	TY	STS	**31**	**15**	**35**				**0**	**0**				**0**	**0**			
	17/06	TY	TY	**15**	**15**	**24**				**0**	**0**				**0**	**0**			
	17/12	TY	TY	**15**	**40**	**55**				**-5**	**-8**				**5**	**10**			
	17/18	TY	TY	**46**	**25**	**11**				**-10**	**-12**				**10**	**15**			
	18/00	TY	TY	**39**	**21**					**-15**					**10**				
	18/06	TY	TY	**15**	**15**					**-7**					**5**				
	18/12	TY	TY	**25**	**49**					**-6**					**5**				
	18/18	TY	TY	**31**	**11**					**-6**					**5**				
	19/00	STS	STS	**44**															
	19/06	STS	TS	**11**															
	19/12	TS	TS	**0**															
	19/18	TS	TS	**40**															
	20/00	TD	TS																
	20/06	TD	TD																
Initial: TS/STS/TY			**mean**	**24**	**37**	**54**	**91**	**120**	**--**	**-3**	**3**	**1**	**-12**	**--**	**1**	**-1**	**-1**	**12**	**--**
Valid: TS/STS/TY			**sample**	**19**	**15**	**11**	**7**	**3**	**0**	**15**	**11**	**7**	**3**	**0**	**15**	**11**	**7**	**3**	**0**
Initial: TD(before upg.)			*mean*	*137*	*114*	*195*	*294*	*367*	*332*	*7*	*10*	*20*	*7*	*-17*	*-12*	*-17*	*-25*	*-13*	*13*
Valid: TD/TS/STS/TY			*sample*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time		Grade		Center Position (km)						Central Pressure (hPa)					Max. Wind (kt)†				
	(UTC)	Best	Prov.	T=0‡	=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120
								Haitang(2221)											
Oct.	18/06	TS	TS	**59**	**115**					**2**					**-5**				
	18/12	TS	TS	**36**															
	18/18	TS	TS	**87**															
	19/00	TS	TS	**24**															
	19/06	TS	TS	**0**															
Initial: TS/STS/TY			**mean**	**41**	**115**	**--**	**--**	**--**	**--**	**2**	**--**	**--**	**--**	**--**	**-5**	**--**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**5**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
Initial: TD(before upg.)			*mean*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Valid: TD/TS/STS/TY			*sample*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time		Grade		Center Position (km)						Central Pressure (hPa)					Max. Wind (kt)[†]				
	(UTC)	Best	Prov.	T=0[‡]	=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120
								Nalgae(2222)											
Oct.	26/00	TD	TD	*278*	*188*	*179*	*427*	*560*	*641*	*2*	*4*	*5*	*-10*	*0*	*0*	*0*	*0*	*15*	*5*
	26/06	TD	TD	*278*	*204*	*227*	*430*	*577*	*626*	*4*	*6*	*5*	*-10*	*5*	*0*	*-5*	*0*	*15*	*0*
	26/12	TD	TD	*240*	*172*	*182*	*304*	*576*	*565*	*4*	*6*	*5*	*-10*	*5*	*0*	*-5*	*0*	*15*	*0*
	26/18	TD	TD	*214*	*146*	*234*	*300*	*344*	*394*	*6*	*9*	*-5*	*-5*	*5*	*-5*	*-10*	*5*	*5*	*-5*
	27/00	TS	TS	**146**	**137**	**254**	**236**	**267**	**295**	**2**	**-5**	**-10**	**0**	**5**	**0**	**0**	**5**	**-5**	**-10**
	27/06	TS	TS	**56**	**159**	**243**	**271**	**278**	**357**	**4**	**-5**	**-10**	**5**	**5**	**-5**	**0**	**5**	**-10**	**-10**
	27/12	TS	TS	**11**	**122**	**198**	**292**	**308**	**410**	**4**	**-5**	**-10**	**5**	**0**	**-5**	**0**	**5**	**-10**	**-5**
	27/18	TS	TS	**0**	**178**	**172**	**249**	**319**	**428**	**9**	**-10**	**-5**	**5**	**-10**	**-10**	**5**	**0**	**-10**	**0**
	28/00	TS	TS	**0**	**194**	**172**	**251**	**328**	**437**	**5**	**-10**	**0**	**0**	**-19**	**-5**	**5**	**-5**	**-5**	**10**
	28/06	TS	TS	**0**	**110**	**150**	**199**	**349**	**614**	**-5**	**-10**	**0**	**0**	**-16**	**5**	**5**	**-5**	**-5**	**10**
	28/12	TS	TS	**0**	**65**	**86**	**150**	**263**	**415**	**-5**	**-10**	**0**	**-5**	**-20**	**5**	**5**	**-5**	**0**	**15**
	28/18	STS	STS	**39**	**49**	**44**	**85**	**173**		**-10**	**-10**	**-5**	**-15**		**5**	**5**	**0**	**5**	
	29/00	STS	STS	**11**	**25**	**70**	**118**	**168**		**-10**	**-5**	**-5**	**-9**		**5**	**0**	**0**	**5**	
	29/06	STS	STS	**32**	**48**	**11**	**39**	**137**		**-15**	**-5**	**-5**	**-11**		**10**	**0**	**0**	**10**	
	29/12	STS	STS	**24**	**44**	**11**	**76**	**148**		**-15**	**-5**	**-5**	**-10**		**10**	**0**	**0**	**10**	
	29/18	TS	STS	**0**	**24**	**54**	**115**			**-10**	**-5**	**-10**			**5**	**0**	**5**		
	30/00	TS	STS	**78**	**39**	**64**	**98**			**-5**	**-5**	**-9**			**0**	**0**	**5**		
	30/06	TS	TS	**60**	**61**	**64**	**84**			**0**	**0**	**-6**			**-5**	**-5**	**5**		
	30/12	TS	TS	**0**	**42**	**115**	**146**			**0**	**0**	**-4**			**-5**	**0**	**5**		
	30/18	STS	TS	**11**	**64**	**128**				**0**	**-5**				**-5**	**0**			
	31/00	STS	STS	**35**	**97**	**124**				**0**	**-4**				**0**	**5**			
	31/06	STS	STS	**35**	**67**	**57**				**-5**	**-6**				**5**	**10**			
	31/12	STS	STS	**0**	**94**	**88**				**-5**	**-8**				**5**	**10**			
	31/18	STS	STS	**35**	**64**					**-10**					**5**				
Nov.	01/00	STS	STS	**0**	**46**					**-4**					**5**				
	01/06	STS	STS	**15**	**74**					**-6**					**10**				
	01/12	STS	STS	**0**	**47**					**-8**					**10**				
	01/18	STS	STS	**0**															
	02/00	TS	TS	**0**															
	02/06	TS	TS	**24**															
	02/12	TS	TS	**43**															
	02/18	TD	TS																
	03/00	TD	TD																
Initial: TS/STS/TY			**mean**	**24**	**81**	**111**	**161**	**249**	**422**	**-4**	**-6**	**-6**	**-3**	**-8**	**2**	**2**	**1**	**-1**	**1**
Valid: TS/STS/TY			**sample**	**27**	**23**	**19**	**15**	**11**	**7**	**23**	**19**	**15**	**11**	**7**	**23**	**19**	**15**	**11**	**7**
Initial: TD(before upg.)			*mean*	*252*	*178*	*205*	*365*	*514*	*557*	*4*	*6*	*3*	*-9*	*4*	*-1*	*-5*	*1*	*13*	*0*
Valid: TD/TS/STS/TY			*sample*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

Date/Time (UTC)		Grade Best	Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
								Banyan(2223)											
Oct.	31/06	TS	TS	**11**															
	31/12	TS	TS	**11**															
	31/18	TS	TS	**11**															
Nov.	01/00	TD	TD																
Initial: TS/STS/TY			**mean**	**11**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial: TD(before upg.)			*mean*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Valid: TD/TS/STS/TY			*sample*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

†Max. wind for TDs are treated as 30 kt in this validation

‡Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0[‡]	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)[†] T=24	=48	=72	=96	=120
										Yamaneko(2224)									
Nov.	11/18	TD	TD	*222*	*106*	*302*	*311*			*2*	*0*	*-10*			*0*	*0*	*10*		
	12/00	TD	TD	*84*	*108*	*210*				*2*	*0*				*0*	*0*			
	12/06	TD	TD	*22*	*98*	*215*				*0*	*-4*				*0*	*5*			
	12/12	TS	TS	**25**	**146**					**-2**					**5**				
	12/18	TS	TS	**33**	**140**					**-4**					**5**				
	13/00	TS	TS	**33**	**30**					**-2**					**0**				
	13/06	TS	TS	**23**															
	13/12	TS	TS	**22**															
	13/18	TS	TS	**11**															
	14/00	TS	TS	**10**															
	14/06	TD	TD																
Initial: TS/STS/TY			**mean**	**22**	**105**	**--**	**--**	**--**	**--**	**-3**	**--**	**--**	**--**	**--**	**3**	**--**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**7**	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**
Initial: TD(before upg.)			*mean*	*109*	*104*	*242*	*311*	--	--	*1*	*-1*	*-10*	--	--	*0*	*2*	*10*	--	--
Valid: TD/TS/STS/TY			*sample*	*3*	*3*	*3*	*1*	*0*	*0*	*3*	*3*	*1*	*0*	*0*	*3*	*3*	*1*	*0*	*0*

[†]Max. wind for TDs are treated as 30 kt in this validation

[‡]Position error of provisional analysis

Date/Time	(UTC)	Grade Best	Prov.	Center Position (km) T=0‡	=24	=48	=72	=96	=120	Central Pressure (hPa) T=24	=48	=72	=96	=120	Max. Wind (kt)† T=24	=48	=72	=96	=120
									Pakhar(2225)										
Dec.	10/00	TD	TD	*31*	*79*	*428*				*-4*	*2*				*5*	*-5*			
	10/06	TD	TD	*32*	*49*	*483*				*-2*	*-2*				*5*	*0*			
	10/12	TD	TD	*70*	*59*					*2*					*0*				
	10/18	TD	TD	*34*	*123*					*4*					*-5*				
	11/00	TD	TD	*34*	*162*					*4*					*-5*				
	11/06	TD	TD	*15*	*201*					*-2*					*0*				
	11/12	TS	TS	**63**															
	11/18	TS	TS	**86**															
	12/00	TS	TS	**11**															
	12/06	TS	TS	**10**															
Initial: TS/STS/TY			**mean**	**43**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial: TD(before upg.)			*mean*	*36*	*112*	*455*	--	--	--	*0*	*0*	--	--	--	*0*	*-3*	--	--	--
Valid: TD/TS/STS/TY			*sample*	*6*	*6*	*2*	*0*	*0*	*0*	*6*	*2*	*0*	*0*	*0*	*6*	*2*	*0*	*0*	*0*

†Max. wind for TDs are treated as 30 kt in this validation

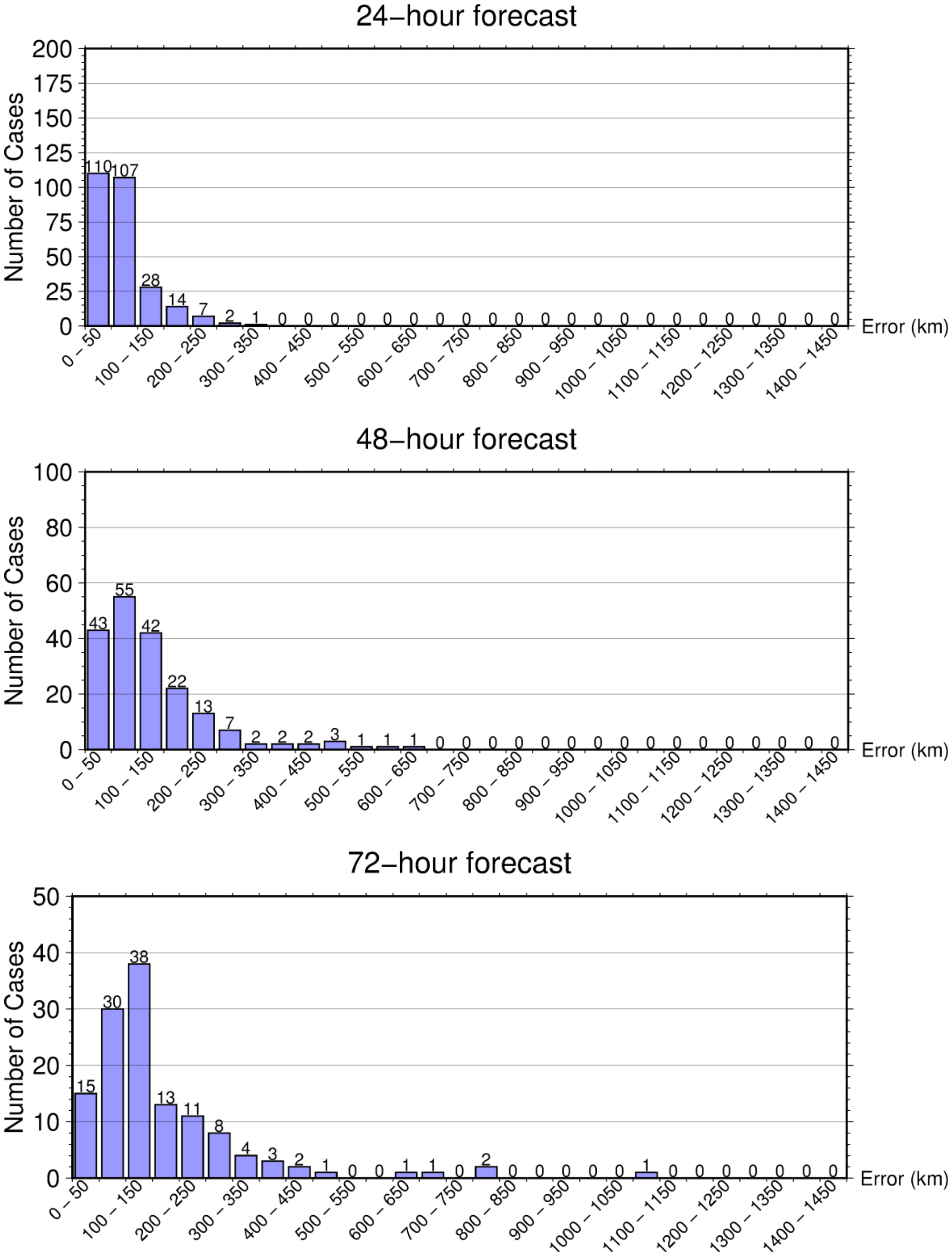
‡Position error of provisional analysis

Appendix 4
Monthly and Annual Frequencies of Tropical Cyclones

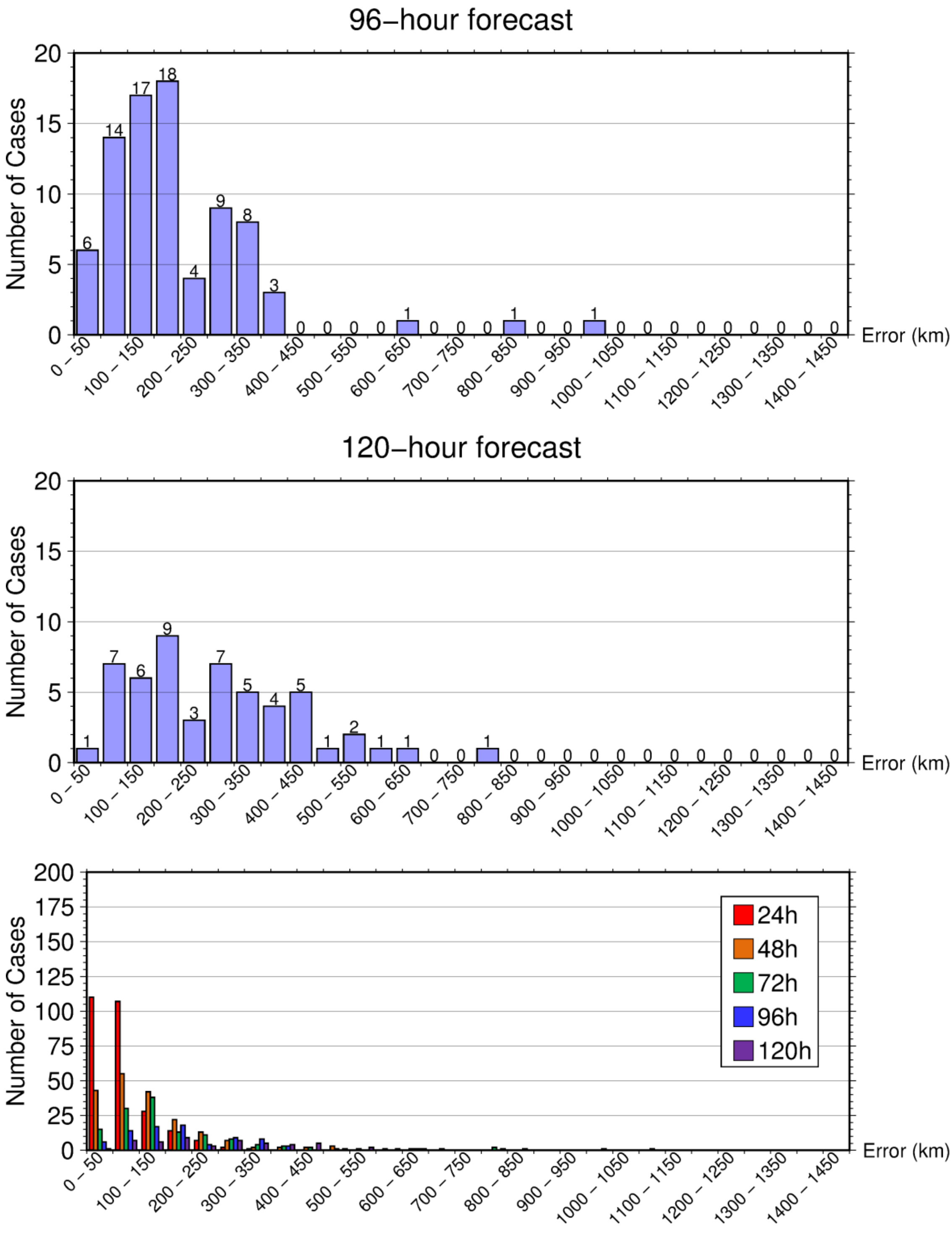
Monthly and annual frequencies of tropical cyclones that attained TS intensity or higher in the western North Pacific and the South China Sea for 1951 - 2022

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1951		1	1	2	1	1	3	3	2	4	1	2	21
1952						3	3	5	3	6	3	4	27
1953		1			1	2	1	6	3	5	3	1	23
1954			1		1		1	5	5	4	3	1	21
1955	1	1	1	1		2	7	6	4	3	1	1	28
1956			1	2		1	2	5	6	1	4	1	23
1957	2			1	1	1	1	4	5	4	3		22
1958	1			1	1	4	7	5	5	3	2	2	31
1959		1	1	1			2	5	5	4	2	2	23
1960				1	1	3	3	10	3	4	1	1	27
1961	1		1		2	3	4	6	6	4	1	1	29
1962		1		1	2		5	8	4	5	3	1	30
1963				1		4	4	3	5	4		3	24
1964					2	2	7	5	6	5	6	1	34
1965	2	1	1	1	2	3	5	6	7	2	2		32
1966				1	2	1	4	10	9	5	2	1	35
1967		1	2	1	1	1	7	9	9	4	3	1	39
1968				1	1	1	3	8	3	5	5		27
1969	1		1	1			3	4	3	3	2	1	19
1970		1				2	3	6	5	5	4		26
1971	1		1	3	4	2	8	5	6	4	2		36
1972	1				1	3	7	5	4	5	3	2	31
1973							7	5	2	4	3		21
1974	1		1	1	1	4	4	5	5	4	4	2	32
1975	1						2	4	5	5	3	1	21
1976	1	1		2	2	2	4	4	5	1	1	2	25
1977			1			1	3	3	5	5	1	2	21
1978	1			1		3	4	8	5	4	4		30
1979	1		1	1	2		4	2	6	3	2	2	24
1980				1	4	1	4	2	6	4	1	1	24
1981			1	2		3	4	8	4	2	3	2	29
1982			3		1	3	3	5	5	3	1	1	25
1983						1	3	5	2	5	5	2	23
1984						2	5	5	4	7	3	1	27
1985	2				1	3	1	8	5	4	1	2	27
1986		1		1	2	2	4	4	3	5	4	3	29
1987	1			1		2	4	4	6	2	2	1	23
1988	1				1	3	2	8	8	5	2	1	31
1989	1			1	2	2	7	5	6	4	3	1	32
1990	1			1	1	3	4	6	4	4	4	1	29
1991			2	1	1	1	4	5	6	3	6		29
1992	1	1				2	4	8	5	7	3		31
1993			1			1	4	7	6	4	2	3	28
1994				1	1	2	7	9	8	6		2	36
1995				1		1	2	6	5	6	1	1	23
1996		1		1	2		6	5	6	2	2	1	26
1997				2	3	3	4	6	4	3	2	1	28
1998							1	3	5	2	3	2	16
1999				2		1	4	6	6	2	1		22
2000					2		5	6	5	2	2	1	23
2001					1	2	5	6	5	3	1	3	26
2002	1	1			1	3	5	6	4	2	2	1	26
2003	1			1	2	2	2	5	3	3	2		21
2004				1	2	5	2	8	3	3	3	2	29
2005	1		1	1	1		5	5	5	2	2		23
2006					1	2	2	7	3	4	2	2	23
2007				1	1		3	4	5	6	4		24
2008				1	4	1	2	4	4	2	3	1	22
2009					2	2	2	5	7	3	1		22
2010			1				2	5	4	2			14
2011					2	3	4	3	7	1		1	21
2012			1		1	4	4	5	3	5	1	1	25
2013	1	1				4	3	6	8	6	2		31
2014	2	1		2		2	5	1	5	2	1	2	23
2015	1	1	2	1	2	2	3	4	5	4	1	1	27
2016							4	7	7	4	3	1	26
2017				1		1	8	6	3	3	3	2	27
2018	1	1	1			4	5	9	4	1	3		29
2019	1	1				1	4	5	6	4	6	1	29
2020					1	1		8	3	6	3	1	23
2021		1		1	1	2	3	4	4	4	1	1	22
2022				2		2	2	5	7	5	1	1	25
Normal 1991-2020	0.3	0.3	0.3	0.6	1.0	1.7	3.7	5.7	5.0	3.4	2.2	1.0	25.1

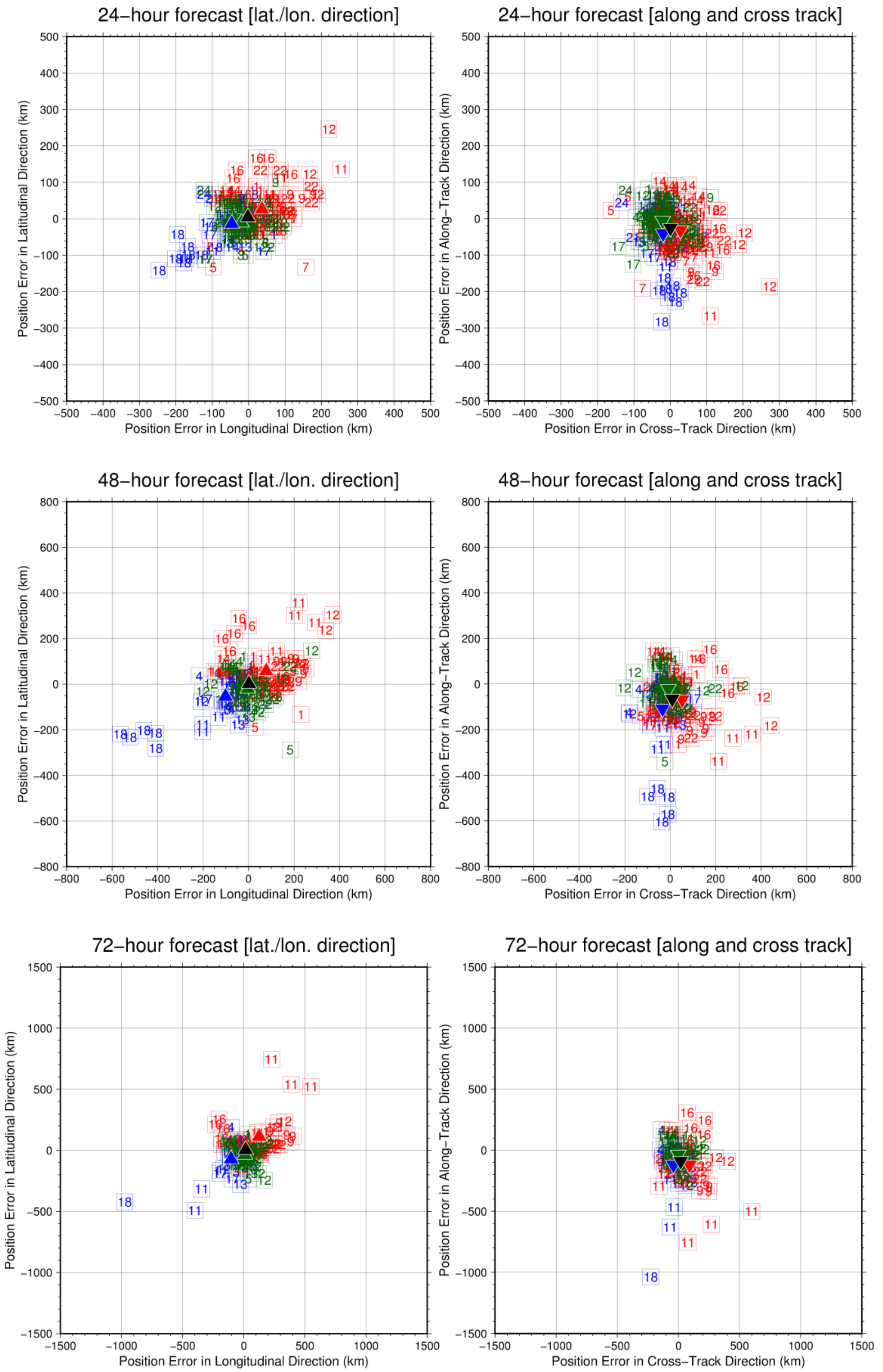
Appendix 5
Other Verification Charts



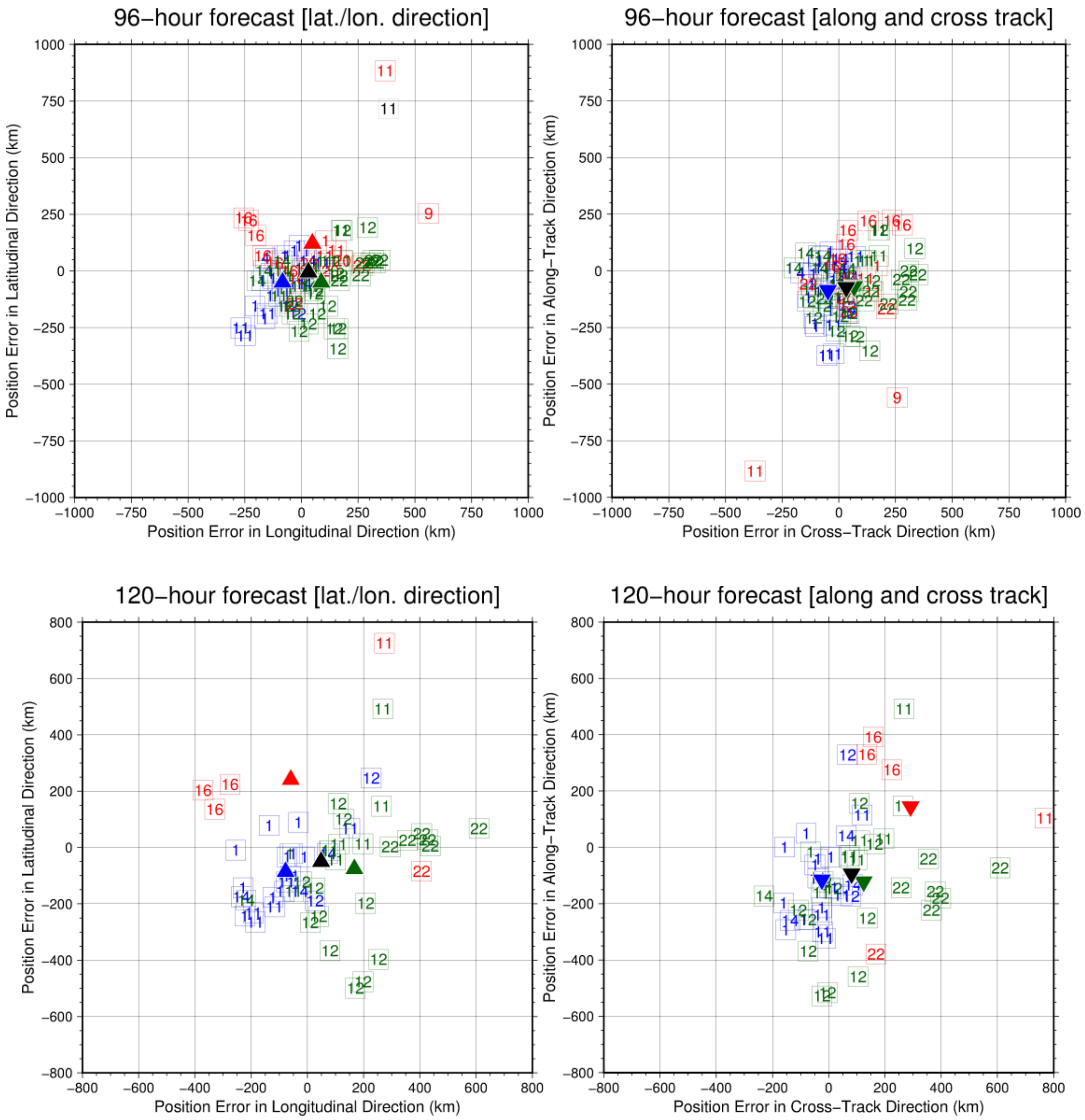
Histograms of RSMC 24-, 48- and 72 hour forecast position errors



Histograms of RSMC 96-hour, 120-hour and all lead time forecast position errors



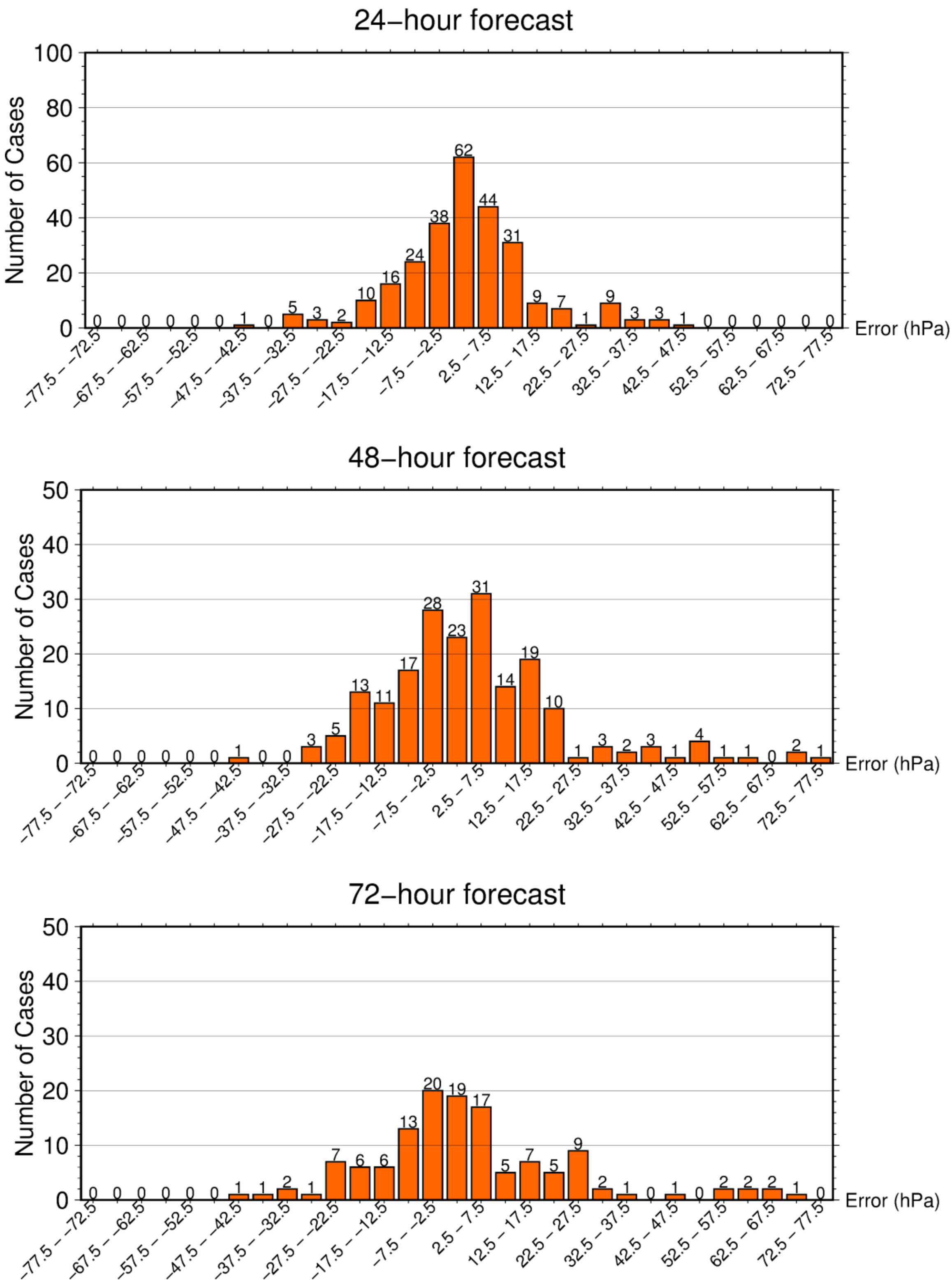
Scatter diagrams of RSMC position errors for 24-, 48- and 72-hour forecast in longitudinal/latitudinal and cross/along-track directions: Red, green and blue squares with TC number and triangles denote biases for each initial time and mean biases in the stages before, during and after recurvature, respectively. Black triangles indicate mean bias for all initial time.



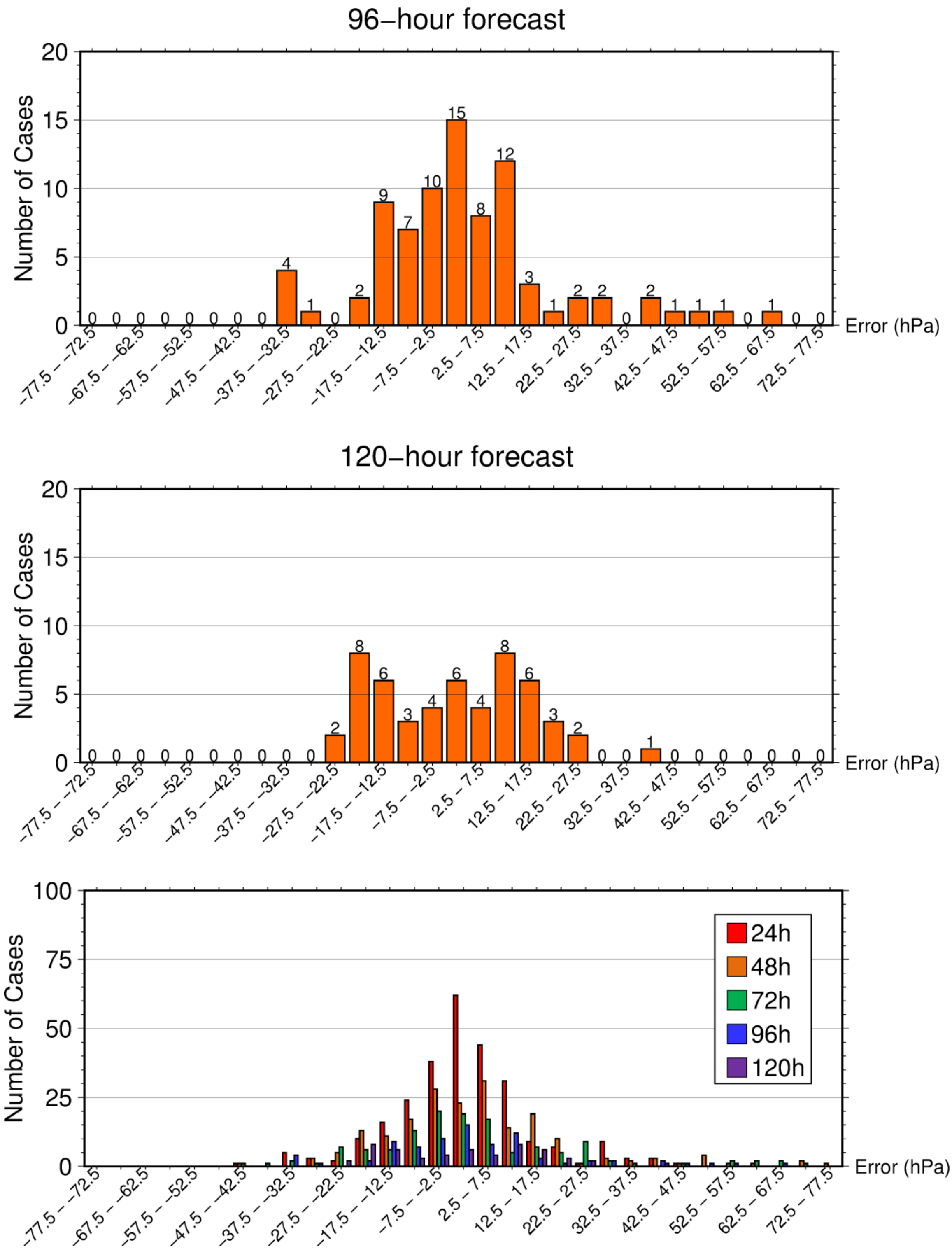
Scatter diagrams of RSMC position errors in longitudinal/latitudinal and cross/along-track directions (continued): Red, green and blue squares with TC number and triangles denote biases for each initial time and mean biases in the stages before, during and after recurvature, respectively. Black triangles indicate mean bias for all initial time.

Annual mean errors, RMSEs and mean improvement ratios of RSMC maximum wind speed forecasts

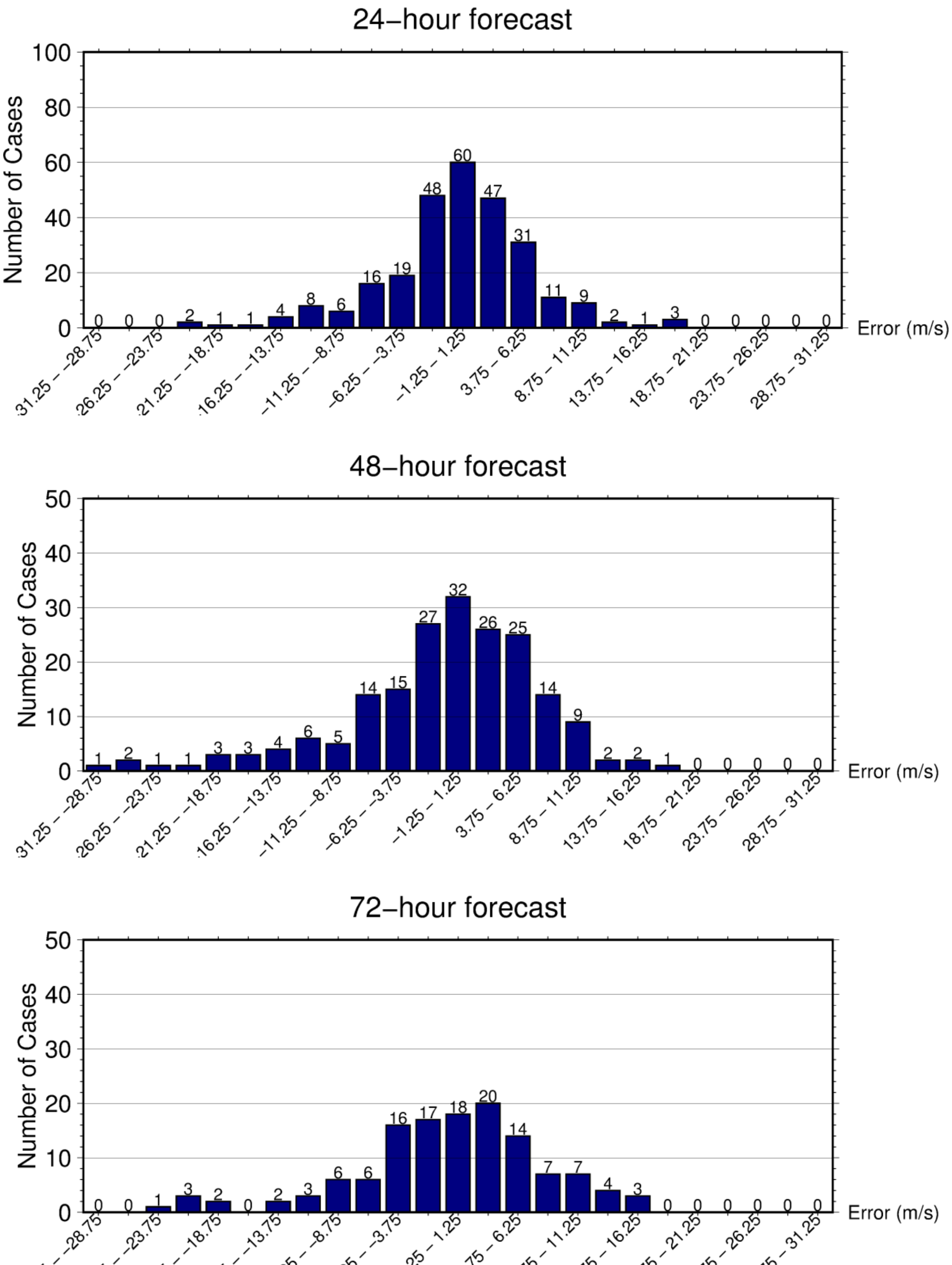
Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
			Error (m/s)	RMSE (m/s)	Num.	Impr. (%)	Error (m/s)	RMSE (m/s)	Num.	Impr. (%)	Error (m/s)	RMSE (m/s)	Num.	Impr. (%)	Error (m/s)	RMSE (m/s)	Num.	Impr. (%)	Error (m/s)	RMSE (m/s)	Num.	Impr. (%)
TY	Malakas	(2201)	2.0	4.7	26	12	2.5	5.8	22	38	1.3	6.0	18	50	-1.5	3.5	14	74	-3.1	4.0	10	71
TS	Megi	(2202)	0.0	0.0	1	100	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Chaba	(2203)	-2.0	4.1	9	47	-3.1	7.6	5	12	2.6	2.6	1	63	-	-	0	-	-	-	0	-
TS	Aere	(2204)	1.2	3.0	13	2	3.1	3.7	9	26	4.1	4.6	5	20	-2.6	2.6	1		-	-	0	-
TS	Songda	(2205)	-0.6	1.2	9	43	-1.0	2.3	5	46	0.0	0.0	1	100	-	-	0	-	-	-	0	-
TS	Trases	(2206)	-2.6	2.6	1	-22	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Mulan	(2207)	0.0	0.0	3	100	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Meari	(2208)	-1.0	1.6	8	-1	-1.9	2.2	4	-30	-	-	0	-	-	-	0	-	-	-	0	-
STS	Ma-on	(2209)	-1.6	3.9	13	-6	-1.7	4.5	9	17	-3.1	4.0	5	53	0.0	0.0	1	100	-	-	0	-
TY	Tokage	(2210)	-4.2	7.7	11	-48	-6.2	11.5	7	-74	-6.9	8.1	3	-85	-	-	0	-	-	-	0	-
TY	Hinnamnor	(2211)	1.6	10.8	33	-35	1.3	12.9	29	2	2.7	13.4	25	11	5.0	10.7	20	34	4.8	7.6	16	54
TY	Muifa	(2212)	-1.4	3.9	29	28	-2.3	4.8	25	38	-1.3	5.5	21	33	-0.8	5.3	17	32	-0.4	5.8	13	34
TY	Merbok	(2213)	-2.6	5.1	11	-89	-6.2	7.7	7	-257	-7.7	8.5	3	-155	-	-	0	-	-	-	0	-
TY	Nanmadol	(2214)	-0.8	9.3	20	-27	-5.3	13.3	16	8	-9.2	14.0	12	18	-7.4	9.9	8	21	-0.6	2.9	4	43
TS	Talas	(2215)	0.0	0.0	2	100	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Noru	(2216)	-3.4	8.9	19	19	-7.7	13.8	15	-32	-3.7	9.2	11	-26	-8.8	10.7	7	3	-7.7	8.5	3	-30
STS	Kulap	(2217)	-0.5	3.0	10	12	-1.7	5.8	6	-46	-2.6	2.6	2	-139	-	-	0	-	-	-	0	-
TY	Roke	(2218)	-0.3	9.0	9	-28	0.5	7.4	5	-29	-2.6	2.6	1	-733	-	-	0	-	-	-	0	-
TS	Sonca	(2219)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Nesat	(2220)	0.7	3.3	15	53	-0.7	5.3	11	43	-0.7	4.8	7	32	6.0	6.5	3	4	-	-	0	-
TS	Haitang	(2221)	-2.6	2.6	1	33	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
STS	Nalgae	(2222)	1.0	3.2	23	29	1.2	2.3	19	64	0.7	2.1	15	58	-0.7	3.9	11	23	0.7	5.0	7	23
TS	Banyan	(2223)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Yamaneko	(2224)	1.7	2.1	3	58	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TS	Pakhar	(2225)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
Annual Mean (Total)			-0.4	6.3	269	-3	-1.3	8.7	194	6	-1.0	8.7	130	19	-0.6	7.7	82	35	0.4	6.0	53	50



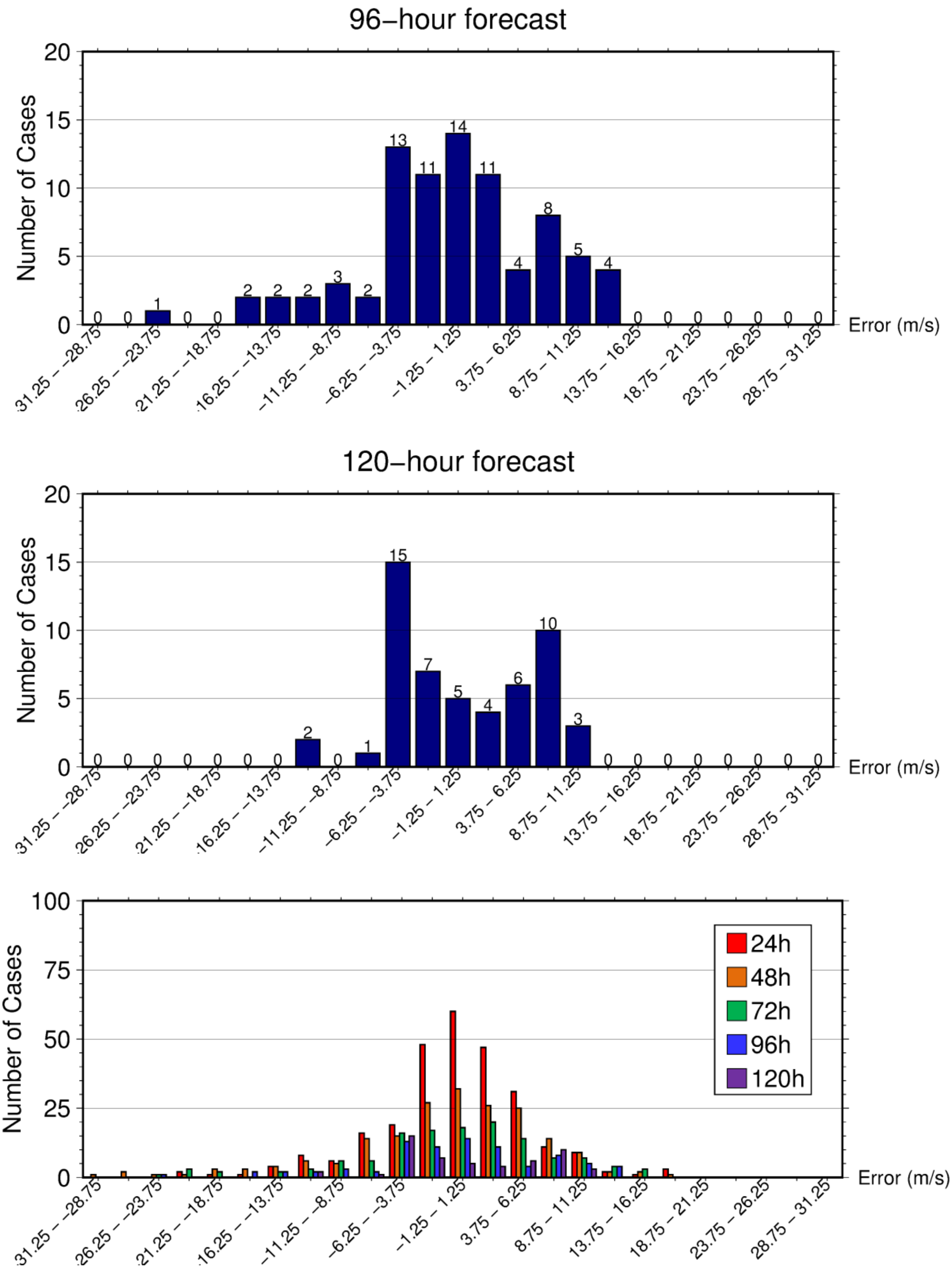
Histograms of RSMC 24-, 48- and 72-hour pressure forecast errors



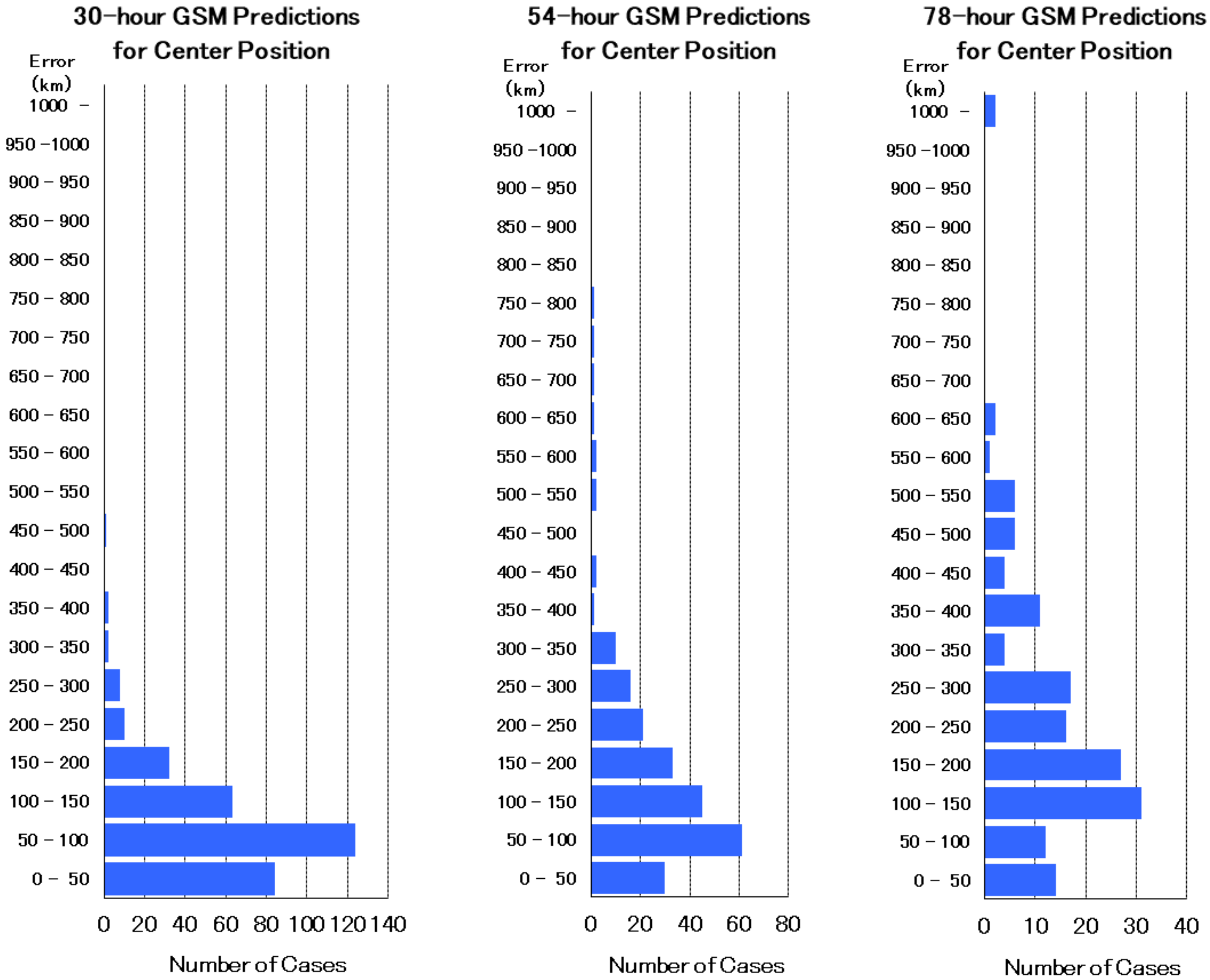
Histograms of RSMC 96-hour, 120-hour and all lead time pressure forecast errors



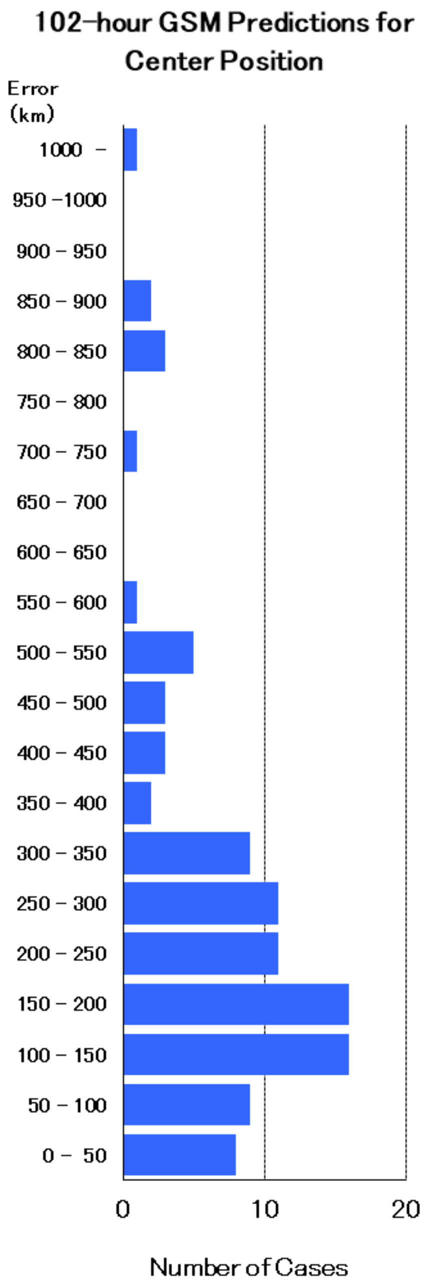
Histograms of RSMC 24-, 48- and 72-hour maximum wind speed forecast errors

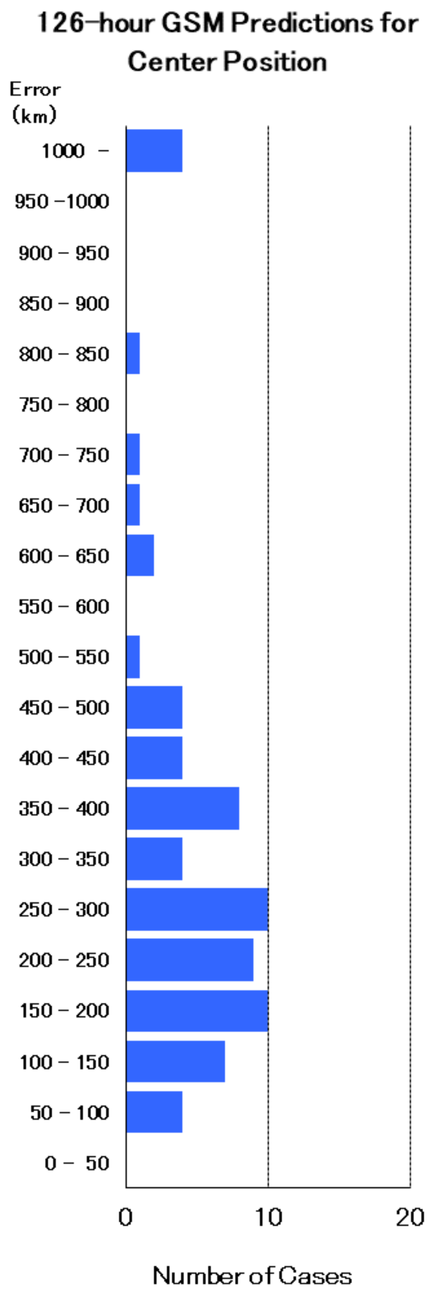


Histograms of RSMC 96-hour, 120-hour and all lead time maximum wind speed forecast errors

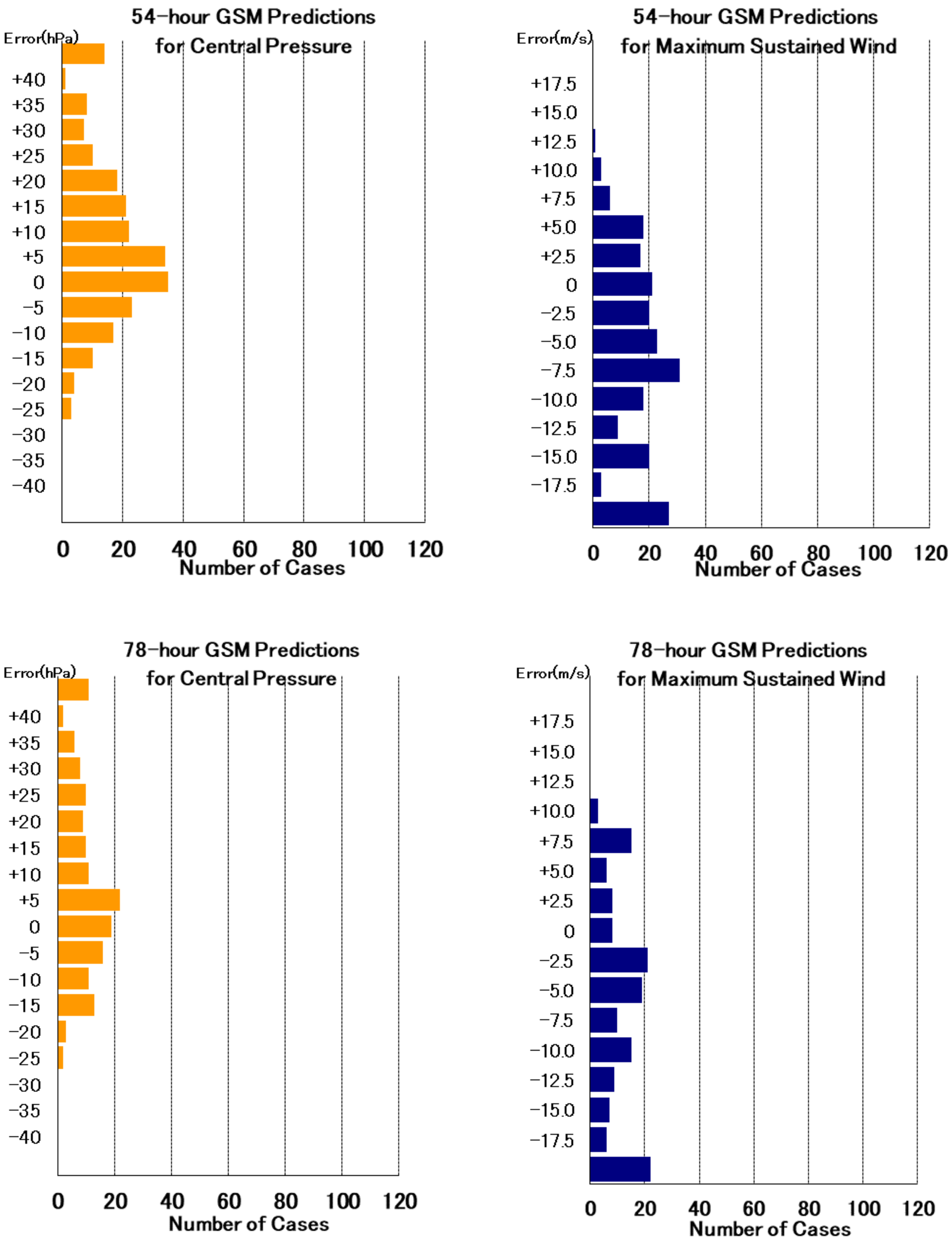


Histograms of GSM position errors for 30-, 54-, and 78-hour prediction

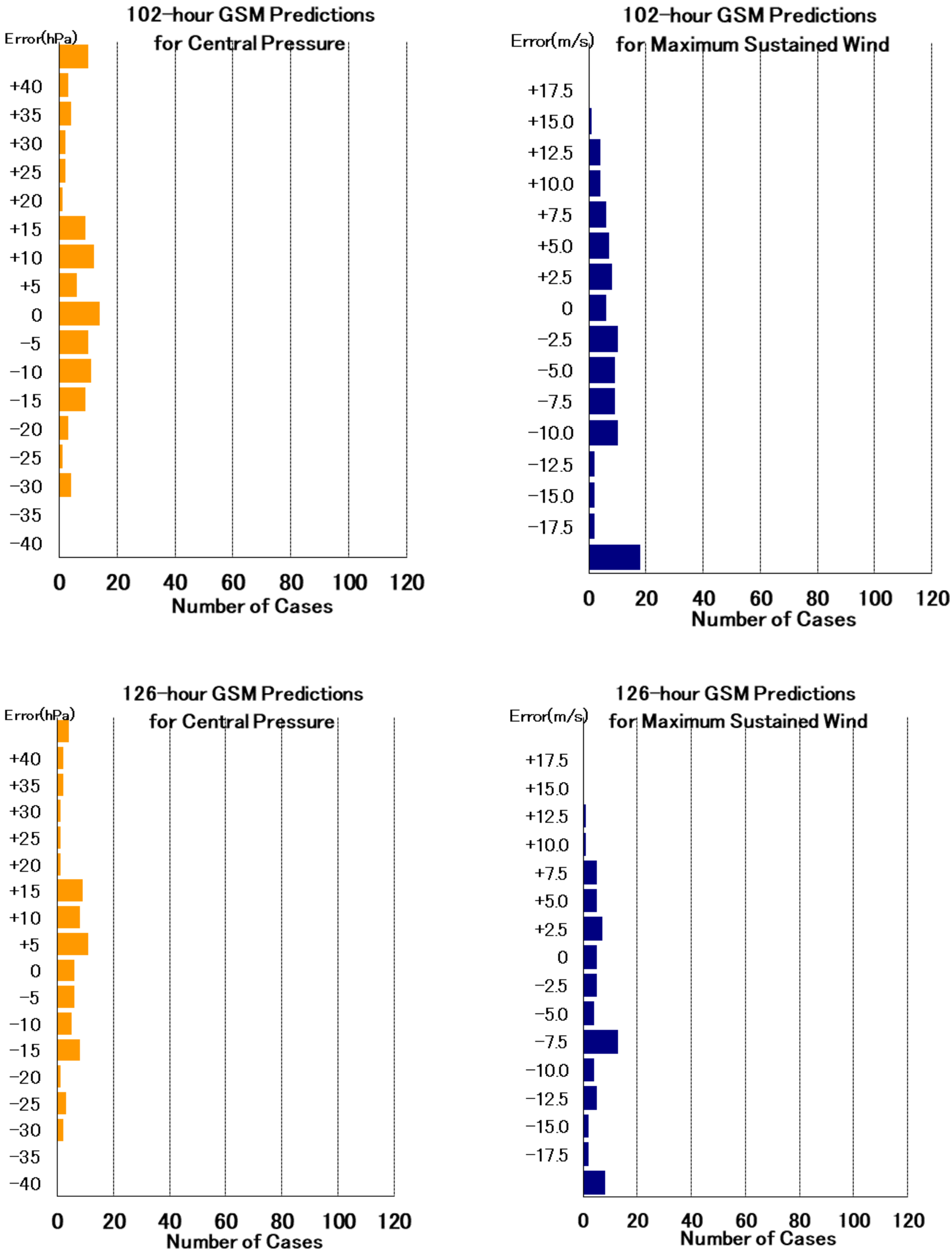




Histograms of GSM position errors for 102- and 126-hour prediction



Histograms of GSM intensity errors for (top) 54- and (bottom) 78-hour prediction



Histograms of GSM intensity errors for (top) 102- and (bottom) 126-hour prediction

Appendix 6
Code Forms of RSMC Products

(1) RSMC Tropical Cyclone Advisory (WTPQ50-55 RJTD)

```
WTPQii RJTD YYGGgg
RSMC TROPICAL CYCLONE ADVISORY
NAME    class    ty-No.    name    (common-No.)
ANALYSIS
PSTN YYGGgg UTC    LaLa.La N LoLoLo.Lo E (or W) confidence
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
50KT RdRdRd NM        (or 50KT RdRdRd NM octant RdRdRd NM octant)
30KT RdRdRd NM        (or 30KT RdRdRd NM octant RdRdRd NM octant)
FORECAST
24HF 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
Ft3Ft3HF 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
Ft4Ft4Ft4HF 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 and symbols are as per the RSMC Tropical Cyclone Advisory for Three-day Forecasts (WTPQ20-25 RJTD) except:

Ft3Ft3	:	96 (00, 06, 12 and 18 UTC) or 93 (03, 09, 15 and 21 UTC)
Ft4Ft4 Ft4	:	120 (00, 06, 12 and 18 UTC) or 117 (03, 09, 15 and 21 UTC)

Example:

```
WTPQ50 RJTD 080000
RSMC TROPICAL CYCLONE ADVISORY
NAME    TY 1919 HAGIBIS (1919)
ANALYSIS
PSTN    080000UTC 16.9N 143.8E GOOD
MOVE    WNW 13KT
PRES    915HPA
```

MXWD 105KT
GUST 150KT
50KT 100NM
30KT 350NM EAST 240NM WEST
FORECAST
24HF 090000UTC 19.8N 140.0E 60NM 70%
MOVE NW 10KT
PRES 915HPA
MXWD 105KT
GUST 150KT
48HF 100000UTC 22.8N 138.4E 90NM 70%
MOVE NNW 08KT
PRES 915HPA
MXWD 105KT
GUST 150KT
72HF 110000UTC 26.5N 136.3E 120NM 70%
MOVE NNW 10KT
PRES 925HPA
MXWD 100KT
GUST 140KT
96HF 120000UTC 31.6N 135.9E 170NM 70%
MOVE N 13KT
PRES 940HPA
MXWD 090KT
GUST 130KT
120HF 130000UTC 37.5N 142.5E 240NM 70%
MOVE NE 20KT
PRES 980HPA
MXWD 060KT
GUST 085KT =

(2) RSMC Guidance for Forecast by GSM (FXPQ20-25 RJTD)

FXPQ i i RJTD YYGGgg
RSMC GUIDANCE FOR FORECAST
NAME class ty-No. name (common-No.)
PSTN YYGGgg UTC LaLa.La N LoLoLo.Lo E (or W)
PRES PPPP HPA
MXWD WWW KT
FORECAST BY GLOBAL MODEL
TIME PSTN PRES MXWD
(CHANGE FROM T=0)
T=006 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=012 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=018 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
:
T=132 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT=

Notes:

a. Underlined parts are fixed.

b. Symbolic letters

i i	:	'20', '21', '22', '23', '24' or '25'
YYGGgg	:	Initial time of the model in UTC
class	:	Intensity classification of the tropical cyclone 'T', 'STS', 'TS' or 'TD'
PPPP	:	Central pressure in hPa
WWW	:	Maximum wind speed in knots
a	:	Sign of ppp and www (+, - or blank)
ppp	:	Absolute value of change in central pressure from T=0, in hPa
www	:	Absolute value of change in maximum wind speed from T=0, in knots

Example:

FXPQ20 RJTD 180600
RSMC GUIDANCE FOR FORECAST
NAME TY 0001DAMREY (0001)
PSTN 180000UTC 15.2N 126.3E
PRES 905HPA
MXWD 105KT

```
FORECAST BY GLOBAL MODEL
TIME        PSTN        PRES        MXWD
                    (CHANGE FROM T=0)
T=006 15.4N 125.8E +018HPA -008KT
T=012 15.5N 125.6E +011HPA -011KT
T=018 15.8N 125.7E +027HPA -028KT
                    :
                    :
T=132 20.7N 128.8E +021HPA -022KT=
```

(3) RSMC Guidance for Forecast by GEPS (FXPQ30-35 RJTD)

FXPQii RJTD YYGGgg
RSMC GUIDANCE FOR FORECAST
NAME class ty-No. name (common-No.)
PSTN YYGGgg UTC LaLa.La N LoLoLo.Lo E (or W)
PRES PPPP HPA
MXWD WWW KT
FORECAST BY GLOBAL ENSEMBLE PREDICTION SYSTEM
TIME PSTN PRES MXWD
(CHANGE FROM T=0)
T=006 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=012 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=018 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
:
T=132 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT=

Notes:

a. Underlined parts are fixed.

b. Symbolic letters

ii	:	'30', '31', '32', '33', '34' or '35'
YYGGgg	:	Initial time of the model in UTC
class	:	Intensity classification of the tropical cyclone 'T', 'STS', 'TS' or 'TD'
PPPP	:	Central pressure in hPa
WWW	:	Maximum wind speed in knots
a	:	Sign of ppp and www (+, - or blank)
ppp	:	Absolute value of change in central pressure from T=0, in hPa
www	:	Absolute value of change in maximum wind speed from T=0, in knots

Example:

```
FXPQ30 RJTD 231200
RSMC GUIDANCE FOR FORECAST
NAME TY 1826 YUTU (1826)
PSTN 231200UTC 12.0N 149.6E
PRES    965HPA
MXWD    75KT
FORECAST BY GLOBAL ENSEMBLE PREDICTION SYSTEM
TIME        PSTN        PRES        MXWD
                    (CHANGE FROM T=0)
T=006 12.7N 149.1E -002HPA +001KT
T=012 13.2N 148.3E -001HPA +004KT
T=018 13.8N 147.6E -005HPA +004KT
                    :
                    :
T=132 18.0N 129.9E -033HPA +030KT=
```

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

Example:

```
WTPQ30 RJTD 231200
RSMC TROPICAL CYCLONE PROGNOSTIC REASONING
REASONING NO.10 FOR TY 1826 YUTU (1826)
```

1.GENERAL COMMENTS
TY YUTU IS LOCATED AT 12.0N, 149.6E. INFORMATION ON THE CURRENT POSITION IS BASED ON ANIMATED MSI. POSITIONAL ACCURACY IS GOOD. THE SYSTEM IS IN A FAVORABLE ENVIRONMENT FOR DEVELOPMENT UNDER THE INFLUENCE OF HIGH SSTS, HIGH TCHP AND WEAK VWS. THIS HAS CAUSED THE SYSTEM TO DEVELOP OVER THE LAST SIX HOURS. HOWEVER, THE INFLUENCE OF DRY AIR IS UNFAVORABLE FOR SYSTEM DEVELOPMENT. INFORMATION ON CURRENT INTENSITY IS BASED ON DVORAK INTENSITY ANALYSES.
2.SYNOPTIC SITUATION
THE SYSTEM IS MOVING WESTWARD ALONG THE SOUTHERN PERIPHERY OF A MID-LEVEL SUB-TROPICAL HIGH. ANIMATED MSI SHOWS THE APPEARANCE OF AN EYE. WATER VAPOR IMAGERY SHOWS DRY AIR IN THE DIRECTION OF THE MOVEMENT. DMSP-F18/SSMIS 89 GHZ MICROWAVE IMAGERY SHOWS THE SYSTEM HAS A BAND WITH CURVATURE INDICATING THE CSC.
3.TRACK FORECAST
THE SYSTEM WILL MOVE NORTHWESTWARD ALONG THE PERIPHERY OF A MID-LEVEL SUB-TROPICAL HIGH UNTIL FT12. THE SYSTEM WILL THEN MOVE WEST-NORTHWESTWARD ALONG THE PERIPHERY OF A MID-LEVEL SUB-TROPICAL HIGH UNTIL FT120. THE JMA TRACK FORECAST IS BASED ON GSM PREDICTIONS, AND REFERENCE TO OTHER NWP MODELS. JMA TRACK FORECAST CONFIDENCE IS FAIR UNTIL FT48 BUT LOW THEREAFTER DUE TO SIGNIFICANT DIFFERENCES AMONG NUMERICAL MODEL OUTPUTS.
4.INTENSITY FORECAST
THE SYSTEM WILL DEVELOP UNTIL FT48 DUE TO THE INFLUENCE OF INTERACTION WITH HIGH SSTS, HIGH TCHP, WEAK VWS AND GOOD UPPER LEVEL OUTFLOW. THE SYSTEM WILL THEN MAINTAIN ITS INTENSITY UNTIL FT72 DUE TO THE INFLUENCE OF INTERACTION WITH HIGH SSTS, HIGH TCHP AND DRY AIR. THE JMA INTENSITY FORECAST IS BASED ON GUIDANCE DATA. =

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

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

Notes:

a. Underlined parts are fixed.

b. [1)] REMARKS is given optionally.

c. Symbolic letters

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

Example:

AXPQ20 RJTD 020600

RSMC TROPICAL CYCLONE BEST TRACK
NAME 0001 DAMREY (0001)
PERIOD FROM OCT1300UTC TO OCT2618UTC
1300 10.8N 155.5E 1008HPA //KT 1306 10.9N 153.6E 1006HPA //KT
1312 11.1N 151.5E 1004HPA //KT 1318 11.5N 149.8E 1002HPA //KT
1400 11.9N 148.5E 1000HPA //KT 1406 12.0N 146.8E 998HPA 35KT
:
:

```
1712 14.6N 129.5E    905HPA 105KT    1718 14.7N 128.3E    905HPA 105KT
                                :
                                :
2612 32.6N 154.0E 1000HPA    //KT    2618 33.8N 157.4E 1010HPA    //KT
REMARKS
TD       FORMATION       AT OCT1300UTC
FROM  TD      TO   TS    AT OCT1406UTC
FROM  TS      TO   STS   AT OCT1512UTC
FROM  STS     TO   TY    AT OCT1600UTC
FROM  TY      TO   STS   AT OCT2100UTC
FROM  STS     TO   TS    AT OCT2112UTC
FROM  TS      TO   L     AT OCT2506UTC
DISSIPATION        AT OCT2700UTC=
```

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

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

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

Notes:

a. Underlined parts are fixed.

b. Abbreviations

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

c. Symbolic letters

i i	:	'30', '31', '32', '33', '34' or '35'
YYGGgg	:	Date(YY), hour(GG) and minute(gg) in UTC (Using “Z”)
yyyymmdd/time	:	Year(yyyy), month(mm), date(dd), hour and minute (time) in UTC (Using “Z”)
name	:	Name assigned to the tropical cyclone by RSMC Tokyo-Typhoon Center
Number	:	Advisory number (starting with “01” for each cyclone)
LaLa.LaLa	:	Latitude of the center position

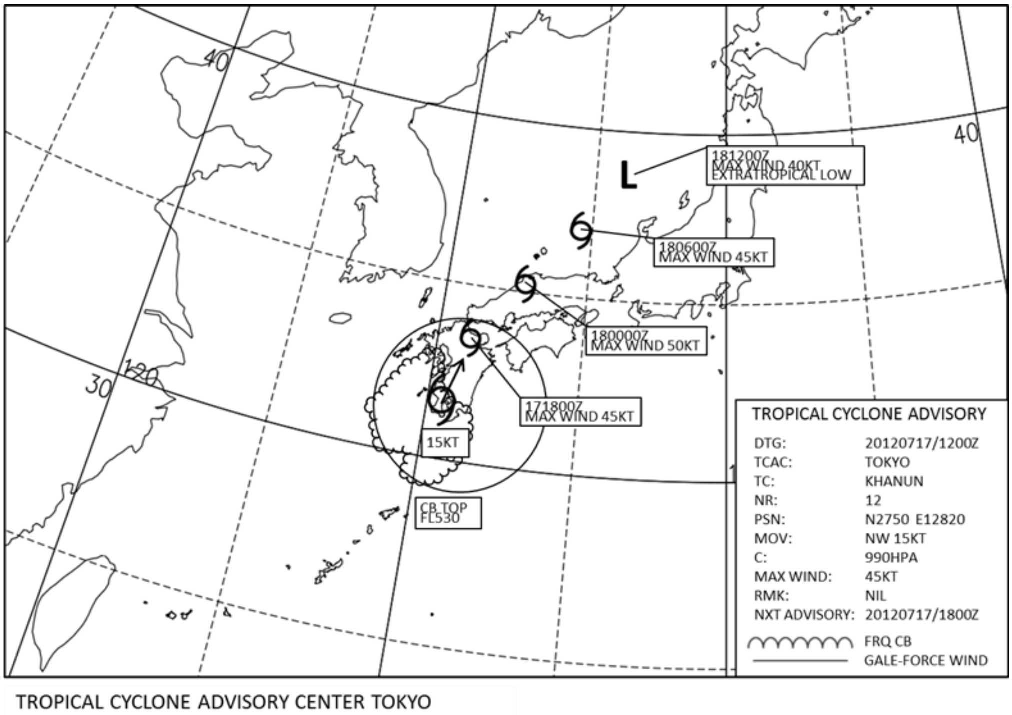
LoLoLo.LoLo	:	Longitude of the center position
direction	:	Direction of movement given in 16 azimuthal direction such as 'N', 'NNE', 'NE' and 'ENE'
SpSpSp	:	Speed of movement. “SLW” for less than 3 kt “STNR” for less than 1 kt.
PPPP	:	Central pressure
WWW	:	Maximum sustained wind

Example:

```
FKPQ30 RJTD 271200
TC ADVISORY
DTG:                        20080927/1200Z
TCAC:                       TOKYO
TC:                         JANGMI
NR:                         15
PSN:                        N2120 E12425
MOV:                        NW 13KT
C:                          910HPA
MAX WIND:                   115KT
FCST PSN +6HR:              27/1800Z N2200 E12330
FCST MAX WIND +6HR:         115KT
FCST PSN +12HR:             28/0000Z N2240 E12250
FCST MAX WIND +12HR:        115KT
FCST PSN +18HR:             28/0600Z N2340 E12205
FCST MAX WIND +18HR:        95KT
FCST PSN +24HR:             28/1200Z N2440 E12105
FCST MAX WIND +24HR:        80KT
RMK:                        NIL
NXT MSG:                    20080927/1800Z =
```

(7) Graphical Tropical Cyclone Advisory for SIGMET

Example:



Appendix 7
Specifications of JMA's NWP Models (GSM, GEPS)

The Global Spectral Model (GSM) and the Global Ensemble Prediction System (GEPS) are used in JMA as a primary basis for TC forecasts. The general specifications of GSM and GEPS are summarized in Table A7.1.

Table A7.1 Specifications of GSM and GEPS

NWP Models	GSM (Global Spectral Model), TL959L128	GEPS (Global Ensemble Prediction System), TQ479L128
Resolution	20 km, 128 layers (Top: 0.01hPa)	27 km, 128 layers (Top: 0.01hPa)
Area	Global	Global
Method for initial value	Global Data Assimilation System (Hybrid-4DVAR) Outer resolution: TL959L128 Inner resolution: TL319L128 Window: Init-3h to Init + 3h	Unperturbed condition: Truncated GSM initial condition Initial perturbation: LETKF-based perturbation and SV-based perturbation Ensemble size: 51 (50 perturbed members and 1 control member) SV target areas: Northern Hemisphere (30 – 90°N), Tropics (30°S – 30°N), Southern Hemisphere (90 – 30°S)
Forecast length (initial times)	264 hours (00, 12 UTC) 132 hours (06, 18 UTC)	432 hours (12 UTC) 264 hours (00, UTC) 132 hours (06, 18 UTC)
Operational as from	30 March 2021	15 March 2022

GSM (TL959L128) has a horizontal resolution of approximately 20 km and 128 vertical layers. Details of the model can be found in JMA (2022) and Ujiie et al. (2021).

GEPS (TQ479L128) is an ensemble prediction system used for TC track forecasts up to five days ahead, one-week forecasts, early warning information on extreme weather, and one-month forecasts. It has 51 members and a horizontal resolution of approximately 27 km along with 128 vertical layers for the first 18 days of forecasts. Details of the system can be found in JMA (2023) and Yamaguchi et al. (2022). A combination of a Local Ensemble Transform Kalman Filter (LETKF; Hunt et al. 2007) and a singular vector (SV) method (Buizza and Palmer 1995) is employed for the initial perturbation setup. In addition, a stochastically perturbed physics tendency scheme (Buizza et al. 1999) is incorporated in consideration of model uncertainties associated with physical parameterizations, and a perturbation technique for sea surface temperature (SST) is incorporated to represent uncertainty in the prescribed SST.

[Recent upgrades to GSM, Global Data Assimilation System and GEPS]
GEPS:

- Horizontal resolution enhancement from 40 to 27 km (March 2022)
- Incorporation of recent GSM development (March 2022)
- Enhancement of SST boundary conditions (March 2022)

- Update of initial perturbation amplitude (March 2022)

[References]

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

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

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

Japan Meteorological Agency, 2023: Outline of the Operational Numerical Weather Prediction at the Japan Meteorological Agency. Appendix to WMO Technical Progress Report on the Global Data-processing and Forecasting System (GDPFS) and Numerical Weather Prediction (NWP) Research. Japan Meteorological Agency, Tokyo, Japan.

Yamaguchi, H., Y. Adachi, S. Hirahara, Y. Ichikawa, T. Iwahira, Y. Kuroki, C. Matsukawa, R. Nagasawa, K. Ochi, R. Sekiguchi, T. Takakura, M. Ujiie, H. Yonehara, 2022: Upgrade of JMA's Global Ensemble Prediction System. WGNE Res. Activ. Earth system Modell., 52, 06.7-8.

Appendix 8
Products on WIS GISC Tokyo Server

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

NWP products (GSM and GEPS with GRIB formatted data)

Model	GSM	GSM	GSM
Area and resolution	Whole globe, 1.25°×1.25°	20°S–60°N, 60°E–160°W 1.25°×1.25°	Whole globe, 2.5°×2.5°
Levels and elements	10 hPa: Z, U, V, T 20 hPa: Z, U, V, T 30 hPa: Z, U, V, T 50 hPa: Z, U, V, T 70 hPa: Z, U, V, T 100 hPa: Z, U, V, T 150 hPa: Z, U, V, T 200 hPa: Z, U, V, T, ψ, χ 250 hPa: Z, U, V, T 300 hPa: Z, U, V, T, H, ω 400 hPa: Z, U, V, T, H, ω 500 hPa: Z, U, V, T, H, ω, ζ 600 hPa: Z, U, V, T, H, ω 700 hPa: Z, U, V, T, H, ω 850 hPa: Z, U, V, T, H, ω, ψ, χ 925 hPa: Z, U, V, T, H, ω 1000 hPa: Z, U, V, T, H, ω Surface: P, U, V, T, H, R†	10 hPa: Z, U, V, T 20 hPa: Z, U, V, T 30 hPa: Z, U, V, T 50 hPa: Z, U, V, T 70 hPa: Z, U, V, T 100 hPa: Z, U, V, T 150 hPa: Z, U, V, T 200 hPa: Z§, U§, V§, T§, ψ, χ 250 hPa: Z, U, V, T 300 hPa: Z, U, V, T, D 400 hPa: Z, U, V, T, D 500 hPa: Z§, U§, V§, T§, D§, ζ 700 hPa: Z§, U§, V§, T§, D§, ω 850 hPa: Z§, U§, V§, T§, D§, ω, ψ, χ 925 hPa: Z, U, V, T, D, ω 1000 hPa: Z, U, V, T, D Surface: P¶, U¶, V¶, T¶, D¶, R¶	10 hPa: Z*, U*, V*, T* 20 hPa: Z*, U*, V*, T* 30 hPa: Z°, U°, V°, T° 50 hPa: Z°, U°, V°, T° 70 hPa: Z°, U°, V°, T° 100 hPa: Z°, U°, V°, T° 150 hPa: Z*, U*, V*, T* 200 hPa: Z, U, V, T 250 hPa: Z°, U°, V°, T° 300 hPa: Z, U, V, T, D*‡ 400 hPa: Z*, U*, V*, T*, D*‡ 500 hPa: Z, U, V, T, D*‡ 700 hPa: Z, U, V, T, D 850 hPa: Z, U, V, T, D 1000 hPa: Z, U*, V*, T*, D*‡ Surface: P, U, V, T, D*‡, R†
Forecast hours	0–84 every 6 hours and 96–192 every 12 hours for 12UTC initial † Except analysis	0–84 (every 6 hours) § 96–192 (every 24 hours) for 12UTC initial ¶ 90–192 (every 6 hours) for 12UTC initial	0–72 every 24 hours and 96–192 every 24 hours for 12UTC ° 0–120 for 12UTC † Except analysis * Analysis only
Initial times	00, 06, 12, 18UTC	00, 06, 12, 18UTC	00UTC and 12UTC ‡ 00UTC only

Model	GEPS
Area and resolution	Whole globe, 2.5°×2.5°
Levels and elements	250 hPa: μU, σU, μV, σV 500 hPa: μZ, σZ 850 hPa: μU, σU, μV, σV, μT, σT 1000 hPa: μZ, σZ Surface: μP, σP
Forecast hours	0–192 every 12 hours
Initial times	00, 12UTC

NWP products (GSM and GEPS with GRIB2 formatted data)

Model	GSM	GSM	GSM
Area and resolution	5S-90N and 30E-165W, Whole globe 0.25° × 0.25°	5S-90N and 30E-165W, Whole globe 0.5° × 0.5°	Whole globe 1.25° × 1.25°
Levels and elements	Surface: U, V, T, H, P, Ps, R, Cla, Clh, Clm, Cll	10 hPa: Z, U, V, T, H, ω 20 hPa: Z, U, V, T, H, ω 30 hPa: Z, U, V, T, H, ω 50 hPa: Z, U, V, T, H, ω 70 hPa: Z, U, V, T, H, ω 100 hPa: Z, U, V, T, H, ω 150 hPa: Z, U, V, T, H, ω 200 hPa: Z, U, V, T, H, ω, ψ, χ 250 hPa: Z, U, V, T, H, ω 300 hPa: Z, U, V, T, H, ω 400 hPa: Z, U, V, T, H, ω 500 hPa: Z, U, V, T, H, ω, ζ 600 hPa: Z, U, V, T, H, ω 700 hPa: Z, U, V, T, H, ω 800 hPa: Z, U, V, T, H, ω 850 hPa: Z, U, V, T, H, ω, ψ, χ 900 hPa: Z, U, V, T, H, ω 925 hPa: Z, U, V, T, H, ω 950 hPa: Z, U, V, T, H, ω 975 hPa: Z, U, V, T, H, ω 1000 hPa: Z, U, V, T, H, ω Surface: U, V, T, H, P, Ps, R, Cla, Clh, Clm, Cll	10 hPa: Z, U, V, T 20 hPa: Z, U, V, T 30 hPa: Z, U, V, T 50 hPa: Z, U, V, T 70 hPa: Z, U, V, T 100 hPa: Z, U, V, T 150 hPa: Z, U, V, T 200 hPa: Z, U, V, T, ψ, χ 250 hPa: Z, U, V, T, ζ, ∇ 300 hPa: Z, U, V, T, H, ω 400 hPa: Z, U, V, T, H, ω 500 hPa: Z, U, V, T, H, ω, ζ 600 hPa: Z, U, V, T, H, ω 700 hPa: Z, U, V, T, H, ω, ζ, ∇ 850 hPa: Z, U, V, T, H, ω, ψ, χ 925 hPa: Z, U, V, T, H, ω, ζ, ∇ 1000 hPa: Z, U, V, T, H, ω Surface: P, U, V, T, H, R
Forecast hours	0–132 (every 3 hours) 138–264 (every 6 hours) are available for 00 UTC and 12 UTC initial	0–132 (every 3 hours) 138–264 (every 6 hours) are available for 00 UTC and 12 UTC initial	0–132 (every 3 hours) 138–264 (every 6 hours) are available for 00 UTC and 12 UTC initial
Initial times	00, 06, 12 and 18 UTC	00, 06, 12 and 18 UTC	00, 06, 12 and 18 UTC

Model	GEPS
Area and resolution	Whole globe, 1.25°×1.25°
Levels and elements	250 hPa: μU, σU, μV, σV 500 hPa: μZ, σZ 850 hPa: μU, σU, μV, σV, μT, σT 1000 hPa: μZ, σZ Surface: μP, σP Probability of precipitation [1,5,10,25,50,100 mm/24hour], Probability of 10m sustained wind and gusts[10,15,25 m/s], Probability of temperature anomalies [±1, ±1.5, ±2σ]
Forecast hours	0-264 every 12 hours
Initial times	00UTC and 12UTC

Notes:

Z: geopotential height	U: eastward wind	V: northward wind
T: temperature	D: dewpoint depression	H: relative humidity
ω: vertical velocity	ζ: vorticity	ψ: stream function
χ: velocity potential	∇: divergence	P: sea level pressure
Ps: pressure	R: rainfall	Cla: total cloudiness
Clh: cloudiness (upper layer)	Clm: cloudiness (middle layer)	
Cll: cloudiness (lower layer)		

The prefixes μ and σ represent the average and standard deviation of ensemble prediction results respectively.
The symbols °, *, ¶, §, ‡ and † indicate limitations on forecast hours or initial time as shown in the tables.

Other products

Data	Contents / frequency (initial time)
Satellite products	High density atmospheric motion vectors (BUFR) Himawari-8/9 (VIS, IR, WVx3: every hour), 60S-60N, 90E-170W Clear Sky Radiance (CSR) data (BUFR) Himawari-8/9 radiances and brightness temperatures averaged over cloud-free pixels: every hour
Tropical cyclone Information	Tropical cyclone related information (BUFR) • tropical cyclone analysis data (00, 06, 12 and 18 UTC)
Wave data	Global Wave Model (GRIB2) • significant wave height • prevailing wave period • wave direction Forecast hours: 0–84 every 6 hours (00, 06 and 18UTC) 0–84 every 6 hours and 96-192 every 12 hours (12 UTC)
Observational data	(a) Surface data (TAC/TDCF) SYNOP, SHIP, BUOY: Mostly 4 times a day (b) Upper-air data (TAC/TDCF) TEMP (parts A-D), PILOT (parts A-D): Mostly twice a day
SATAID service	(a) Satellite imagery (SATAID) Himawari-8/9 (b) Observation data (SATAID) SYNOP, SHIP, METAR, TEMP (A, B) and ASCAT sea-surface wind (c) NWP products (SATAID) GSM (Available at https://www.wis-jma.go.jp/cms/sataid/)

Appendix 9
RSMC Tokyo Products and Services Provided Through the Internet

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

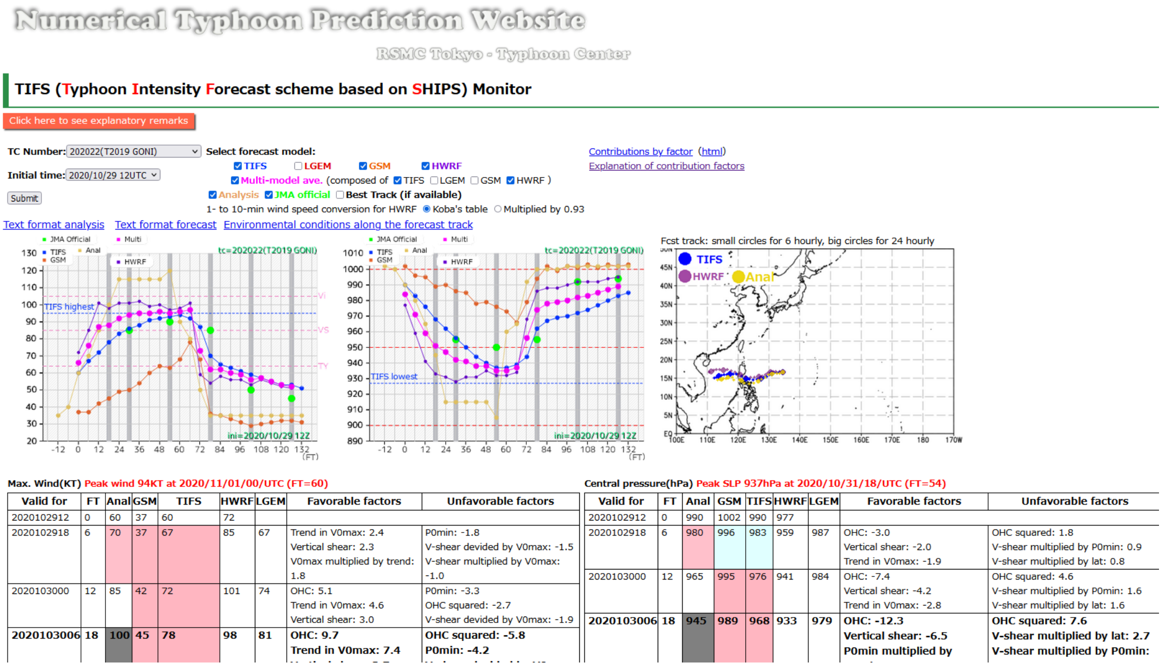
Products	Frequency	Details
RSMC Advisories		
RSMC TC Advisory	At least 8 times/day	• The Center's TC analysis and forecasts up to 120 hours ahead (linked to the JMA website at https://www.jma.go.jp/en/typh/)
Storm Wind Probability Map	4 times/day	• Probabilistic forecast map for sustained wind of 50-kt or more for 1, 2, 3, 4 and 5 days ahead
Prognostic Reasoning	4 times/day	• RSMC Tokyo Tropical Cyclone Prognostic Reasoning (WTPQ3X)
Advance notice		• Advance notice on TC status change from the Center *Information supplemental to RSMC advisories (may not be provided in certain situations; should not be considered as an official RSMC advisory or a replacement therefor)
Graphical TC Advisory	4 times/day	• Graphical TC Advisory including RSMC Tokyo - Typhoon Center's TC analysis, track and intensity forecasts up to 24-hours and horizontal extents of cumulonimbus cloud and cloud top height associated with TCs potentially affecting aviation safety (linked to the Tropical Cyclone Advisory Center Tokyo Website)
Remote Sensing		
Satellite Analysis	At least 4 times/day	• Results and historical logs of the Center's TC analysis conducted using satellite images (Conventional Dvorak analysis and Early-stage Dvorak analysis)
Satellite Imagery	Up to 142 times/day	• Satellite imagery of Himawari-8/9 (linked to the JMA website at https://www.jma.go.jp/en/gms/smallc.html?area=6&element=0&mode=UTC)
Satellite Microwave Products		• TC snapshot images • Warm-core-based TC intensity estimates • Weighted consensus TC intensity estimates made using Dvorak analysis and satellite microwave warm-core-based intensity estimates
Sea-surface AMV (ASWind)	Every 10 / 30 minutes	• AMV-based Sea-surface Wind in the vicinity of TC (linked to the Meteorological Satellite Center web site)
Radar Composite Imagery	Every hour	• Radar composite imagery of the Typhoon Committee Regional Radar Network
Atmospheric Circulation		
Weather Charts	4 times/day	• Weather maps for surface analysis, 24- and 48-hour forecasts (linked to the JMA website at https://www.jma.go.jp/en/g3/)
NWP Multi Center Weather Charts	Twice/day	• Mean sea level pressure and 500 hPa Geopotential height (up to 168 hours) of deterministic NWP models from nine centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP, UKMO and JMA)
JMA GSM Analysis and Forecast	4 times/day	• Upper-air analysis and forecast data based on JMA-GSM - Streamlines at 850 and 200 hPa - Divergence at 200 hPa - Velocity potential at 200 hPa - Vertical Velocity in Pressure Coordinate at 500 hPa - Dew Point Depression at 600 hPa - Curvature Vorticity at 850 hPa - Vertical wind shear between 200 and 850 hPa - Sea Level Pressure - Genesis Potential Index
MJO Phase Diagram	Once/day	MJO phase and amplitude diagram and MJO Hovmöller diagram (linked to the Tokyo Climate Center web site)

Products	Frequency	Details
Ocean Condition		
SST	Once/day	• Sea surface temperature and related differences from 24 hours ago
TCHP	Once/day	• Tropical cyclone heat potential and related differences from 24 hours ago
Numerical TC Prediction		
Track Bulletin	4 times/day	• RSMC Tokyo Tropical Cyclone Track Forecast Bulletin - Track forecast by GSM (FXPQ2X) - Track forecast by GEPS (FXPQ3X)
TC intensity (TIFS monitor)	4 times/day	• TIFS (Typhoon Intensity Forecast scheme based on SHIPS) Monitor
TC Track Prediction	4 times/day	• TC track prediction of deterministic NWP models from nine centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP, UKMO and JMA) and a related consensus • TC track prediction of EPS models from four centers (ECMWF, NCEP, UKMO and JMA)
TC Activity Prediction	Twice/day	• Two- and five-day TC activity prediction maps based on EPS models from four centers (ECMWF, UKMO, NCEP and JMA) and a related consensus
TC Verification	4 times/day	• Verification results of RSMC Tokyo's official forecasts as well as NWP model and guidance predictions
Marine Forecast		
Storm Surge Forecasts	4 times/day	• Distribution maps of storm surge for RSMC Tokyo - Typhoon Center's TC track forecast and each of five TC track forecasts selected from GEPS ensemble members and maximum storm surge among these six TC track forecasts (up to 72 hours) • Time-series storm surge forecast charts for RSMC Tokyo - Typhoon Center's TC track forecast and each of five TC track forecasts selected from GEPS ensemble members (up to 72 hours)
Ocean Wave Forecasts	Twice/day	• Distribution maps for ensemble mean, maximum, probability of exceeding various thresholds and ensemble spread of wave height and period based on the Wave Ensemble System (WENS) (up to 264 hours) • Time-series representations with box-and-whisker plots for wave height/period and probability of exceeding various wave height/period thresholds based on the WENS (up to 264 hours)

List of services provided on the TC communication platform

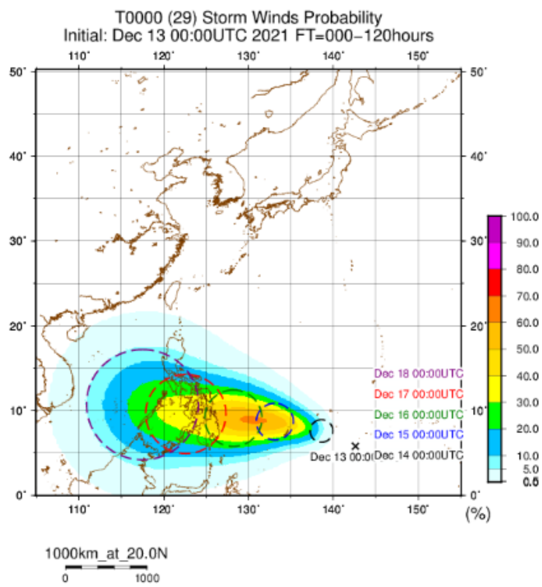
Services	Details
Advance notice	• Advance notice on TC status change from the Centre *Supplemental information to RSMC advisories (It may not be provided in certain situations and should not be considered as an official RSMC advisory and/or its replacement)
Enhanced communication	• A platform on which Committee Members can post inquiries or comments related to tropical cyclone analysis and forecasts

RSMC Tokyo - Typhoon Center product examples



Website on the TIFS (Typhoon Intensity Forecast scheme based on SHIPS) monitor

The upper figure shows TIFS and GSM intensity prediction values at each initial time for individual TCs with analysis data in line graphs as well as a map of tracks. In the lower tables, the pink-colored and light blue-colored cells represent development and weakening from 12 hours before, respectively.

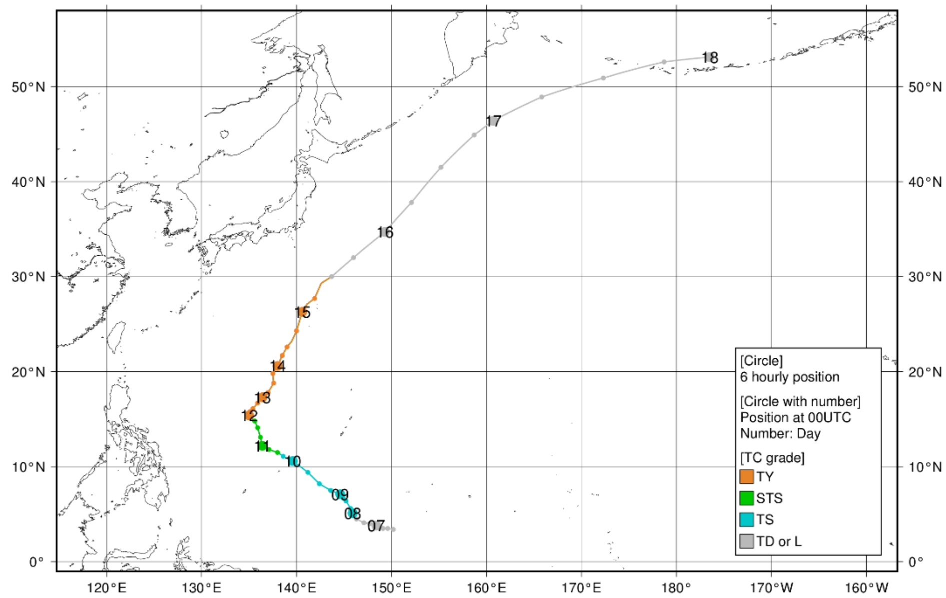


Five-day storm wind product probability (50 kt and above)
for Tropical Depressions (TDs) expected to reach tropical storm (TS) intensity or higher within 24 hours.

Appendix 10
Tropical Cyclones in 2022

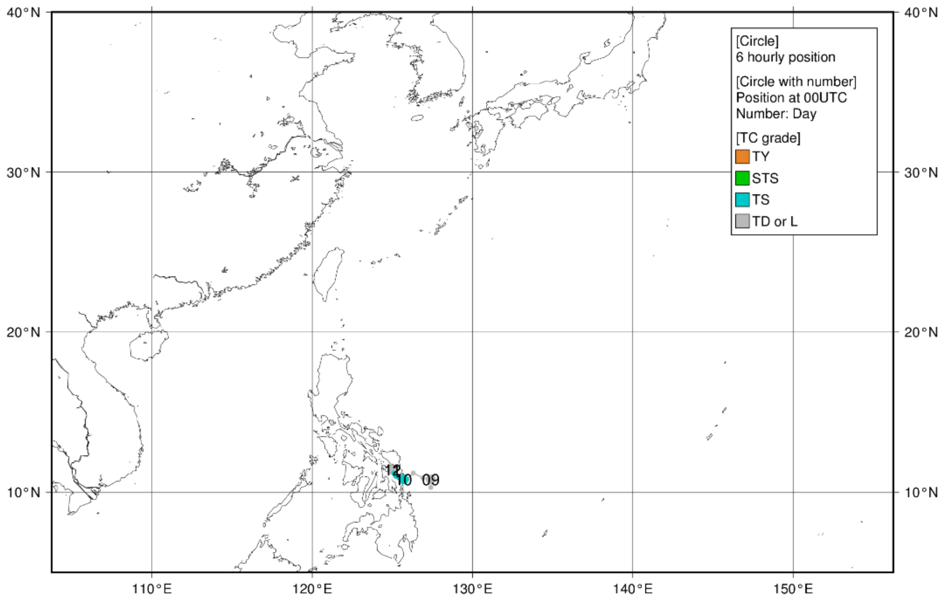
MALAKAS (2201)

MALAKAS formed as a tropical depression (TD) over the sea around the Chuuk Islands at 06 UTC on 6 April 2022 and moved westward. It changed its move north-northwestward before it was upgraded to tropical storm (TS) intensity over the sea around the Caroline Islands at 00 UTC on 8 April and gradually moved northwestward. It was upgraded to typhoon (TY) intensity over the sea east of the Philippines at 00 UTC on 12 April and turned northeastward. Keeping its northeastward track, it reached its peak intensity with maximum sustained winds of 90 kt and a central pressure of 945 hPa over the same waters at 18 UTC the next day. It transitioned into an extratropical cyclone over the sea east of Japan by 12 UTC on 15 April. It entered the sea around the Aleutian Islands and crossed longitude 180 degrees east before 00 UTC on 18 April.



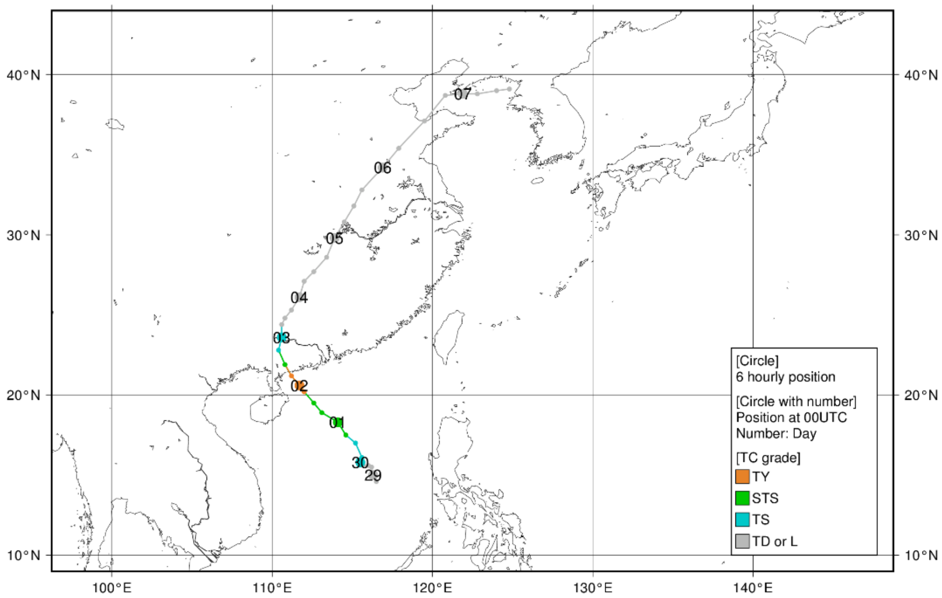
MEGI (2202)

MEGI formed as a tropical depression (TD) over the sea east of the Philippines at 18 UTC on 8 April 2022 and moved northward and soon turned westward. It was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on 9 April. It reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 996 hPa over the central part of the Philippines at 00 UTC on 10 April and decelerated northwestward. It weakened to TD intensity near the central part of the Philippines at 00UTC on 11 April and remained almost stationary until it dissipated at 06 UTC on 12 April.



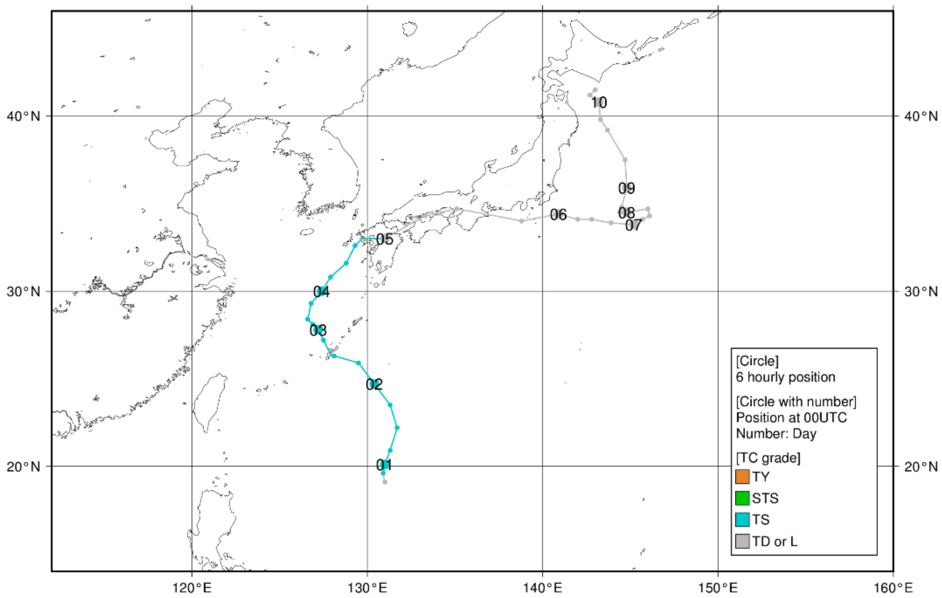
CHABA (2203)

CHABA formed as a tropical depression (TD) over the South China Sea at 18 UTC on 28 June 2022 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 30 June and after upgrading to severe tropical storm (STS) intensity 18 hours later, it was further upgraded to typhoon (TY) intensity at 18 UTC on 1 July over the same waters. It reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 965 hPa over the waters east of Hainan Island 6 hours later. It hit the coast of southern China with TY intensity before 12 UTC on 2 July and moved northward. It weakened to TD intensity in southern China at 06 UTC on 3 July and moved north-northeastward. It transitioned into an extratropical cyclone in the central part of China by 18 UTC on 5 July. It dissipated over the Yellow Sea at 00 UTC on 8 July.



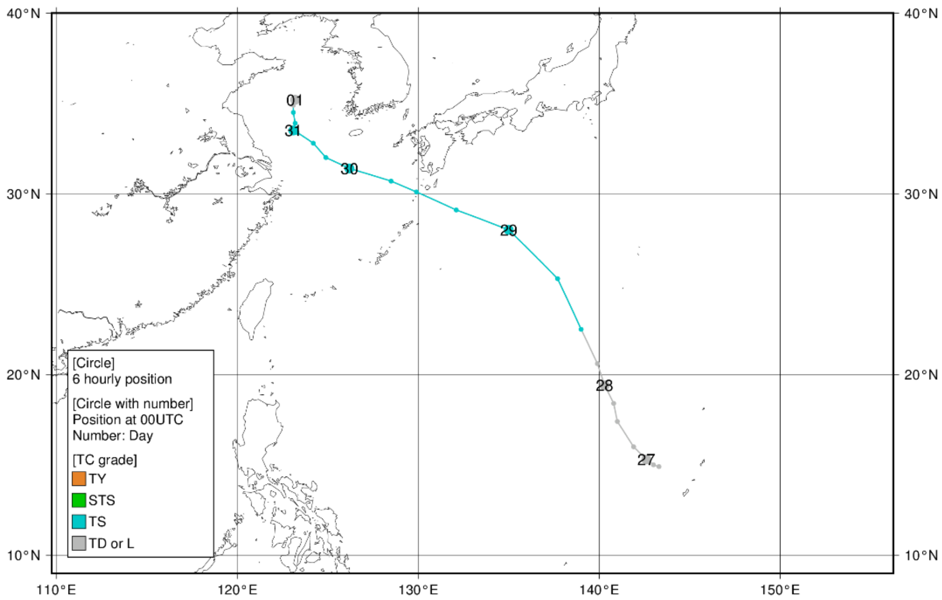
AERE (2204)

AERE formed as a tropical depression (TD) over the sea east of the Philippines at 12 UTC on 30 June 2022 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC the same day and moved north-northeastward. After changing its move northwestward, it reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 994 hPa near Okinawa Island at 06 UTC on 2 July. It crossed Okinawa Island with TS intensity around 14 UTC the same day and moved northwestward and then turned northeastward. It landed near Sasebo City, Nagasaki Prefecture with TS intensity before 21 UTC on 4 July. It transitioned into an extratropical cyclone over the northern part of Kyushu Island by 00 UTC on 5 July. It moved eastward over the Seto Inland Sea toward the Kii Peninsula and entered the Pacific Ocean. It further moved over the waters east of Honshu Island and dissipated over the waters south of Hokkaido Island at 18 UTC on 10 July.



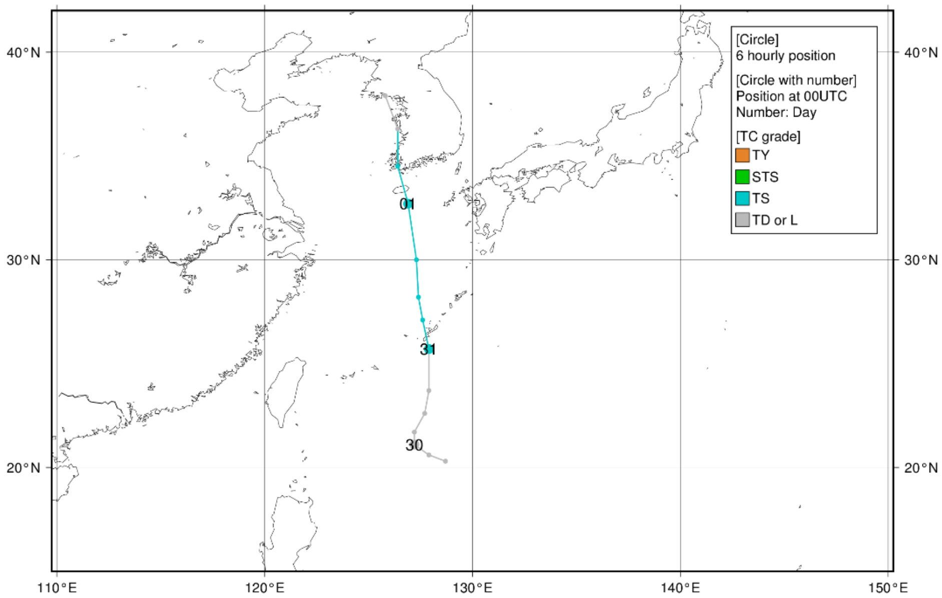
SONGDA (2205)

SONGDA formed as a tropical depression (TD) over the sea west of the Mariana Islands at 12 UTC on 26 July 2022 and moved northwestward. Keeping its northwestward track, it was upgraded to tropical storm (TS) intensity at 12 UTC 28 July over the sea south of Japan. It reached its peak intensity with maximum sustained winds of 40 kt over the waters southwest of Kyushu Island at 12 UTC on 29 July. Its central pressure was 1000 hPa at that time and lowered to 996 hPa at 00 UTC on 31 July. It decelerated and changed its move northward over the Yellow Sea. It weakened to TD intensity at 18 UTC on 31 July and dissipated over the same waters at 12 UTC on 1 August.



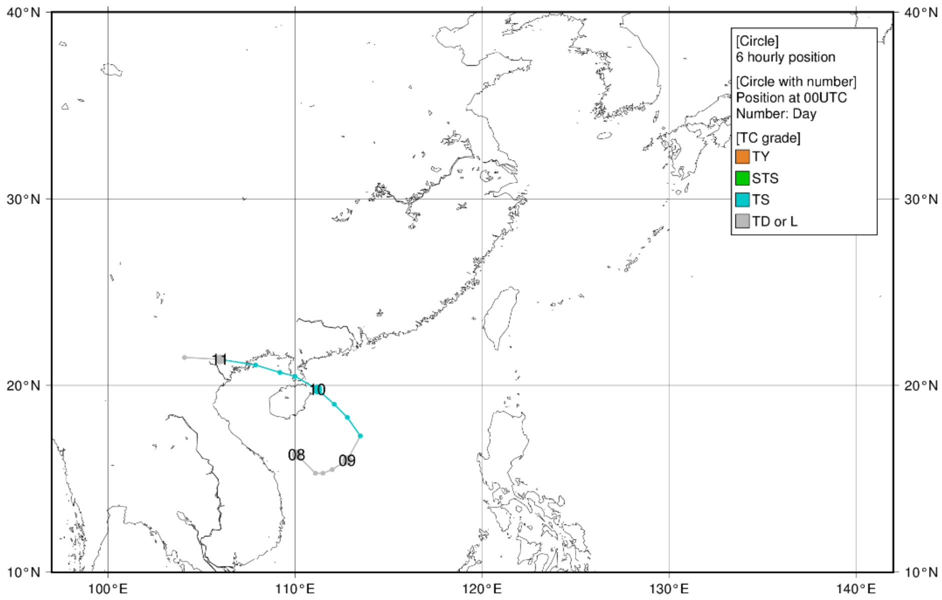
TRASES (2206)

TRASES formed as a tropical depression (TD) over the sea south of Okinawa Island at 12 UTC on 29 July 2022 and moved west-northwestward. It gradually changed its move northward and was upgraded to tropical storm (TS) intensity, and at the same time, reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 998 hPa over the same waters at 00 UTC on 31 July. Keeping its northward track, it weakened to TD intensity over the waters near the western coast of the Korean Peninsula at 12 UTC on 1 August and dissipated over the northern part of the Korean Peninsula 12 hours later.



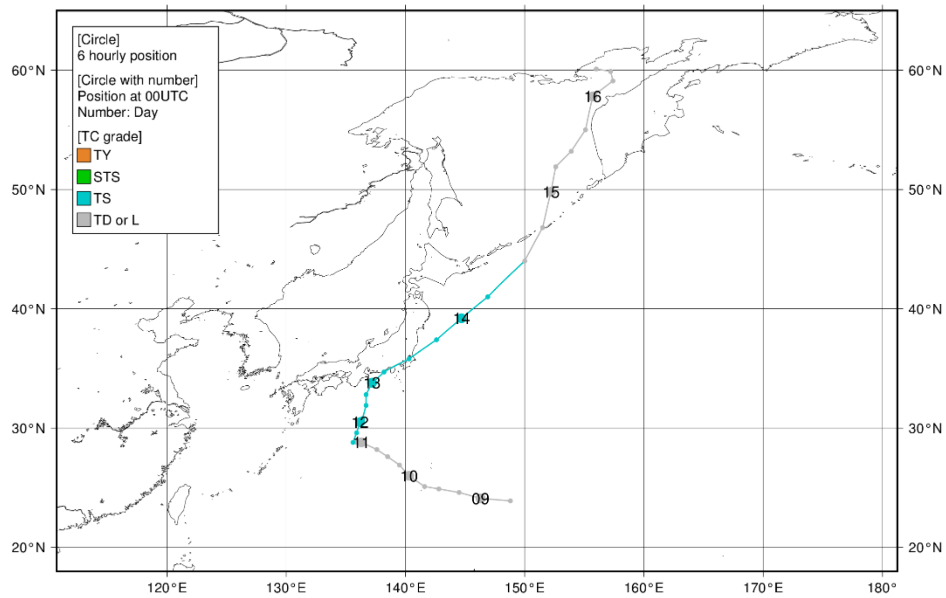
MULAN (2207)

MULAN formed as a tropical depression (TD) over the sea south of Hainan Island at 00 UTC on 8 August 2022. It moved southeastward over the South China Sea for several hours and then gradually turned northeastward over the same waters. It was upgraded to tropical storm (TS) intensity and reached its peak intensity with maximum sustained winds of 35 kt over the same waters at 06 UTC on 9 August. Its central pressure was 996 hPa at that time and lowered to 994 hPa at 12 UTC the same day. After changing its move northwestward, it crossed the Leizhou Peninsula before 12 UTC on 10 August. It moved west-northwestward over the Gulf of Tonkin, and hit the coast of Viet Nam in the second half of 10 August. It weakened to TD intensity over the northern part of Viet Nam at 00 UTC on 11 August and dissipated 12 hours later.



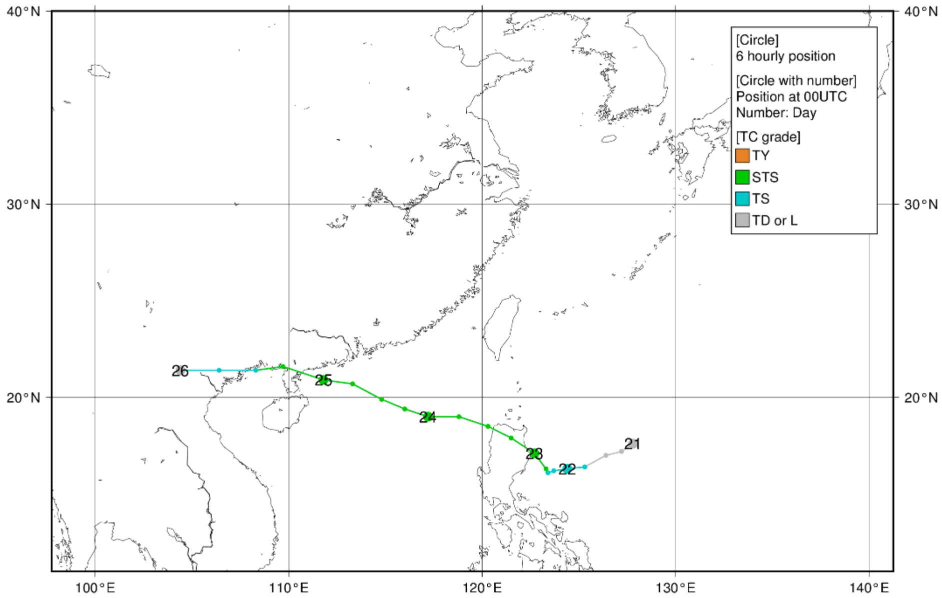
MEARI (2208)

MEARI formed as a tropical depression (TD) over the sea west of Minamitorishima Island at 18 UTC on 8 August 2022 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity over the sea south of Japan at 12 UTC on 11 August, and turned north-northeastward. It reached its peak intensity with maximum sustained winds of 40 kt over the same waters at 12 UTC on 12 August. Its central pressure was 1000 hPa at that time and lowered to 998 hPa 12 hours later. MEARI gradually turned northeastward, and passed around Omaezaki, Shizuoka Prefecture with TS intensity before 06 UTC on 13 August and then landed on the Izu Peninsula, Shizuoka Prefecture with TS intensity around 0830 UTC the same day. Its central pressure further lowered to 996 hPa over the sea east of Japan at 06 UTC on 14 August keeping its peak intensity of maximum sustained winds of 40 kt. It transitioned into an extratropical cyclone over the sea around the Kuril Islands by 12 UTC the same day. It gradually turned northward, and crossed latitude 60 degrees north before 18 UTC on 16 August.



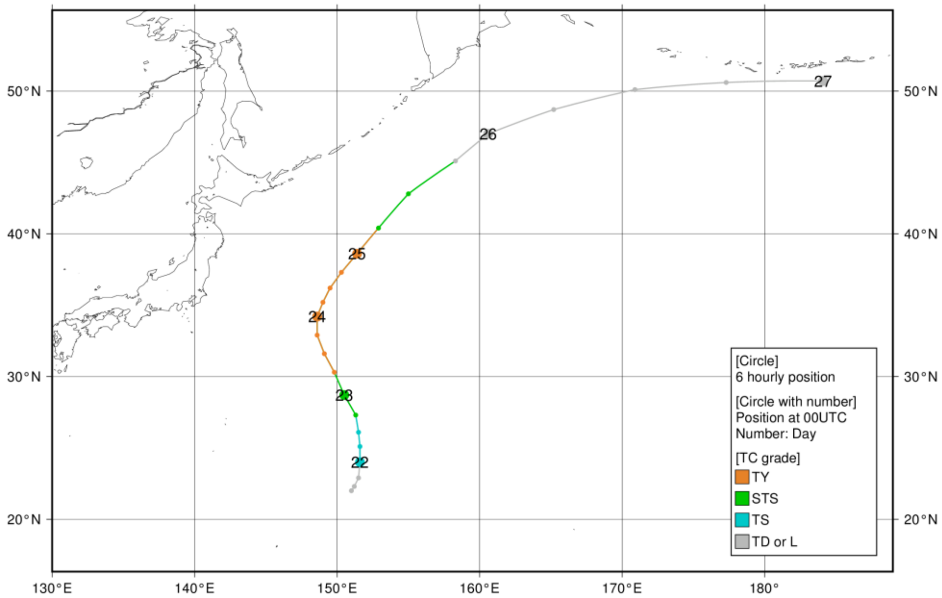
MA-ON (2209)

MA-ON formed as a tropical depression (TD) over the sea east of the Philippines at 00 UTC on 21 August 2022 and moved southwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on the same day and moved west-southwestward. After changing its move northwestward, it was further upgraded to severe tropical storm (STS) intensity at 18 UTC on 22 August and it reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 985 hPa over the South China Sea at 18 UTC the next day. It hit southern China with STS intensity on 25 August and moved westward. It weakened to TD intensity in Viet Nam at 00 UTC on 26 August and dissipated six hours later.



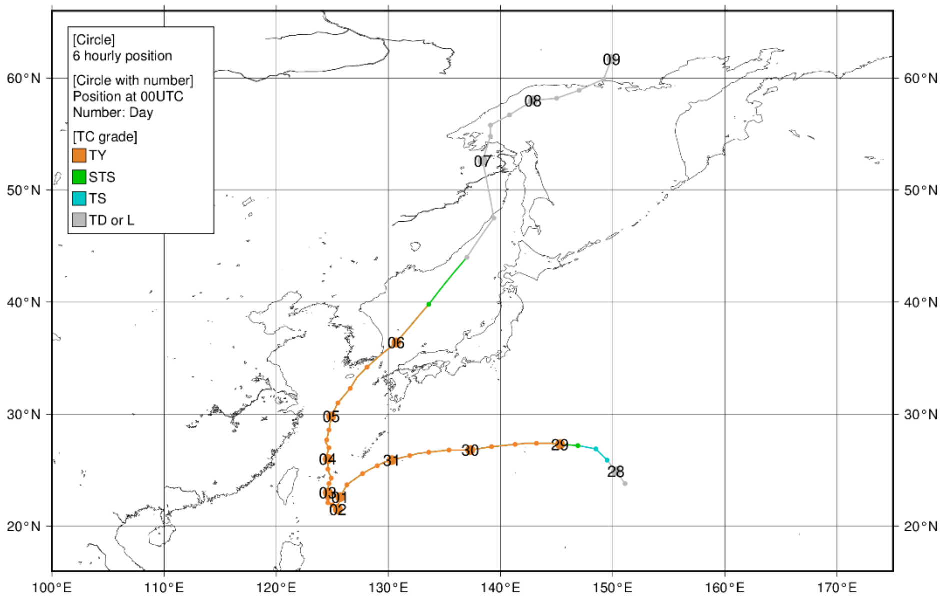
TOKAGE (2210)

TOKAGE formed as a tropical depression (TD) over the sea southwest of Minamitorishima Island at 06 UTC on 21 August 2022 and moved north-northeastward. It was upgraded to tropical storm (TS) intensity at 00 UTC the next day to the west of the island. Gradually changing its move north-northwestward, it was further upgraded to Typhoon (TY) intensity over the sea east of Japan at 06 UTC on 23 August. It reached its peak intensity with maximum sustained winds of 75 kt and a central pressure of 970 hPa over the same waters at 12 UTC the same day. It gradually changed its move northeastward and transitioned into an extratropical cyclone over the sea east of the Kuril Islands by 18 UTC on 25 August. After it accelerated east-northeastward toward the sea around the Aleutian Islands, it further moved eastward and crossed longitude 180 degrees east before 00 UTC on 27 August.



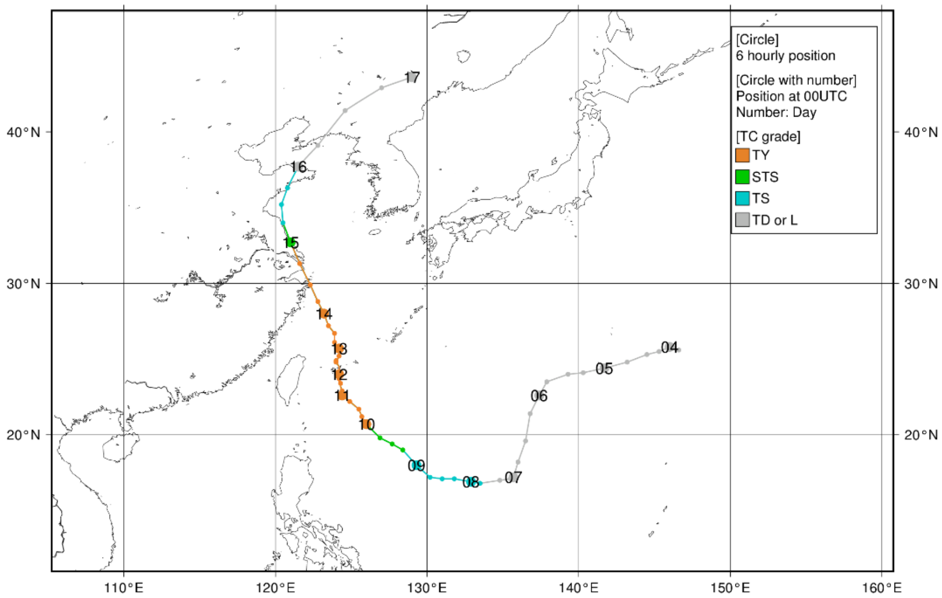
HINNAMNOR (2211)

HINNAMNOR formed as a tropical depression (TD) over the sea around Minamitorishima Island at 18 UTC on 27 August 2022 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 06 UTC on 28 August before moving westward. It was upgraded to typhoon (TY) intensity over the sea around the Ogasawara Islands at 00 UTC on 29 August. Keeping its westward track, it reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 920 hPa over the sea around Minamidaitojima Island at 12 UTC on 30 August. Gradually weakening and turning southward, it decelerated over the sea south of Okinawa Island during 1 September. Then it turned sharply northward over the same waters on the next day. It developed again over the East China Sea in the first half of 4 September. It passed through the Tsushima Strait in the second half of 5 September and moved northeastward. It was downgraded to STS intensity over the Sea of Japan at 06 UTC on 6 September and transitioned into an extratropical cyclone over the same waters by 12 UTC the same day. It entered the Sea of Okhotsk and crossed latitude 60 degrees north over Russia before 00 UTC on 9 September.



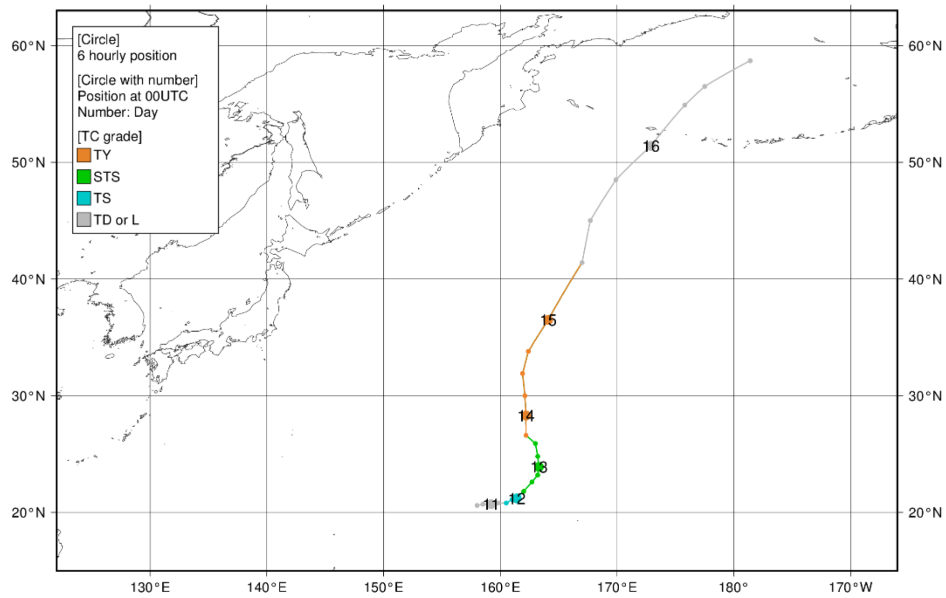
MUIFA (2212)

MUIFA formed as a tropical depression (TD) over the sea east of the Ogasawara Islands at 18 UTC on 3 September 2022 and moved west-southwestward for about two days and then south-southwestward. After turning westward, it was upgraded to tropical storm (TS) intensity over the sea east of the Philippines at 18 UTC on 7 September and was further upgraded to severe tropical storm (STS) intensity over the same waters at 06 UTC on 9 September. It gradually turned northward and decelerated and was upgraded to typhoon (TY) intensity over the sea south of Okinawa Island at 00 UTC on 10 September. It reached its peak intensity with maximum sustained winds of 85 kt and a central pressure of 950 hPa over the same waters at 00 UTC on 11 September. After a slight weakening, it passed over Ishigakijima Island still with TY intensity around 03 UTC the next day. It redeveloped and accelerated north-northwestward and reached an intensity with maximum sustained winds of 80 kt and a central pressure of 955 hPa over the East China Sea at 00 UTC on 13 September. It hit the coast line of central China with TY intensity late on 14 September. It turned north-northeastward and transitioned into an extratropical cyclone by 00 UTC on 16 September near the Shandong Peninsula. After changing its move northeastward, it dissipated in Northeast China at 06 UTC on 17 September.



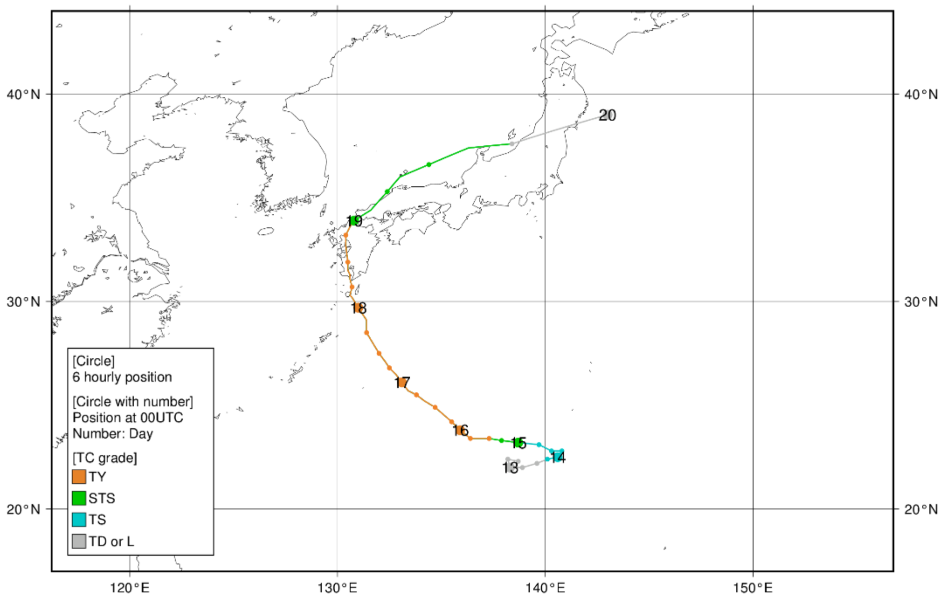
MERBOK (2213)

MERBOK formed as a tropical depression (TD) southeast of Minamitorishima Island at 12 UTC on 10 September 2022 and moved eastward. It was upgraded to tropical storm (TS) intensity west-northwest of Wake Island 24 hours later and moved northeastward. It was upgraded to severe tropical storm (STS) intensity at 06 UTC on 12 September and was further upgraded to typhoon □TY□ intensity at 18 UTC on 13 September over the same waters and moved northward. It reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 970 hPa over the sea far off east of Japan at 06 UTC on 14 September. It lowered to 965 hPa six hours later and moved north-northeastward. It transitioned into an extratropical cyclone over the same waters by 06 UTC the next day. Keeping its move north-northeastward, it crossed longitude 180 degrees east before 18 UTC on 16 September.



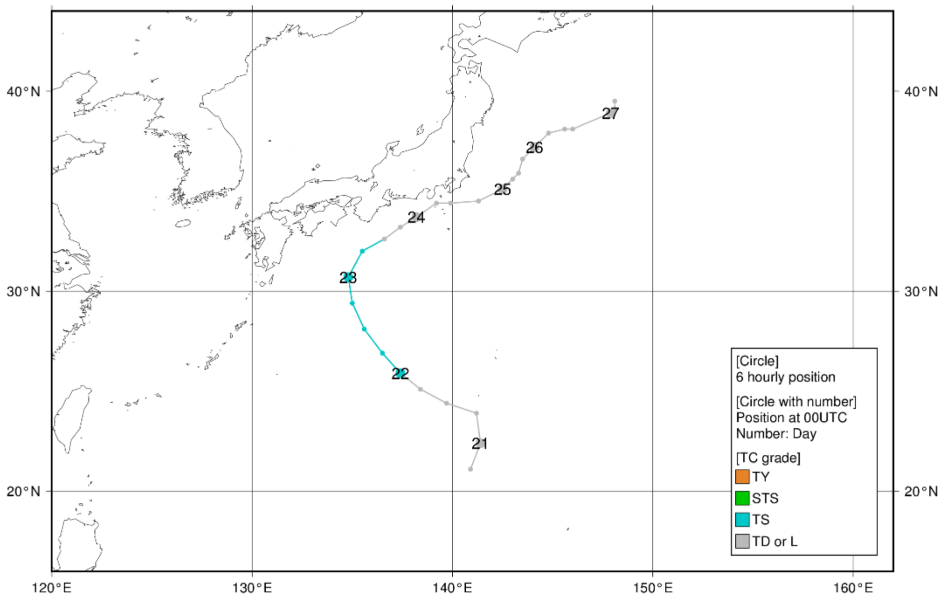
NANMADOL (2214)

NANMADOL formed as a tropical depression (TD) over the sea south of Japan at 12 UTC on 12 September 2022 and turned in a counterclockwise direction to circle over the same waters for about one day long. It moved east-northeastward and was upgraded to tropical storm (TS) intensity over the sea south of the Ogasawara Islands at 18 UTC on 13 September and turned sharply westward 12 hours later. Keeping its westward track, it developed rapidly and was upgraded to typhoon (TY) intensity over the sea south of Japan at 12 UTC on 15 September. It turned northwestward six hours later and subsequently reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 910 hPa over the waters east of Minamidaitojima Island at 18 UTC on 16 September. NANMADOL turned north-northwestward and passed over Yakushima Island with TY intensity at around 0430 UTC on 18 September before moving northward. It further crossed near Ibusuki City, Kagoshima Prefecture with TY intensity about four hours later and then landed near Kagoshima City, Kagoshima Prefecture with TY intensity at around 10 UTC on 18 September. Keeping its northward track, it entered the Ariake Sea and landed again near Yanagawa City, Fukuoka Prefecture with TY intensity at around 18 UTC on 18 September. Gradually turning northeastward, it was downgraded to severe tropical storm (STS) intensity at 00 UTC on 19 September and entered the Sea of Japan at around 06 UTC the same day. It gradually turned eastward and transformed into an extratropical cyclone over the same waters by 18 UTC on 19 September. It crossed Honshu Island to the east-northeast and dissipated over the sea east of Japan at 06 UTC on 20 September.



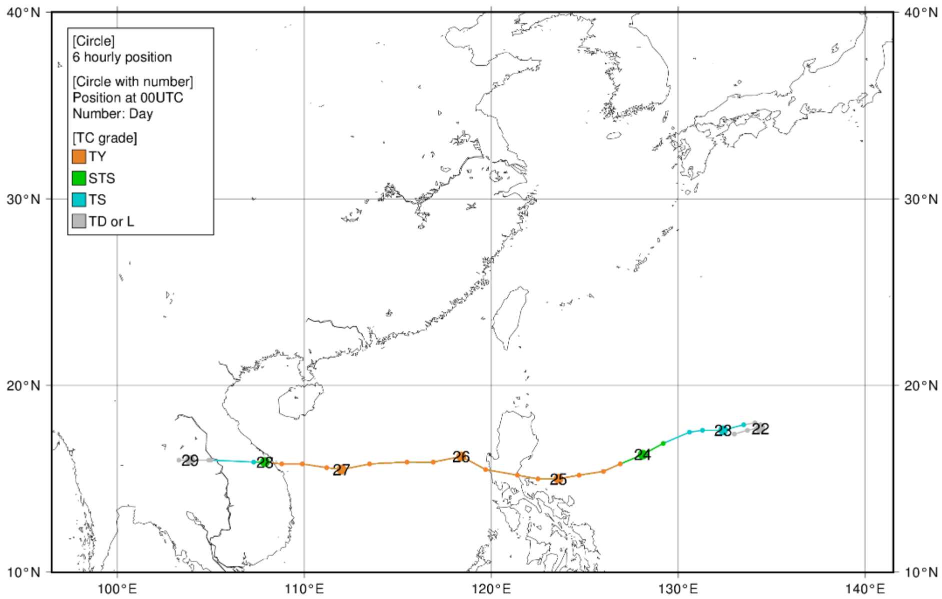
TALAS (2215)

TALAS formed as a tropical depression (TD) near the Ogasawara Islands at 18 UTC on 20 September 2022. It moved northward until 06 UTC on 21 September, and gradually turned northwestward. It was upgraded to tropical storm (TS) intensity and reached its peak intensity with maximum sustained winds of 35 kt over the sea south of Japan at 00 UTC on 22 September. Its central pressure was 1002 hPa at that time. TALAS continued to move northwestward and gradually turned to the north over the sea south of Japan, and its central pressure lowered to 1000 hPa at 00 UTC on 23 September. After moving over the same waters, it weakened to TD intensity south of the Kii peninsula at 12 UTC on 23 September. The TD moved northeastward and transitioned into an extratropical cyclone over the waters south of Shizuoka Prefecture by 00 UTC on 24 September. It further moved over the waters east of Honshu Island and dissipated over the waters southeast of Hokkaido Island at 18 UTC on 27 September.



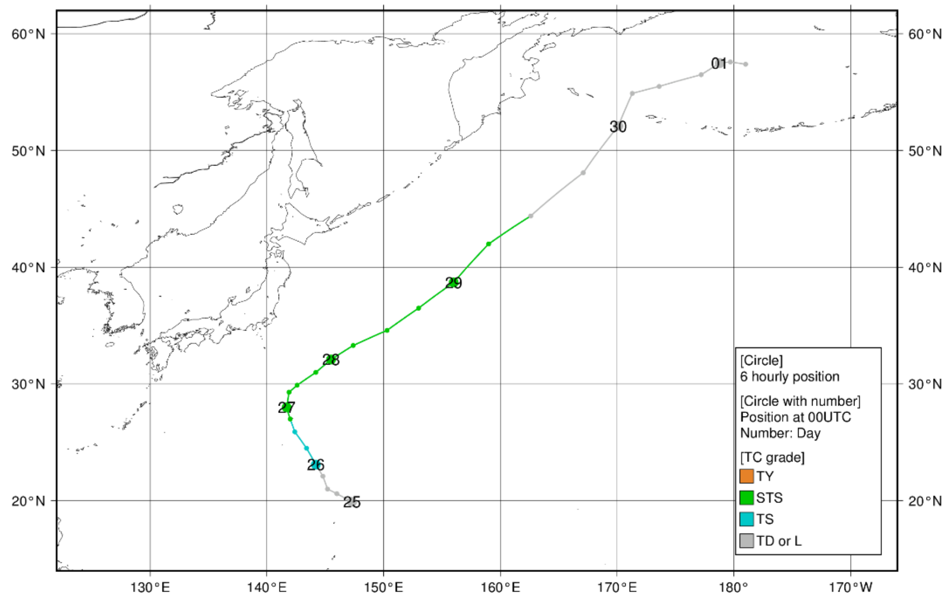
NORU (2216)

NORU formed as a tropical depression (TD) over the sea east of the Philippines at 06 UTC on 21 September 2022 and moved eastward. It turned sharply westward around 06 UTC on 22 September, and was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC the same day. It gradually turned west-southwestward and was upgraded to typhoon (TY) intensity over the sea east of the Philippines at 06 UTC on 24 September. It reached its peak intensity with maximum sustained winds of 95 kt and a central pressure of 940 hPa over the same waters at 00 UTC on 25 September. It gradually turned westward and crossed Luzon Island with TY intensity on the same day. After weakening to maximum sustained winds of 65 kt and a central pressure of 980 hPa over the South China Sea at 06 UTC on September 26, NORU developed again and reached maximum sustained winds of 85 kt and a central pressure of 950 hPa over the same waters at 00 UTC on 27 September. It hit Viet Nam before 00 UTC on 28 September, and weakened to TD intensity in eastern Thailand at 12 UTC the same day. It dissipated in the same country at 12 UTC on 29 September.



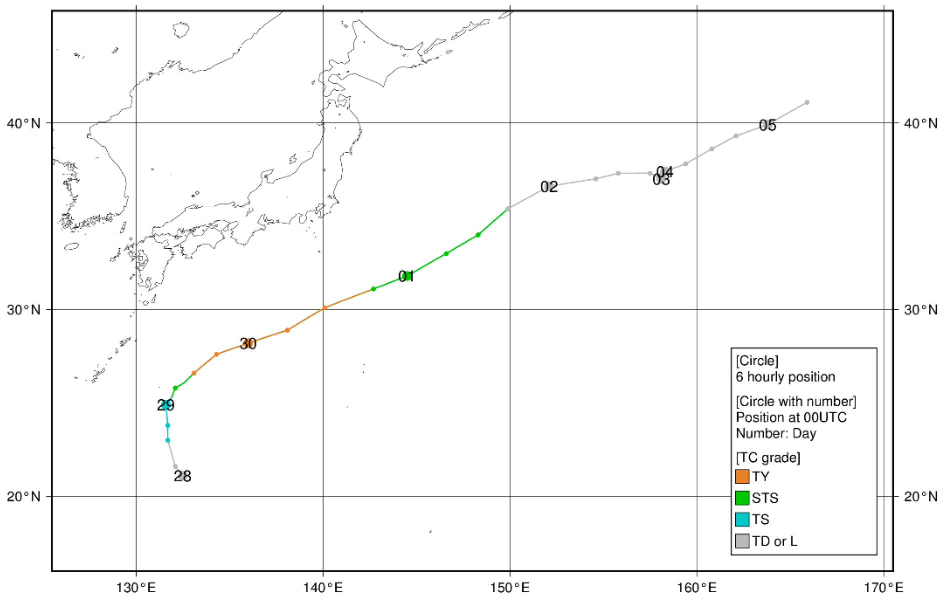
KULAP (2217)

KULAP formed as a tropical depression (TD) over the sea around the Mariana Islands at 00 UTC on 25 September 2022 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the sea around the Ogasawara Islands at 00 UTC on 26 September and was further upgraded to severe tropical storm (STS) intensity around Chichijima Island at 18 UTC the same day. It gradually turned northeastward and accelerated in that direction. It reached its peak intensity with maximum sustained winds of 60 kt over the sea east of Japan at 00 UTC on 28 September. Its central pressure was 975 hPa at that time and lowered to 970 hPa at 18 UTC the same day. Keeping its move northeastward, it transitioned into an extratropical cyclone over the sea east of the Kuril Islands by 12 UTC on 29 September. It entered the Bering Sea and crossed longitude 180 degrees east before 12 UTC on 1 October.



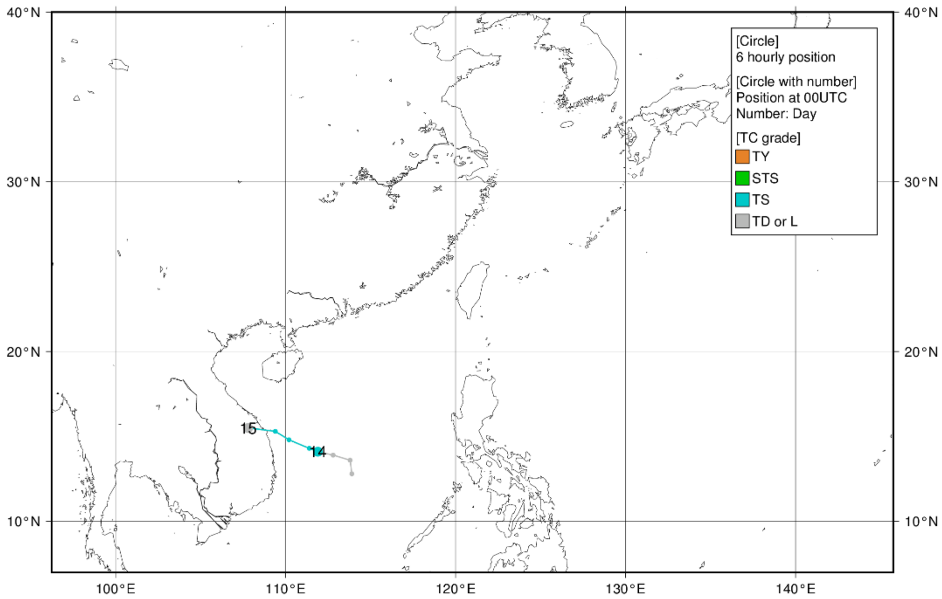
ROKE (2218)

ROKE formed as a tropical depression (TD) over the sea south of Japan at 00 UTC on 28 September 2022 and moved northward. It was upgraded to tropical storm (TS) intensity south of Minamidaitojima Island 12 hours later. After changing its move northeastward, it was upgraded to severe tropical storm (STS) intensity at 03 UTC on 29 September and was further upgraded to typhoon (TY) intensity nine hours later over the same waters and moved east-northeastward. It reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 975 hPa over the same waters at 00 UTC on 30 September. It gradually changed its move northeastward and transitioned into an extratropical cyclone over the sea east of Japan by 18 UTC on 1 October. It dissipated over the waters far off east of Japan at 12 UTC on 5 October



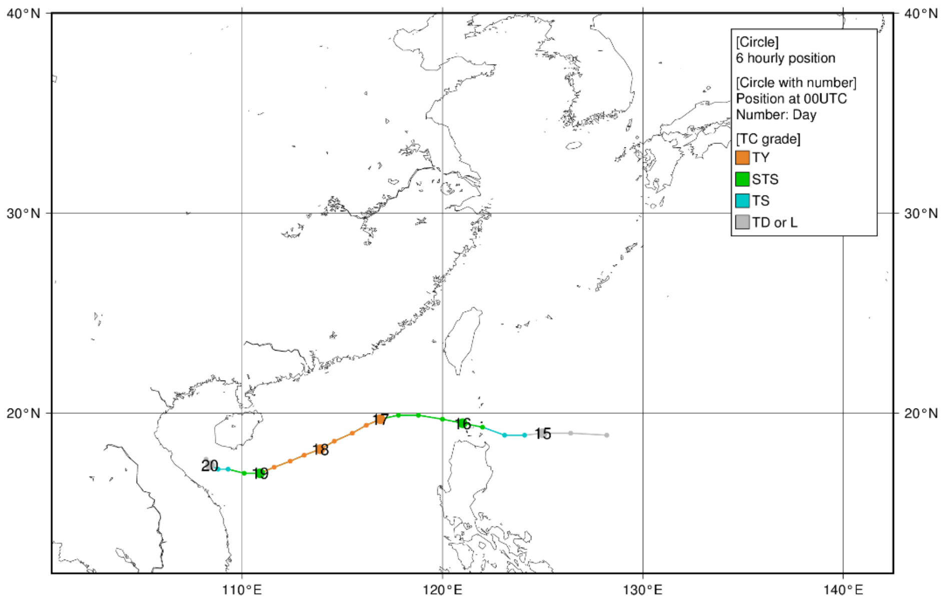
SONCA (2219)

SONCA formed as a tropical depression (TD) over the South China Sea at 06 UTC on 13 October 2022 and moved northward. After changing its move west-northwestward, it was upgraded to tropical storm (TS) intensity and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 998 hPa over the same waters at 00 UTC on 14 October. It moved northwestward and hit Viet Nam with TS intensity in the second half of 14 October before weakening to TD intensity in Viet Nam at 00 UTC on 15 October and dissipated six hours later



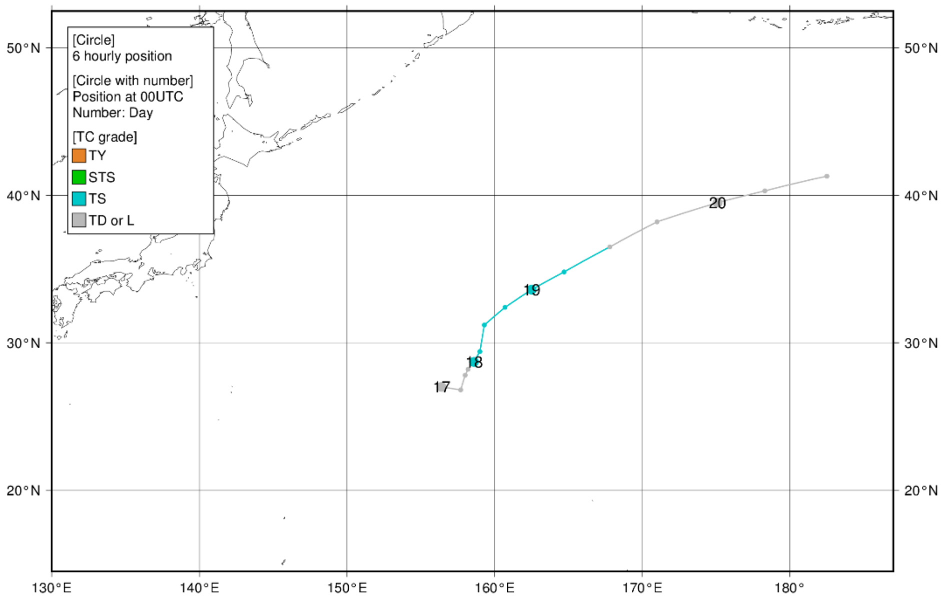
NESAT (2220)

NESAT formed as a tropical depression (TD) over the sea east of the Philippines at 12 UTC on 14 October 2022 and moved westward. It was upgraded to tropical storm (TS) intensity at 06 UTC on 15 October over the same waters and was upgraded to severe tropical storm (STS) intensity at 18 UTC the same day before passing the Bashi Channel. After entering the South China Sea, it gradually turned west-southwestward and was upgraded to typhoon (TY) intensity and reached its peak intensity with maximum sustained winds of 75 kt and a central pressure of 965 hPa at 12 UTC on 17 October. It downgraded to STS intensity at 00 UTC on 19 October and weakened to TS intensity over the same waters 12 hours later. It further weakened to TD intensity over the Gulf of Tonkin at 00 UTC on 20 October and dissipated over the same waters at 12 UTC the same day.



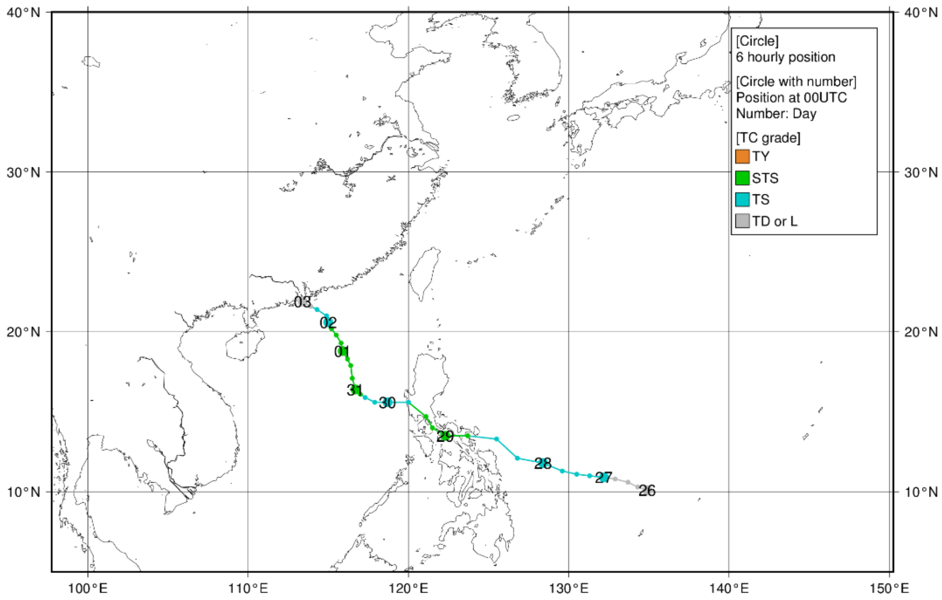
HAITANG (2221)

HAITANG formed as a tropical depression (TD) over the sea northeast of Minamitorishima Island at 00 UTC on 17 October 2022 and moved eastward. After changing its move north-northeastward, it was upgraded to tropical storm (TS) intensity and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 1004 hPa over the same waters at 00 UTC on 18 October. It gradually turned northeastward, and transitioned into an extratropical cyclone over the sea far off east of Japan by 12 UTC on 19 October. After entering the sea south of the Aleutian Islands, it moved east-northeastward and crossed longitude 180 degrees east before 12 UTC on 20 October.



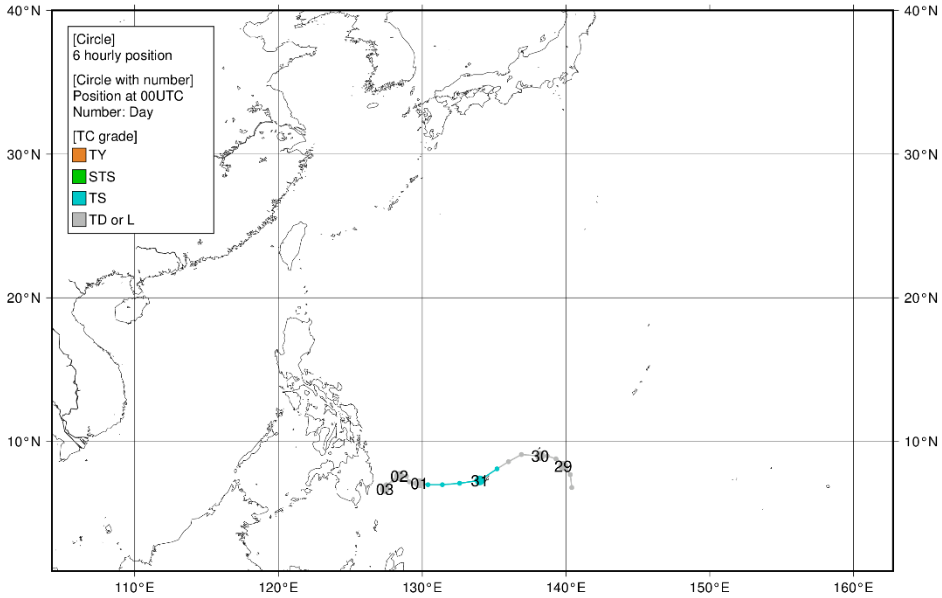
NALGAE (2222)

NALGAE formed as a tropical depression (TD) over the sea east of the Philippines at 00 UTC on 26 October 2022 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity at 00 UTC the next day over the same waters and kept its west-northwestward track. Turning westward, it was upgraded to severe tropical storm (STS) intensity at 18 UTC on 28 October and crossed Luzon Island with STS intensity from 28 to 29 October. Downgrading to TS intensity, it turned westward and entered the South China Sea around 18 UTC on 29 October. Gradually turning north-northwestward, it developed again and was upgraded to STS intensity over the same waters at 18 UTC on 30 October. Keeping its north-northwestward track, it reached its peak intensity with maximum sustained winds of 60 kt and a central pressure of 975 hPa over the same waters at 06 UTC on 31 October. It kept its peak intensity for about one day long and then rapidly weakened to TD intensity over the same waters at 18 UTC on 2 November. It slowly moved northwestward and dissipated over the same waters 12 hours later.



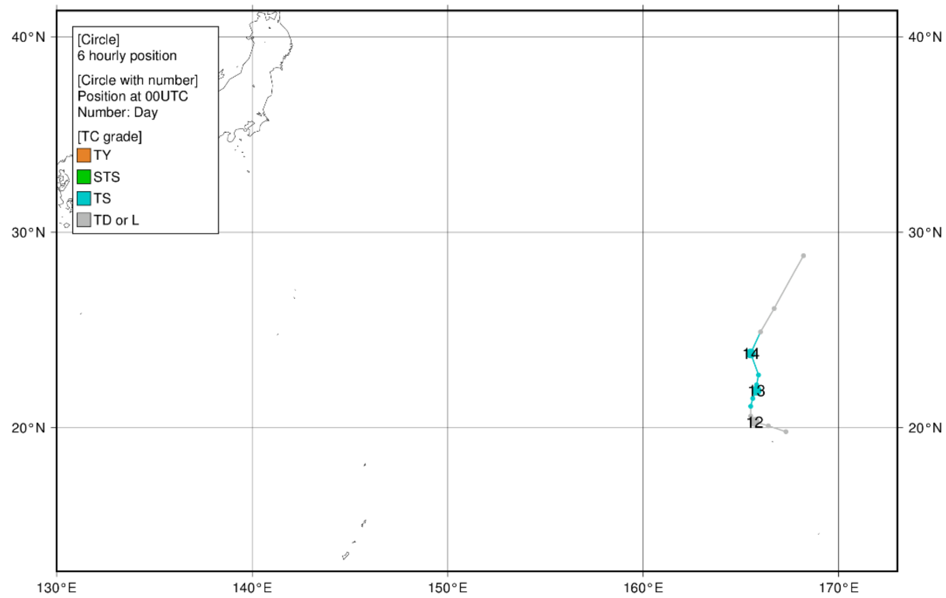
BANYAN (2223)

BANYAN formed as a tropical depression (TD) near the Caroline Islands at 06 UTC on 28 October 2022 and moved northward. After changing its move southwestward around 06 UTC on 30 October, it was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on the same day and reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 1002 hPa over the same waters at 00 UTC on 31 October. It continued to move westward and weakened to TD intensity over the sea east of Mindanao Island at 00 UTC on 1 November. After moving westward, it gradually became stationary over the same waters until 18 UTC on 2 November. It dissipated over the same waters at 06 UTC on 3 November.



YAMANEKO (2224)

YAMANEKO formed as a tropical depression (TD) over the sea northeast of Wake Island at 12 UTC on 11 November 2022. It moved west-northwestward, and then gradually turned northward around 00 UTC on 12 November. It was upgraded to tropical storm (TS) intensity and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 1004 hPa over the sea north of Wake Island at 12 UTC the same day. Gradually turning north-northeastward around 00 UTC on 14 November, it weakened to TD intensity over the same waters at 06 UTC the same day and dissipated 18 hours later.



PAKHAR (2225)

PAKHAR formed as a tropical depression (TD) over the sea east of the Philippines at 00 UTC on 10 December 2022 and moved northwestward. It gradually turned northeastward and was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on 11 December. It reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 998 hPa six hours later. After changing its move eastward, it transitioned into an extratropical cyclone over the sea south of Japan by 12 UTC on 12 December and dissipated six hours later.