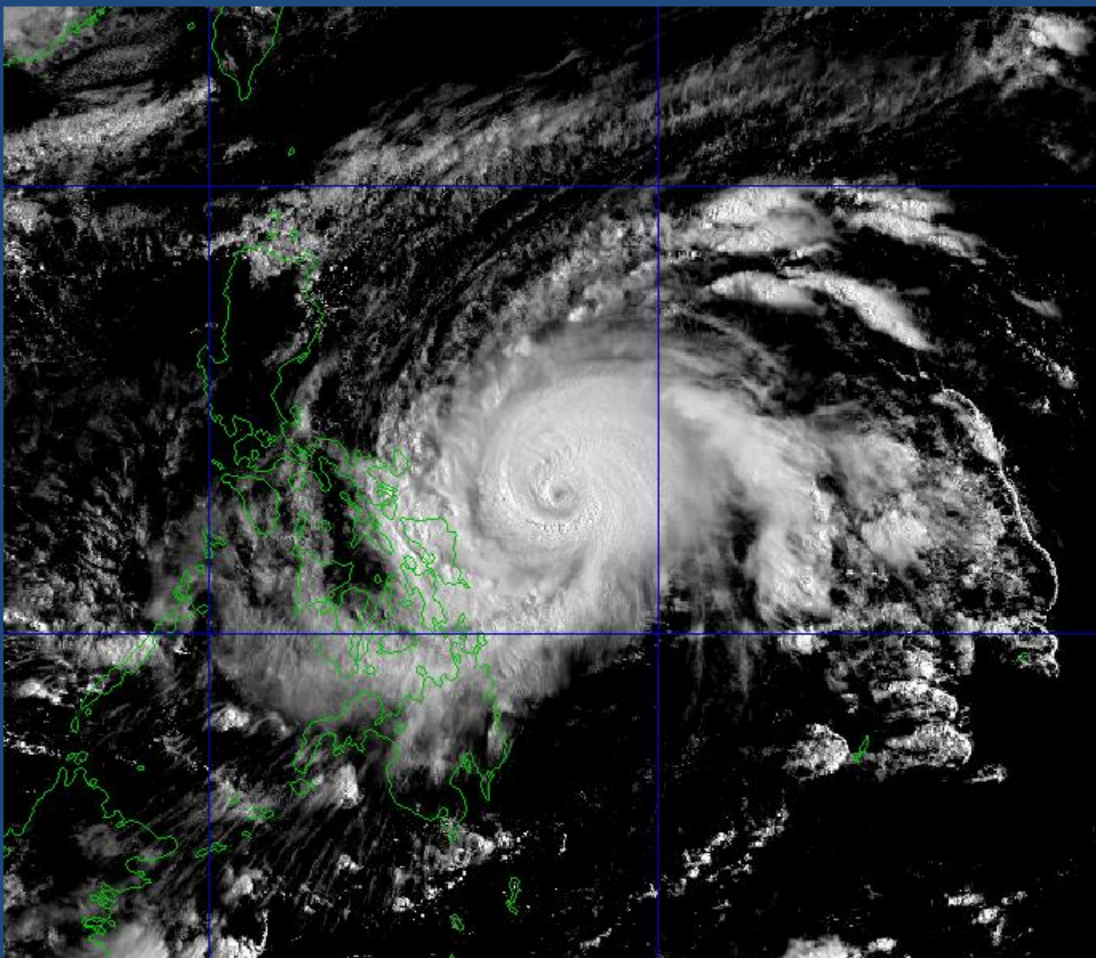
Annual Report
on the Activities of
the RSMC Tokyo - Typhoon Center
2021



TY SURIGAE 00 UTC, 18 April 2021

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 2021, Chapter 1 outlines routine operations performed at the Center and its operational products, while Chapter 2 reports on its major activities in 2021. Chapter 3 describes atmospheric and oceanic conditions in the tropics and notes the highlights of TC activity in 2021. 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 2021 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 2021

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

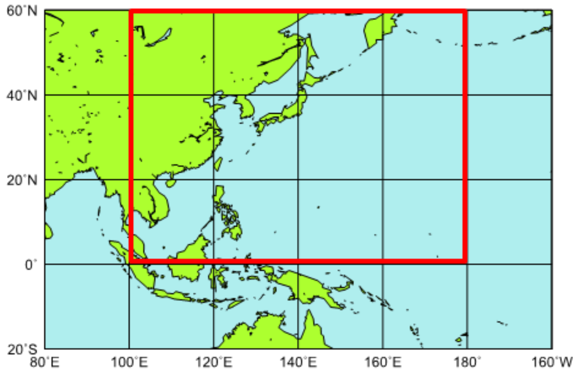

Figure 1.1
Area of responsibility of the RSMC Tokyo - Typhoon Center

1.1 Analysis

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

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

1.2 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 January, 2021) has a horizontal resolution of approximately 20 km and 128 vertical layers, while GEPS (TL479; upgraded on 30 March 2021) has 51 members with a horizontal resolution of approximately 40 km and 128 vertical layers. The number of vertical layers for both the GSM and GEPS were increased from 100 to 128 in 2021. In addition, the numbers of GEPS ensemble members for each initial time was increased from 27 to 51. 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.

RSMC Tropical Cyclone Advisory (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) RSMC Guidance for Forecast by GSM (FXPQ20-25 RJTD: via GTS)

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

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

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

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

The RSMC Guidance for Forecast by GEPS reports the results of predictions made by the GEPS; which is run four times a day with initial analyses at 00, 06, 12 and 18 UTC. The guidance presents 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) SAREP (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

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

intensity or higher at 00, 03, 06, 09, 12, 15, 18 and 21 UTC (TDs expected to reach TS intensity or higher within 24 hours at 00, 06, 12 and 18), and reports the following elements:

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

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

BUFR/CREX templates for translation into table-driven code forms are provided on the WMO website at 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)
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, the IWXXM GML format (Annex 3, Amendment 78, Appendix 2, para. 5.1.3) was introduced and certain element changes (Amendments 78 and 79, Table A2-2) were made, along with the commencement of tropical cyclone advisory messages in IWXXM 3.0 format on the TCAC Tokyo website.

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 2021

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 2021 are listed in Table 2.1.

Table 2.1 Monthly and annual totals of products issued by the RSMC Tokyo - Typhoon Center in 2021

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
IUCC10	0	35	0	93	13	87	150	143	205	186	9	90	1011
WTPQ20-25	0	41	0	98	22	97	163	163	214	203	12	96	1109
WTPQ30-35	0	20	0	48	12	47	78	81	105	99	6	47	543
WTPQ50-55	0	41	0	98	22	97	163	163	214	203	12	96	1109
FXPQ20-25	0	20	0	48	11	47	79	79	105	99	6	47	541
FXPQ30-35	0	20	0	48	11	47	79	79	105	99	6	47	541
FKPQ30-35	0	20	0	49	11	47	80	80	106	99	6	47	545
AXPQ20	5	5	0	0	1	0	1	2	1	1	5	5	26

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 2021, the 23rd issue of the RSMC Technical Review was issued with the following area of focus:

1. Upgrades to JMA's Operational NWP High-resolution Global Model

In December 2021, the Center published the *Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2020*. 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 2021, preparations were made for the 21st event to be held from 11 to 13 January 2022. Amid the COVID-19 pandemic, the course was held virtually (as in March 2021) with 55 attendees from eight Typhoon Committee Members (China, Hong Kong China, Macao China, Malaysia, the Philippines, the Republic of Korea, Thailand, the United States of America and Viet Nam), along with two invited lecturers.

The 2022 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 2021, was conducted for two TCs:

1. Typhoon (TY) Chanthu (2114), from 00 UTC 9 September to 23 UTC 13 September 2021
2. Severe Tropical Storm (STS) Kompasu (2118), from 00 UTC 9 October to 23 UTC 14 October 2021

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 2021

2.5.1 Services Introduced in 2021

The Center introduced the services detailed below in 2021.

(1) Commencement of five-day storm wind probability maps for tropical depression (TD) expected to reach TS intensity within 24 hours
In response to the September 2020 commencement of five-day track and intensity forecast provision for TDs expected to reach TS intensity within 24 hours, five-day storm wind probability maps were updated in December 2021. These are provided when named TCs or TDs expected to reach TS intensity are present.

(2) Full operation of the TC communication platform
The RSMC Tokyo – Typhoon Center’s TC communication platform (developed and maintained by the Center since July 2019) began full operation in May 2021, supporting enhanced interaction between operational forecasters and the Center, as well as sharing of advance-notice updates. Many inquiries

relating to tropical cyclones were submitted in 2021, with related discussions helping to clarify TC status and forecasts.

2.5.2 Upgrades of Numerical Typhoon Prediction Website

The changes outlined below were made to the NTP website in 2021.

(1) Enhanced use of ensemble forecasts
GEPS upgrades were made in March 2021, with increased ensemble size (27 to 51) for forecasts with lead times up to 264 hours. The ensemble size for track prediction provided on the NTP website was upgraded accordingly in May 2021.

(2) Update of five-day storm wind probability map
Five-day storm wind (50 kt or above) probability maps for Tropical Depressions (TDs) expected to reach Tropical Storm (TS) intensity or higher within 24 hours were added to the product in December 2021.

Chapter 3
Summary of the 2021 Typhoon Season

In 2021, 22 TCs of TS intensity or higher formed over the western North Pacific and the South China Sea. This total is below the climatological normal[2] frequency of 25.1. Among these 22 TCs, 9 reached TY intensity, 5 reached severe tropical storm (STS) intensity and 8 reached TS intensity (Table 3.1).

Table 3.1 List of tropical cyclones reaching TS intensity or higher in 2021

Tropical Cyclone			Duration (UTC) (TS or higher)	Minimum Central Pressure (UTC)	lat (N)	lon (E)	(hPa)	Max Wind (kt)
TS	Dujuan	(2101)	180000 Feb - 211200 Feb	181200	7.2	131.9	996	40
TY	Surigae	(2102)	131800 Apr - 250000 Apr	171800	12.6	128.4	895	120
TS	Choi-wan	(2103)	301800 May - 050600 Jun	311800	9.7	128.3	998	40
TS	Koguma	(2104)	111800 Jun - 130600 Jun	120600	19.4	108.9	996	35
TY	Champi	(2105)	230000 Jun - 271800 Jun	250600	21.9	139.1	980	65
TY	In-fa	(2106)	171200 Jul - 271800 Jul	211800	23.7	126.2	950	85
TY	Cempaka	(2107)	181800 Jul - 220000 Jul	200000	21.3	112.4	980	70
TS	Nepartak	(2108)	231200 Jul - 280600 Jul	261800	34.3	142.9	990	40
TS	Lupit	(2109)	040000 Aug - 090000 Aug	081800	33.9	132.3	984	45
STS	Mirinae	(2110)	050600 Aug - 100000 Aug	071800	33.2	139.5	980	50
STS	Nida	(2111)	040000 Aug - 080000 Aug	061800	37.8	155.5	992	55
TS	Omais	(2112)	201200 Aug - 240000 Aug	212100	23.9	126.1	994	45
STS	Conson	(2113)	060000 Sep - 111800 Sep	091200	15.8	115.1	992	50
TY	Chanthu	(2114)	061200 Sep - 180600 Sep	101800	19.5	122.3	905	115
TS	Dianmu	(2115)	230600 Sep - 231800 Sep	230600	14.8	110.5	1000	35
TY	Mindulle	(2116)	231200 Sep - 020000 Oct	260600	18.8	136.7	920	105
TS	Lionrock	(2117)	071800 Oct - 100600 Oct	071800	17.3	110.9	994	35
STS	Kompasu	(2118)	080000 Oct - 141200 Oct	111800	18.8	120.5	975	55
STS	Namtheun	(2119)	100000 Oct - 170000 Oct	160000	29.2	164.3	996	50
TY	Malou	(2120)	241800 Oct - 291200 Oct	271800	22.7	140.0	965	75
TY	Nyatoh	(2121)	300000 Nov - 040000 Dec	021800	19.5	137.5	925	100
TY	Rai	(2122)	130600 Dec - 201800 Dec	160600	9.9	126.0	915	105

3.1 Atmospheric and Oceanographic Conditions in the Tropics

The La Niña event that started in summer 2020 terminated in spring 2021. In boreal winter 2021 (December 2020 – February 2021), remarkably positive SST anomalies were observed west of 150°E, and remarkably negative anomalies were observed from 160°E to the central part. In association with the SST patterns, tropical convection was enhanced from the northern Indian Ocean to the Maritime Continent. The first named tropical cyclone (Dujuan) formed under atmospheric conditions associated with the La Niña event. In spring, tropical convection was enhanced over the western tropical North Pacific and cyclonic circulation anomalies were seen near the Philippines.

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

Though ENSO-neutral conditions have persisted throughout the boreal summer (June – August), negative SST anomalies were observed from the central to eastern part of the equatorial Pacific (Figure 3.1 (a)). The negative phase of an Indian Ocean Dipole (IOD) event emerged with remarkably positive SST anomalies south of Sumatra. Tropical convection was enhanced from the area southwest of Sumatra to the Maritime Continent, and was suppressed from the Bay of Bengal to the Philippines (Figure 3.1 (b)). Convective activity over the Asian summer monsoon region was weaker than normal. In the lower troposphere of the tropical region, anti-cyclonic circulation anomalies straddling the equator were seen over the western tropical Pacific (Figure 3.1 (c)). Intra-seasonal variation of the North Pacific Subtropical High (NPSH) was large. Westward expansion of the NPSH over the seas south of Japan was weaker than normal in July and stronger than normal in August. The timing of TC formations is significantly affected by these clear intra-seasonal variations.

In the equatorial Pacific, La Niña-like SST conditions emerged in autumn (September – November). In addition, the negative phase of the IOD persisted with remarkably positive SST anomalies over west of Sumatra. Tropical convection was suppressed from the western to central equatorial Pacific. It is likely that circulation anomalies were associated with the SST anomalies observed in the equatorial Pacific and the negative phase of the IOD.

From June to August, there were fewer TC formations than the climatological normal. This is attributable to weaker-than-normal Asian summer monsoon activity and the negative phase of the IOD, which suppressed convection in the western part of the tropical North Pacific where many TCs climatologically form.

2021 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 2021

A total of 22 named TCs formed over the western North Pacific and the South China Sea in 2021, which was below the climatological normal. Monthly and its normal numbers of named TC formation are shown in Figure 3.2, and the tracks of the 22 TCs are shown in Figure 3.3. Figure 3.4 shows the genesis points of the 22 TCs (dots) and related frequency distribution for past years (1951 – 2020).

The 2021 typhoon season started in February with Dujuan (2101), which originally formed as a TD over the sea around the Caroline Islands, followed by seven named TCs from April to July. Eight named TCs formed during the peak period from August to September, and this was less than the normal of 10.7, mainly due to inactive convection over the sea where TCs frequently form.

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[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)

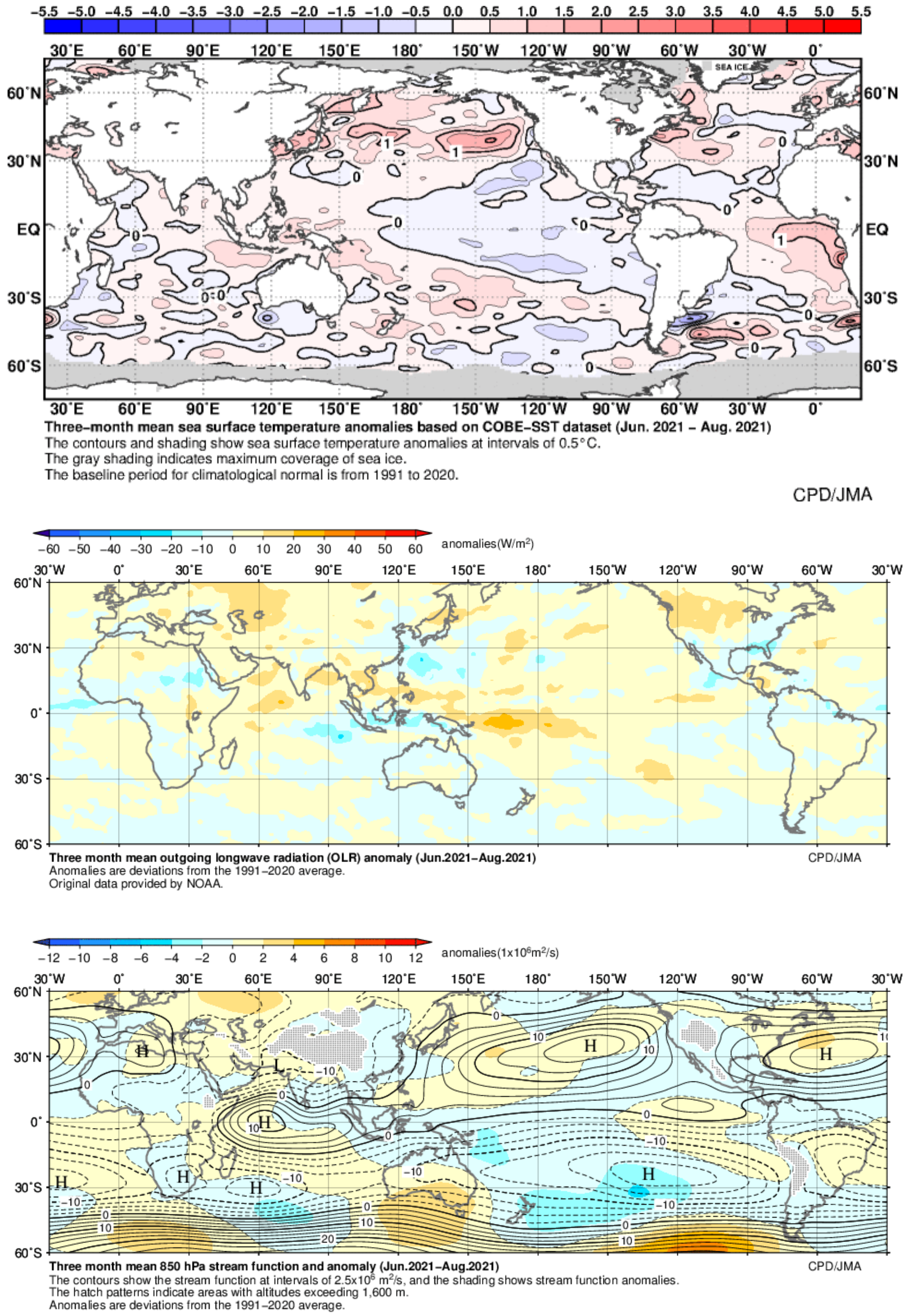

Figure 3.1 Three-month mean (a) sea surface temperature (SST) anomaly, (b) outgoing longwave radiation (OLR) anomaly, (c) 850-hPa stream function and related anomaly in boreal summer (June - August)
The base period for the normal is 1991 – 2020. (a) The contour interval is 0.5°C. Sea ice coverage areas 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 16.0˚N and 132.4˚E, which deviated west-southwestward 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 21.5˚N and 129.8˚E, with west-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 14.4˚N and 133.6˚E, with west-southwestward deviation from that of the 30-year autumn average (16.2˚N and 137.0˚E). The westward shift of the mean genesis point from autumn onward is partly attributed to the La Niña event that persisted from this season onward.

The mean duration of TCs sustaining TS intensity or higher was 5.5 days, longer than that of the 30-year average (5.2 days). The mean duration of TCs sustaining TS intensity or higher formed in summer was 4.6 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 5.7 days, longer than that of the 30-year average (5.4 days).

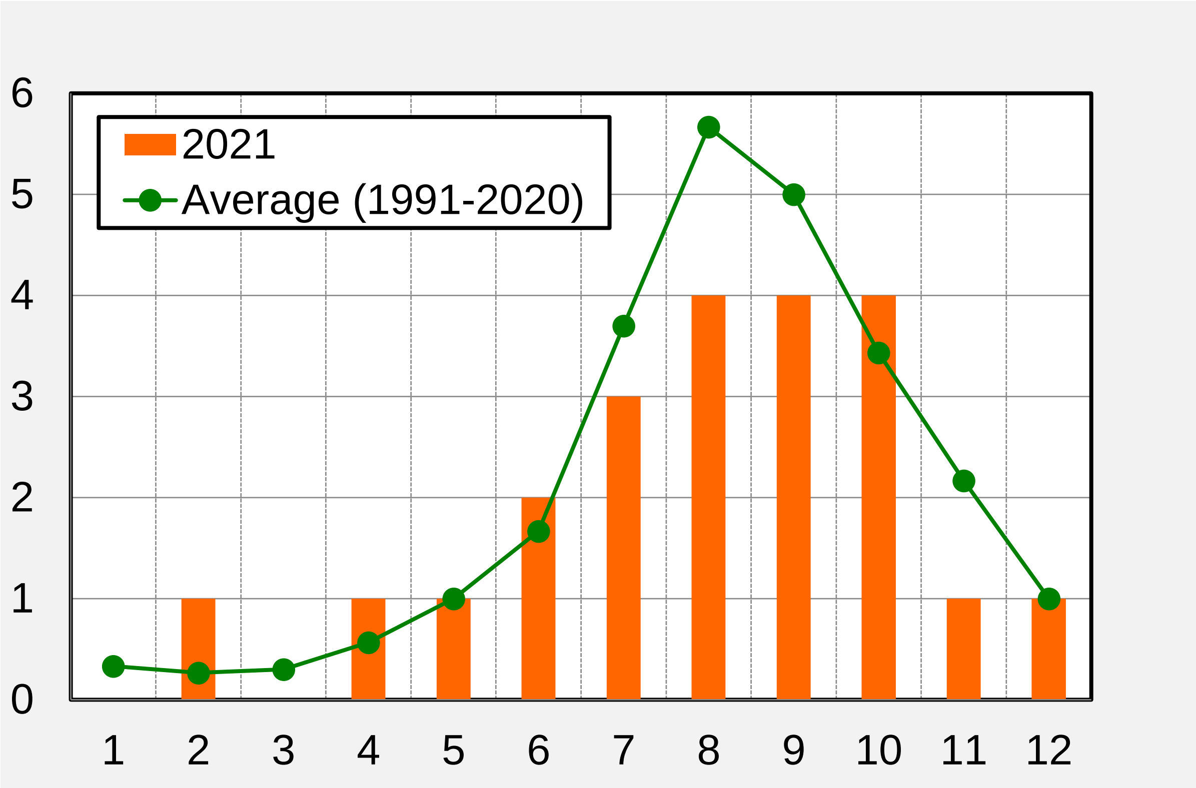

Figure 3.2 Monthly number of named TC formation for 2021 compared to the climatological normal

[4] The 30-year averaging period is from 1981 to 2010

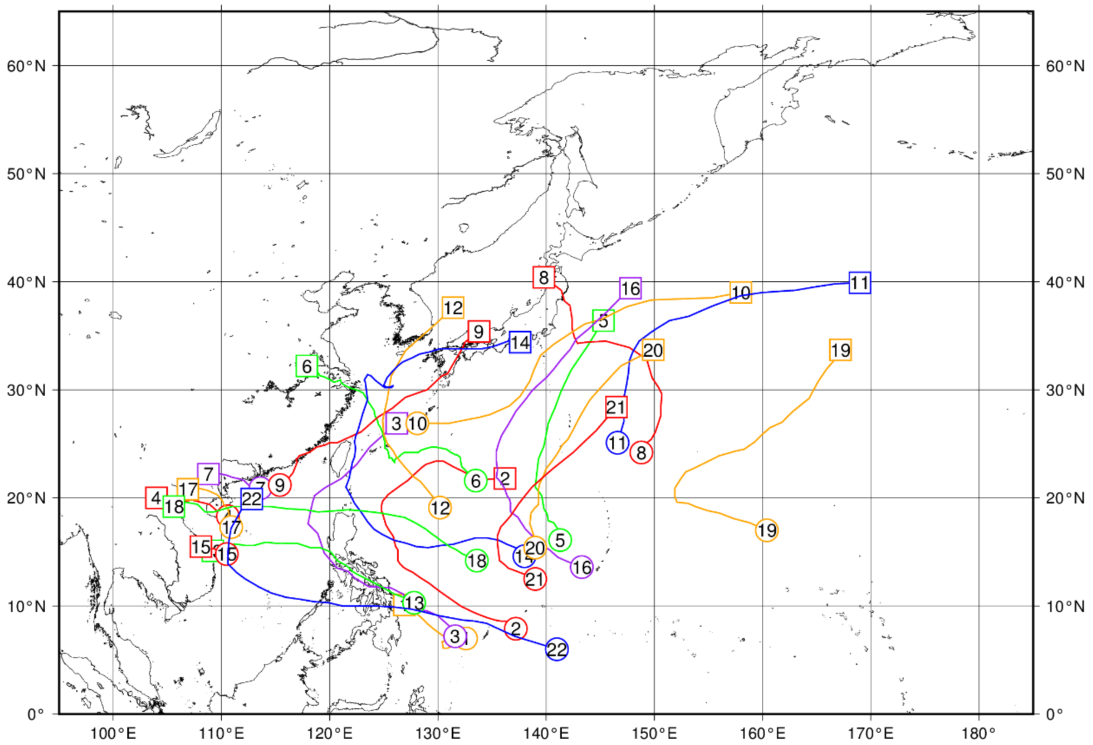

Figure 3.3 Tracks of the 22 named TCs that formed in 2021. TC tracks for those with an intensity of TS or higher are shown.

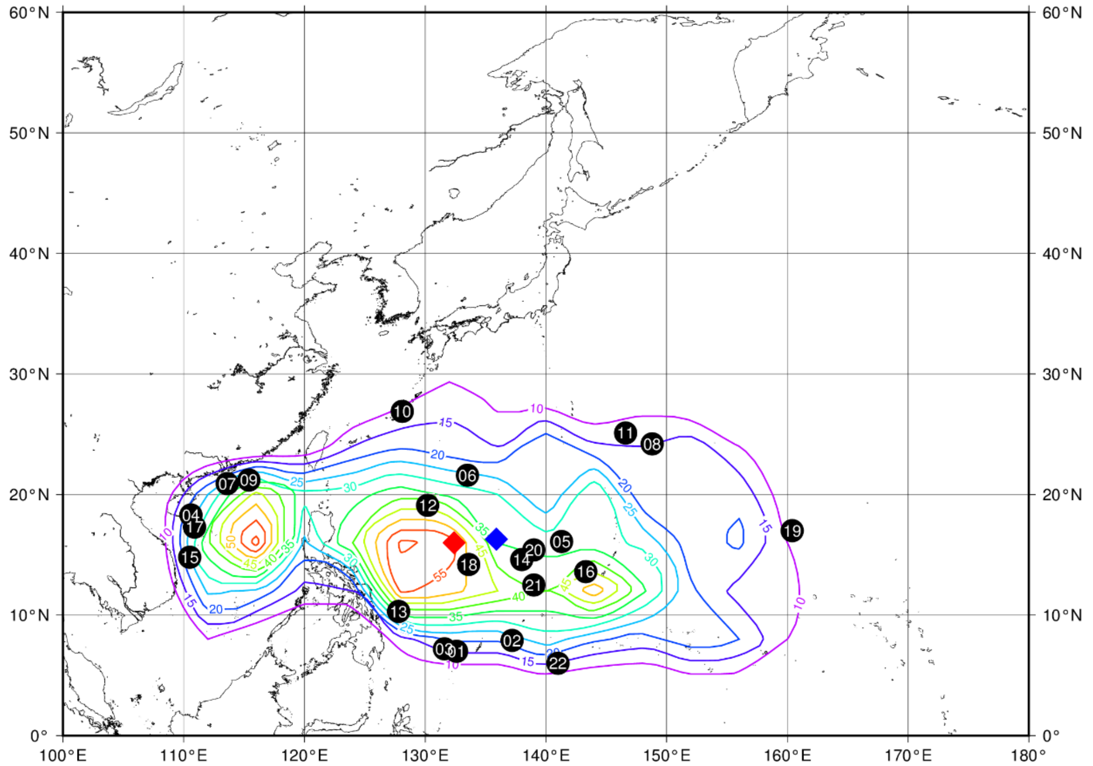

Figure 3.4 Genesis points of the 22 named TCs forming in 2021 (dots) and related frequency distribution for 1951 - 2020 (lines). Red and blue diamonds show the mean genesis points of TCs forming in 2021 and the 30-year average period (1991 – 2020), respectively.

Chapter 4
Verification of Forecasts and Other Products in 2021

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

Operational forecasts for the 22 TCs of TS intensity or higher that formed in 2021 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 2021 were 87, 157, 225, 261 and 264 km for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively. 120-hour forecast errors in 2021 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 2021 were 51% (59% in 2020), 62% (71%), 66% (73%), 68% (76%) and 71% (78%), respectively.

The details of errors including improvement ratios to CLIPER for each named TC that formed in 2021 are summarized in Table 4.1. Forecasts for Choi-wan (2103), Lupit (2109) and Namtheun (2119) were characterized by large errors. Those in forecasts for Choi-wan (2103) (Namtheun (2119)) were attributed to the fact that guidance models predict a weaker (stronger) North Pacific Subtropical High, which resulted in large track errors. Those in forecasts for Lupit (2109) were attributed to the difficulty inherent in estimating

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[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.

the influence of land (southern part of China and Taiwan) on the TC. Meanwhile, forecasts for Surigae (2102), Mindulle (2116) and Kompasu (2118) showed relatively small errors.

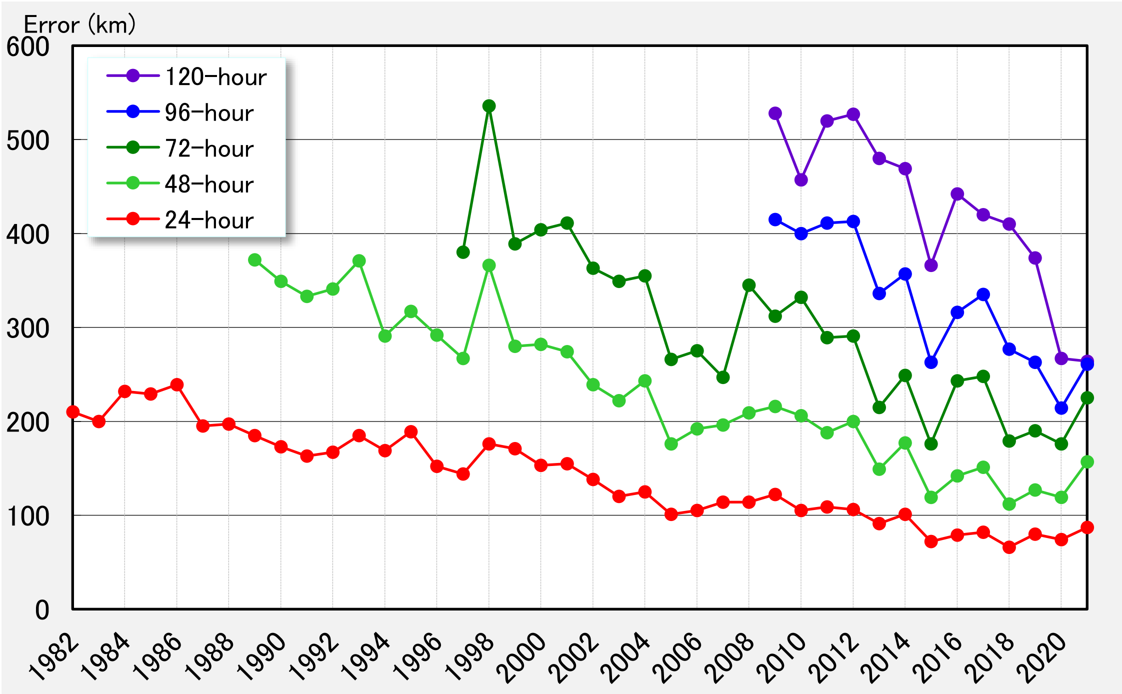

Figure 4.1 Annual mean position errors in 24-, 48-, 72-, 96- and 120-hour operational track forecasts

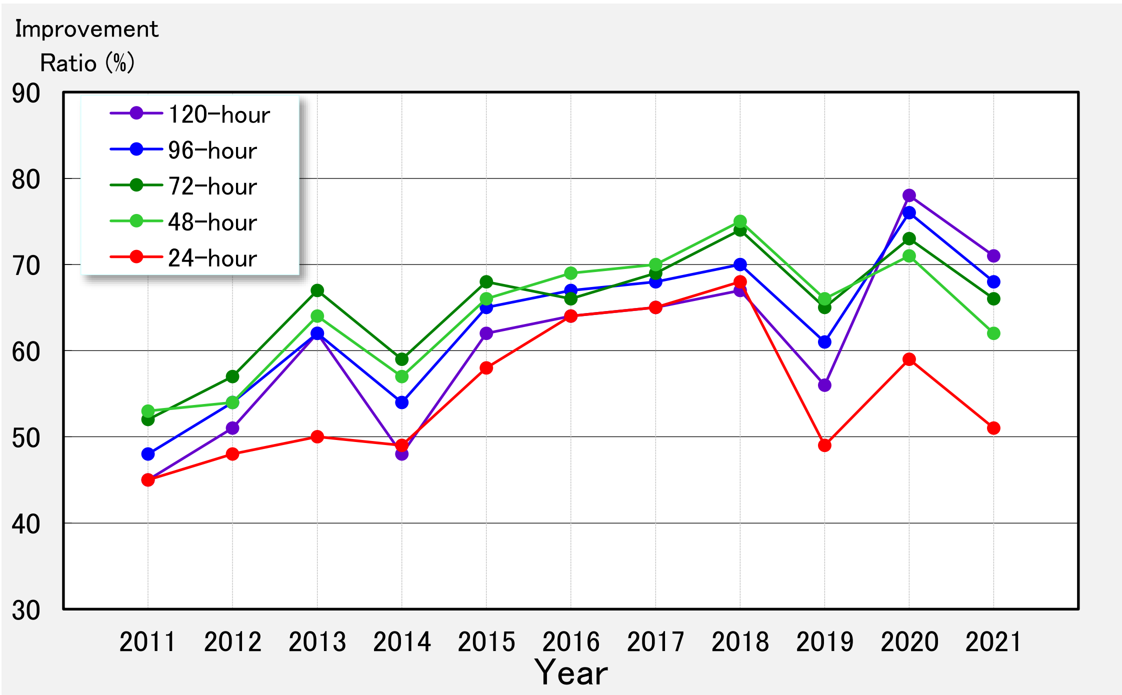

Figure 4.2 Annual mean improvement ratios in 24-, 48-, 72-, 96- and 120-hour operational track forecasts.

Table 4.1 Mean position errors of 24-, 48-, 72-, 96- and 120-hour operational forecasts for each named TC that formed in 2021. 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. (%)
TS	Dujuan	(2101)	170	65	10	27	270	32	6	-4	382	13	2	11	-	-	0	-	-	-	0	-
TY	Surigae	(2102)	46	29	41	73	74	47	37	79	105	70	33	79	123	51	29	81	148	69	25	81
TS	Choi-wan	(2103)	145	63	18	37	359	64	9	16	497	81	6	22	553	130	3	30	-	-	0	-
TS	Koguma	(2104)	62	1	2	42	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Champi	(2105)	82	46	15	43	142	78	11	52	176	110	7	61	140	56	3	63	-	-	0	-
TY	In-fa	(2106)	44	19	37	69	92	42	33	74	176	65	29	68	275	118	25	56	380	195	21	49
TY	Cempaka	(2107)	41	25	9	52	70	50	5	55	326	0	1	-55	-	-	0	-	-	-	0	-
TS	Nepartak	(2108)	110	51	15	64	157	71	11	77	164	98	7	85	324	32	3	73	-	-	0	-
TS	Lupit	(2109)	183	167	16	12	485	350	11	-17	650	331	8	19	679	268	4	43	-	-	0	-
STS	Mirinae	(2110)	98	91	15	63	110	63	11	81	116	91	7	89	196	46	3	88	-	-	0	-
STS	Nida	(2111)	150	61	7	23	463	69	3	27	-	-	0	-	-	-	0	-	-	-	0	-
TS	Omais	(2112)	93	35	10	65	111	38	6	79	218	93	2	82	-	-	0	-	-	-	0	-
STS	Conson	(2113)	126	58	18	11	224	91	14	27	326	99	10	18	423	145	6	-8	479	152	2	-38
TY	Chanthu	(2114)	89	54	43	57	159	95	39	71	210	114	34	75	227	91	31	79	217	154	27	81
TS	Dianmu	(2115)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Mindulle	(2116)	46	27	30	54	59	24	26	74	86	42	22	78	103	59	18	79	139	68	14	72
TS	Lionrock	(2117)	50	28	6	56	82	26	2	71	-	-	0	-	-	-	0	-	-	-	0	-
STS	Kompasu	(2118)	67	44	22	56	69	41	18	85	110	64	14	88	172	90	10	88	209	131	6	88
STS	Namtheun	(2119)	169	125	24	0	438	253	20	-7	719	338	16	-26	914	328	10	-9	839	374	6	10
TY	Malou	(2120)	71	49	15	60	93	64	11	77	105	74	7	77	253	170	3	51	-	-	0	-
TY	Nyatoh	(2121)	73	67	12	69	129	68	8	84	345	73	4	79	-	-	0	-	-	-	0	-
TY	Rai	(2122)	53	27	26	68	72	31	22	78	115	71	18	81	178	77	14	80	261	67	10	75
Annual Mean (Total)			87	77	391	51	157	165	303	62	225	227	227	66	261	239	162	68	264	225	111	71

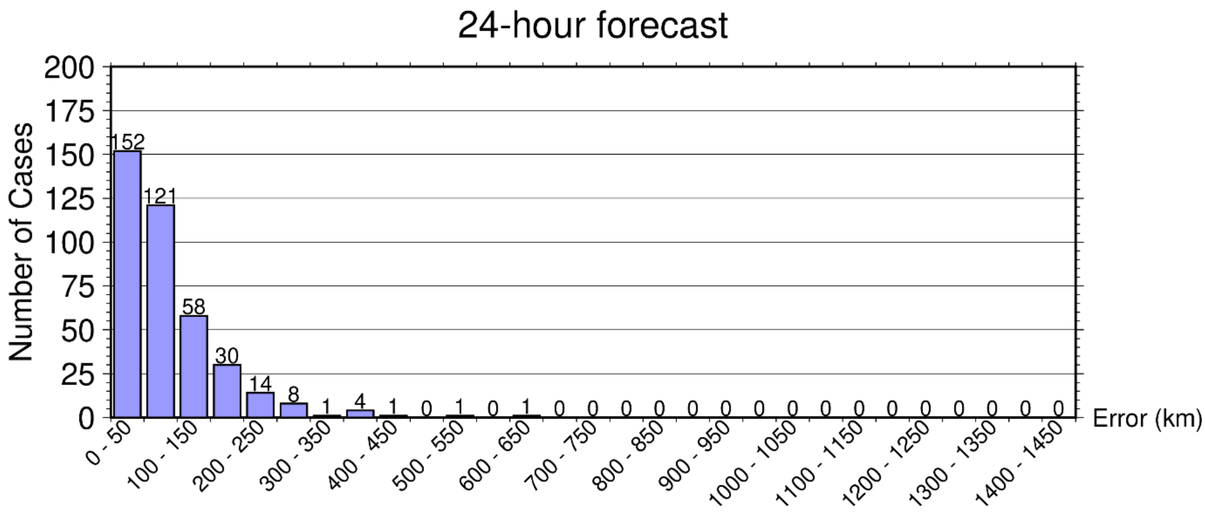

Figure 4.3 Histogram of 24-hour forecast position errors in 2021. (Histograms for 48-, 72-, 96- and 120-hour forecasts are available in the Appendix 5)).

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 85% (91% in 2020) of 24-hour forecasts, 86% (95%) of 48-hour forecasts, 89% (96%) of 72-hour forecasts, 91% (95%) of 96-hour forecasts and 89% (100%) of 120-hour forecasts had errors of less than 150, 300, 450, 500 and 600 km, respectively.

Figure 4.4 shows frequency distributions of 96-hour forecast position errors in longitudinal/latitudinal direction and cross-track/along-track direction (Scatter diagrams of 24-, 48-, 72- and 120-hour forecasts are available in Appendix 5.). While mean position biases are relatively small, a clear slow bias for Namtheun (2119) 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 2021. 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 93 km (93 km in 2020), and their hitting ratio was 67% (74%). The corresponding values for 48-hour forecasts were 168 km (163 km in 2020) and 72% (77%), those for 72-hour forecasts were 266 km (256 km in 2020) and 74% (83%), those for 96-hour forecasts were 386 km (362 km in 2020) and 86% (89%), and those for 120-hour forecasts were 533 km (505 km in 2020) and 93% (100%).

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

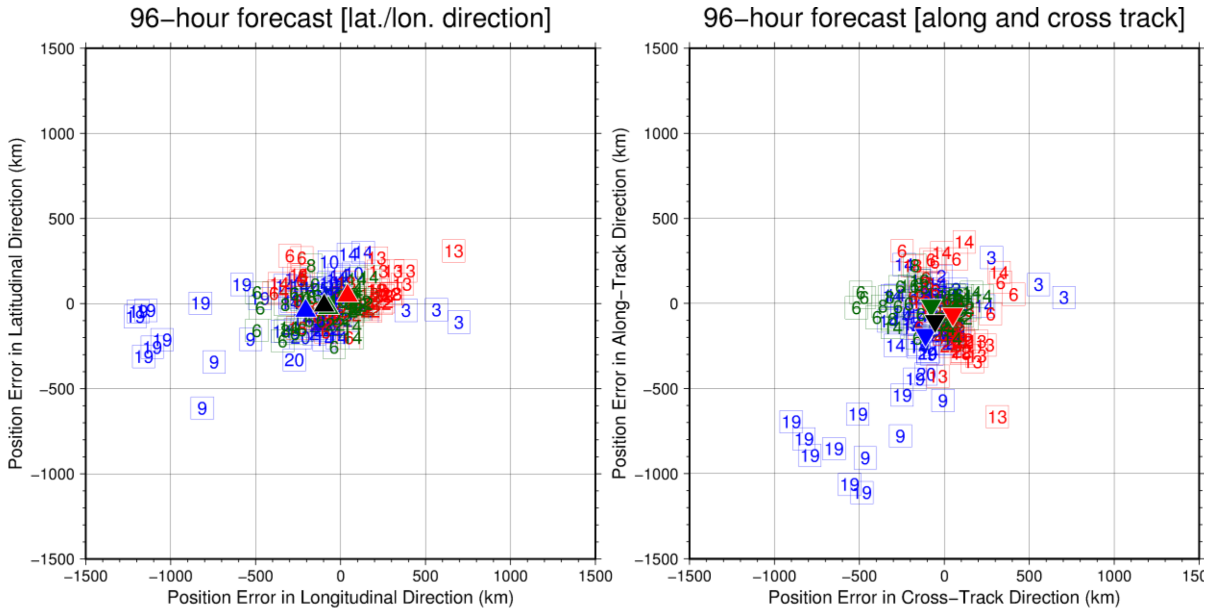

Figure 4.4 Scatter diagrams of 96-hour forecast position errors in longitudinal/latitudinal direction (left) and cross-/along-track direction (right) in 2021. (Scatter diagrams of 24-, 48-, 72- and 120-hour forecasts are available in Appendix 5.) Red, green and blue squares with TC numbers denote biases 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.

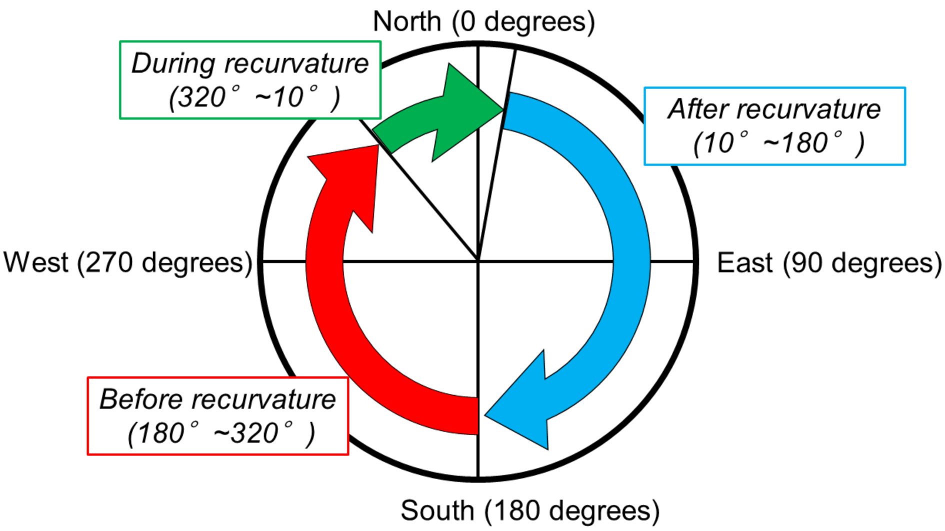

Figure 4.5 Definition of the stages before, during and after recurvature based on TC direction as calculated from positions at individual prediction times and those observed six hours prior.

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 2021. 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)
TS	Dujuan	(2101)	10	10	115	17	6	198	0	2	315	-	0	-	-	0	-
TY	Surigae	(2102)	90	41	85	86	37	151	94	33	235	100	29	344	100	25	477
TS	Choi-wan	(2103)	39	18	123	11	9	228	0	6	349	33	3	519	-	0	-
TS	Koguma	(2104)	100	2	130	-	0	-	-	0	-	-	0	-	-	0	-
TY	Champi	(2105)	73	15	93	73	11	177	86	7	280	100	3	426	-	0	-
TY	In-fa	(2106)	95	37	77	94	33	137	83	29	229	80	25	353	81	21	513
TY	Cempaka	(2107)	100	9	76	100	5	133	0	1	259	-	0	-	-	0	-
TS	Nepartak	(2108)	60	15	112	82	11	200	86	7	291	100	3	407	-	0	-
TS	Lupit	(2109)	38	16	123	36	11	227	25	8	338	25	4	491	-	0	-
STS	Mirinae	(2110)	67	15	85	73	11	159	100	7	275	100	3	407	-	0	-
STS	Nida	(2111)	29	7	90	0	3	139	-	0	-	-	0	-	-	0	-
TS	Omais	(2112)	60	10	97	100	6	208	100	2	315	-	0	-	-	0	-
STS	Conson	(2113)	33	18	102	36	14	179	30	10	285	67	6	435	50	2	556
TY	Chanthu	(2114)	53	43	88	59	39	161	59	34	270	90	31	401	100	27	568
TS	Dianmu	(2115)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
TY	Mindulle	(2116)	83	30	75	96	26	133	100	22	227	100	18	335	100	14	501
TS	Lionrock	(2117)	100	6	102	100	2	204	-	0	-	-	0	-	-	0	-
STS	Kompasu	(2118)	68	22	104	100	18	197	100	14	303	100	10	459	100	6	667
STS	Namtheun	(2119)	38	24	106	20	20	208	19	16	329	20	10	482	50	6	667
TY	Malou	(2120)	80	15	87	82	11	175	100	7	296	100	3	482	-	0	-
TY	Nyatoh	(2121)	83	12	97	88	8	188	50	4	324	-	0	-	-	0	-
TY	Rai	(2122)	81	26	76	95	22	133	100	18	220	100	14	327	100	10	496
Annual Mean (Total)			67	391	93	72	303	168	74	227	266	86	162	386	93	111	533

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 11.9 hPa (11.6 hPa in 2020), 15.9 hPa (15.0 hPa), 18.0 hPa (14.6 hPa), 19.0 hPa (13.9 hPa) and 17.9 hPa (13.0 hPa), respectively. The corresponding values for maximum wind speed were 5.0 m/s (5.8 m/s in 2020), 6.5 m/s (7.0 m/s), 6.9 m/s (7.3 m/s), 7.6 m/s (7.2 m/s) and 8.2 m/s (6.8 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 15% (28% in 2020), 25% (36%), 26% (44%), 24% (44%) and 17% (43%), respectively. The corresponding values of maximum wind were 11% (19% in 2020), 27% (31%), 37% (30%), 38% (28%) and 33% (15%), respectively.

The details of errors in operational central pressure forecasts, including improvement ratios to SHIFOR for each named TC that formed in 2021, are summarized in Table 4.3. The data for maximum wind speed forecasts are available in Appendix 5. Forecasts for Chanthu (2114), Mindulle (2116) and Rai (2122) were characterized by large errors attributed to the difficulty of estimation for rapid intensification and weakening.

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 67% (61% in 2020) of 24-hour forecasts had errors of less than ±3.75 m/s, with figures of ±6.25 m/s for 72% (69%) of 48-hour forecasts, ±6.25 m/s for 69% (69%) of 72-hour forecasts, ±8.75 m/s for 80% (85%) of 96-hour forecasts and ±8.75 m/s for 76% (88%) of 120-hour forecasts.

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[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.
Merrill, R. T., 1980: A statistical tropical cyclone motion forecasting system for the Gulf of Mexico. *NOAA Tech. Memo. NWS NHC 14*, 21 pp.

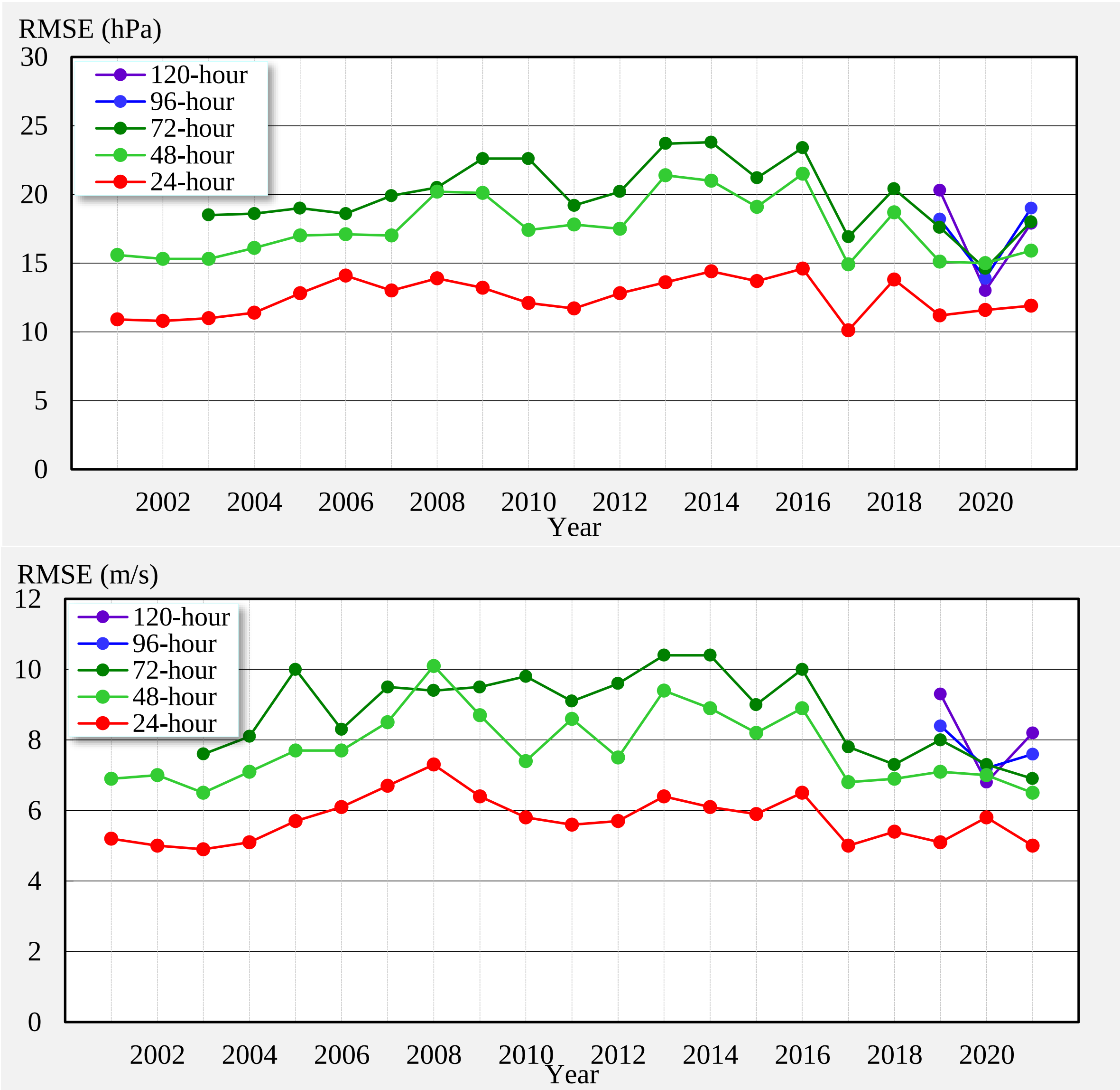
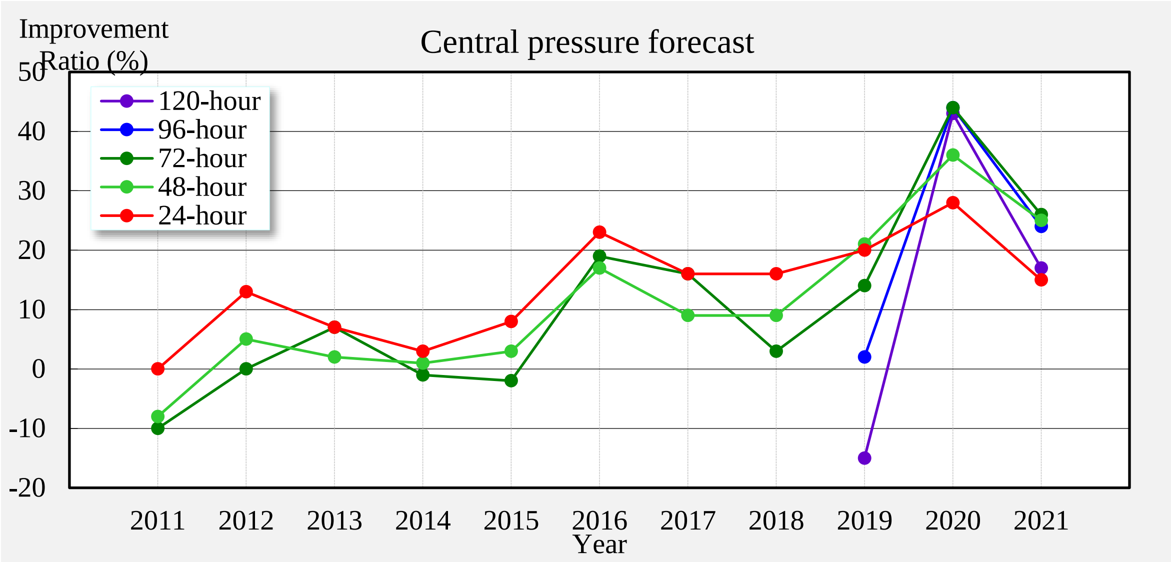


Figure 4.6 Annual RMSEs in 24-, 48, 72-, 96- and 120-hour operational central pressure (top) and maximum wind speed (bottom) forecasts



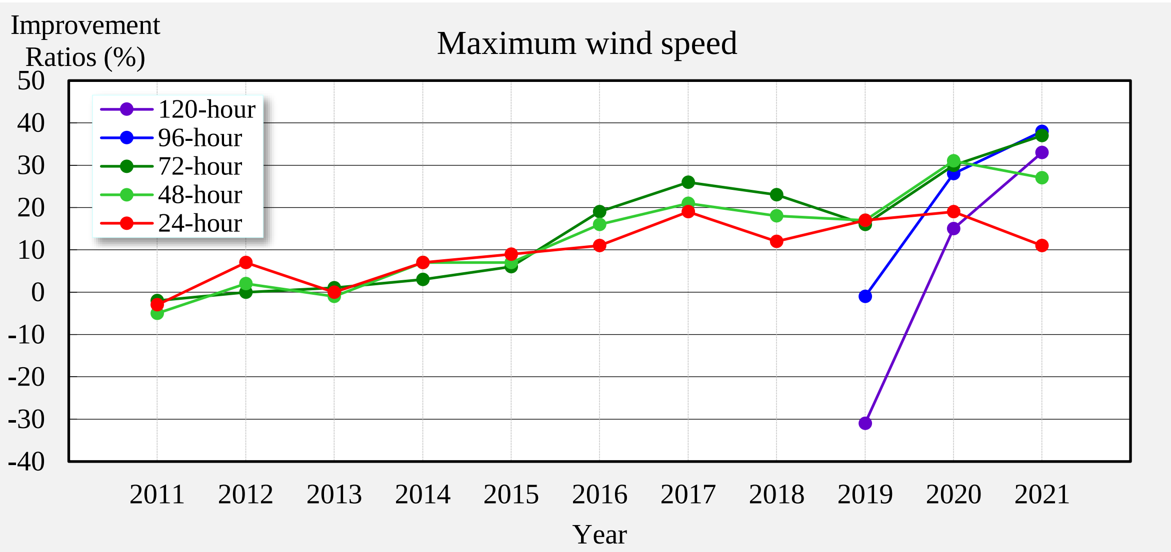


Figure 4.7 Annual mean improvement ratios in 24-, 48, 72-, 96- and 120-hour operational central pressure (top) and maximum wind speed (bottom) forecasts

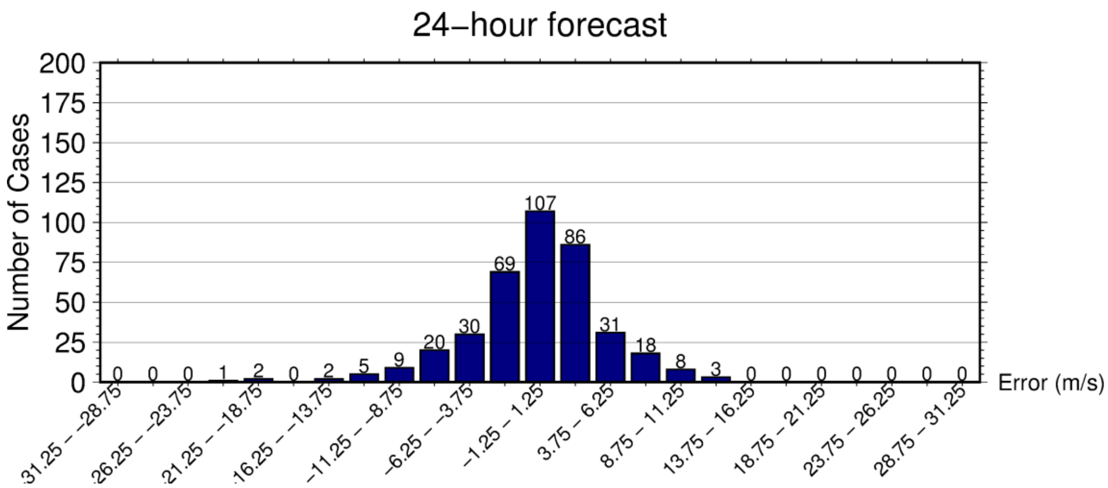


Figure 4.8 Histogram of 24-hour forecast maximum wind speed errors in 2021. (Histograms for 48-, 72-, 96- and 120-hour forecasts are also available at Appendix 5).

Table 4.3 Mean errors of 24-, 48-, 72-, 96- and 120-hour operational central pressure forecasts for each named TC that formed in 2021. 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. (%)
TS	Dujuan	(2101)	-3.0	3.8	10	56	-9.0	9.1	6	26	-10.0	10.0	2	52	-	-	0	-	-	-	0	-
TY	Surigae	(2102)	5.7	15.2	41	-9	7.7	17.5	37	33	7.3	20.4	33	35	4.4	19.2	29	37	-0.6	12.7	25	49
TS	Choi-wan	(2103)	1.8	3.1	18	78	0.7	3.8	9	87	1.7	3.9	6	91	2.0	2.0	3	96	-	-	0	-
TS	Koguma	(2104)	-1.0	1.4	2	80	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Champi	(2105)	-3.1	8.7	15	13	-2.9	10.3	11	54	-3.1	5.8	7	81	-4.0	4.3	3	89	-	-	0	-
TY	In-fa	(2106)	-1.1	7.9	37	4	-1.3	9.6	33	18	2.0	7.9	29	41	10.9	12.0	25	22	15.7	18.1	21	-63
TY	Cempaka	(2107)	3.2	6.5	9	52	1.2	1.5	5	92	0.0	0.0	1	100	-	-	0	-	-	-	0	-
TS	Nepartak	(2108)	-1.5	3.7	15	4	-1.2	3.6	11	63	-1.0	2.8	7	81	4.7	4.8	3	77	-	-	0	-
TS	Lupit	(2109)	0.8	3.2	16	39	-0.2	4.6	11	61	-0.3	4.4	8	66	2.0	3.2	4	66	-	-	0	-
STS	Mirinae	(2110)	-2.1	5.7	15	-38	2.1	4.3	11	-20	4.0	5.4	7	-46	1.0	3.1	3	31	-	-	0	-
STS	Nida	(2111)	2.0	4.8	7	-30	5.3	5.7	3	-10	-	-	0	-	-	-	0	-	-	-	0	-
TS	Omais	(2112)	2.8	3.3	10	56	6.7	6.8	6	65	6.0	6.0	2	80	-	-	0	-	-	-	0	-
STS	Conson	(2113)	-3.8	6.5	18	52	-5.2	9.6	14	63	-1.6	4.6	10	86	-1.0	3.4	6	91	-1.5	7.6	2	80
TY	Chanthu	(2114)	5.7	17.0	43	-16	6.2	21.9	39	-16	2.7	24.8	34	-17	1.2	28.5	31	-26	-4.7	23.4	27	-57
TS	Dianmu	(2115)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY	Mindulle	(2116)	-10.7	20.9	30	-18	-14.0	26.8	26	-17	-16.1	27.0	22	-50	-19.2	20.8	18	-28	-13.2	14.3	14	24
TS	Lionrock	(2117)	-3.7	4.4	6	43	-7.0	7.1	2	65	-	-	0	-	-	-	0	-	-	-	0	-
STS	Kompasu	(2118)	0.2	3.8	22	65	3.6	7.1	18	57	4.6	6.7	14	63	3.8	8.6	10	55	-1.7	9.3	6	61
STS	Namtheun	(2119)	-1.5	2.9	24	69	-2.8	6.1	20	75	-2.1	8.2	16	76	-3.4	9.5	10	74	-2.2	7.6	6	80
TY	Malou	(2120)	-2.0	7.2	15	9	-12.3	13.9	11	-83	-14.3	15.1	7	-401	-16.7	17.3	3	-179	-	-	0	-
TY	Nyatoh	(2121)	16.3	21.2	12	19	24.6	26.8	8	1	32.5	38.2	4	-42	-	-	0	-	-	-	0	-
TY	Rai	(2122)	8.7	16.9	26	40	15.7	22.8	22	29	17.4	23.8	18	5	18.6	24.3	14	5	16.5	24.5	10	12
Annual Mean (Total)			0.9	11.9	391	15	1.4	15.9	303	25	1.7	18.0	227	26	2.0	19.0	162	24	1.3	17.9	111	17

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.)
TS	Dujuan	(2101)	0000UTC 17 Feb	0000UTC 18 Feb	0600UTC 18 Feb	24 h	30 h
TY	Surigae	(2102)	0000UTC 13 Apr	1800UTC 13 Apr	1800UTC 13 Apr	18 h	18 h
TS	Choi-wan	(2103)	0000UTC 30 May	1800UTC 30 May	0000UTC 31 May	18 h	24 h
TS	Koguma	(2104)	0600UTC 11 Jun	1800UTC 11 Jun	0600UTC 12 Jun	12 h	24 h
TY	Champi	(2105)	0000UTC 22 Jun	0000UTC 23 Jun	0000UTC 23 Jun	24 h	24 h
TY	In-fa	(2106)	1200UTC 16 Jul	1200UTC 17 Jul	1800UTC 17 Jul	24 h	30 h
TY	Cempaka	(2107)	1800UTC 18 Jul	1800UTC 18 Jul	0000UTC 19 Jul	0 h	6 h
TS	Nepartak	(2108)	0000UTC 23 Jul	1200UTC 23 Jul	1200UTC 23 Jul	12 h	12 h
TS	Lupit	(2109)	0000UTC 03 Aug	0000UTC 04 Aug	0000UTC 04 Aug	24 h	24 h
STS	Mirinae	(2110)	1800UTC 03 Aug	0600UTC 05 Aug	0600UTC 05 Aug	36 h	36 h
STS	Nida	(2111)	0600UTC 05 Aug	0000UTC 04 Aug	0600UTC 05 Aug	-30 h	0 h
TS	Omais	(2112)	0600UTC 20 Aug	1200UTC 20 Aug	1200UTC 20 Aug	6 h	6 h
STS	Conson	(2113)	0600UTC 06 Sep	0000UTC 06 Sep	0600UTC 06 Sep	-6 h	0 h
TY	Chanthu	(2114)	1200UTC 06 Sep	1200UTC 06 Sep	0000UTC 07 Sep	0 h	12 h
TS	Dianmu	(2115)	0000UTC 23 Sep	0600UTC 23 Sep	0600UTC 23 Sep	6 h	6 h
TY	Mindulle	(2116)	0600UTC 23 Sep	1200UTC 23 Sep	1200UTC 23 Sep	6 h	6 h
TS	Lionrock	(2117)	0000UTC 07 Oct	1800UTC 07 Oct	1800UTC 07 Oct	18 h	18 h
STS	Kompasu	(2118)	1200UTC 07 Oct	0000UTC 08 Oct	0600UTC 08 Oct	12 h	18 h
STS	Namtheun	(2119)	1200UTC 09 Oct	0000UTC 10 Oct	0000UTC 10 Oct	12 h	12 h
TY	Malou	(2120)	1200UTC 23 Oct	1800UTC 24 Oct	0000UTC 25 Oct	30 h	36 h
TY	Nyatoh	(2121)	1200UTC 29 Nov	0000UTC 30 Nov	0000UTC 30 Nov	12 h	12 h
TY	Rai	(2122)	0000UTC 12 Dec	0600UTC 13 Dec	0600UTC 13 Dec	30 h	30 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 2021, the annual mean errors for 30-, 54-, 78-, 102- and 126-hour[9] predictions were 120 km (98 km in 2020), 232km (172 km), 330km (250 km), 394km (300 km) and 445km (357 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 51% (51% in 2020), 58% (64%), 58% (69%), 62% (71%), 67% (74%) and 70% (75%) for 18-, 30-, 54-, 78-, 102- and 126-hour predictions, respectively.

About 73% (82% in 2020) 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 75% (89%) of 54-hour predictions had errors of less than 300 km, and 79% (86%) of 78-hour predictions had errors of less than 450 km.

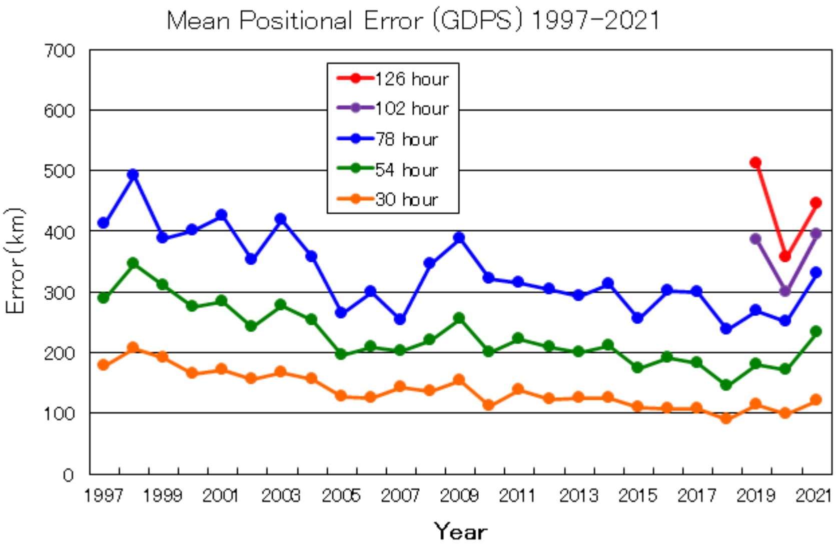


Figure 4.9 GSM annual mean position errors since 1997

[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 2021. 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	
TS	2101	DUJUAN	115.3	(17)	159.4	(15)	224.4	(13)	301.6	(11)	359.6	(9)	395.3	(7)	423.3	(5)	411.4	(3)	328.4	(1)	-	(-)
TY	2102	SURIGAE	62.4	(45)	90.8	(43)	119.4	(41)	148.4	(39)	192.3	(37)	231.4	(35)	265.7	(33)	286.1	(31)	316.5	(29)	364.1	(27)
TS	2103	CHOI-WAN	144.1	(21)	243.0	(15)	370.3	(13)	520.2	(11)	658.2	(10)	777.6	(8)	781.5	(8)	754.9	(8)	860.2	(5)	914.6	(3)
TS	2104	KOGUMA	46.4	(5)	100.8	(3)	191.3	(1)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2105	CHAMPI	86.7	(19)	135.1	(17)	181.9	(15)	247.2	(13)	278.1	(11)	268.6	(9)	352.9	(7)	496.8	(5)	591.2	(3)	792.0	(1)
TY	2106	IN-FA	45.3	(43)	55.5	(41)	78.1	(39)	123.9	(37)	182.2	(35)	248.8	(33)	309.6	(31)	376.6	(29)	464.2	(27)	558.4	(25)
TY	2107	CEMPAKA	39.7	(11)	46.3	(9)	53.2	(7)	69.8	(5)	78.9	(3)	122.8	(1)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2108	NEPARTAK	86.7	(18)	127.4	(16)	167.3	(14)	204.1	(12)	209.0	(10)	216.5	(8)	283.8	(6)	349.2	(4)	348.0	(2)	-	(-)
TS	2109	LUPIT	83.3	(19)	152.2	(16)	314.4	(14)	503.9	(13)	724.5	(13)	832.4	(11)	872.6	(9)	973.5	(6)	975.2	(3)	529.1	(1)
STS	2110	MIRINAE	75.8	(22)	152.7	(20)	237.8	(18)	305.1	(16)	351.9	(14)	361.3	(12)	332.8	(10)	237.4	(7)	164.7	(3)	238.2	(1)
STS	2111	NIDA	146.1	(14)	265.2	(12)	435.9	(10)	725.5	(8)	878.0	(5)	1187.2	(3)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2112	OMAIS	66.8	(9)	106.7	(6)	161.7	(4)	276.0	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
STS	2113	CONSON	121.6	(19)	229.9	(17)	328.4	(14)	463.9	(12)	472.5	(6)	709.7	(4)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2114	CHANTHU	68.2	(45)	109.8	(43)	162.8	(41)	215.2	(39)	260.9	(37)	292.1	(35)	291.4	(33)	257.6	(31)	236.9	(29)	242.3	(27)
TS	2115	DIANMU	132.1	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2116	MINDULLE	38.3	(32)	55.4	(30)	70.0	(28)	72.1	(26)	82.9	(24)	108.1	(22)	143.7	(20)	191.3	(18)	249.4	(16)	351.4	(14)
TS	2117	LIONROCK	87.0	(10)	130.2	(8)	155.9	(6)	159.2	(4)	192.3	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
STS	2118	KOMPASU	70.8	(23)	70.4	(21)	93.3	(19)	105.4	(17)	114.2	(15)	143.6	(13)	173.8	(11)	186.7	(9)	236.1	(7)	264.0	(5)
STS	2119	NAMTHEUN	97.9	(27)	178.9	(25)	293.8	(23)	433.6	(21)	590.1	(19)	758.0	(17)	941.2	(15)	1125.0	(13)	1246.5	(11)	1266.4	(9)
TY	2120	MALOU	88.1	(20)	110.4	(18)	144.5	(16)	189.8	(14)	207.0	(12)	213.2	(10)	325.0	(8)	533.4	(6)	750.1	(4)	689.2	(2)
TY	2121	NYATOH	80.0	(16)	151.4	(14)	184.4	(12)	208.6	(10)	214.1	(8)	387.6	(6)	632.2	(4)	977.4	(2)	-	(-)	-	(-)
TY	2122	RAI	60.7	(29)	76.4	(27)	82.3	(25)	90.6	(23)	96.8	(21)	114.7	(19)	123.1	(17)	154.4	(15)	183.9	(13)	200.6	(10)
All	Annual	Mean	78.0	(466)	120.3	(416)	172.3	(373)	232.4	(333)	279.9	(291)	329.9	(253)	358.7	(217)	393.9	(187)	417.3	(153)	445.3	(125)

Table 4.6 Mean position errors (km) of GSM and PER method predictions for the 22 named TCs that formed in 2021 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	79.1	(202)	74.0	(114)	79.5	(150)	78.0	(466)
	PER	143.0	(202)	148.7	(114)	189.8	(150)	159.4	(466)
	IMPROV	44.7	%	50.3	%	58.1	%	51.1	%
T=30	GSM	112.4	(176)	112.4	(102)	136.2	(138)	120.3	(416)
	PER	242.2	(176)	274.3	(102)	353.4	(138)	286.9	(416)
	IMPROV	53.6	%	59.0	%	61.5	%	58.1	%
T=42	GSM	149.2	(151)	146.5	(91)	216.9	(131)	172.3	(373)
	PER	348.4	(151)	362.2	(91)	553.1	(131)	423.7	(373)
	IMPROV	57.2	%	59.5	%	60.8	%	59.3	%
T=54	GSM	196.1	(126)	175.9	(81)	305.1	(126)	232.4	(333)
	PER	463.1	(126)	475.4	(81)	694.4	(126)	553.6	(333)
	IMPROV	57.7	%	63.0	%	56.1	%	58.0	%
T=66	GSM	225.1	(105)	187.5	(67)	380.2	(119)	279.9	(291)
	PER	624.1	(105)	620.0	(67)	831.7	(119)	708.1	(291)
	IMPROV	63.9	%	69.8	%	54.3	%	60.5	%
T=78	GSM	274.8	(84)	231.5	(60)	426.4	(109)	329.9	(253)
	PER	755.7	(84)	754.8	(60)	1007.	(109)	863.8	(253)
	IMPROV	63.6	%	69.3	%	57.7	%	61.8	%
T=90	GSM	270.2	(64)	290.9	(53)	451.2	(100)	358.7	(217)
	PER	897.3	(64)	871.9	(53)	1150.	(100)	1007.	(217)
	IMPROV	69.9	%	66.6	%	60.8	%	64.4	%
T=102	GSM	312.4	(52)	284.5	(46)	498.0	(89)	393.9	(187)
	PER	1068.	(52)	942.3	(46)	1368.	(89)	1180.	(187)
	IMPROV	70.8	%	69.8	%	63.6	%	66.6	%
T=114	GSM	336.2	(41)	335.5	(39)	506.5	(73)	417.3	(153)
	PER	1284.	(41)	1008.	(39)	1570.	(73)	1350.	(153)
	IMPROV	73.8	%	66.7	%	67.8	%	69.1	%
T=126	GSM	380.9	(33)	455.5	(31)	474.9	(61)	445.3	(125)
	PER	1480.	(33)	1003.	(31)	1746.	(61)	1492.	(125)
	IMPROV	74.3	%	54.6	%	72.8	%	70.2	%

2) Central Pressure and Maximum Wind Speed

The mean errors of 30-, 54-, 78-, 102- and 126-hour GSM central pressure predictions in 2021 were +7.6 hPa (+8.0 hPa in 2020), +8.3 hPa (+9.5 hPa), +9.4 hPa (+8.1 hPa), +8.6 hPa (+2.0 hPa) and +7.1 hPa (-3.0 hPa), respectively. Their root mean square errors (RMSEs) were 20.2 hPa (15.9 hPa in 2020) for 30-hour predictions, 22.1 hPa (20.9 hPa) for 54-hour predictions, 24.6 hPa (24.8 hPa) for 78-hour predictions, 24.0 hPa (21.8 hPa) for 102-hour predictions and 23.4 hPa (14.3 hPa) for 126-hour predictions. The biases in 30-, 54-, 78-, 102- and 126-hour maximum wind speed predictions were -6.2 m/s (-7.1 m/s in 2020) with an RMSE of 10.1 m/s (10.1 m/s), -6.5 m/s (-7.4 m/s) with a RMSE of 10.9 m/s (12.5 m/s), -7.0 m/s (-6.4 m/s) with a RMSE of 11.7 m/s (13.8 m/s), -7.1 m/s (-3.5 m/s) with a RMSE of 11.6 m/s (11.4 m/s) and -7.6 m/s (-1.3 m/s) with a RMSE of 12.7 m/s (7.2 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 current horizontal resolution (about 20 km) is not fine enough to produce the TC core structure, especially when the TC is intense and small.

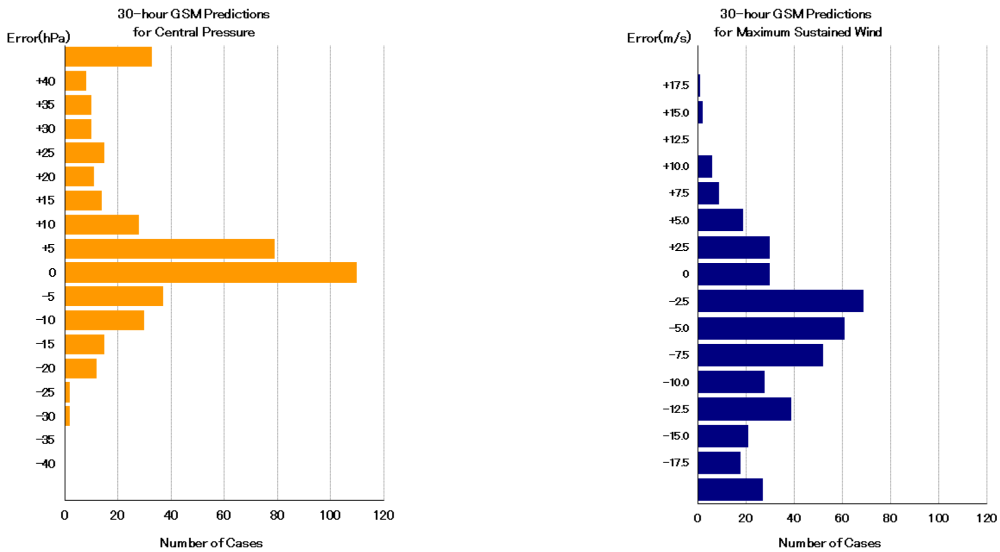


Figure 4.10 Error distribution of GSM 30-hour intensity predictions in 2021. The figure on the left shows error distribution for central pressure, while the one on the right shows that for maximum wind speed (the error distributions of 54-, 78-, 102- and 126-hour predictions are shown at the Appendix 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 2021, 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 135 km (120 km with the GSM), 242 km (232 km), 335 km (330 km), 425 km (394 km) and 438 km (445 km), respectively.

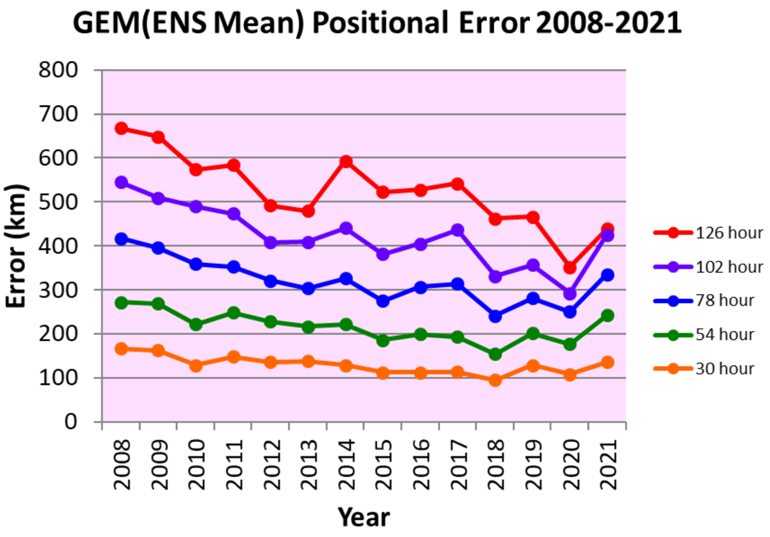


Figure 4.11 GEPS and TEPS annual mean position errors since 2008

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. The figure shows that significant errors were seen in 2021 only when GEPS predicted large spreads.

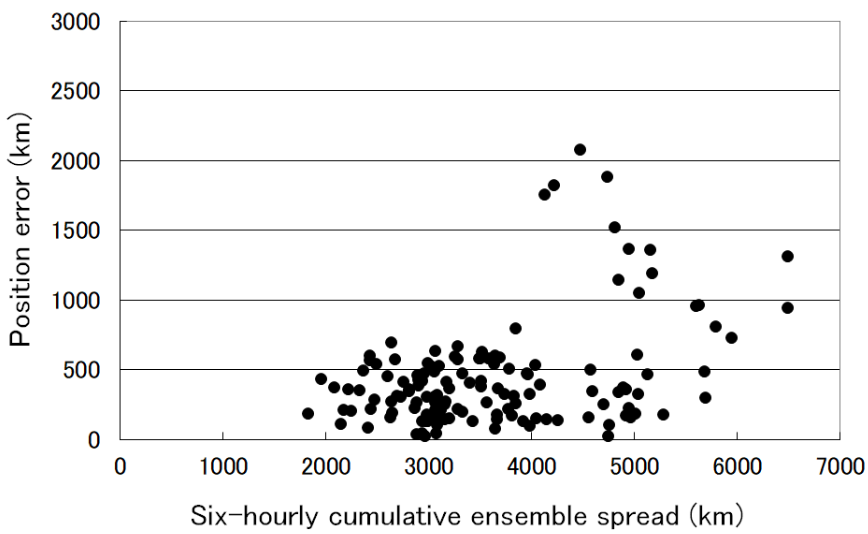


Figure 4.12 Relationship between six-hourly cumulative ensemble spread in TC position forecasts (km) and ensemble mean forecast position errors (km) in 126-hour predictions in 2021.

Table 4.7 Mean position errors (km) of GEPS ensemble mean forecasts for each named TC that formed in 2021. 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**	
TS	2101	DUJUAN	104.1	(17)	148.3	(15)	214.0	(13)	300.4	(11)	364.5	(9)	394.7	(7)	416.1	(5)	415.4	(3)	351.8	(1)	-	(-)
TY	2102	SURIGAE	68.7	(45)	105.7	(43)	136.2	(41)	169.5	(39)	213.3	(37)	253.1	(35)	288.2	(33)	314.7	(31)	334.4	(29)	354.7	(27)
TS	2103	CHOI-WAN	179.1	(21)	278.3	(16)	428.8	(13)	603.3	(11)	755.4	(9)	807.1	(9)	801.4	(9)	827.7	(7)	797.4	(3)	-	(-)
TS	2104	KOGUMA	83.9	(5)	161.8	(3)	275.6	(1)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2105	CHAMPI	86.0	(18)	136.5	(16)	195.0	(14)	254.7	(12)	291.9	(10)	290.0	(8)	386.9	(6)	561.4	(4)	606.8	(2)	-	(-)
TY	2106	IN-FA	42.8	(43)	60.0	(41)	87.6	(39)	132.1	(37)	176.1	(35)	229.4	(33)	281.8	(31)	340.2	(29)	404.8	(27)	457.5	(25)
TY	2107	CEMPAKA	44.5	(10)	46.7	(9)	69.1	(7)	102.1	(4)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2108	NEPARTAK	81.5	(18)	125.0	(16)	160.3	(14)	196.8	(12)	202.4	(10)	190.8	(8)	256.0	(6)	325.9	(4)	329.2	(2)	-	(-)
TS	2109	LUPIT	90.1	(20)	160.7	(18)	289.5	(16)	479.0	(13)	644.4	(10)	789.4	(7)	787.8	(5)	669.2	(3)	-	(-)	-	(-)
STS	2110	MIRINAE	84.9	(20)	171.9	(18)	244.9	(16)	306.0	(14)	338.4	(12)	375.6	(10)	415.2	(8)	464.6	(5)	716.0	(3)	-	(-)
STS	2111	NIDA	189.5	(15)	336.0	(13)	505.9	(11)	730.2	(8)	863.9	(4)	770.0	(1)	-	(-)	-	(-)	-	(-)	-	(-)
TS	2112	OMAIS	77.5	(8)	116.8	(5)	204.7	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
STS	2113	CONSON	139.8	(19)	251.2	(17)	329.7	(12)	390.5	(6)	522.2	(4)	805.7	(1)	832.2	(1)	-	(-)	-	(-)	-	(-)
TY	2114	CHANTHU	69.2	(45)	109.1	(43)	155.6	(41)	203.6	(39)	240.2	(37)	267.5	(35)	296.0	(33)	307.3	(31)	294.1	(29)	295.2	(27)
TS	2115	DIANMU	162.3	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
TY	2116	MINDULLE	37.6	(32)	52.3	(30)	64.9	(28)	66.6	(26)	84.1	(24)	105.9	(22)	137.1	(20)	168.7	(18)	206.9	(16)	249.3	(14)
TS	2117	LIONROCK	90.9	(10)	131.2	(8)	153.8	(6)	170.1	(4)	200.3	(2)	-	(-)	-	(-)	-	(-)	-	(-)	-	(-)
STS	2118	KOMPASU	74.9	(23)	73.6	(21)	88.3	(19)	95.9	(17)	114.9	(15)	162.5	(13)	212.6	(11)	235.6	(9)	261.7	(7)	283.4	(5)
STS	2119	NAMTHEUN	114.3	(27)	225.9	(25)	364.1	(23)	529.4	(21)	722.5	(19)	929.9	(17)	1128.8	(15)	1317.3	(13)	1478.6	(11)	1533.4	(9)
TY	2120	MALOU	91.2	(20)	114.7	(18)	145.5	(16)	192.0	(14)	233.2	(12)	329.9	(10)	518.0	(8)	778.5	(6)	979.7	(4)	920.7	(2)
TY	2121	NYATOH	131.2	(16)	244.7	(14)	305.0	(12)	370.0	(10)	465.5	(8)	720.8	(6)	1030.7	(4)	1376.3	(2)	-	(-)	-	(-)
TY	2122	RAI	67.1	(30)	86.0	(27)	91.5	(25)	97.3	(23)	111.0	(21)	127.9	(19)	150.3	(17)	182.3	(15)	236.3	(13)	277.6	(11)
All	Annual	Mean	86.8	(464)	135.3	(416)	187.1	(369)	242.0	(321)	290.4	(278)	335.4	(241)	387.2	(212)	425.0	(180)	437.5	(147)	438.2	(120)

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 2021 TC track forecasts.

Table 4.8 Ensemble mean forecast position errors (km) in 2021 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	(150)	126	(171)	207	(123)
T=54	135	(170)	285	(120)	380	(63)
T=78	219	(145)	437	(82)	472	(43)
T=102	280	(109)	540	(71)	674	(19)
T=126	331	(86)	594	(45)	940	(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.

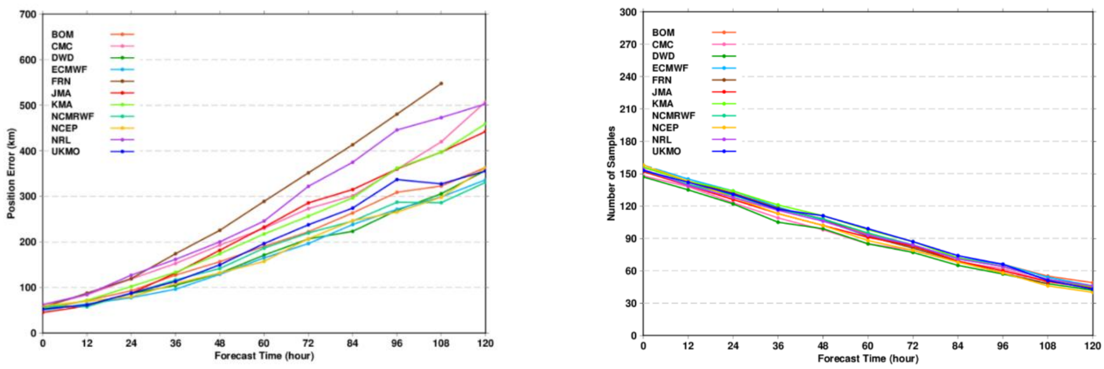


Figure 4.13 (Left) Positional errors for 2021 named TCs. The tropical depression (TD) stage of targeted TCs is also included in this verification. (Right) Sample numbers.

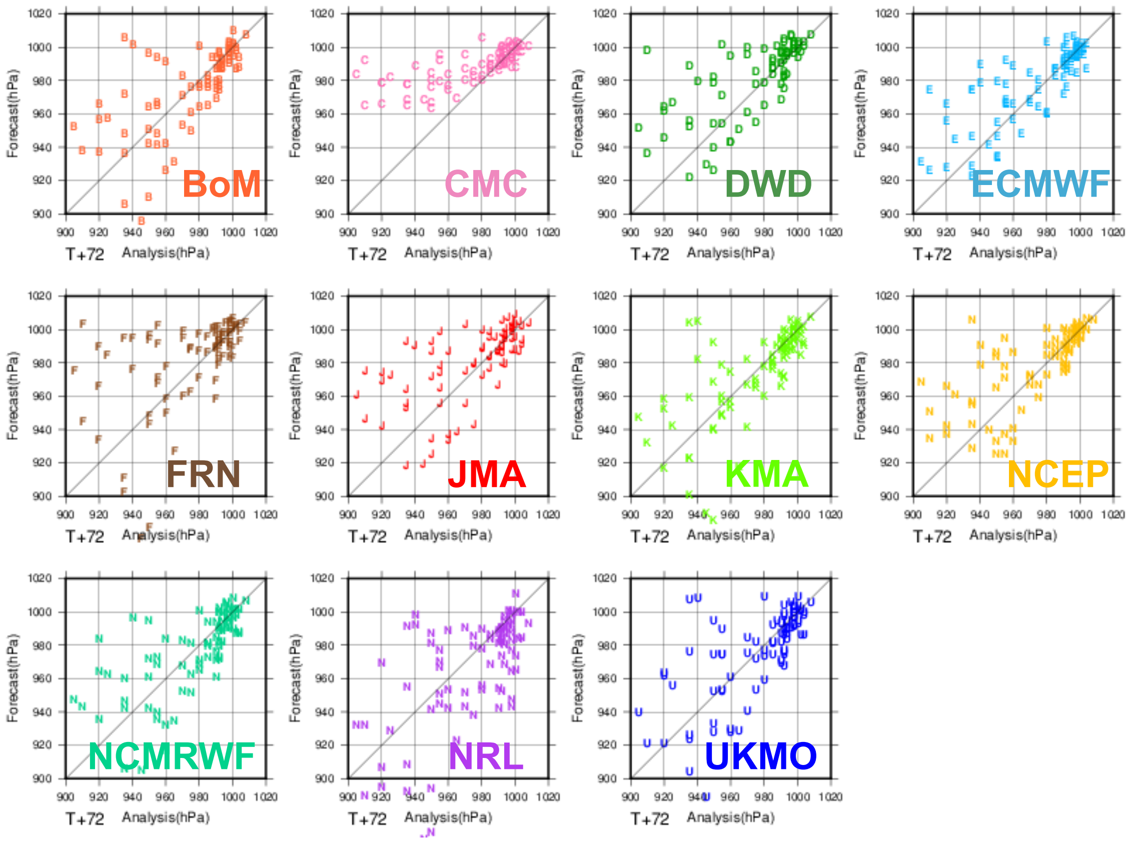


Figure 4.14 Scatter diagrams of 72-hour TC center pressure forecasts from 11 deterministic models for 2021. The tropical depression (TD) stage of targeted TCs is also included in this verification.

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 2021. 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	-1.4	13.8	379	-4.5	18.2	296	-6.2	21.3	220	-6.2	23.1	160	-5.1	22.7	108
	LGEM	0.4	13.3	379	-2.9	16.4	296	-5.5	18.5	220	-5.3	18.8	160	-	-	0
Consensus method	TIFS&LGEM	-0.5	13.2	379	-3.7	17.0	296	-5.9	19.6	220	-5.7	20.5	160	-	-	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	-0.4	5.9	379	0.5	7.4	296	0.7	8.4	220	0.4	9.4	160	-0.4	9.8	108
	LGEM	-0.2	5.5	379	1.6	7.1	296	2.2	7.9	220	1.5	8.3	160	-	-	0
Consensus	TIFS&LGEM	-0.3	5.6	379	1	7.1	296	1.5	8	220	1	8.7	160	-	-	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 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 TS Nepartak (2108). 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 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 22 TCs occurring in 2021 (Table 4.10). Wind speed biases in ASWinds data from Full-disk and Region 3 observation are small at -0.5 to -0.4 m/s, and -0.5 to -0.3 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 2021 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.

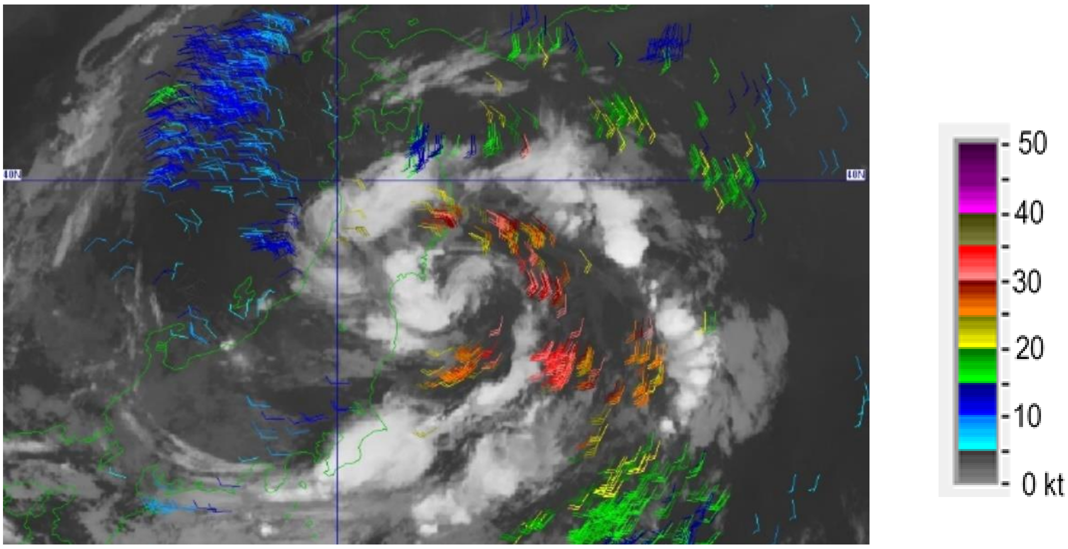


Figure 4.15 ASWinds derived from a series of Himawari-8 Full-disk and Region 3 Infrared (B13) and Short-wave Infrared (B07) images for TS Nepartak (2108) at 1758 UTC on 27 July 2021.

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 22 TCs in 2021.

(a) ASWind (Full-disk)

	Number of collocations	Vector Difference [m/s]	Bias [m/s]
B03 (VIS)	514187	1.9	-0.4
B07 (SWIR)	427252	2.3	-0.5
B13 (IR)	434846	2.2	-0.5

(b) ASWind (Region 3)

	Number of collocations	Vector Difference [m/s]	Bias [m/s]
B03 (VIS)	1153137	2.7	-0.3
B07 (SWIR)	1312949	2.9	-0.4
B13 (IR)	1101510	2.8	-0.5

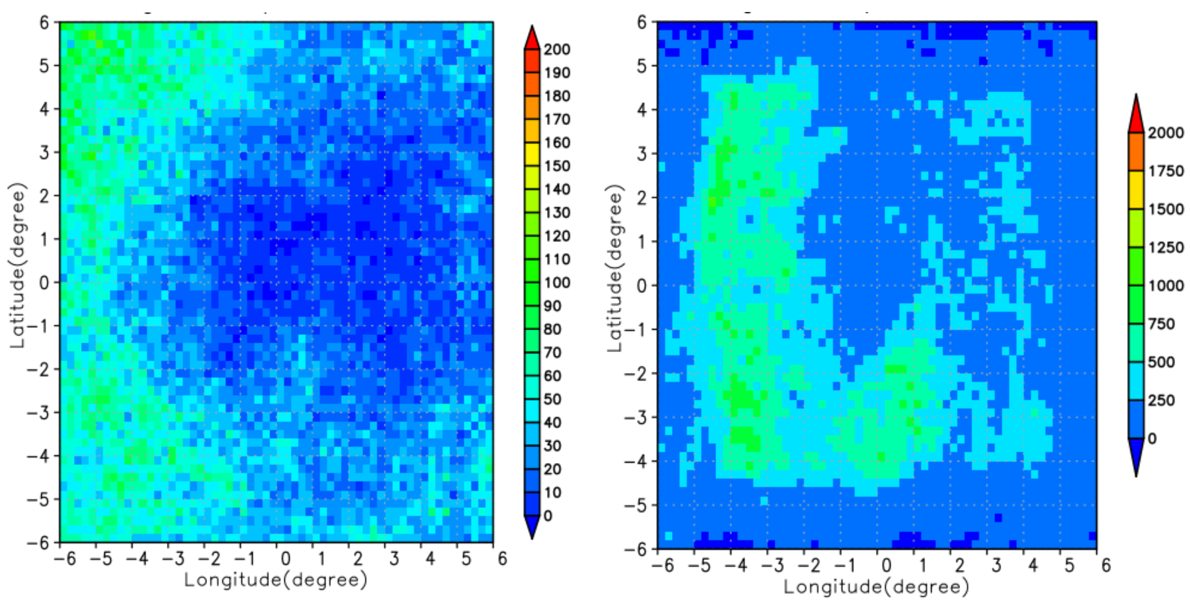


Figure 4.16 Spatial distributions of Full-disk (left) and Region 3 (right) ASWind data derived from Infrared (B13) images within a square of 12 degrees centered at TC center for 22 TCs in 2021.

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 In-fa (2106).

Table 4.11 shows the results of AMSU and ATMS estimate verification with respect to JMA best-track data for 201–5 - 2021 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 seven 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.

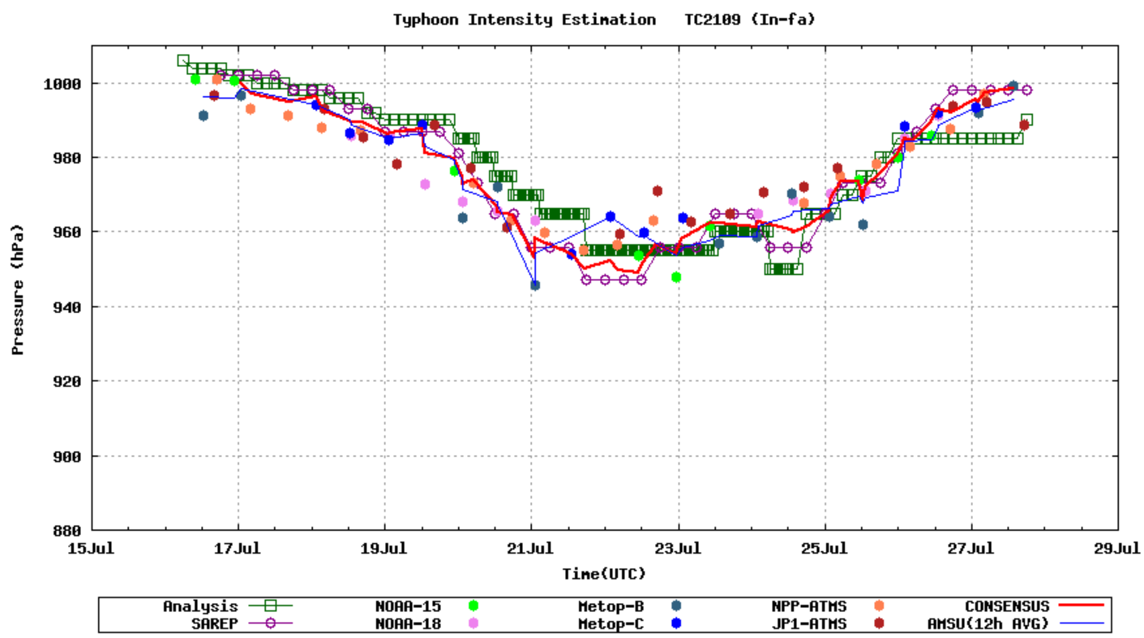


Figure 4.17 Time-series representation of Dvorak MSLP estimates, microwave-based MSLP estimates (AMSU and ATMS), CONSENSUS between Dvorak and AMSU/ATMS estimates and JMA analysis for TY In-fa (2106) on the Numerical Typhoon Prediction (NTP) website

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 seven years (2015 - 2021); (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
BIAS	AMSU	1.3	2.7	-2.9	-3.1	-2.5	-5.5	-2.9
	Dvorak	0.1	-2.1	-2.0	-0.4	-2.9	-2.8	-2.1
	Consensus	**0.3**	**-0.8**	**-2.6**	**-1.5**	**-3.2**	**-4.0**	**-2.8**
RMSE (hPa)	AMSU	12.8	13.8	10.0	12.4	11.7	14.0	13.1
	Dvorak	7.5	9.6	7.2	7.0	9.2	8.4	7.9
	Consensus	**6.8**	**8.2**	**6.7**	**6.7**	**7.6**	**7.9**	**6.6**
Number of Data		819	595	569	680	645	478	703

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

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

4.7 Verification of Storm Surge Prediction

Storm surge predictions have been provided since 2011 via the Numerical Typhoon Prediction website to Typhoon Committee Members within the framework of the Storm Surge Watch Scheme (SSWS). For details of the storm surge model, refer to Hasegawa et al. (2012) on the Center's website. Verification of deterministic storm surge prediction was conducted on data from eight 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) for all named TCs in 2021. Hourly hindcast data (from FT = -5 to FT = 0) and forecast data (from FT = 1 to FT = 72) were compared with observation data.

In addition, a multi-scenario prediction method was incorporated into the model in June 2016 to support the provision of more useful risk management information (Hasegawa et al., 2017). Verification of multi-scenario predictions was conducted on data from the Quarry Bay tide station (Hong Kong) for TY Kompasu (2118).

Table 4.12 Stations used for verification

	Station	Abbreviation	Member
1	Quarry Bay	QB	Hong Kong
2	Langkawi	LK	Malaysia
3	Legaspi Port	LG	Philippines
4	Manila South Harbor	ML	Philippines
5	Subic Bay	SB	Philippines
6	Apra Harbor	AP	U.S.A.
7	Qui Nhon	QN	Viet Nam
8	Vung Tau	VT	Viet Nam

Table 4.13 Storm surges exceeding 0.5 m observed at the eight stations for each named TC that formed in 2021

Station	Named TC	Storm surge [m]
QB	KOMPASU (2118)	1.11

4.7.1 Deterministic Prediction

Storm surges exceeding a meter in height were observed in Quarry Bay (Hong Kong) in 2021 (Table 4.13). Figure 4.18 shows scatter diagrams of modeled storm surges (hindcast and forecast) against observation data. Verification results (Figure 4.18, right) indicate that the model underestimated 2021 storm surges caused by TY Kompasu among others as described below in the Multi-scenario Prediction section.

The results of the verification shown in Figure 4.19 are probably insufficient to evaluate model accuracy for TCs because the number of available observations is limited and remarkable storm surges were not observed in 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 storm surge model is considered to have comparable accuracy at storm surge watch scheme stations.

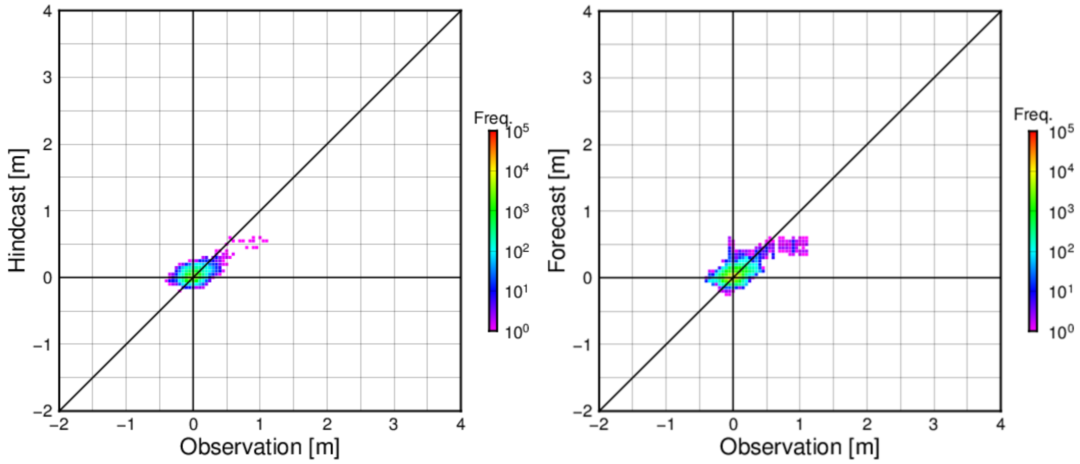


Figure 4.18 Scatter diagrams of modeled storm surges against observation data from eight stations for all the named TCs that formed in 2021 (left: hindcast; right: forecast)

Figure 4.19 shows scatter diagrams of modeled storm surges (forecast) against observation data from 207 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 2021, and cases of TCs are extracted. Twelve named TCs approached the country, with the three making landfall. The figure on the left indicates that first-day forecasts for Japan compare well with observed storm surges. Naturally, errors increase with lead time. For the third day in particular, the figure shows extreme overestimation attributed mainly to TC track errors.

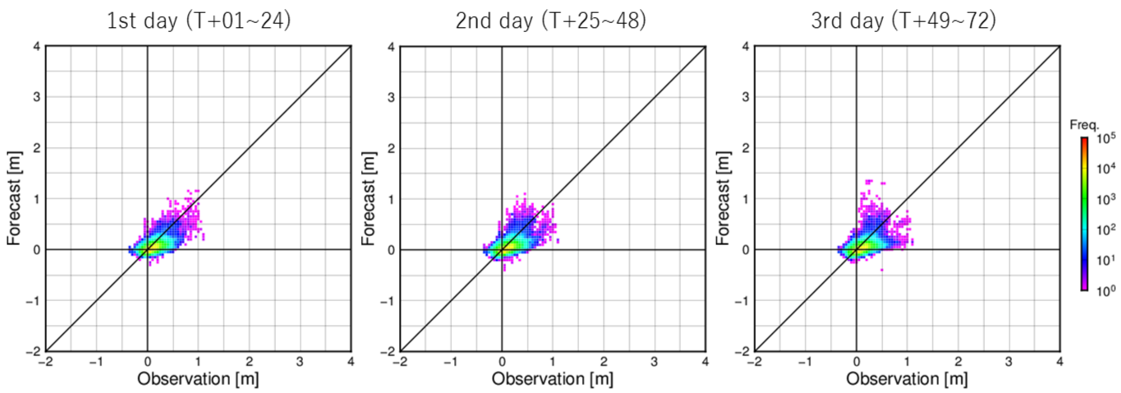


Figure 4.19 Scatter diagrams of modeled storm surges (forecast) against observation data from 207 stations (operated by JMA, the Port Authority, the Japan Coast Guard and the Geospatial Information Authority of Japan) in Japan for TCs in 2021. All plots are three-hourly maximum values.

4.7.2 Multi-Scenario Prediction

TY Kompasu (2118) moved westward over the South China Sea with a maximum wind speed of 30 m/s and a minimum pressure of 975 hPa in October 2021. Figure 4.20 shows the analysis track and the six predicted tracks (the official and five selected instances) covering the 48-hour period before the peak of a storm surge in Quarry Bay. The typhoon covered a large area with 30 knots winds, causing storm surges along the southern coast of China. The maximum storm tide for Quarry Bay in the official forecast scenario was 2.95 m (Figure 4.21), while the corresponding maximum storm surge was 0.53 m. In Quarry Bay, the peak storm surge was underestimated in all scenarios (observed maximum storm tide: 3.35 m above mean sea level; maximum storm surge: 1.11 m). This may be attributable to errors in the model scheme and inadequate topographical representations due to the low model resolution (approx. 3.7 km) while the typhoon track and wind field characteristics were predicted well.

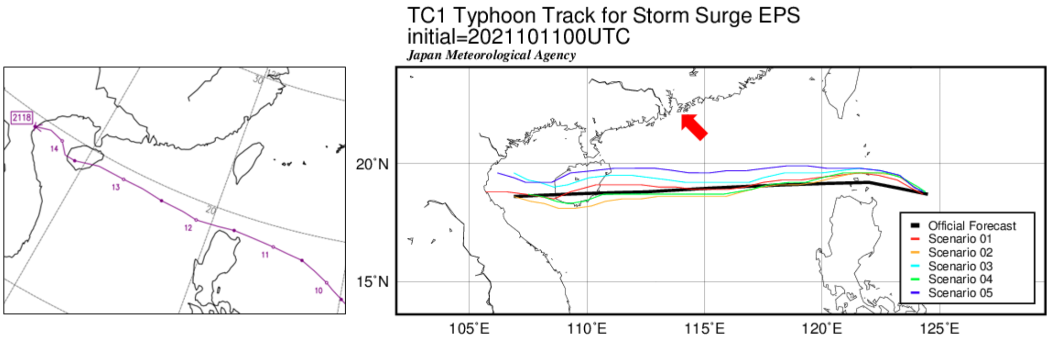


Figure 4.20 Analysis track (left) and predicted tracks (right) for TY Kompasu. In the figure on the right, colored lines show the five selected tracks and the bold black line shows the official JMA forecast. The red arrow shows Quarry Bay.

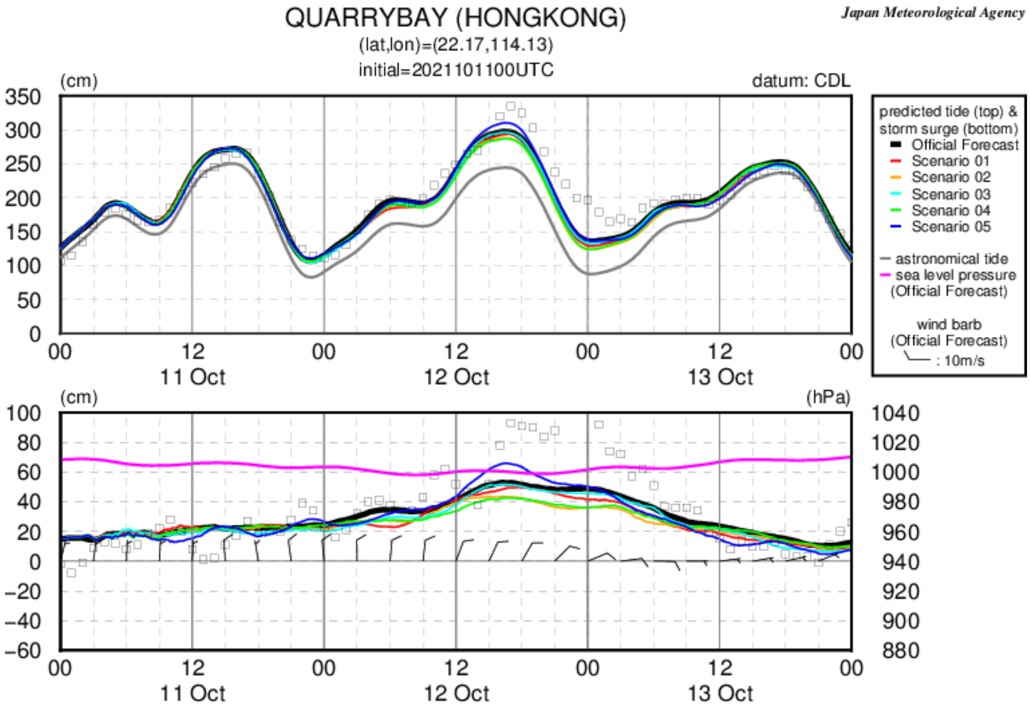


Figure 4.21 Time-series representation of storm tide and astronomical tide (top), storm surge, sea level pressure and surface wind (bottom) for Quarry Bay (Hong Kong). Squares show hourly observation values.

[Reference]

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

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

Appendices

Appendix 1
RSMC Tropical Cyclone Best Track Data in 2021

TS DUJUAN (2101)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Feb.	16/06	6.9	136.9	1004	−	0.0	TD
	16/12	6.9	136.2	1006	−	0.0	TD
	16/18	6.8	135.1	1004	−	0.5	TD
	17/00	6.6	134.2	1004	−	1.0	TD
	17/06	6.5	133.7	1002	−	1.5	TD
	17/12	6.5	133.2	1004	−	1.5	TD
	17/18	6.7	132.7	1002	−	2.0	TD
	18/00	7.0	132.6	1000	35	2.0	TS
	18/06	7.3	132.1	998	35	2.0	TS
	18/12	7.2	131.9	996	40	2.5	TS
	18/18	7.1	131.6	996	40	2.5	TS
	19/00	6.9	131.1	996	40	2.5	TS
	19/06	6.7	130.4	996	40	2.5	TS
	19/12	6.1	130.5	998	40	2.5	TS
	19/18	6.1	130.9	998	40	2.5	TS
	20/00	6.3	131.3	998	40	2.5	TS
	20/06	6.9	131.1	998	40	2.5	TS
	20/12	7.3	130.4	1000	35	2.5	TS
	20/18	7.8	129.7	1000	35	2.5	TS
	21/00	8.3	129.1	1000	35	2.5	TS
	21/06	9.0	128.4	1000	35	2.5	TS
	21/12	10.1	126.9	1004	−	2.5	TD
	21/18	11.5	126.0	1006	−	2.0	TD
	22/00	12.3	125.0	1008	−	2.0	TD
	22/06	13.3	124.1	1006	−	2.0	TD
	22/12	14.1	123.3	1008	−	2.0	TD
	22/18	14.6	122.6	1008	−	1.5	TD
	23/00	15.2	122.2	1010	−	−	TD
	23/06						Dissip.

TY SURIGAE (2102)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Apr.	12/18	7.6	138.0	1006	−	0.5	TD
	13/00	7.6	137.8	1006	−	0.5	TD
	13/06	7.7	137.6	1004	−	1.0	TD
	13/12	7.8	137.4	1004	−	1.5	TD
	13/18	7.9	137.2	1002	35	1.5	TS
	14/00	8.1	137.0	1000	40	2.0	TS
	14/06	8.3	136.9	998	40	2.5	TS
	14/12	8.4	136.7	994	45	3.0	TS
	14/18	8.5	136.5	994	45	3.0	TS
	15/00	8.6	136.3	990	50	3.0	STS
	15/06	8.6	136.1	985	55	3.5	STS
	15/12	8.6	135.8	975	65	4.0	TY
	15/18	8.7	135.3	970	70	4.0	TY
	16/00	8.9	134.6	965	75	5.0	TY
	16/06	9.2	133.8	955	80	5.0	TY
	16/12	9.5	133.1	950	85	5.0	TY
	16/18	10.0	132.1	940	90	6.0	TY
	17/00	10.7	131.1	935	95	6.0	TY
	17/06	11.4	130.1	925	100	7.0	TY
	17/12	12.1	129.2	905	110	7.0	TY
	17/18	12.6	128.4	895	120	7.5	TY
	18/00	13.1	127.7	895	120	7.5	TY
	18/06	13.4	127.1	900	115	7.5	TY
	18/12	13.6	126.8	910	105	7.0	TY
	18/18	13.9	126.5	910	105	7.0	TY
	19/00	14.2	126.3	910	105	7.0	TY
	19/06	14.6	126.3	920	100	6.5	TY
	19/12	14.9	126.3	920	100	6.5	TY
	19/18	15.2	126.3	930	95	6.5	TY
	20/00	15.5	126.1	935	90	5.5	TY
	20/06	15.9	126.0	935	90	5.5	TY
	20/12	16.4	125.9	935	90	5.5	TY
	20/18	17.0	125.5	935	90	5.5	TY
	21/00	17.5	125.2	935	90	5.5	TY
	21/06	18.2	125.0	935	90	5.5	TY
	21/12	18.8	124.8	935	90	5.5	TY
	21/18	19.3	124.8	945	85	5.5	TY
	22/00	19.7	124.9	945	85	5.5	TY
	22/06	20.3	125.4	945	85	5.5	TY
	22/12	20.9	126.2	950	80	4.5	TY
	22/18	21.6	127.2	960	75	4.5	TY
	23/00	22.8	128.5	970	65	4.0	TY
	23/06	23.1	128.9	975	60	4.0	STS
	23/12	23.4	129.8	980	55	3.5	STS
	23/18	23.4	130.5	985	50	3.0	STS
	24/00	23.0	131.2	985	50	3.0	STS
	24/06	22.7	131.8	990	45	2.5	TS
	24/12	22.2	132.8	994	40	2.5	TS
	24/18	21.7	134.1	996	35	2.0	TS
	25/00	21.8	136.2	996	−	1.5	L
	25/06	22.3	138.2	992	−	−	L
	25/12	23.9	141.0	992	−	−	L
	25/18	25.7	144.9	990	−	−	L
	26/00	28.9	149.4	988	−	−	L
	26/06	33.5	153.5	982	−	−	L
	26/12	37.1	156.5	970	−	−	L
	26/18	40.1	157.7	950	−	−	L
	27/00	42.5	159.3	944	−	−	L
	27/06	44.0	161.1	948	−	−	L
	27/12	45.8	162.3	952	−	−	L
	27/18	46.0	164.1	956	−	−	L
	28/00	46.4	165.8	964	−	−	L
	28/06	46.8	167.2	968	−	−	L
	28/12	47.2	168.7	972	−	−	L
	28/18	47.5	169.1	976	−	−	L
	29/00	47.4	169.9	980	−	−	L
	29/06	47.3	170.4	984	−	−	L
	29/12	47.2	171.1	988	−	−	L
	29/18	46.7	172.2	990	−	−	L
	30/00	46.2	173.5	992	−	−	L
	30/06	45.2	176.3	994	−	−	L
	30/12	44.6	179.8	998	−	−	L
	30/18	44.6	184.1	998	−	−	Out

TS CHOI-WAN (2103)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
May	29/00	6.4	137.1	1004	−	0.5	TD
	29/06	6.0	135.8	1004	−	1.0	TD
	29/12	5.8	135.1	1004	−	1.5	TD
	29/18	5.8	134.3	1004	−	1.5	TD
	30/00	5.9	133.5	1004	−	1.5	TD
	30/06	6.0	132.9	1002	−	1.5	TD
	30/12	6.6	132.5	1002	−	1.5	TD
	30/18	7.2	131.6	1000	35	2.0	TS
	31/00	8.1	131.1	1000	35	2.0	TS
	31/06	9.1	130.0	1000	35	2.0	TS
	31/12	9.5	129.1	1000	35	2.0	TS
	31/18	9.7	128.3	998	40	2.5	TS
Jun.	01/00	10.0	127.3	998	40	2.5	TS
	01/06	11.1	126.8	998	35	2.5	TS
	01/12	11.7	125.6	998	35	2.5	TS
	01/18	11.8	123.6	1000	35	2.5	TS
	02/00	12.6	122.3	1000	35	2.5	TS
	02/06	13.2	121.7	1000	35	2.5	TS
	02/12	13.5	120.7	1000	35	2.5	TS
	02/18	14.9	119.5	1000	35	2.5	TS
	03/00	16.7	118.9	998	40	2.5	TS
	03/06	17.6	118.0	998	40	2.5	TS
	03/12	18.6	118.2	998	40	2.5	TS
	03/18	19.5	118.4	1000	40	2.5	TS
	04/00	20.2	118.6	1000	40	2.5	TS
	04/06	20.9	119.5	1002	35	2.0	TS
	04/12	21.8	121.1	1002	35	1.5	TS
	04/18	23.1	122.5	1002	35	1.5	TS
	05/00	24.7	123.7	1002	35	1.5	TS
	05/06	26.9	126.2	1000	−	1.5	L
	05/12	28.3	128.9	1002	−	−	L
	05/18	29.8	131.7	1004	−	−	L
	06/00	32.2	136.3	1008	−	−	L
	06/06						Dissip.

TS KOGUMA (2104)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Jun.	11/00	17.7	113.5	1000	−	0.0	TD
	11/06	17.4	112.8	1000	−	0.5	TD
	11/12	17.7	112.0	1000	−	1.0	TD
	11/18	18.3	110.6	998	35	1.5	TS
	12/00	18.7	109.7	998	35	2.0	TS
	12/06	19.4	108.9	996	35	2.0	TS
	12/12	19.8	107.3	996	35	2.0	TS
	12/18	19.7	106.5	996	35	2.0	TS
	13/00	19.6	105.4	996	35	2.0	TS
	13/06	20.0	104.0	1000	−	1.5	TD
	13/12	20.7	101.9	998	−	1.5	TD
	13/18						Dissip.

TY CHAMPI (2105)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Jun.	20/00	9.9	150.9	1010	-	0.0	TD
	20/06	10.1	150.3	1008	-	0.0	TD
	20/12	10.6	149.5	1010	-	0.5	TD
	20/18	11.1	148.3	1008	-	1.0	TD
	21/00	11.6	147.8	1010	-	1.0	TD
	21/06	11.8	147.1	1008	-	1.0	TD
	21/12	12.1	145.8	1010	-	1.0	TD
	21/18	12.6	144.8	1010	-	1.0	TD
	22/00	13.4	143.6	1010	-	1.5	TD
	22/06	14.3	142.6	1008	-	2.0	TD
	22/12	14.6	141.9	1008	-	2.0	TD
	22/18	15.3	141.3	1006	-	2.0	TD
	23/00	16.1	141.3	1002	35	2.5	TS
	23/06	17.1	141.1	1000	40	2.5	TS
	23/12	17.7	140.7	998	45	2.5	TS
	23/18	17.9	140.2	998	45	2.5	TS
	24/00	18.5	140.1	992	50	3.0	STS
	24/06	19.0	139.8	992	50	3.0	STS
	24/12	19.6	139.7	992	50	3.0	STS
	24/18	20.2	139.6	990	55	3.0	STS
	25/00	21.0	139.0	985	60	3.5	STS
	25/06	21.9	139.1	980	65	3.5	TY
	25/12	22.8	139.2	980	65	3.5	TY
	25/18	23.6	139.3	985	60	3.5	STS
	26/00	24.8	139.8	985	60	3.5	STS
	26/06	25.8	140.0	985	60	3.5	STS
	26/12	26.9	140.2	992	50	3.5	STS
	26/18	28.3	140.8	994	45	3.0	TS
	27/00	29.9	141.4	996	40	2.5	TS
	27/06	31.8	142.3	998	35	2.5	TS
	27/12	34.0	143.8	998	35	-	TS
	27/18	36.4	145.3	996	-	-	L
	28/00	38.2	148.8	994	-	-	L
	28/06	39.5	152.0	994	-	-	L
	28/12	40.4	155.1	994	-	-	L
	28/18	41.1	159.7	996	-	-	L
	29/00						Dissip.

TY IN-FA (2106)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Jul.	15/18	16.6	135.1	1006	-	-	TD
	16/00	16.9	135.3	1006	-	0.0	TD
	16/06	17.5	135.4	1004	-	0.5	TD
	16/12	18.5	135.3	1004	-	1.0	TD
	16/18	19.5	135.3	1004	-	1.5	TD
	17/00	20.7	134.3	1002	-	1.5	TD
	17/06	21.2	133.9	1000	-	1.5	TD
	17/12	21.6	133.5	998	35	1.5	TS
	17/18	22.1	133.0	998	35	2.0	TS
	18/00	22.6	132.5	998	35	2.0	TS
	18/06	22.9	132.2	996	40	2.0	TS
	18/12	23.4	132.1	996	40	2.5	TS
	18/18	23.7	132.1	992	45	2.5	TS
	19/00	23.9	131.9	990	50	3.0	STS
	19/06	24.0	131.7	990	50	3.0	STS
	19/12	24.0	131.6	990	50	3.0	STS
	19/18	24.2	131.2	990	50	3.0	STS
	20/00	24.5	130.8	985	55	3.0	STS
	20/03	24.6	130.3	985	55	-	STS
	20/06	24.7	129.8	980	60	3.5	STS
	20/09	24.7	129.4	980	60	-	STS
	20/12	24.6	129.0	975	65	4.0	TY
	20/15	24.4	128.4	975	65	-	TY
	20/18	24.2	128.2	970	70	5.0	TY
	20/21	24.2	128.0	970	70	-	TY
	21/00	24.2	127.9	965	75	5.0	TY
	21/03	24.2	127.6	965	75	-	TY
	21/06	24.2	127.2	965	75	5.0	TY
	21/09	24.2	126.9	965	75	-	TY
	21/12	24.0	126.6	955	80	5.0	TY
	21/15	23.8	126.4	955	80	-	TY
	21/18	23.7	126.2	950	85	5.5	TY
	21/21	23.5	126.0	950	85	-	TY
	22/00	23.3	126.0	950	85	5.5	TY
	22/03	23.4	125.9	950	85	-	TY
	22/06	23.5	125.8	950	85	5.5	TY
	22/09	23.5	125.8	950	85	-	TY
	22/12	23.6	125.8	955	80	5.0	TY
	22/15	23.7	125.7	955	80	-	TY
	22/18	23.7	125.5	960	75	4.5	TY
	22/21	23.8	125.5	960	75	-	TY
	23/00	24.3	125.4	960	75	4.0	TY
	23/03	24.5	125.3	960	75	-	TY
	23/06	24.6	125.1	960	75	4.0	TY
	23/09	24.7	125.1	960	75	-	TY
	23/12	24.8	125.1	960	75	4.0	TY
	23/15	25.2	125.1	965	70	-	TY
	23/18	25.5	125.0	965	70	4.0	TY
	23/21	26.0	124.9	965	70	-	TY
	24/00	26.5	124.7	960	75	4.5	TY
	24/03	26.8	124.5	960	75	-	TY
	24/06	27.2	124.4	960	75	4.5	TY
	24/09	27.6	124.2	960	75	-	TY
	24/12	28.1	124.1	960	75	4.5	TY
	24/18	28.7	123.7	960	75	4.5	TY
	25/00	29.7	123.1	970	65	4.0	TY
	25/06	30.0	122.5	970	65	4.0	TY
	25/12	30.1	122.1	975	60	4.0	STS
	25/18	30.3	121.6	980	55	4.0	STS
	26/00	30.6	121.1	985	50	3.5	STS
	26/06	30.9	121.0	985	50	3.0	STS
	26/12	30.7	120.4	985	45	2.5	TS
	26/18	31.0	119.9	985	40	2.5	TS
	27/00	31.2	119.5	985	40	2.5	TS
	27/06	31.3	119.1	985	35	2.5	TS
	27/12	31.6	118.9	985	35	2.5	TS
	27/18	32.2	117.9	990	-	-	TD
	28/00	32.5	117.3	990	-	-	TD
	28/06	32.7	117.0	990	-	-	TD
	28/12	33.3	116.9	990	-	-	TD
	28/18	33.8	116.9	990	-	-	TD
	29/00	35.1	117.1	990	-	-	TD
	29/06	35.7	117.2	992	-	-	TD
	29/12	37.1	118.1	992	-	-	TD
	29/18	38.1	118.5	992	-	-	L
	30/00	38.5	119.0	992	-	-	L
	30/06	38.9	119.4	992	-	-	L
	30/12	39.1	119.8	994	-	-	L
	30/18	39.6	120.4	994	-	-	L
	31/00	40.2	121.0	994	-	-	L
	31/06	40.9	121.5	994	-	-	L
	31/12						Dissip.

TY CEMPAKA (2107)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Jul.	17/00	18.9	117.1	1004	-	-	TD
	17/06	19.4	116.8	1002	-	-	TD
	17/12	19.7	116.3	1002	-	0.0	TD
	17/18	19.9	115.8	1002	-	0.5	TD
	18/00	20.3	115.4	1002	-	1.0	TD
	18/06	20.7	114.8	1000	-	1.0	TD
	18/12	20.9	114.1	1000	-	1.5	TD
	18/18	20.9	113.6	998	35	2.0	TS
	19/00	20.9	113.2	994	45	2.5	TS
	19/06	21.0	112.9	992	50	3.0	STS
	19/12	21.1	112.7	990	55	3.5	STS
	19/18	21.2	112.5	985	65	4.5	TY
	20/00	21.3	112.4	980	70	4.5	TY
	20/06	21.4	112.3	980	70	4.5	TY
	20/12	21.6	112.1	990	60	4.0	STS
	20/18	21.8	111.5	992	50	3.5	STS
	21/00	21.9	111.0	996	40	3.0	TS
	21/06	22.1	110.5	998	35	2.5	TS
	21/12	22.2	110.0	998	35	2.0	TS
	21/18	22.3	109.5	998	35	2.0	TS
	22/00	22.2	108.8	1000	-	2.0	TD
	22/06	22.0	108.3	1000	-	1.5	TD
	22/12	21.7	107.7	998	-	1.0	TD
	22/18	21.4	107.3	998	-	0.5	TD
	23/00	21.0	107.1	998	-	0.5	TD
	23/06	20.6	107.0	996	-	1.0	TD
	23/12	20.1	107.1	996	-	1.0	TD
	23/18	19.6	107.0	996	-	1.0	TD
	24/00	19.3	106.8	996	-	1.0	TD
	24/06	18.9	106.6	996	-	1.0	TD
	24/12	18.5	106.6	996	-	1.0	TD
	24/18	18.2	106.7	998	-	1.0	TD
	25/00	18.1	107.1	998	-	0.5	TD
	25/06						Dissip.

TS NEPARTAK (2108)

Date/Time	(UTC)	Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Jul.	22/12	21.5	146.1	1002	-	0.0	TD
	22/18	21.8	147.0	1000	-	0.0	TD
	23/00	22.4	147.9	1002	-	0.0	TD
	23/06	23.4	148.5	1000	-	0.5	TD
	23/12	24.2	148.8	998	35	1.0	TS
	23/18	25.1	149.3	998	35	1.5	TS
	24/00	25.4	149.7	996	35	1.5	TS
	24/06	26.1	150.1	996	35	2.0	TS
	24/12	27.6	150.6	994	40	2.0	TS
	24/18	28.4	150.6	994	40	2.0	TS
	25/00	29.6	150.7	994	40	2.0	TS
	25/06	30.2	150.4	992	40	2.0	TS
	25/12	31.1	149.8	992	40	2.0	TS
	25/18	32.8	149.3	992	40	2.0	TS
	26/00	33.9	147.7	992	40	2.0	TS
	26/06	34.5	145.5	992	40	2.0	TS
	26/12	34.4	143.7	992	40	2.0	TS
	26/18	34.3	142.9	990	40	2.0	TS
	27/00	34.9	142.6	990	40	2.0	TS
	27/06	35.7	142.4	990	40	2.0	TS
	27/12	36.6	142.4	992	35	2.0	TS
	27/18	37.8	142.2	994	35	2.0	TS
	27/20	38.2	141.7	994	35	-	TS
	28/00	39.2	141.4	994	35	2.0	TS
	28/06	40.4	139.8	998	-	-	L
	28/12	40.6	138.1	998	-	-	L
	28/18	40.7	137.6	998	-	-	L
	29/00	40.7	136.9	998	-	-	L
	29/06	40.7	136.6	998	-	-	L
	29/12	40.8	136.3	998	-	-	L
	29/18	40.8	136.2	998	-	-	L
	30/00	40.8	135.9	1000	-	-	L
	30/06	40.8	135.7	1000	-	-	L
	30/12	40.8	135.4	1000	-	-	L
	30/18	40.8	135.2	1000	-	-	L
	31/00	40.7	135.0	1002	-	-	L
	31/06	40.9	133.9	1002	-	-	L
	31/12						Dissip.

TS LUPIT (2109)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Aug.	02/12	21.1	111.8	996	−	0.5	TD
	02/18	21.3	112.4	996	−	1.0	TD
	03/00	21.5	113.3	996	−	1.5	TD
	03/06	21.5	113.4	996	−	1.5	TD
	03/12	21.2	114.1	996	−	1.5	TD
	03/18	21.0	114.7	996	−	2.0	TD
	04/00	21.2	115.4	994	35	2.0	TS
	04/06	21.5	115.5	992	35	2.5	TS
	04/12	21.7	116.1	990	40	2.5	TS
	04/18	22.3	116.6	990	40	3.0	TS
	05/00	23.3	117.0	990	40	3.0	TS
	05/06	23.5	116.9	990	40	2.5	TS
	05/12	23.9	117.2	992	40	2.0	TS
	05/18	24.0	117.5	992	40	2.0	TS
	06/00	24.2	118.1	992	40	2.0	TS
	06/06	24.7	118.8	992	40	2.0	TS
	06/12	24.9	119.6	994	35	2.5	TS
	06/18	25.1	120.0	994	35	2.5	TS
	07/00	25.1	120.7	994	35	2.5	TS
	07/06	26.1	122.9	994	35	2.5	TS
	07/12	27.5	124.5	994	35	2.5	TS
	07/18	28.3	125.8	992	40	2.5	TS
	08/00	29.3	127.0	990	40	2.5	TS
	08/06	30.0	129.0	990	40	2.5	TS
	08/11	31.3	130.4	988	40	−	TS
	08/12	31.5	130.9	988	40	2.0	TS
	08/18	33.9	132.3	984	45	2.0	TS
	08/20	34.4	132.5	984	45	−	TS
	09/00	35.4	133.8	982	−	2.0	L
	09/06	36.6	135.0	982	−	−	L
	09/12	37.9	136.3	984	−	−	L
	09/18	39.1	138.2	984	−	−	L
	10/00	39.8	140.9	988	−	−	L
	10/06	40.7	143.3	988	−	−	L
	10/12	40.9	145.7	988	−	−	L
	10/18	41.4	148.2	988	−	−	L
	11/00	42.1	150.8	988	−	−	L
	11/06	42.5	153.4	984	−	−	L
	11/12	42.9	155.7	984	−	−	L
	11/18	43.2	157.7	984	−	−	L
	12/00	43.4	159.4	984	−	−	L
	12/06	43.7	161.7	986	−	−	L
	12/12	44.4	163.9	988	−	−	L
	12/18	44.8	165.1	988	−	−	L
	13/00	44.9	165.5	986	−	−	L
	13/06	45.0	166.1	988	−	−	L
	13/12	44.7	167.5	992	−	−	L
	13/18	44.8	170.4	996	−	−	L
	14/00	45.1	172.5	1000	−	−	L
	14/06	45.6	173.5	1002	−	−	L
	14/12	46.0	173.8	1006	−	−	L
	14/18	46.4	174.1	1006	−	−	L
	15/00	46.5	174.6	1008	−	−	L
	15/06	46.9	174.9	1008	−	−	L
	15/12	47.6	175.2	1008	−	−	L
	15/18	47.6	175.2	1006	−	−	L
	16/00						Dissip.

STS MIRINAE (2110)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Aug.	03/06	23.8	124.5	998	−	0.0	TD
	03/12	23.8	125.2	1000	−	0.0	TD
	03/18	24.0	125.7	998	−	0.0	TD
	04/00	24.4	125.6	1000	−	0.5	TD
	04/06	25.2	125.5	998	−	0.5	TD
	04/12	25.5	126.9	998	−	0.5	TD
	04/18	25.9	127.4	996	−	0.5	TD
	05/00	26.0	127.4	996	−	0.5	TD
	05/06	26.9	128.1	992	35	1.0	TS
	05/12	26.9	128.6	992	40	1.5	TS
	05/18	26.9	130.0	992	40	1.5	TS
	06/00	26.9	131.0	992	40	2.0	TS
	06/06	27.4	133.6	990	40	2.5	TS
	06/12	27.7	134.8	990	40	2.5	TS
	06/18	28.5	136.6	990	40	2.5	TS
	07/00	29.4	137.6	990	40	2.5	TS
	07/06	30.8	138.5	985	45	2.5	TS
	07/12	31.9	138.9	985	45	2.5	TS
	07/18	33.2	139.5	980	50	3.0	STS
	08/00	34.2	140.7	980	50	3.0	STS
	08/06	35.2	142.2	980	50	3.0	STS
	08/12	36.1	143.6	980	50	3.0	STS
	08/18	36.5	145.1	985	45	3.0	TS
	09/00	37.7	147.5	985	45	3.0	TS
	09/06	38.3	149.7	985	45	3.0	TS
	09/12	38.4	152.3	990	40	2.5	TS
	09/18	38.5	155.3	992	40	2.5	TS
	10/00	39.0	158.0	992	−	2.0	L
	10/06	37.8	160.9	992	−	−	L
	10/12	37.5	164.2	996	−	−	L
	10/18	37.2	167.2	996	−	−	L
	11/00	37.2	169.3	998	−	−	L
	11/06						Dissip.

STS NIDA (2111)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Aug.	03/12	20.8	144.4	1004	−	0.0	TD
	03/18	22.9	146.0	1004	−	0.5	TD
	04/00	25.1	146.6	1002	35	1.0	TS
	04/06	27.1	147.2	1002	35	1.0	TS
	04/12	28.8	147.1	1000	40	1.5	TS
	04/18	30.3	147.4	1000	40	1.5	TS
	05/00	31.5	147.6	998	45	2.0	TS
	05/06	32.7	147.7	998	45	2.0	TS
	05/12	33.5	148.0	998	45	2.0	TS
	05/18	34.5	148.6	998	45	2.0	TS
	06/00	35.4	149.8	996	50	2.5	STS
	06/06	36.4	151.4	996	50	2.5	STS
	06/12	36.8	153.2	996	50	2.5	STS
	06/18	37.8	155.5	992	55	3.0	STS
	07/00	38.7	158.0	992	55	3.0	STS
	07/06	39.0	160.0	992	55	3.0	STS
	07/12	39.2	163.0	996	50	2.5	STS
	07/18	39.8	166.7	996	50	2.5	STS
	08/00	39.9	169.0	998	−	2.0	L
	08/06	40.2	172.0	1000	−	−	L
	08/12	41.7	175.0	1000	−	−	L
	08/18						Dissip.

TS OMAIS (2112)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Aug.	18/12	15.4	138.4	1008	−	0.0	TD
	18/18	16.1	136.9	1006	−	0.0	TD
	19/00	16.7	135.5	1008	−	0.0	TD
	19/06	17.6	134.0	1006	−	0.5	TD
	19/12	18.2	133.2	1008	−	0.5	TD
	19/18	18.7	132.3	1006	−	0.5	TD
	20/00	18.9	131.5	1008	−	1.0	TD
	20/06	18.9	130.8	1008	−	1.0	TD
	20/12	19.1	130.2	1004	35	1.5	TS
	20/18	19.9	129.7	1002	35	2.0	TS
	21/00	21.5	128.4	1000	40	2.0	TS
	21/06	22.0	127.7	1000	40	2.5	TS
	21/12	22.8	127.0	998	45	2.5	TS
	21/18	23.4	126.5	996	45	2.5	TS
	21/21	23.9	126.1	994	45	−	TS
	22/00	24.3	125.9	994	45	2.5	TS
	22/03	24.7	125.6	994	45	−	TS
	22/06	25.1	125.3	994	45	3.0	TS
	22/12	25.9	125.0	996	40	3.0	TS
	22/18	27.2	124.9	996	40	3.0	TS
	23/00	29.0	125.3	996	40	2.5	TS
	23/06	31.3	125.7	998	35	2.0	TS
	23/12	33.6	127.0	998	35	2.0	TS
	23/18	36.0	129.7	998	35	2.0	TS
	24/00	37.6	131.4	998	−	2.0	L
	24/06	39.0	132.3	998	−	−	L
	24/12	39.9	132.9	998	−	−	L
	24/18	40.6	134.9	998	−	−	L
	25/00	41.2	136.4	1000	−	−	L
	25/06	41.8	137.6	1002	−	−	L
	25/12	42.4	138.6	1004	−	−	L
	25/18	43.5	139.8	1004	−	−	L
	26/00	44.9	141.4	1006	−	−	L
	26/06	46.0	143.6	1004	−	−	L
	26/12	46.8	144.9	1002	−	−	L
	26/18	47.7	146.5	1002	−	−	L
	27/00	47.8	148.2	1000	−	−	L
	27/06	48.1	149.4	1000	−	−	L
	27/12	48.3	152.4	1000	−	−	L
	27/18	48.9	153.4	1000	−	−	L
	28/00	49.8	155.5	1000	−	−	L
	28/06	50.2	157.0	998	−	−	L
	28/12	50.6	157.9	998	−	−	L
	28/18	50.7	158.8	996	−	−	L
	29/00	51.0	159.6	996	−	−	L
	29/06	51.0	159.8	996	−	−	L
	29/12	51.0	161.4	998	−	−	L
	29/18	51.0	162.1	998	−	−	L
	30/00	51.0	164.7	998	−	−	L
	30/06	50.8	166.0	998	−	−	L
	30/12	50.9	169.0	1000	−	−	L
	30/18	51.3	171.6	1000	−	−	L
	31/00	51.5	174.3	1000	−	−	L
	31/06	51.7	176.7	1002	−	−	L
	31/12	51.9	179.6	1002	−	−	L
	31/18						Dissip.

STS CONSON (2113)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	05/06	9.8	130.2	1006	−	0.5	TD
	05/12	10.0	129.6	1006	−	1.0	TD
	05/18	10.0	128.6	1004	−	1.5	TD
	06/00	10.3	127.8	1002	35	2.0	TS
	06/06	10.8	126.8	998	45	2.5	TS
	06/12	11.1	126.0	994	50	3.0	STS
	06/18	11.7	124.9	994	50	3.0	STS
	07/00	12.1	124.2	998	45	3.0	TS
	07/06	12.4	123.6	998	45	3.0	TS
	07/12	12.9	122.6	998	45	2.5	TS
	07/18	13.2	122.1	998	45	3.0	TS
	08/00	13.7	121.6	998	45	3.0	TS
	08/06	14.2	120.7	998	45	2.5	TS
	08/12	15.0	120.1	998	45	2.0	TS
	08/18	15.4	119.1	998	45	2.0	TS
	09/00	15.4	118.2	994	45	2.0	TS
	09/06	15.8	117.0	994	45	2.5	TS
	09/12	15.8	115.1	992	50	2.5	STS
	09/18	15.9	114.1	992	50	2.5	STS
	10/00	15.6	113.0	992	50	2.5	STS
	10/06	15.6	112.2	992	50	2.5	STS
	10/12	15.7	111.5	992	50	2.0	STS
	10/18	15.7	110.8	992	50	2.0	STS
	11/00	15.6	110.0	992	50	2.5	STS
	11/06	15.6	109.8	992	50	2.5	STS
	11/12	15.3	109.3	994	40	2.5	TS
	11/18	15.1	109.2	996	−	2.5	TD
	12/00	15.2	109.2	996	−	2.0	TD
	12/06	15.3	109.1	998	−	1.5	TD
	12/12	15.3	109.1	1000	−	1.0	TD
	12/18	15.6	109.0	1000	−	−	TD
	13/00	15.8	108.8	1002	−	−	TD
	13/06	16.1	108.5	1002	−	−	TD
	13/12	15.9	107.8	1004	−	−	TD
	13/18						Dissip.

TY CHANTHU (2114)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	05/06	12.4	140.5	1006	−	0.0	TD
	05/12	13.0	139.9	1008	−	0.0	TD
	05/18	13.4	139.5	1006	−	0.5	TD
	06/00	13.5	139.0	1006	−	1.0	TD
	06/06	13.9	138.6	1004	−	1.5	TD
	06/12	14.6	138.0	1002	35	2.0	TS
	06/18	15.3	137.4	1000	35	2.5	TS
	07/00	15.7	136.4	994	45	3.0	TS
	07/06	16.1	135.6	990	55	3.5	STS
	07/12	16.3	134.5	980	65	4.0	TY
	07/18	16.3	133.5	960	80	5.0	TY
	08/00	16.0	132.4	950	90	5.5	TY
	08/06	15.7	131.4	940	95	6.0	TY
	08/12	15.6	130.3	940	95	6.0	TY
	08/18	15.4	129.1	935	100	6.5	TY
	09/00	15.5	128.0	935	100	6.5	TY
	09/06	15.8	127.1	935	100	6.5	TY
	09/12	16.1	125.9	935	100	6.5	TY
	09/18	16.6	124.9	935	100	6.5	TY
	10/00	17.1	124.1	930	105	6.5	TY
	10/06	17.8	123.5	910	115	7.5	TY
	10/12	18.7	122.9	910	115	7.5	TY
	10/18	19.5	122.3	905	115	7.5	TY
	11/00	20.3	121.9	905	115	7.5	TY
	11/06	21.0	121.5	910	110	7.5	TY
	11/12	21.8	121.8	920	105	6.5	TY
	11/18	22.8	122.0	935	100	6.5	TY
	11/21	23.3	122.1	935	100	−	TY
	12/00	23.8	122.3	935	100	6.5	TY
	12/03	24.6	122.4	940	95	−	TY
	12/06	25.2	122.3	950	90	6.0	TY
	12/09	25.7	122.4	955	85	−	TY
	12/12	26.2	122.6	960	80	5.0	TY
	12/18	27.6	123.0	955	85	5.5	TY
	13/00	29.1	123.5	955	85	5.5	TY
	13/06	30.7	123.3	960	80	5.5	TY
	13/12	30.9	123.2	970	75	5.0	TY
	13/18	31.4	123.5	975	70	4.5	TY
	14/00	31.3	123.8	980	65	4.0	TY
	14/06	30.9	124.2	985	55	3.5	STS
	14/12	30.5	124.7	990	50	3.0	STS
	14/18	30.2	125.1	992	45	2.5	TS
	15/00	30.3	125.7	992	45	2.5	TS
	15/06	30.4	125.9	992	45	2.5	TS
	15/12	30.2	125.7	992	45	2.5	TS
	15/18	30.2	125.3	990	50	3.0	STS
	16/00	30.4	125.0	990	50	3.0	STS
	16/06	31.1	125.3	990	50	3.0	STS
	16/12	31.7	125.8	990	50	3.0	STS
	16/15	31.9	126.0	990	50	−	STS
	16/18	32.3	126.4	990	50	3.0	STS
	16/21	32.6	126.8	990	50	−	STS
	17/00	32.9	127.5	990	50	3.0	STS
	17/03	33.3	128.3	990	50	−	STS
	17/06	33.5	129.2	990	50	3.0	STS
	17/09	33.8	130.2	990	50	−	STS
	17/12	33.8	131.6	992	45	2.5	TS
	17/15	33.8	132.5	994	45	−	TS
	17/18	33.8	134.1	994	45	2.0	TS
	17/21	34.0	135.1	996	40	−	TS
	18/00	34.5	136.5	1000	35	1.5	TS
	18/03	34.3	137.1	1000	35	−	TS
	18/06	34.4	137.6	1002	−	1.5	L
	18/12	34.4	139.1	1004	−	−	L
	18/18	34.0	140.4	1006	−	−	L
	19/00	33.6	140.9	1008	−	−	L
	19/06	33.0	141.1	1008	−	−	L
	19/12	32.5	141.2	1010	−	−	L
	19/18	32.2	141.0	1010	−	−	L
	20/00	31.8	140.7	1010	−	−	L
	20/06						Dissip.

TS DIANMU (2115)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	22/00	11.9	115.0	1006	−	0.0	TD
	22/06	12.7	113.8	1006	−	0.5	TD
	22/12	12.7	113.5	1004	−	1.0	TD
	22/18	13.0	113.0	1002	−	1.5	TD
	23/00	14.0	111.6	1002	−	1.5	TD
	23/06	14.8	110.5	1000	35	1.5	TS
	23/12	15.3	109.3	1000	35	2.0	TS
	23/18	15.5	108.1	1004	−	2.0	TD
	24/00	15.9	106.1	1004	−	1.5	TD
	24/06	16.1	105.0	1004	−	1.0	TD
	24/12	16.2	104.8	1004	−	−	TD
	24/18	16.0	103.5	1004	−	−	TD
	25/00	16.0	102.5	1004	−	−	TD
	25/06	16.1	101.5	1004	−	−	TD
	25/12	16.2	101.0	1002	−	−	TD
	25/18	16.2	100.4	1004	−	−	TD
	26/00	16.1	99.3	1004	−	−	Out

TY MINDULLE (2116)

	Date/Time (UTC)	Center Position Lat (N)	Center Position Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
Sep.	22/12	11.2	148.6	1008	−	0.0	TD
	22/18	12.0	147.7	1006	−	0.0	TD
	23/00	12.7	146.2	1006	−	0.5	TD
	23/06	13.3	144.5	1004	−	1.0	TD
	23/12	13.6	143.3	1002	35	1.5	TS
	23/18	14.1	142.0	1002	35	2.0	TS
	24/00	14.5	141.1	998	40	2.5	TS
	24/06	15.2	140.3	994	45	3.0	TS
	24/12	15.9	139.3	992	50	3.5	STS
	24/18	16.6	138.6	985	60	4.0	STS
	25/00	17.1	138.1	975	70	5.0	TY
	25/06	17.7	137.7	960	80	5.0	TY
	25/12	18.2	137.4	955	85	6.0	TY
	25/18	18.5	137.0	955	85	6.0	TY
	26/00	18.6	136.8	935	100	6.5	TY
	26/06	18.8	136.7	920	105	7.0	TY
	26/12	19.0	136.7	920	105	7.0	TY
	26/18	19.4	136.7	920	105	7.0	TY
	27/00	19.6	136.7	935	95	6.0	TY
	27/06	19.9	136.6	950	85	5.5	TY
	27/12	20.2	136.4	950	85	5.5	TY
	27/18	20.5	136.3	950	85	5.5	TY
	28/00	21.0	136.1	950	85	5.5	TY
	28/06	21.6	135.7	950	85	5.5	TY
	28/12	21.9	135.4	950	85	5.5	TY
	28/18	22.6	135.5	945	85	5.5	TY
	29/00	23.4	135.4	945	85	5.5	TY
	29/06	24.3	135.4	935	90	5.5	TY
	29/12	25.0	135.6	935	90	5.5	TY
	29/18	25.8	135.9	935	90	5.5	TY
	30/00	26.6	136.4	935	90	5.5	TY
	30/06	28.0	137.2	945	85	5.5	TY
	30/12	29.1	138.1	945	85	5.5	TY
	30/15	29.8	138.6	945	85	−	TY
	30/18	30.4	139.2	945	85	5.5	TY
	30/21	31.1	140.0	945	85	−	TY
Oct.	01/00	31.9	140.7	950	80	5.0	TY
	01/03	32.8	141.4	950	80	−	TY
	01/06	33.7	142.2	960	75	4.5	TY
	01/09	34.7	142.8	960	75	−	TY
	01/12	35.6	143.9	965	70	4.0	TY
	01/18	37.2	145.6	970	65	3.5	TY
	02/00	39.4	147.8	976	−	3.0	L
	02/06	41.6	150.1	976	−	−	L
	02/12	43.8	152.6	976	−	−	L
	02/18	46.0	155.5	980	−	−	L
	03/00	48.8	157.9	978	−	−	L
	03/06	51.2	160.1	976	−	−	L
	03/12	53.6	162.2	968	−	−	L
	03/18	55.6	164.3	964	−	−	L
	04/00	57.1	166.1	964	−	−	L
	04/06	58.3	168.5	964	−	−	L
	04/12	58.9	169.8	964	−	−	L
	04/18	59.3	171.3	968	−	−	L
	05/00	59.6	173.4	972	−	−	L
	05/06	59.9	175.4	976	−	−	L
	05/12	60.4	177.9	980	−	−	Out

Date/Time (UTC)		Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
TS LIONROCK (2117)							
Oct.	05/00	11.6	119.0	1004	−	0.5	TD
	05/06	12.4	117.7	1002	−	0.5	TD
	05/12	13.3	116.3	1002	−	0.0	TD
	05/18	14.1	115.2	1002	−	0.0	TD
	06/00	14.6	114.4	1000	−	0.5	TD
	06/06	15.1	113.8	1000	−	0.5	TD
	06/12	15.6	113.2	998	−	0.0	TD
	06/18	16.0	112.7	998	−	0.5	TD
	07/00	16.6	112.1	998	−	1.0	TD
	07/06	16.9	111.8	996	−	1.5	TD
	07/12	17.2	111.4	996	−	1.5	TD
	07/18	17.3	110.9	994	35	2.0	TS
	08/00	17.6	110.8	994	35	2.5	TS
	08/06	18.5	110.7	994	35	2.5	TS
	08/12	19.0	110.6	994	35	2.5	TS
	08/18	19.4	110.2	994	35	2.5	TS
	09/00	19.7	110.1	994	35	2.5	TS
	09/06	20.0	109.9	994	35	2.0	TS
	09/12	20.3	109.6	994	35	2.0	TS
	09/18	20.7	108.7	996	35	1.5	TS
	10/00	20.9	107.9	998	35	1.5	TS
	10/06	20.8	106.9	1000	−	1.0	TD
	10/12	20.7	106.3	1002	−	1.0	TD
	10/18	20.6	105.4	1004	−	1.0	TD
	11/00						Dissip.

Date/Time (UTC)		Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
STS KOMPASU (2118)							
Oct.	07/00	13.7	136.5	1002	−	0.0	TD
	07/06	13.7	135.7	1002	−	0.0	TD
	07/12	13.8	134.8	1002	−	0.0	TD
	07/18	14.0	134.2	1000	−	0.5	TD
	08/00	14.2	133.6	996	35	1.0	TS
	08/06	14.6	132.8	994	35	1.5	TS
	08/12	14.8	132.3	994	35	2.0	TS
	08/18	15.2	131.7	992	40	2.0	TS
	09/00	15.5	131.1	992	40	2.0	TS
	09/06	15.9	130.5	992	40	2.5	TS
	09/12	16.2	130.1	990	45	2.5	TS
	09/18	16.7	129.4	990	45	2.5	TS
	10/00	17.1	128.9	990	45	2.5	TS
	10/06	17.7	127.9	990	45	2.5	TS
	10/12	18.2	126.9	985	45	2.5	TS
	10/18	18.4	125.8	980	50	3.0	STS
	11/00	18.6	124.7	980	50	3.0	STS
	11/06	18.8	123.0	980	50	3.0	STS
	11/12	18.9	121.7	980	50	3.0	STS
	11/18	18.8	120.5	975	55	3.0	STS
	12/00	18.7	118.9	975	55	3.0	STS
	12/06	18.9	117.8	975	55	3.0	STS
	12/12	19.0	116.1	975	55	3.0	STS
	12/18	19.2	114.5	975	55	3.0	STS
	13/00	19.2	113.0	975	55	3.0	STS
	13/06	19.2	111.0	975	55	3.0	STS
	13/12	18.7	109.3	985	45	2.5	TS
	13/18	18.7	108.5	992	40	2.0	TS
	14/00	19.4	107.8	998	35	1.5	TS
	14/06	19.6	106.7	1000	35	1.0	TS
	14/12	19.2	105.6	1004	−	0.5	TD
	14/18						Dissip.

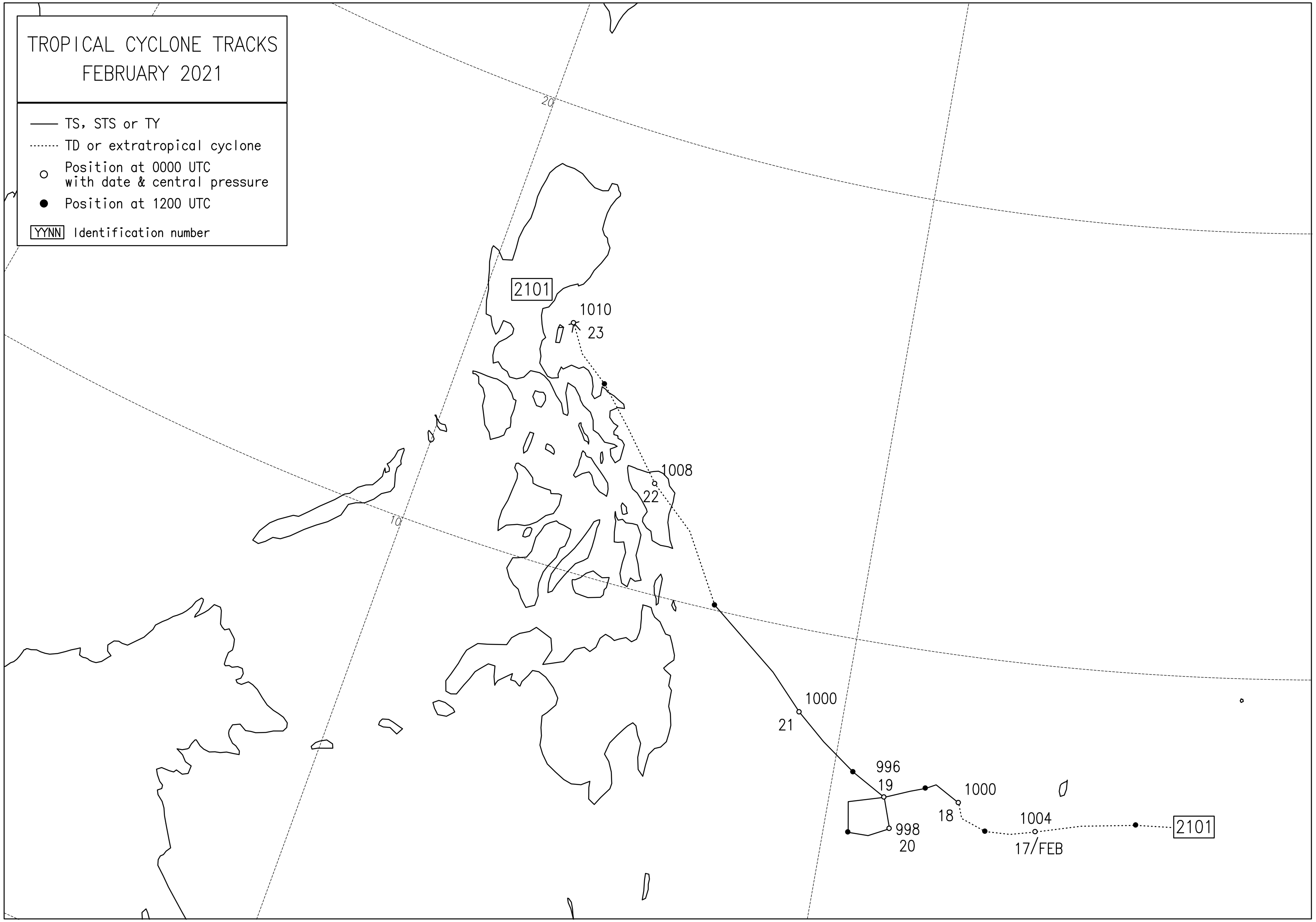
Date/Time (UTC)		Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
STS NAMTHEUN (2119)							
Oct.	08/18	16.6	166.0	1010	−	0.0	TD
	09/00	16.8	164.6	1010	−	0.0	TD
	09/06	16.7	163.4	1006	−	0.0	TD
	09/12	16.9	162.1	1004	−	0.5	TD
	09/18	16.9	161.0	1002	−	1.0	TD
	10/00	17.0	160.4	1000	35	1.5	TS
	10/06	17.1	159.9	998	40	1.5	TS
	10/12	17.4	159.5	998	40	2.0	TS
	10/18	17.7	158.8	998	40	2.0	TS
	11/00	18.1	157.3	998	40	2.0	TS
	11/06	18.6	156.0	998	40	2.0	TS
	11/12	18.8	155.0	998	40	2.0	TS
	11/18	19.2	153.8	998	40	2.5	TS
	12/00	19.5	153.1	998	40	2.5	TS
	12/06	19.6	152.1	998	40	2.5	TS
	12/12	20.1	151.9	998	40	2.5	TS
	12/18	20.9	151.9	998	40	2.5	TS
	13/00	21.7	152.4	998	40	2.5	TS
	13/06	22.4	152.9	998	40	2.5	TS
	13/12	22.8	153.8	998	40	2.5	TS
	13/18	23.4	155.0	998	40	2.5	TS
	14/00	23.9	156.0	998	40	2.5	TS
	14/06	24.3	157.4	998	40	2.5	TS
	14/12	24.5	158.3	998	40	2.5	TS
	14/18	25.2	159.3	998	40	2.5	TS
	15/00	25.9	160.0	998	45	3.0	TS
	15/06	26.5	160.7	998	45	3.0	TS
	15/12	27.0	161.8	998	45	3.0	TS
	15/18	28.0	162.8	998	45	3.0	TS
	16/00	29.2	164.3	996	50	3.0	STS
	16/06	30.7	165.1	996	50	3.0	STS
	16/12	31.9	165.9	998	45	3.0	TS
	16/18	32.7	166.6	1000	40	3.0	TS
	17/00	33.7	167.2	1002	−	2.5	L
	17/06	35.0	167.3	1002	−	−	L
	17/12	36.1	167.0	1004	−	−	L
	17/18	38.0	167.4	1004	−	−	L
	18/00	39.8	168.4	1004	−	−	L
	18/06	41.7	171.0	1002	−	−	L
	18/12	43.3	174.5	1000	−	−	L
	18/18	44.5	179.6	1000	−	−	L
	19/00	45.2	183.7	1000	−	−	Out

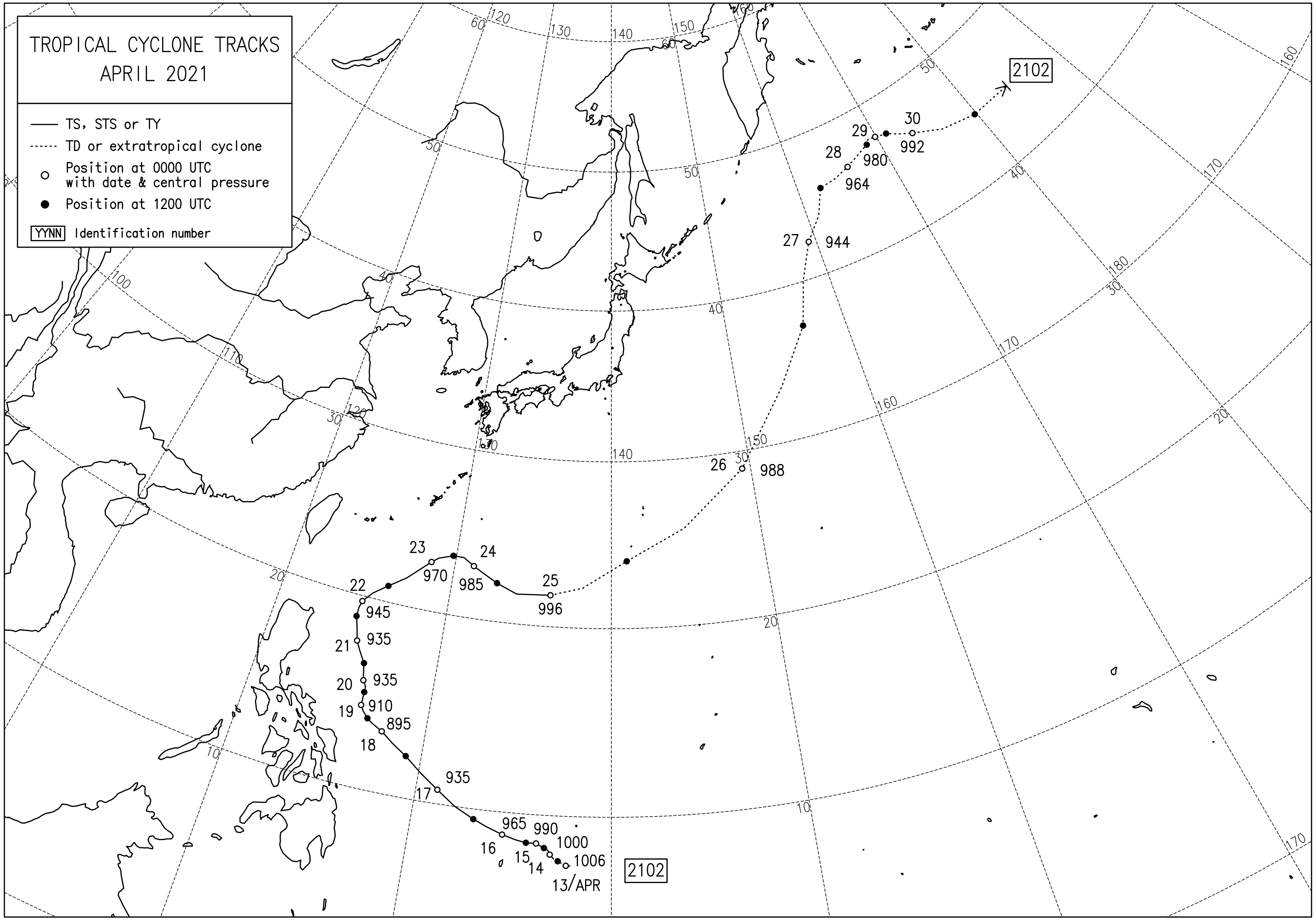
Date/Time (UTC)		Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
TY MALOU (2120)							
Oct.	23/06	11.3	141.5	1008	−	0.0	TD
	23/12	11.4	140.9	1008	−	0.0	TD
	23/18	11.4	140.6	1006	−	0.5	TD
	24/00	12.0	140.4	1008	−	1.0	TD
	24/06	12.6	140.2	1006	−	1.5	TD
	24/12	14.1	139.7	1006	−	2.0	TD
	24/18	15.4	139.0	1002	35	2.0	TS
	25/00	16.1	139.0	1002	35	2.0	TS
	25/06	17.6	138.5	1000	35	2.0	TS
	25/12	18.6	138.6	1000	35	2.0	TS
	25/18	19.0	138.9	998	40	2.5	TS
	26/00	19.1	139.0	994	45	2.5	TS
	26/06	19.4	139.3	992	50	3.0	STS
	26/12	20.4	139.3	992	50	3.0	STS
	26/18	20.7	139.3	985	55	3.5	STS
	27/00	20.8	139.3	980	60	3.5	STS
	27/06	21.3	139.4	980	60	3.5	STS
	27/12	21.9	139.7	970	70	4.5	TY
	27/18	22.7	140.0	965	75	5.0	TY
	27/21	23.2	140.4	965	75	−	TY
	28/00	23.6	140.7	965	75	5.0	TY
	28/03	24.2	141.1	965	75	−	TY
	28/06	24.9	141.5	965	75	5.0	TY
	28/09	25.4	142.0	965	75	−	TY
	28/12	26.3	142.5	970	70	5.0	TY
	28/15	27.1	142.9	970	70	−	TY
	28/18	28.0	143.4	970	70	5.0	TY
	28/21	29.0	144.0	970	70	−	TY
	29/00	29.7	144.6	970	70	4.5	TY
	29/06	32.2	146.9	975	65	4.0	TY
	29/12	33.7	149.9	980	−	3.5	L
	29/18	35.9	153.1	990	−	−	L
	30/00	38.3	157.9	992	−	−	L
	30/06	41.4	164.0	992	−	−	L
	30/12	44.3	169.0	984	−	−	L
	30/18	44.7	172.1	978	−	−	L
	31/00	44.1	175.0	974	−	−	L
	31/06	43.1	178.0	978	−	−	L
	31/12	42.1	181.8	984	−	−	Out

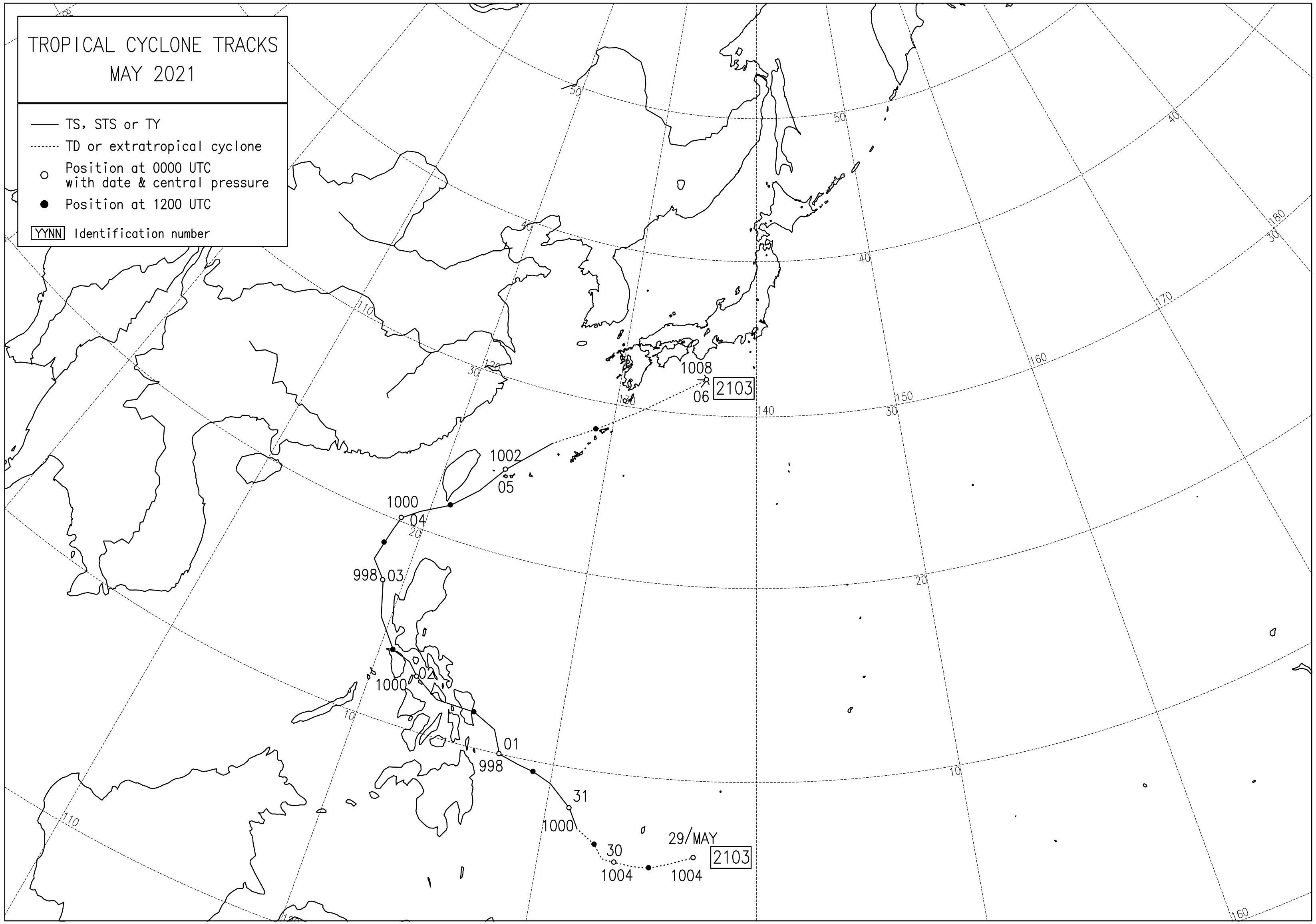
Date/Time (UTC)		Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
TY NYATOH (2121)							
Nov.	28/18	11.7	144.0	1004	−	0.5	TD
	29/00	11.8	142.8	1006	−	1.0	TD
	29/06	12.0	141.8	1004	−	1.5	TD
	29/12	12.2	141.0	1006	−	1.5	TD
	29/18	12.3	140.0	1002	−	1.5	TD
	30/00	12.5	139.0	1000	35	2.0	TS
	30/06	12.9	138.1	998	35	2.0	TS
	30/12	13.2	137.3	996	40	2.5	TS
	30/18	13.5	136.5	992	45	3.0	TS
Dec.	01/00	13.8	136.2	990	50	3.0	STS
	01/06	14.2	135.7	985	55	3.5	STS
	01/12	15.0	135.6	975	65	4.0	TY
	01/18	15.8	135.5	970	70	4.5	TY
	02/00	16.5	135.5	970	70	4.5	TY
	02/06	17.3	135.8	955	80	5.0	TY
	02/12	18.3	136.7	950	85	5.5	TY
	02/18	19.5	137.5	925	100	6.5	TY
	03/00	21.0	138.7	925	100	6.5	TY
	03/06	22.6	140.5	935	95	6.5	TY
	03/12	24.2	142.5	955	80	6.5	TY
	03/18	26.2	144.6	980	60	5.5	STS
	04/00	28.4	146.5	1000	−	5.0	L
	04/06	29.0	148.1	1006	−	−	L
	04/12						Dissip.

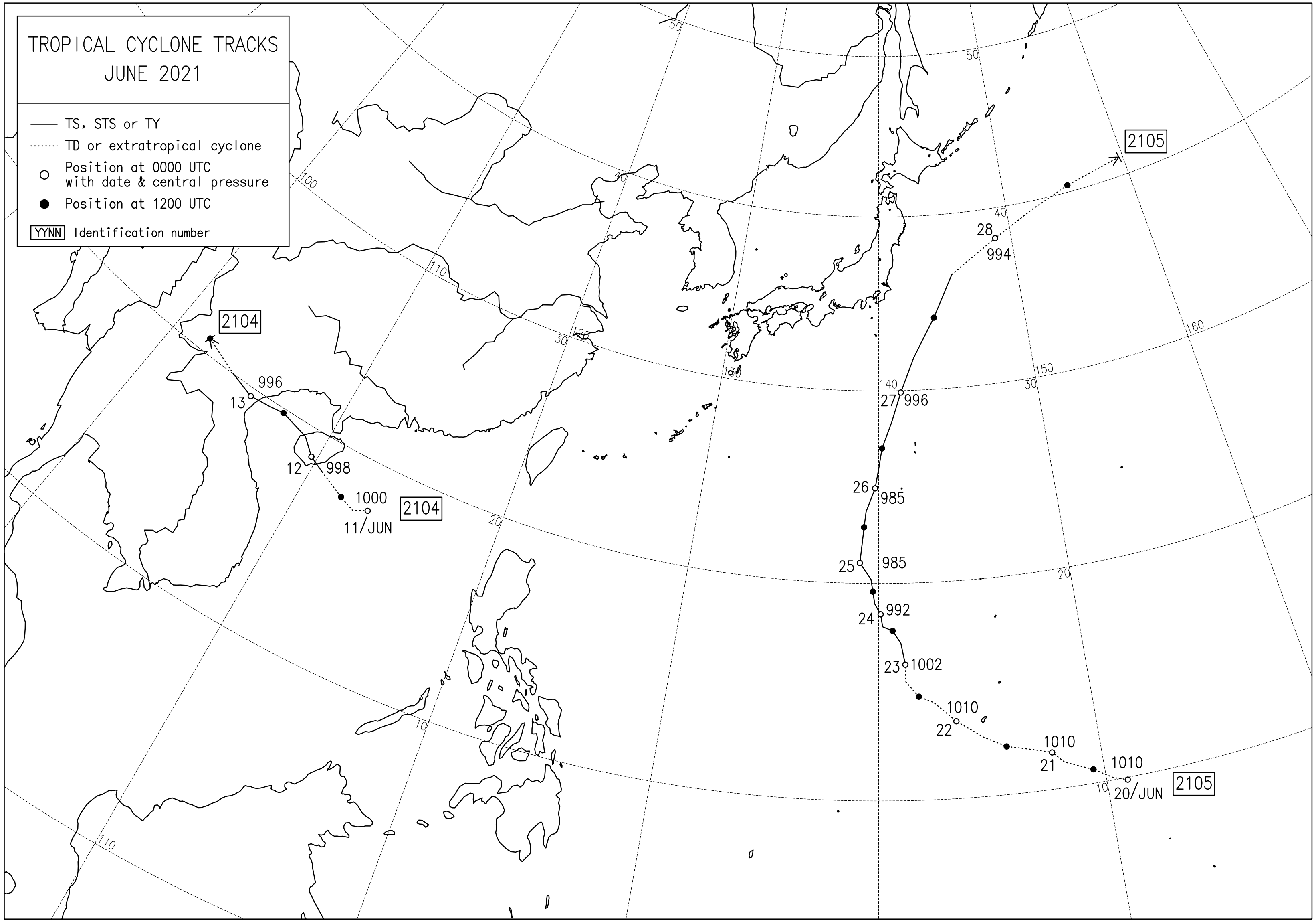
Date/Time (UTC)		Center Position Lat (N)	Lon (E)	Central pressure (hPa)	Max Wind (kt)	CI num.	Grade
TY RAI (2122)							
Dec.	11/18	5.8	144.8	1002	−	0.0	TD
	12/00	5.8	144.4	1004	−	0.0	TD
	12/06	5.8	144.0	1002	−	0.0	TD
	12/12	5.8	143.5	1004	−	0.5	TD
	12/18	5.8	143.0	1002	−	1.0	TD
	13/00	5.8	142.0	1000	−	1.5	TD
	13/06	6.0	141.0	998	35	2.0	TS
	13/12	6.4	139.7	996	40	2.5	TS
	13/18	6.8	138.4	992	45	3.0	TS
	14/00	7.2	137.1	990	50	3.0	STS
	14/06	7.8	135.8	985	55	3.0	STS
	14/12	8.4	134.5	980	60	3.5	STS
	14/18	8.6	133.4	970	70	4.5	TY
	15/00	8.7	132.3	965	75	5.0	TY
	15/06	8.9	131.2	955	80	5.0	TY
	15/12	9.1	130.1	955	80	5.0	TY
	15/18	9.4	128.9	950	85	5.5	TY
	16/00	9.7	127.6	925	100	6.5	TY
	16/06	9.9	126.0	915	105	6.5	TY
	16/12	10.0	124.3	935	95	5.5	TY
	16/18	10.0	122.6	950	85	5.0	TY
	17/00	10.0	121.2	955	80	5.0	TY
	17/06	10.3	119.9	955	80	5.0	TY
	17/12	10.4	118.6	955	80	5.0	TY
	17/18	10.6	117.4	955	80	5.0	TY
	18/00	10.8	116.0	950	85	5.5	TY
	18/06	11.2	114.6	935	95	6.5	TY
	18/12	11.8	113.4	925	100	7.0	TY
	18/18	12.5	112.2	915	105	7.0	TY
	19/00	13.1	111.4	915	105	7.0	TY
	19/06	13.9	110.6	925	100	7.0	TY
	19/12	14.9	110.6	940	90	6.0	TY
	19/18	16.1	110.7	955	80	5.5	TY
	20/00	17.2	110.9	970	70	5.0	TY
	20/06	18.1	111.4	985	55	4.5	STS
	20/12	19.0	111.9	1000	35	4.0	TS
	20/18	19.9	112.8	1006	−	3.5	TD
	21/00	20.8	114.0	1008	−	3.0	TD
	21/06	21.3	115.3	1008	−	−	TD
	21/12						Dissip.

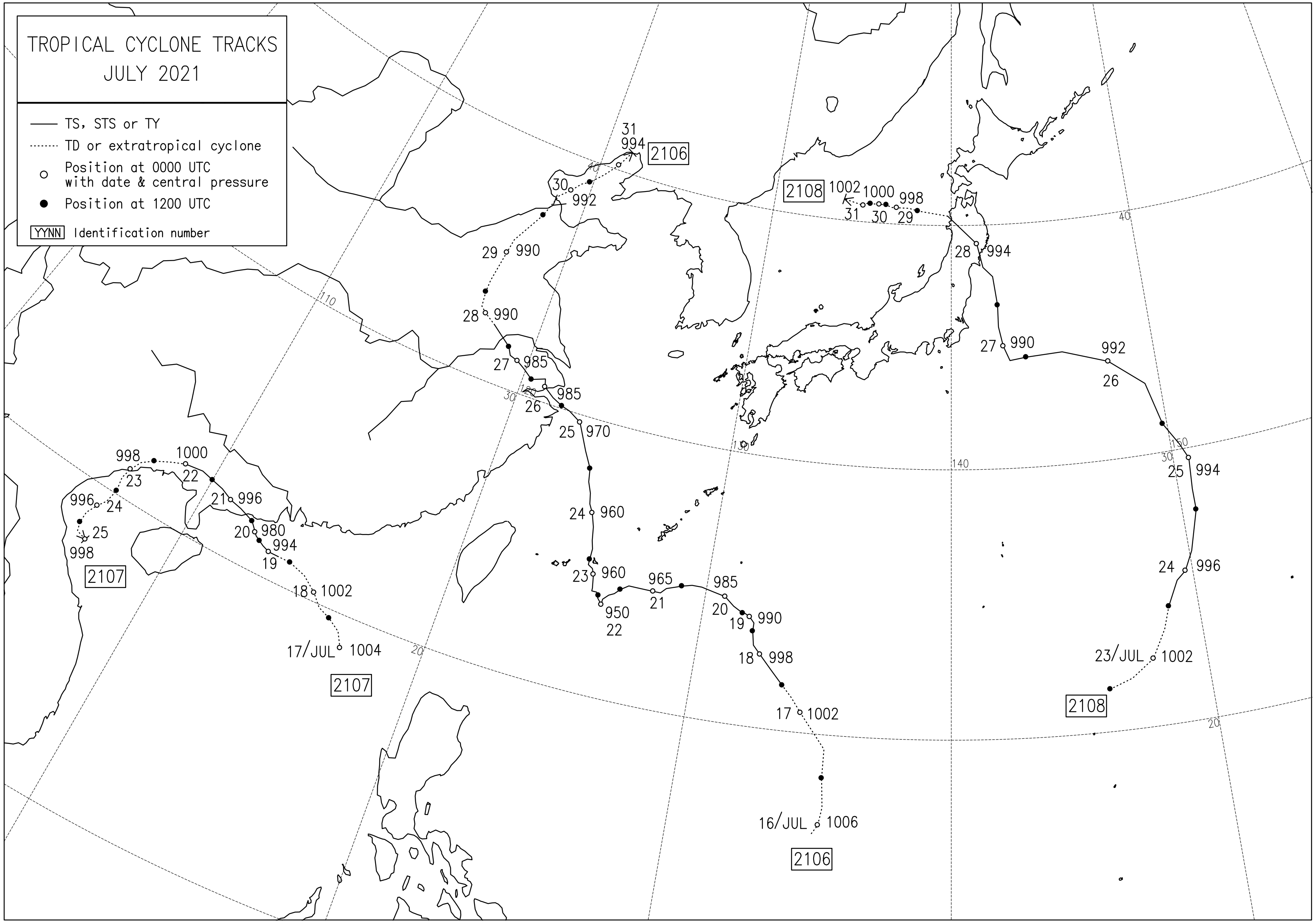
Appendix 2
Monthly Tracks of Tropical Cyclones in 2021

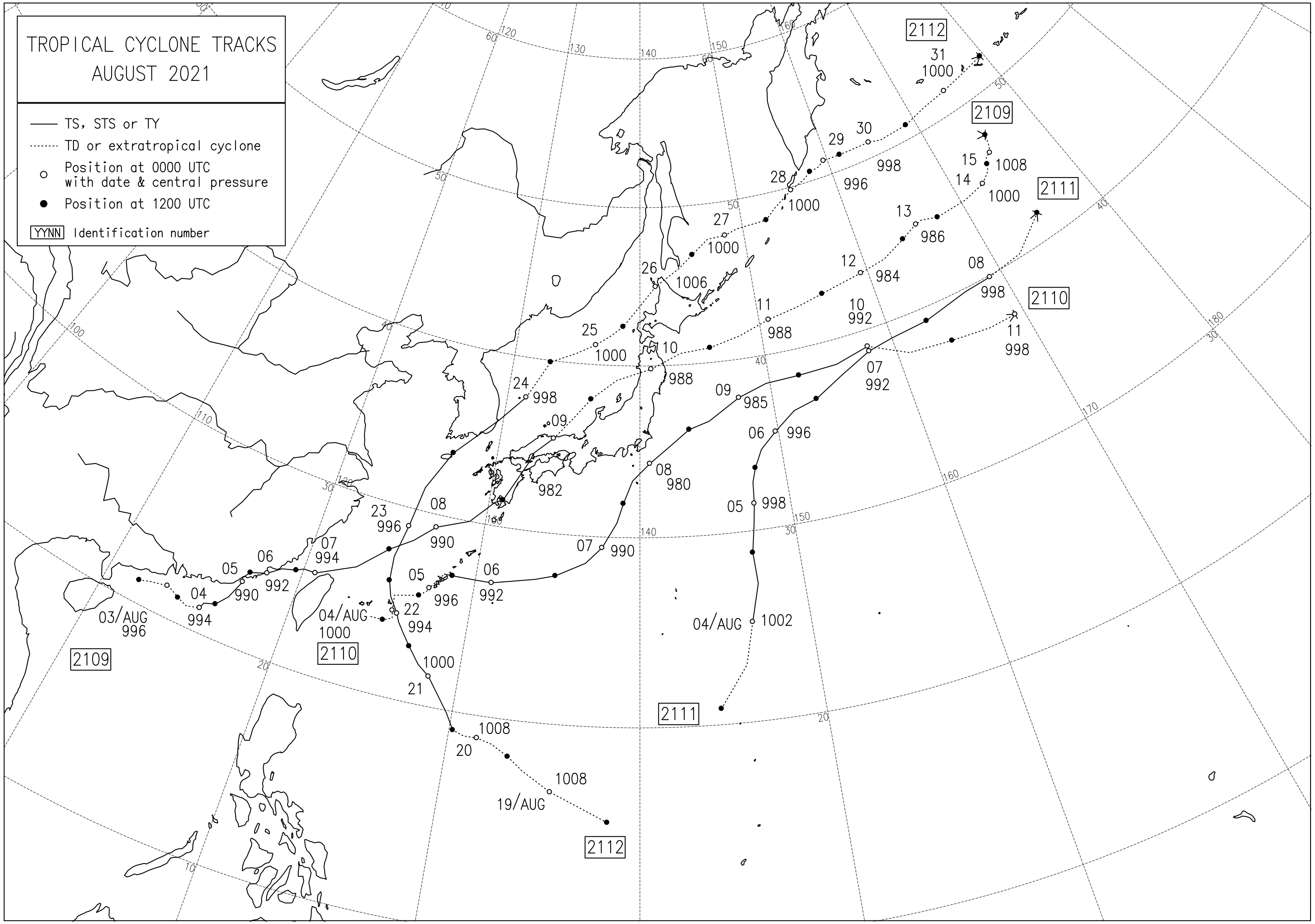

TROPICAL CYCLONE TRACKS
FEBRUARY 2021
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2101
1010
23
1008
22
1000
21
996
19
998
20
1000
18
1004
17/FEB
2101
20
10

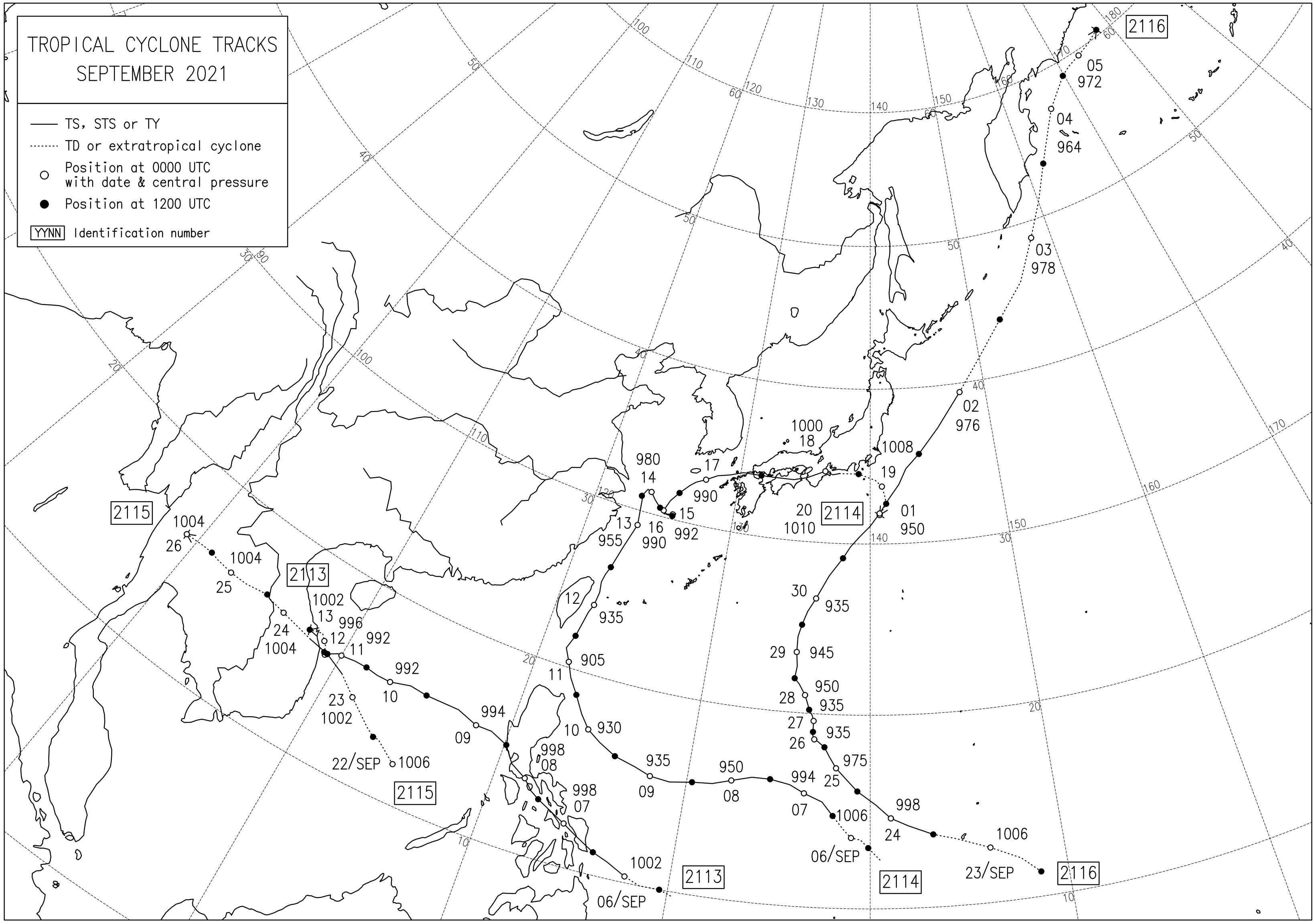

TROPICAL CYCLONE TRACKS
APRIL 2021
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2102
13/APR
14
1006
15
1000
990
16
965
17
935
18
895
19
910
20
935
21
935
945
22
23
970
24
985
25
996
26
988
27
944
28
964
980
29
30
992
2102

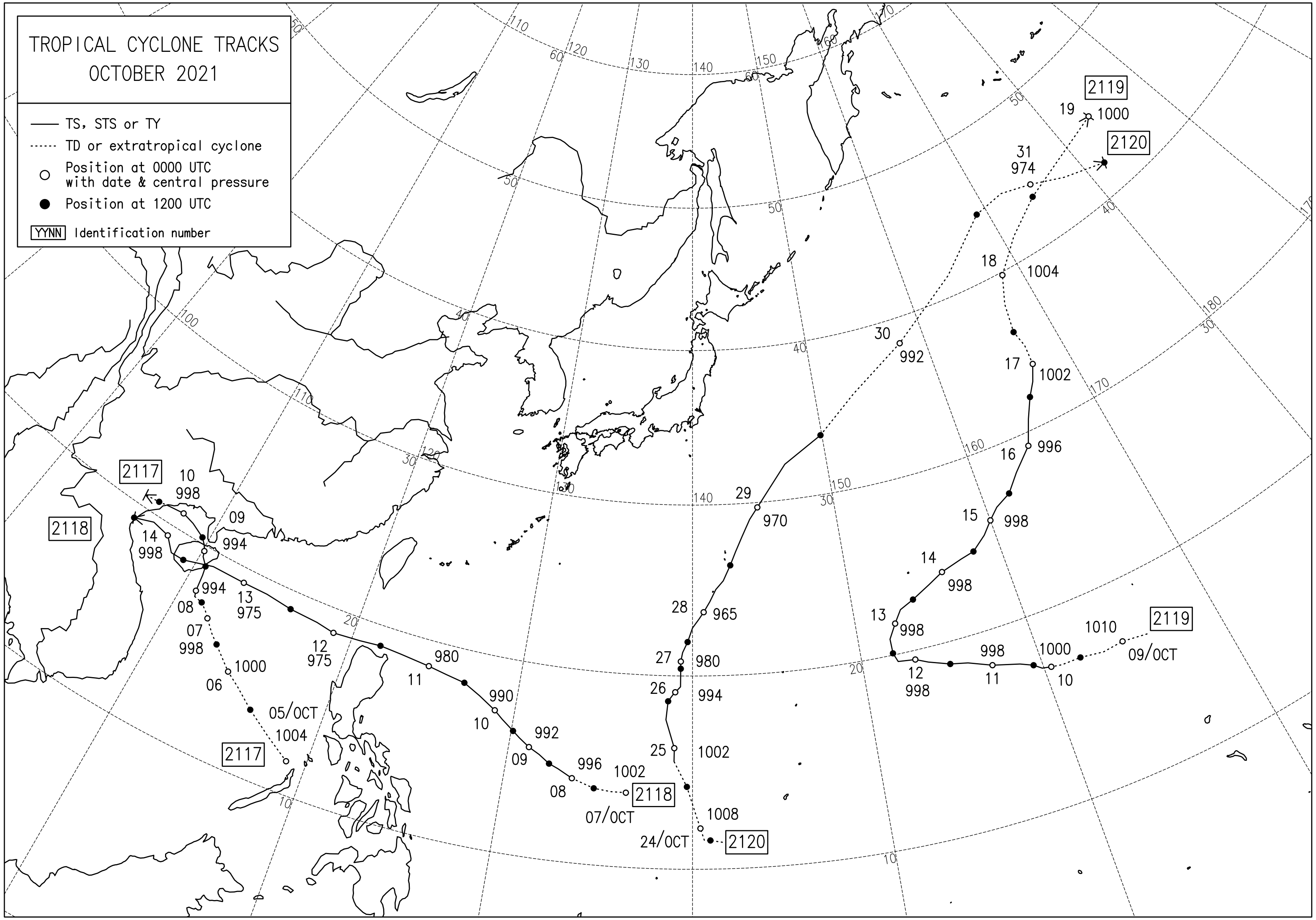

TROPICAL CYCLONE TRACKS
MAY 2021
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2103
29/MAY
1004
30
1004
31
1000
01
998
02
1000
03
998
04
1000
05
1002
06
1008
2103

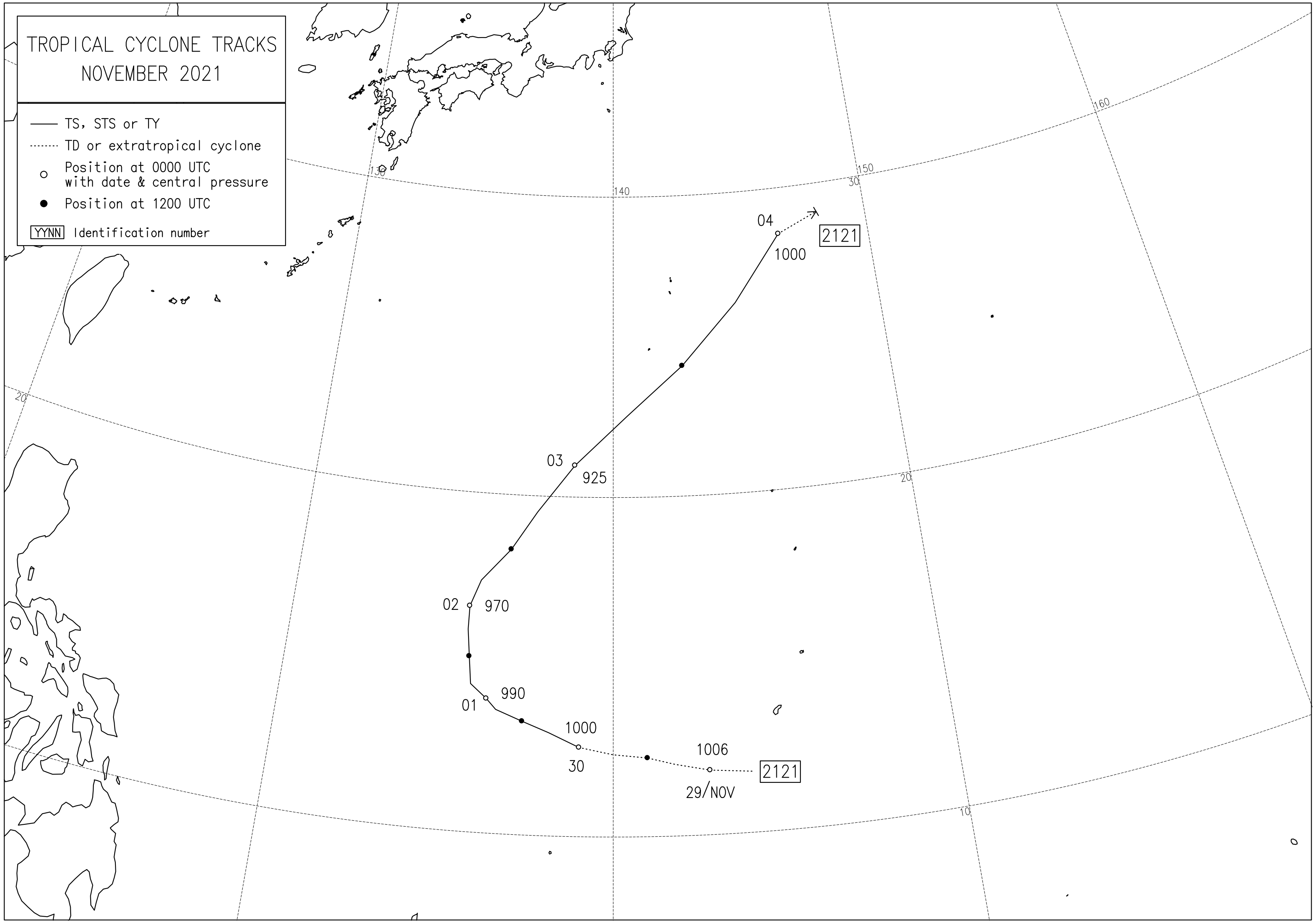

TROPICAL CYCLONE TRACKS
JUNE 2021
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2104
996
13
12
998
1000
11/JUN
2104
2105
28
994
27 996
26
985
25
985
24
992
23
1002
22
1010
21
1010
1010
20/JUN
2105

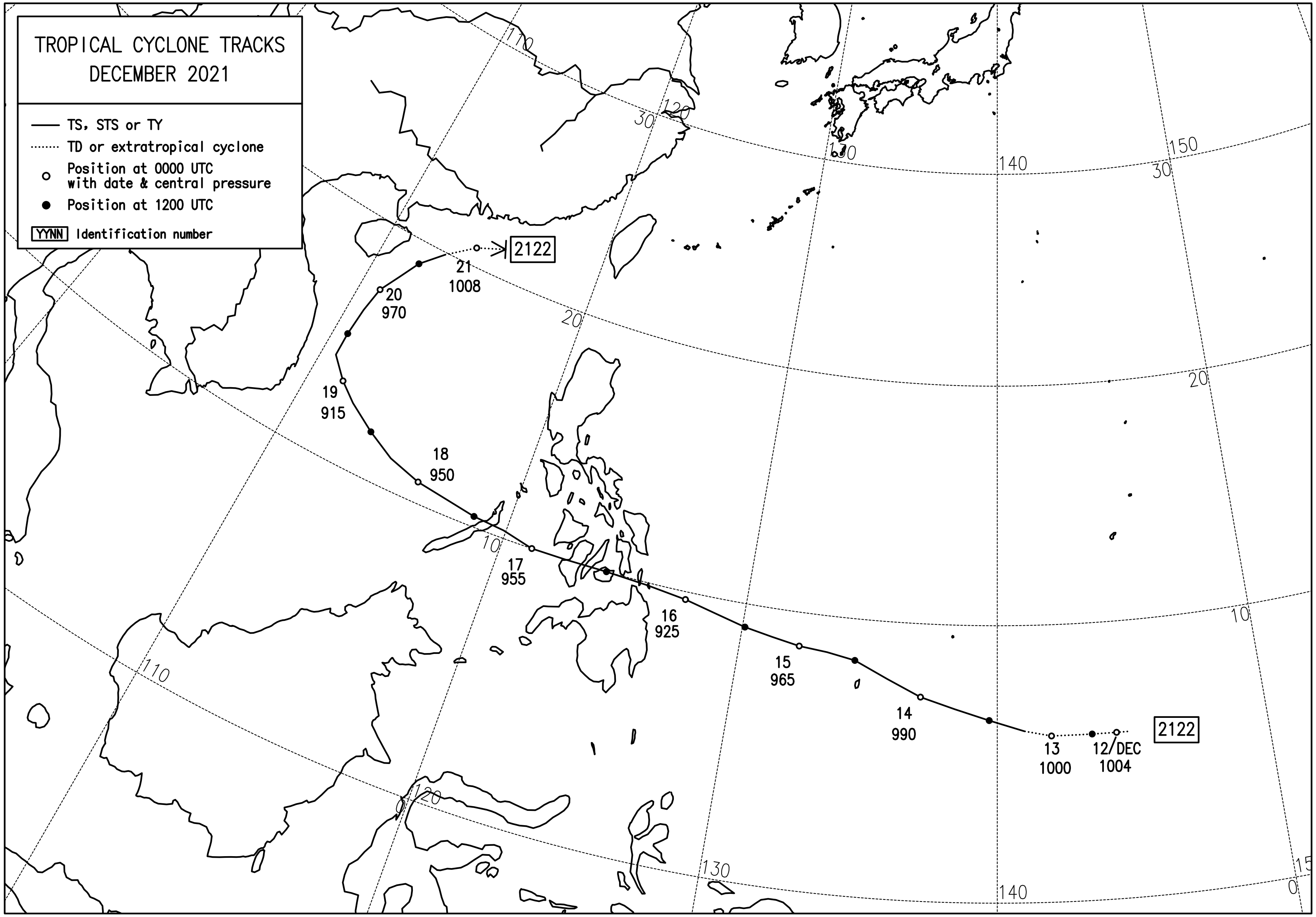

TROPICAL CYCLONE TRACKS
JULY 2021
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2106
31
994
30
992
29 990
28 990
27 985
26
985
25 970
24 960
23 960
950
22
965
21
985
20
19 990
18 998
17 1002
16/JUL 1006
2106
2107
998
1000
23
22
21 996
996
24
25
998
20 980
994
19
18 1002
17/JUL 1004
2107
2108
1002
1000
998
31
30
29
28 994
27 990
992
26
25 994
24 996
23/JUL 1002
2108


TROPICAL CYCLONE TRACKS
AUGUST 2021
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2109
2110
2111
2112
03/AUG
996
04/AUG
1000
04/AUG
1002
19/AUG
1008


TROPICAL CYCLONE TRACKS
SEPTEMBER 2021
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2113
2114
2115
2116
06/SEP
22/SEP
23/SEP


TROPICAL CYCLONE TRACKS
OCTOBER 2021
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
2117
2118
2119
2120
05/OCT
07/OCT
09/OCT
24/OCT


TROPICAL CYCLONE TRACKS
NOVEMBER 2021
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC
with date & central pressure
Position at 1200 UTC
YYNN Identification number
2121
04
1000
03
925
02
970
01
990
1000
30
1006
29/NOV
2121


TROPICAL CYCLONE TRACKS
DECEMBER 2021
TS, STS or TY
TD or extratropical cyclone
Position at 0000 UTC with date & central pressure
Position at 1200 UTC
YYNN Identification number
2122
21
1008
20
970
19
915
18
950
17
955
16
925
15
965
14
990
13
1000
12/DEC
1004
2122
110
120
130
140
150
30
20
10
0

Appendix 3
Errors of Track and Intensity Forecasts for Each Tropical Cyclone in 2021

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
								Dujuan(2101)											
Feb.	17/00	TD	TD	*55*	*22*	*46*	*233*	*374*	*480*	*0*	*2*	*-4*	*-6*	*-10*	*0*	*0*	*5*	*10*	*5*
	17/06	TD	TD	*40*	*49*	*95*	*190*	*320*	*253*	*0*	*0*	*-6*	*-4*	*-8*	*0*	*0*	*5*	*5*	*5*
	17/12	TD	TD	*0*	*56*	*124*	*184*	*262*	*245*	*2*	*-2*	*-8*	*-8*	*-10*	*-5*	*0*	*10*	*10*	*5*
	17/18	TD	TD	*0*	*63*	*179*	*245*	*296*	*302*	*2*	*-6*	*-10*	*-14*	*-10*	*-5*	*5*	*15*	*15*	*5*
	18/00	TS	TD	**0**	**70**	**228**	**394**			**2**	**-6**	**-10**			**-5**	**5**	**15**		
	18/06	TS	TS	**16**	**95**	**262**	**369**			**0**	**-8**	**-10**			**0**	**10**	**15**		
	18/12	TS	TS	**22**	**105**	**258**				**-6**	**-10**				**5**	**15**			
	18/18	TS	TS	**22**	**126**	**248**				**-6**	**-10**				**5**	**15**			
	19/00	TS	TS	**67**	**183**	**297**				**-2**	**-10**				**0**	**15**			
	19/06	TS	TS	**35**	**211**	**325**				**-2**	**-10**				**0**	**15**			
	19/12	TS	TS	**141**	**189**					**-4**					**5**				
	19/18	TS	TS	**115**	**193**					**-4**					**5**				
	20/00	TS	TS	**154**	**254**					**-4**					**5**				
	20/06	TS	TS	**144**	**271**					**-4**					**5**				
	20/12	TS	TS	**67**															
	20/18	TS	TS	**55**															
	21/00	TS	TS	**81**															
	21/06	TS	TS	**71**															
	21/12	TD	TS																
	21/18	TD	TS																
	22/00	TD	TD																
Initial: TS/STS/TY			**mean**	**71**	**170**	**270**	**382**	**--**	**--**	**-3**	**-9**	**-10**	**--**	**--**	**3**	**13**	**15**	**--**	**--**
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*	*24*	*48*	*111*	*213*	*313*	*320*	*1*	*-2*	*-7*	*-8*	*-10*	*-3*	*1*	*9*	*10*	*5*
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		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
							Surigae(2102)												
Apr.	13/00	TD	TD	*238*	*231*	*286*	*291*	*317*	*468*	*-2*	*6*	*25*	*40*	*60*	*-5*	*-10*	*-25*	*-30*	*-40*
	13/06	TD	TD	*196*	*165*	*157*	*200*	*225*	*485*	*0*	*11*	*35*	*45*	*40*	*-5*	*-15*	*-30*	*-30*	*-25*
	13/12	TD	TD	*143*	*154*	*143*	*121*	*235*	*328*	*4*	*21*	*35*	*60*	*30*	*-10*	*-25*	*-30*	*-35*	*-15*
	13/18	TS	TS	**35**	**160**	**95**	**132**	**177**	**270**	**0**	**15**	**30**	**55**	**30**	**0**	**-15**	**-20**	**-35**	**-15**
	14/00	TS	TS	**11**	**78**	**74**	**109**	**164**	**218**	**4**	**20**	**35**	**55**	**25**	**-5**	**-20**	**-25**	**-35**	**-10**
	14/06	TS	TS	**22**	**65**	**71**	**109**	**184**	**264**	**7**	**20**	**30**	**40**	**5**	**-5**	**-15**	**-20**	**-25**	**0**
	14/12	TS	TS	**33**	**78**	**35**	**31**	**73**	**141**	**17**	**20**	**45**	**25**	**5**	**-15**	**-15**	**-25**	**-10**	**0**
	14/18	TS	TS	**16**	**47**	**22**	**103**	**76**	**131**	**15**	**35**	**55**	**25**	**-5**	**-15**	**-25**	**-35**	**-10**	**5**
	15/00	STS	STS	**22**	**56**	**11**	**31**	**92**	**185**	**15**	**20**	**40**	**15**	**-10**	**-15**	**-15**	**-25**	**-5**	**10**
	15/06	STS	STS	**11**	**46**	**25**	**34**	**79**	**183**	**20**	**25**	**35**	**5**	**-10**	**-15**	**-15**	**-20**	**0**	**10**
	15/12	TY	STS	**11**	**40**	**95**	**40**	**54**	**176**	**25**	**45**	**25**	**5**	**0**	**-20**	**-25**	**-10**	**0**	**5**
	15/18	TY	STS	**16**	**11**	**84**	**24**	**76**	**181**	**30**	**45**	**15**	**-5**	**5**	**-20**	**-30**	**-5**	**5**	**0**
	16/00	TY	TY	**22**	**25**	**71**	**68**	**161**	**301**	**20**	**40**	**15**	**0**	**15**	**-15**	**-25**	**-5**	**5**	**-5**
	16/06	TY	TY	**11**	**64**	**73**	**89**	**150**	**270**	**25**	**25**	**5**	**0**	**15**	**-15**	**-15**	**0**	**5**	**-5**
	16/12	TY	TY	**11**	**70**	**49**	**68**	**78**	**118**	**30**	**15**	**5**	**0**	**15**	**-15**	**-5**	**0**	**5**	**-5**
	16/18	TY	TY	**0**	**39**	**34**	**55**	**87**	**100**	**30**	**5**	**-15**	**-10**	**-5**	**-20**	**0**	**10**	**10**	**5**
	17/00	TY	TY	**0**	**25**	**66**	**89**	**128**	**133**	**30**	**5**	**-20**	**-10**	**-5**	**-20**	**0**	**15**	**10**	**5**
	17/06	TY	TY	**11**	**16**	**39**	**46**	**81**	**95**	**15**	**-5**	**-10**	**0**	**5**	**-10**	**5**	**10**	**5**	**0**
	17/12	TY	TY	**11**	**11**	**31**	**39**	**111**	**71**	**-10**	**-5**	**-10**	**0**	**0**	**10**	**5**	**10**	**5**	**5**
	17/18	TY	TY	**0**	**31**	**25**	**48**	**97**	**91**	**-15**	**-15**	**-10**	**-5**	**-5**	**15**	**10**	**10**	**5**	**5**
	18/00	TY	TY	**0**	**34**	**48**	**64**	**120**	**152**	**-5**	**-10**	**5**	**5**	**-15**	**5**	**10**	**0**	**0**	**15**
	18/06	TY	TY	**0**	**39**	**46**	**54**	**76**	**121**	**-15**	**-10**	**5**	**10**	**-5**	**10**	**10**	**0**	**-5**	**10**
	18/12	TY	TY	**11**	**24**	**22**	**54**	**68**	**91**	**-15**	**-10**	**5**	**5**	**-5**	**10**	**10**	**0**	**0**	**10**
	18/18	TY	TY	**11**	**15**	**11**	**70**	**159**	**80**	**-15**	**-10**	**-5**	**-5**	**-10**	**10**	**10**	**5**	**5**	**15**
	19/00	TY	TY	**11**	**11**	**22**	**74**	**236**	**56**	**-20**	**0**	**5**	**-5**	**-5**	**15**	**5**	**0**	**10**	**10**
	19/06	TY	TY	**11**	**11**	**70**	**160**	**236**	**74**	**-10**	**5**	**5**	**-10**	**-15**	**10**	**0**	**0**	**15**	**20**
	19/12	TY	TY	**11**	**34**	**116**	**200**	**196**	**90**	**-10**	**5**	**0**	**-15**	**-19**	**10**	**0**	**5**	**20**	**25**
	19/18	TY	TY	**11**	**69**	**153**	**270**	**169**	**115**	**0**	**-5**	**-5**	**-15**	**-21**	**5**	**5**	**5**	**20**	**30**

continued on the next page

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

‡Position error of provisional analysis

continued from the previous page

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
						Surigae(2102)												
20/00	TY	TY	**0**	**69**	**145**	**310**	**91**		**5**	**5**	**-15**	**-15**		**0**	**0**	**15**	**20**	
20/06	TY	TY	**0**	**77**	**154**	**214**	**90**		**5**	**5**	**-10**	**-15**		**0**	**0**	**15**	**20**	
20/12	TY	TY	**15**	**55**	**152**	**191**	**108**		**15**	**5**	**0**	**-4**		**-5**	**0**	**5**	**10**	
20/18	TY	TY	**11**	**49**	**118**	**168**	**161**		**10**	**10**	**0**	**-4**		**-5**	**-5**	**5**	**10**	
21/00	TY	TY	**11**	**46**	**201**	**148**			**10**	**5**	**7**			**-5**	**0**	**-5**		
21/06	TY	TY	**11**	**46**	**137**	**102**			**20**	**5**	**-5**			**-10**	**0**	**5**		
21/12	TY	TY	**11**	**30**	**123**	**129**			**15**	**0**	**-9**			**-5**	**5**	**10**		
21/18	TY	TY	**0**	**43**	**90**	**126**			**5**	**-5**	**-11**			**0**	**10**	**15**		
22/00	TY	TY	**0**	**99**	**70**				**0**	**0**				**5**	**5**			
22/06	TY	TY	**0**	**46**	**84**				**0**	**-5**				**5**	**10**			
22/12	TY	TY	**0**	**46**	**53**				**-5**	**-9**				**10**	**10**			
22/18	TY	TY	**33**	**11**	**43**				**-5**	**-6**				**10**	**10**			
23/00	TY	TY	**10**	**20**					**0**					**5**				
23/06	STS	TY	**11**	**35**					**0**					**5**				
23/12	STS	STS	**0**	**49**					**-4**					**5**				
23/18	STS	STS	**0**	**79**					**-6**					**10**				
24/00	STS	STS	**10**															
24/06	TS	TS	**11**															
24/12	TS	TS	**57**															
24/18	TS	TS	**47**															
Initial: TS/STS/TY		**mean**	**12**	**46**	**74**	**105**	**123**	**148**	**6**	**8**	**7**	**4**	**-1**	**-2**	**-3**	**-2**	**2**	**6**
Valid: TS/STS/TY		**sample**	**45**	**41**	**37**	**33**	**29**	**25**	**41**	**37**	**33**	**29**	**25**	**41**	**37**	**33**	**29**	**25**
Initial: TD(before upg.)		*mean*	*192*	*184*	*195*	*204*	*259*	*427*	*1*	*13*	*32*	*48*	*43*	*-7*	*-17*	*-28*	*-32*	*-27*
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	(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
									Choi-wan(2103)										
May.	30/00	TD	TD	*44*	*135*	*305*	*540*	*767*		*-2*	*-2*	*-4*	*4*		*0*	*0*	*5*	*-10*	
	30/06	TD	TD	*22*	*177*	*252*	*618*	*756*		*-2*	*-2*	*-4*	*4*		*0*	*5*	*5*	*-10*	
	30/12	TD	TD	*214*	*46*	*250*	*676*	*923*		*-2*	*-2*	*-4*	*4*		*0*	*5*	*5*	*-10*	
	30/18	TS	TD	**78**	**165**	**431**	**628**	**705**		**0**	**-4**	**-4**	**2**		**-5**	**5**	**5**	**-10**	
	31/00	TS	TS	**31**	**226**	**432**	**543**	**566**		**0**	**-4**	**-2**	**2**		**-5**	**5**	**0**	**-10**	
	31/06	TS	TS	**35**	**45**	**313**	**500**	**387**		**0**	**-2**	**2**	**2**		**5**	**5**	**-5**	**-5**	
	31/12	TS	TS	**0**	**114**	**360**	**504**			**0**	**-2**	**6**			**5**	**5**	**-10**		
	31/18	TS	TS	**22**	**229**	**380**	**440**			**-2**	**0**	**4**			**5**	**0**	**-10**		
Jun.	01/00	TS	TS	**0**	**227**	**342**	**367**			**-2**	**2**	**4**			**5**	**-5**	**-10**		
	01/06	TS	TS	**0**	**224**	**414**				**0**	**6**				**0**	**-10**			
	01/12	TS	TS	**0**	**220**	**350**				**0**	**6**				**0**	**-10**			
	01/18	TS	TS	**33**	**173**	**215**				**2**	**4**				**0**	**-10**			
	02/00	TS	TS	**33**	**128**					**6**					**-10**				
	02/06	TS	TS	**25**	**183**					**6**					**-10**				
	02/12	TS	TS	**11**	**144**					**6**					**-10**				
	02/18	TS	TS	**40**	**84**					**4**					**-10**				
	03/00	TS	TS	**0**	**133**					**4**					**-10**				
	03/06	TS	TS	**11**	**121**					**2**					**-5**				
	03/12	TS	TS	**11**	**84**					**2**					**-5**				
	03/18	TS	TS	**0**	**47**					**2**					**-5**				
	04/00	TS	TS	**21**	**62**					**2**					**-5**				
	04/06	TS	TS	**0**															
	04/12	TS	TS	**0**															
	04/18	TS	TS	**15**															
	05/00	TS	TS	**0**															
Initial: TS/STS/TY			**mean**	**17**	**145**	**359**	**497**	**553**	**--**	**2**	**1**	**2**	**2**	**--**	**-3**	**-2**	**-5**	**-8**	**--**
Valid: TS/STS/TY			**sample**	**22**	**18**	**9**	**6**	**3**	**0**	**18**	**9**	**6**	**3**	**0**	**18**	**9**	**6**	**3**	**0**
Initial: TD(before upg.)			*mean*	*93*	*119*	*269*	*611*	*815*	--	*-2*	*-2*	*-4*	*4*	--	*0*	*3*	*5*	*-10*	--
Valid: TD/TS/STS/TY			*sample*	*3*	*3*	*3*	*3*	*3*	*0*	*3*	*3*	*3*	*3*	*0*	*3*	*3*	*3*	*3*	*0*

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

‡Position error of provisional analysis

Date/Time (UTC)		Grade		Center Position (km)						Central Pressure (hPa)					Max. Wind (kt)[†]				
		Best	Prov.	T=0[‡]	=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120	T=24	=48	=72	=96	=120
								Koguma(2104)											
Jun.	11/06	TD	TD	*77*	*48*	*283*				*2*	*-4*				*0*	*10*			
	11/12	TD	TD	*35*	*95*	*427*				*2*	*-2*				*0*	*10*			
	11/18	TS	TD	**0**	**64**					**0**					**5**				
	12/00	TS	TD	**0**	**61**					**-2**					**5**				
	12/06	TS	TS	**31**															
	12/12	TS	TS	**0**															
	12/18	TS	TS	**0**															
	13/00	TS	TS	**0**															
	13/06	TD	TD																
Initial: TS/STS/TY			**mean**	**5**	**62**	**--**	**--**	**--**	**--**	**-1**	**--**	**--**	**--**	**--**	**5**	**--**	**--**	**--**	**--**
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*	*56*	*71*	*355*	*--*	*--*	*--*	*2*	*-3*	*--*	*--*	*--*	*0*	*10*	*--*	*--*	*--*
Valid: TD/TS/STS/TY			*sample*	*2*	*2*	*2*	*0*	*0*	*0*	*2*	*2*	*0*	*0*	*0*	*2*	*2*	*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
								Champi(2105)											
Jun.	22/00	TD	TD	*0*	*131*	*155*	*145*	*173*	*270*	*2*	*8*	*9*	*5*	*-4*	*0*	*-10*	*-15*	*-10*	*5*
	22/06	TD	TD	*0*	*131*	*62*	*73*	*242*	*251*	*2*	*6*	*12*	*9*	*0*	*-5*	*-10*	*-15*	*-15*	*5*
	22/12	TD	TD	*54*	*57*	*74*	*108*	*258*	*192*	*4*	*6*	*12*	*2*	*0*	*-10*	*-10*	*-15*	*-5*	*5*
	22/18	TD	TD	*78*	*44*	*105*	*124*	*204*		*4*	*8*	*7*	*0*		*-10*	*-15*	*-10*	*0*	
	23/00	TS	TS	**55**	**46**	**63**	**182**	**131**		**8**	**9**	**7**	**-2**		**-10**	**-15**	**-10**	**5**	
	23/06	TS	TS	**15**	**25**	**116**	**222**	**213**		**6**	**12**	**0**	**-6**		**-5**	**-15**	**0**	**15**	
	23/12	TS	TS	**79**	**54**	**99**	**122**	**76**		**4**	**10**	**-7**	**-4**		**0**	**-10**	**10**	**10**	
	23/18	TS	TS	**124**	**88**	**101**	**104**			**6**	**5**	**-2**			**-5**	**0**	**10**		
	24/00	STS	STS	**90**	**57**	**84**	**39**			**0**	**-5**	**-6**			**0**	**5**	**15**		
	24/06	STS	STS	**39**	**38**	**96**	**154**			**5**	**-5**	**-8**			**-5**	**5**	**20**		
	24/12	STS	STS	**0**	**121**	**223**	**411**			**5**	**-7**	**-6**			**-5**	**10**	**15**		
	24/18	STS	STS	**31**	**137**	**289**				**-5**	**-9**				**5**	**15**			
	25/00	STS	STS	**61**	**195**	**262**				**-10**	**-16**				**10**	**25**			
	25/06	TY	TY	**10**	**138**	**173**				**-10**	**-18**				**10**	**30**			
	25/12	TY	TY	**21**	**83**	**60**				**-17**	**-8**				**20**	**20**			
	25/18	STS	TY	**10**	**63**					**-14**					**20**				
	26/00	STS	TY	**10**	**24**					**-11**					**20**				
	26/06	STS	TY	**10**	**88**					**-8**					**20**				
	26/12	STS	STS	**0**	**71**					**-6**					**15**				
	26/18	TS	STS	**0**															
	27/00	TS	TS	**0**															
	27/06	TS	TS	**0**															
	27/12	TS	LOW	**18**															
Initial: TS/STS/TY			**mean**	**30**	**82**	**142**	**176**	**140**	**--**	**-3**	**-3**	**-3**	**-4**	**--**	**6**	**6**	**9**	**10**	**--**
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*	*33*	*91*	*99*	*112*	*219*	*238*	*3*	*7*	*10*	*4*	*-1*	*-6*	*-11*	*-14*	*-8*	*5*
Valid: TD/TS/STS/TY			*sample*	*4*	*4*	*4*	*4*	*4*	*3*	*4*	*4*	*4*	*4*	*3*	*4*	*4*	*4*	*4*	*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
In-fa(2106)																			
Jul.	16/12	TD	TD	*84*	*35*	*15*	*208*	*285*	*503*	*2*	*-6*	*-20*	*-10*	*10*	*0*	*10*	*15*	*10*	*-5*
	16/18	TD	TD	*33*	*15*	*117*	*271*	*328*	*485*	*2*	*-2*	*-15*	*-5*	*15*	*0*	*5*	*15*	*5*	*-10*
	17/00	TD	TD	*57*	*70*	*159*	*307*	*380*	*648*	*2*	*-5*	*-15*	*0*	*15*	*0*	*5*	*15*	*0*	*-10*
	17/06	TD	TD	*64*	*42*	*116*	*193*	*313*	*567*	*0*	*-10*	*-10*	*0*	*15*	*0*	*10*	*10*	*0*	*-10*
	17/12	TS	TD	**80**	**42**	**185**	**232**	**353**	**545**	**0**	**-10**	**-5**	**10**	**10**	**0**	**10**	**5**	**-5**	**-5**
	17/18	TS	TS	**43**	**61**	**203**	**285**	**411**	**607**	**0**	**-10**	**0**	**15**	**5**	**0**	**10**	**0**	**-10**	**0**
	18/00	TS	TS	**15**	**30**	**133**	**187**	**279**	**325**	**0**	**-10**	**0**	**15**	**10**	**0**	**10**	**0**	**-10**	**-5**
	18/06	TS	TS	**15**	**75**	**129**	**176**	**269**	**314**	**0**	**-5**	**0**	**15**	**10**	**0**	**5**	**0**	**-10**	**-5**
	18/12	TS	TS	**23**	**94**	**30**	**84**	**189**	**286**	**-5**	**0**	**10**	**10**	**10**	**5**	**0**	**-5**	**-5**	**-5**
	18/18	TS	TS	**56**	**84**	**67**	**143**	**272**	**478**	**-5**	**5**	**15**	**5**	**5**	**5**	**-5**	**-10**	**0**	**0**
	19/00	STS	STS	**69**	**51**	**67**	**186**	**279**	**490**	**-10**	**0**	**5**	**5**	**15**	**10**	**0**	**-5**	**0**	**-10**
	19/06	STS	STS	**46**	**42**	**121**	**266**	**397**	**614**	**-5**	**0**	**5**	**5**	**25**	**5**	**0**	**-5**	**0**	**-20**
	19/12	STS	STS	**38**	**46**	**127**	**300**	**497**	**660**	**0**	**10**	**10**	**15**	**36**	**0**	**-5**	**-5**	**-10**	**-35**
	19/18	STS	STS	**10**	**57**	**114**	**282**	**473**	**685**	**5**	**15**	**-5**	**10**	**36**	**-5**	**-10**	**5**	**-5**	**-35**
	20/00	STS	STS	**10**	**69**	**165**	**314**	**518**	**674**	**10**	**15**	**-5**	**20**	**28**	**-10**	**-10**	**5**	**-15**	**-30**
	20/06	STS	STS	**0**	**32**	**113**	**191**	**406**	**515**	**5**	**5**	**-15**	**-5**	**22**	**-5**	**-10**	**5**	**0**	**-20**
	20/12	TY	TY	**0**	**10**	**127**	**185**	**321**	**359**	**10**	**0**	**-5**	**5**	**21**	**-5**	**0**	**5**	**0**	**-20**
	20/18	TY	TY	**10**	**15**	**104**	**180**	**274**	**275**	**5**	**-5**	**-10**	**15**	**16**	**-5**	**5**	**10**	**-10**	**-15**
	21/00	TY	TY	**15**	**67**	**84**	**156**	**210**	**116**	**5**	**-10**	**-5**	**15**	**13**	**-5**	**10**	**5**	**-10**	**-15**
	21/06	TY	TY	**0**	**49**	**74**	**133**	**184**	**191**	**5**	**-10**	**-5**	**15**	**13**	**-5**	**10**	**5**	**-10**	**-15**
	21/12	TY	TY	**11**	**56**	**91**	**167**	**250**	**192**	**0**	**-15**	**-5**	**15**	**7**	**0**	**10**	**0**	**-15**	**-10**
	21/18	TY	TY	**0**	**46**	**101**	**176**	**148**	**103**	**-15**	**-25**	**-5**	**10**	**7**	**10**	**20**	**5**	**-10**	**-5**
	22/00	TY	TY	**10**	**61**	**105**	**180**	**155**	**173**	**-10**	**-20**	**0**	**7**	**15**	**10**	**15**	**5**	**-5**	**-10**
	22/06	TY	TY	**10**	**38**	**63**	**111**	**152**	**160**	**-20**	**-10**	**5**	**11**	**15**	**15**	**10**	**0**	**-10**	**-5**
	22/12	TY	TY	**15**	**55**	**68**	**99**	**91**	**212**	**-20**	**-10**	**5**	**9**	**11**	**15**	**10**	**0**	**-5**	**-5**
	22/18	TY	TY	**11**	**37**	**20**	**31**	**102**		**-15**	**-5**	**0**	**11**		**15**	**5**	**0**	**-5**	
	23/00	TY	TY	**15**	**22**	**59**	**83**	**206**		**-10**	**-5**	**0**	**11**		**10**	**10**	**0**	**-10**	
	23/06	TY	TY	**10**	**30**	**59**	**152**	**188**		**-10**	**0**	**11**	**15**		**10**	**5**	**-10**	**-5**	

continued on the next page

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

‡Position error of provisional analysis

continued from the previous page

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
						In-fa(2106)												
23/12	TY	TY	**10**	**24**	**59**	**147**	**259**		**5**	**5**	**11**	**13**		**-5**	**-5**	**-10**	**-5**	
23/18	TY	TY	**11**	**31**	**68**	**138**			**5**	**5**	**11**			**-5**	**-5**	**-5**		
24/00	TY	TY	**0**	**53**	**89**	**168**			**0**	**5**	**13**			**0**	**-5**	**-10**		
24/06	TY	TY	**0**	**36**	**111**	**168**			**0**	**5**	**11**			**0**	**-10**	**-5**		
24/12	TY	TY	**23**	**38**	**73**	**188**			**-5**	**5**	**11**			**5**	**-5**	**-5**		
24/18	TY	TY	**15**	**48**	**83**				**5**	**9**				**-5**	**-5**			
25/00	TY	TY	**11**	**15**	**56**				**0**	**9**				**0**	**-5**			
25/06	TY	TY	**0**	**61**	**44**				**5**	**9**				**-10**	**-5**			
25/12	STS	STS	**0**	**24**	**36**				**0**	**5**				**-5**	**-5**			
25/18	STS	STS	**22**	**22**					**9**					**-5**				
26/00	STS	STS	**15**	**31**					**5**					**-5**				
26/06	STS	STS	**0**	**24**					**5**					**0**				
26/12	TS	TS	**19**	**49**					**5**					**0**				
26/18	TS	TS	**11**															
27/00	TS	TS	**0**															
27/06	TS	TS	**15**															
27/12	TS	TS	**9**															
27/18	TD	TD																
Initial: TS/STS/TY		**mean**	**16**	**44**	**92**	**176**	**275**	**380**	**-1**	**-1**	**2**	**11**	**16**	**1**	**2**	**-1**	**-7**	**-13**
Valid: TS/STS/TY		**sample**	**41**	**37**	**33**	**29**	**25**	**21**	**37**	**33**	**29**	**25**	**21**	**37**	**33**	**29**	**25**	**21**
Initial: TD(before upg.)		*mean*	*59*	*41*	*102*	*245*	*327*	*551*	*2*	*-6*	*-15*	*-4*	*14*	*0*	*8*	*14*	*4*	*-9*
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
Cempaka(2107)																			
Jul.	18/18	TS	TD	**15**	**94**	**165**	**326**			**11**	**2**	**0**			**-30**	**-10**	**-5**		
	19/00	TS	TS	**15**	**53**	**41**				**12**	**2**				**-25**	**-5**			
	19/06	STS	TS	**31**	**35**	**21**				**10**	**0**				**-20**	**0**			
	19/12	STS	TS	**15**	**10**	**56**				**0**	**0**				**-10**	**0**			
	19/18	TY	TS	**10**	**41**	**68**				**2**	**2**				**-5**	**-5**			
	20/00	TY	STS	**10**	**31**					**0**					**0**				
	20/06	TY	STS	**11**	**10**					**-2**					**5**				
	20/12	STS	STS	**22**	**30**					**-2**					**-5**				
	20/18	STS	STS	**31**	**64**					**-2**					**-5**				
	21/00	TS	TS	**21**															
	21/06	TS	TS	**10**															
	21/12	TS	TS	**61**															
	21/18	TS	TS	**25**															
	22/00	TD	TD																
Initial: TS/STS/TY			**mean**	**21**	**41**	**70**	**326**	**--**	**--**	**3**	**1**	**0**	**--**	**--**	**-11**	**-4**	**-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*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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
								Nepartak(2108)											
Jul.	23/00	TD	TD	*0*	*46*	*50*	*170*	*254*	*406*	*2*	*2*	*0*	*6*	*6*	*0*	*0*	*5*	*0*	*-5*
	23/06	TD	TD	*0*	*41*	*97*	*78*	*155*		*2*	*4*	*0*	*6*		*0*	*0*	*5*	*0*	
	23/12	TS	TS	**61**	**51**	**82**	**123**	**284**		**4**	**4**	**0**	**6**		**-5**	**0**	**5**	**0**	
	23/18	TS	TS	**0**	**107**	**115**	**46**	**325**		**2**	**0**	**2**	**4**		**0**	**5**	**5**	**0**	
	24/00	TS	TS	**0**	**132**	**230**	**80**	**363**		**2**	**0**	**2**	**4**		**0**	**5**	**5**	**0**	
	24/06	TS	TS	**0**	**102**	**148**	**154**			**-2**	**-7**	**-5**			**0**	**5**	**5**		
	24/12	TS	TS	**0**	**72**	**95**	**125**			**-2**	**-7**	**-2**			**0**	**5**	**5**		
	24/18	TS	TS	**0**	**160**	**56**	**294**			**-2**	**-5**	**-4**			**0**	**5**	**5**		
	25/00	TS	TS	**49**	**105**	**106**	**327**			**-7**	**0**	**0**			**5**	**0**	**0**		
	25/06	TS	TS	**51**	**82**	**168**				**-7**	**0**				**5**	**0**			
	25/12	TS	TS	**106**	**178**	**210**				**-7**	**2**				**5**	**0**			
	25/18	TS	TS	**149**	**247**	**303**				**0**	**0**				**0**	**-5**			
	26/00	TS	TS	**73**	**124**	**208**				**0**	**0**				**0**	**-5**			
	26/06	TS	TS	**141**	**62**					**2**					**0**				
	26/12	TS	TS	**86**	**94**					**-2**					**5**				
	26/18	TS	TS	**0**	**78**					**-4**					**5**				
	27/00	TS	TS	**0**	**61**					**0**					**0**				
	27/06	TS	TS	**0**															
	27/12	TS	TS	**0**															
	27/18	TS	TS	**0**															
	28/00	TS	TS	**11**															
Initial: TS/STS/TY			**mean**	**38**	**110**	**157**	**164**	**324**	**--**	**-2**	**-1**	**-1**	**5**	**--**	**1**	**1**	**4**	**0**	**--**
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*	*0*	*44*	*73*	*124*	*204*	*406*	*2*	*3*	*0*	*6*	*6*	*0*	*0*	*5*	*0*	*-5*
Valid: TD/TS/STS/TY			*sample*	*2*	*2*	*2*	*2*	*2*	*1*	*2*	*2*	*2*	*2*	*1*	*2*	*2*	*2*	*2*	*1*

† 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
									Lupit(2109)										
Aug.	03/00	TD	TD	*0*	*115*	*131*	*150*	*131*	*507*	*0*	*0*	*-2*	*-4*	*0*	*0*	*0*	*0*	*5*	*0*
	03/06	TD	TD	*0*	*62*	*101*	*84*	*301*	*579*	*0*	*0*	*-2*	*-4*	*0*	*0*	*0*	*0*	*5*	*0*
	03/12	TD	TD	*0*	*30*	*105*	*90*	*435*	*695*	*2*	*-2*	*-4*	*-4*	*2*	*-5*	*0*	*5*	*5*	*0*
	03/18	TD	TD	*0*	*30*	*53*	*37*	*334*	*802*	*4*	*-2*	*-4*	*-2*	*6*	*-5*	*0*	*5*	*0*	*-5*
	04/00	TS	TS	**30**	**46**	**102**	**135**	**306**		**0**	**-2**	**-4**	**0**		**0**	**0**	**5**	**0**	
	04/06	TS	TS	**38**	**11**	**91**	**284**	**570**		**0**	**-2**	**-4**	**0**		**0**	**0**	**5**	**0**	
	04/12	TS	TS	**0**	**33**	**194**	**457**	**819**		**-2**	**-4**	**-4**	**2**		**0**	**5**	**5**	**0**	
	04/18	TS	TS	**30**	**53**	**192**	**564**	**1020**		**-2**	**-4**	**-2**	**6**		**0**	**5**	**0**	**-5**	
	05/00	TS	TS	**0**	**134**	**282**	**736**			**-2**	**-4**	**0**			**0**	**5**	**0**		
	05/06	TS	TS	**15**	**182**	**457**	**882**			**-2**	**-4**	**0**			**0**	**5**	**0**		
	05/12	TS	TS	**0**	**203**	**482**	**964**			**-4**	**-4**	**2**			**5**	**5**	**0**		
	05/18	TS	TS	**0**	**141**	**567**	**1175**			**0**	**2**	**10**			**0**	**-5**	**-10**		
	06/00	TS	TS	**0**	**173**	**824**				**0**	**6**				**0**	**-10**			
	06/06	TS	TS	**39**	**353**	**977**				**0**	**6**				**0**	**-10**			
	06/12	TS	TS	**52**	**529**	**1169**				**0**	**8**				**0**	**-10**			
	06/18	TS	TS	**82**	**601**					**4**					**-10**				
	07/00	TS	TS	**35**	**29**					**2**					**0**				
	07/06	TS	TS	**67**	**127**					**4**					**0**				
	07/12	TS	TS	**115**	**167**					**6**					**0**				
	07/18	TS	TS	**94**	**140**					**8**					**-5**				
	08/00	TS	TS	**53**															
	08/06	TS	TS	**126**															
	08/12	TS	TS	**0**															
	08/18	TS	TS	**28**															
Initial: TS/STS/TY			**mean**	**40**	**183**	**485**	**650**	**679**	**--**	**1**	**0**	**0**	**2**	**--**	**-1**	**-1**	**1**	**-1**	**--**
Valid: TS/STS/TY			**sample**	**20**	**16**	**11**	**8**	**4**	**0**	**16**	**11**	**8**	**4**	**0**	**16**	**11**	**8**	**4**	**0**
Initial: TD(before upg.)			*mean*	*0*	*59*	*97*	*90*	*300*	*646*	*2*	*-1*	*-3*	*-4*	*2*	*-3*	*0*	*3*	*4*	*-1*
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
									Mirinae(2110)										
Aug.	03/18	TD	TD	*68*	*210*	*404*	*681*	*662*	*684*	*-2*	*2*	*0*	*10*	*5*	*5*	*-5*	*0*	*-10*	*-5*
	04/00	TD	TD	*54*	*132*	*275*	*389*	*212*	*456*	*-2*	*2*	*0*	*10*	*5*	*5*	*-5*	*0*	*-10*	*-5*
	04/06	TD	TD	*177*	*139*	*606*	*659*	*428*	*587*	*2*	*0*	*5*	*10*	*5*	*0*	*0*	*-5*	*-10*	*-5*
	04/12	TD	TD	*46*	*222*	*589*	*546*	*488*	*824*	*2*	*0*	*5*	*10*	*8*	*-5*	*0*	*-5*	*-10*	*-10*
	04/18	TD	TD	*52*	*266*	*535*	*389*	*358*	*677*	*2*	*0*	*10*	*5*	*6*	*-5*	*0*	*-10*	*-5*	*-10*
	05/00	TD	TD	*55*	*240*	*370*	*157*	*43*		*2*	*0*	*10*	*5*		*-5*	*0*	*-10*	*-5*	
	05/06	TS	TS	**50**	**298**	**256**	**91**	**194**		**0**	**0**	**5**	**5**		**0**	**0**	**-5**	**-5**	
	05/12	TS	TS	**0**	**279**	**170**	**52**	**141**		**-5**	**0**	**10**	**0**		**5**	**0**	**-10**	**0**	
	05/18	TS	TS	**11**	**215**	**30**	**240**	**254**		**-5**	**5**	**5**	**-2**		**5**	**-5**	**-5**	**0**	
	06/00	TS	TS	**46**	**155**	**56**	**263**			**-5**	**5**	**5**			**5**	**-5**	**-5**		
	06/06	TS	TS	**59**	**102**	**117**	**103**			**0**	**5**	**5**			**0**	**-5**	**-5**		
	06/12	TS	TS	**20**	**38**	**123**	**9**			**0**	**5**	**0**			**0**	**-5**	**0**		
	06/18	TS	TS	**41**	**43**	**154**	**52**			**5**	**0**	**-2**			**-5**	**0**	**0**		
	07/00	TS	TS	**19**	**57**	**80**				**5**	**5**				**-5**	**-5**			
	07/06	TS	TS	**15**	**45**	**91**				**5**	**5**				**-5**	**-5**			
	07/12	TS	TS	**11**	**27**	**38**				**5**	**0**				**-5**	**0**			
	07/18	STS	TS	**11**	**66**	**91**				**-5**	**-7**				**0**	**0**			
	08/00	STS	TS	**35**	**14**					**-5**					**0**				
	08/06	STS	TS	**29**	**17**					**-5**					**0**				
	08/12	STS	TS	**0**	**45**					**-10**					**5**				
	08/18	TS	TS	**11**	**68**					**-12**					**5**				
	09/00	TS	TS	**0**															
	09/06	TS	TS	**9**															
	09/12	TS	TS	**28**															
	09/18	TS	TS	**70**															
Initial: TS/STS/TY			**mean**	**24**	**98**	**110**	**116**	**196**	**--**	**-2**	**2**	**4**	**1**	**--**	**0**	**-3**	**-4**	**-2**	**--**
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*	*75*	*202*	*463*	*470*	*365*	*646*	*1*	*1*	*5*	*8*	*6*	*-1*	*-2*	*-5*	*-8*	*-7*
Valid: TD/TS/STS/TY			*sample*	*6*	*6*	*6*	*6*	*6*	*5*	*6*	*6*	*6*	*6*	*5*	*6*	*6*	*6*	*6*	*5*

†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
									Nida(2111)										
Aug.	05/06	TS	TS	**22**	**219**	**542**				**4**	**8**				**-15**	**-20**			
	05/12	TS	TS	**22**	**237**	**473**				**4**	**4**				**-15**	**-15**			
	05/18	TS	TS	**14**	**175**	**374**				**8**	**4**				**-20**	**-15**			
	06/00	STS	TS	**9**	**130**					**6**					**-15**				
	06/06	STS	TS	**29**	**81**					**0**					**-5**				
	06/12	STS	TS	**55**	**60**					**-4**					**0**				
	06/18	STS	STS	**57**	**150**					**-4**					**0**				
	07/00	STS	STS	**0**															
	07/06	STS	STS	**24**															
	07/12	STS	TS	**62**															
	07/18	STS	TS	**130**															
Initial: TS/STS/TY			**mean**	**38**	**150**	**463**	**--**	**--**	**--**	**2**	**5**	**--**	**--**	**--**	**-10**	**-17**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**11**	**7**	**3**	**0**	**0**	**0**	**7**	**3**	**0**	**0**	**0**	**7**	**3**	**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
									Omais(2112)										
Aug.	20/06	TD	TD	*79*	*74*	*111*	*132*			*2*	*8*	*6*			*-5*	*-10*	*-5*		
	20/12	TS	TS	**24**	**95**	**55**	**125**			**2**	**8**	**6**			**-5**	**-5**	**-5**		
	20/18	TS	TS	**0**	**93**	**119**	**311**			**4**	**8**	**6**			**-5**	**-5**	**-5**		
	21/00	TS	TS	**0**	**51**	**167**				**4**	**8**				**0**	**-10**			
	21/06	TS	TS	**43**	**84**	**145**				**2**	**6**				**5**	**-5**			
	21/12	TS	TS	**39**	**75**	**87**				**2**	**6**				**5**	**-5**			
	21/18	TS	STS	**10**	**115**	**91**				**4**	**4**				**0**	**-5**			
	22/00	TS	STS	**0**	**121**					**6**					**-10**				
	22/06	TS	TS	**0**	**69**					**4**					**-5**				
	22/12	TS	TS	**0**	**52**					**0**					**0**				
	22/18	TS	TS	**15**	**172**					**0**					**0**				
	23/00	TS	TS	**15**															
	23/06	TS	TS	**15**															
	23/12	TS	TS	**0**															
	23/18	TS	TS	**0**															
Initial: TS/STS/TY			**mean**	**11**	**93**	**111**	**218**	**--**	**--**	**3**	**7**	**6**	**--**	**--**	**-2**	**-6**	**-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*	*79*	*74*	*111*	*132*	*--*	*--*	*2*	*8*	*6*	*--*	*--*	*-5*	*-10*	*-5*	*--*	*--*
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	(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
								Conson(2113)											
Sep.	06/06	TS	TS	0	285	444	578	734	630	0	0	0	6	6	-5	-5	0	-15	-15
	06/12	STS	TS	33	211	129	317	380	327	-6	-6	0	-2	-9	5	5	-5	0	15
	06/18	STS	STS	0	132	249	299	362		0	0	2	-2		0	0	-5	0	
	07/00	TS	TS	0	95	149	297	341		0	4	2	-2		0	0	-5	0	
	07/06	TS	TS	0	76	117	304	293		0	4	0	-2		0	0	0	5	
	07/12	TS	TS	0	141	353	428	428		2	2	0	-4		-5	-5	0	15	
	07/18	TS	TS	25	157	302	303			-4	0	-2			0	0	5		
	08/00	TS	TS	0	143	268	261			4	0	-2			0	0	5		
	08/06	TS	TS	24	108	170	214			4	0	-2			0	0	5		
	08/12	TS	TS	54	183	154	262			0	-12	-14			0	15	25		
	08/18	TS	TS	46	120	154				-2	-12				5	15			
	09/00	TS	TS	49	156	250				-7	-17				5	15			
	09/06	TS	TS	150	48	198				-7	-17				5	15			
	09/12	STS	STS	34	72	193				-12	-19				10	25			
	09/18	STS	STS	39	63					-12					10				
	10/00	STS	STS	0	106					-12					10				
	10/06	STS	STS	0	106					-7					5				
	10/12	STS	STS	0	62					-9					15				
	10/18	STS	STS	21															
	11/00	STS	STS	24															
	11/06	STS	STS	21															
	11/12	TS	TS	0															
	11/18	TD	TD																
Initial: TS/STS/TY			**mean**	**24**	**126**	**224**	**326**	**423**	**479**	**-4**	**-5**	**-2**	**-1**	**-2**	**3**	**6**	**3**	**1**	**0**
Valid: TS/STS/TY			**sample**	**22**	**18**	**14**	**10**	**6**	**2**	**18**	**14**	**10**	**6**	**2**	**18**	**14**	**10**	**6**	**2**
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
									Chanthu(2114)										
Sep.	06/12	TS	TD	**0**	**239**	**309**	**323**	**229**	**83**	**20**	**54**	**55**	**75**	**65**	**-30**	**-50**	**-45**	**-55**	**-45**
	06/18	TS	TD	**0**	**195**	**300**	**307**	**172**	**105**	**40**	**59**	**55**	**75**	**45**	**-45**	**-55**	**-45**	**-50**	**-35**
	07/00	TS	TS	**0**	**195**	**286**	**279**	**99**	**228**	**42**	**45**	**40**	**55**	**25**	**-40**	**-35**	**-30**	**-35**	**-20**
	07/06	STS	TS	**0**	**164**	**255**	**237**	**115**	**223**	**50**	**40**	**50**	**50**	**20**	**-40**	**-30**	**-35**	**-30**	**-15**
	07/12	TY	STS	**0**	**165**	**287**	**265**	**122**	**171**	**35**	**25**	**40**	**30**	**0**	**-25**	**-20**	**-25**	**-15**	**0**
	07/18	TY	TY	**0**	**135**	**161**	**135**	**170**	**418**	**15**	**5**	**30**	**15**	**5**	**-10**	**-5**	**-15**	**-10**	**-5**
	08/00	TY	TY	**0**	**136**	**164**	**59**	**241**	**412**	**5**	**5**	**30**	**15**	**5**	**-5**	**-5**	**-15**	**-10**	**-5**
	08/06	TY	TY	**0**	**78**	**74**	**63**	**336**	**634**	**0**	**25**	**30**	**0**	**0**	**0**	**-15**	**-15**	**0**	**0**
	08/12	TY	TY	**0**	**107**	**54**	**128**	**380**	**601**	**0**	**25**	**20**	**-10**	**0**	**0**	**-15**	**-10**	**10**	**0**
	08/18	TY	TY	**0**	**119**	**104**	**49**	**128**	**197**	**0**	**30**	**5**	**-5**	**-15**	**0**	**-15**	**-5**	**5**	**10**
	09/00	TY	TY	**11**	**101**	**85**	**46**	**174**	**93**	**5**	**40**	**10**	**-5**	**-20**	**0**	**-15**	**-5**	**5**	**15**
	09/06	TY	TY	**0**	**54**	**106**	**60**	**211**	**24**	**25**	**35**	**-5**	**-10**	**-25**	**-10**	**-10**	**5**	**10**	**25**
	09/12	TY	TY	**0**	**67**	**80**	**59**	**149**	**40**	**25**	**20**	**-20**	**-20**	**-30**	**-10**	**-5**	**15**	**15**	**30**
	09/18	TY	TY	**0**	**39**	**73**	**241**	**201**	**119**	**30**	**5**	**-15**	**-25**	**-32**	**-10**	**0**	**10**	**20**	**35**
	10/00	TY	TY	**0**	**38**	**225**	**396**	**232**	**288**	**30**	**5**	**-15**	**-25**	**-32**	**-10**	**0**	**10**	**20**	**35**
	10/06	TY	TY	**0**	**46**	**212**	**302**	**68**	**106**	**10**	**-15**	**-20**	**-35**	**-27**	**-5**	**10**	**10**	**30**	**30**
	10/12	TY	TY	**0**	**59**	**167**	**100**	**83**	**44**	**-5**	**-30**	**-30**	**-40**	**-32**	**5**	**20**	**15**	**30**	**30**
	10/18	TY	TY	**0**	**112**	**139**	**110**	**194**	**53**	**-15**	**-15**	**-25**	**-27**	**-20**	**5**	**10**	**15**	**30**	**20**
	11/00	TY	TY	**10**	**80**	**116**	**153**	**299**	**138**	**0**	**-5**	**-25**	**-22**	**-20**	**0**	**5**	**15**	**25**	**20**
	11/06	TY	TY	**0**	**56**	**101**	**182**	**297**	**115**	**-15**	**-10**	**-30**	**-22**	**-20**	**10**	**10**	**25**	**25**	**20**
	11/12	TY	TY	**0**	**35**	**128**	**298**	**370**	**191**	**-20**	**-15**	**-25**	**-17**	**-15**	**15**	**10**	**25**	**20**	**15**
	11/18	TY	TY	**0**	**37**	**168**	**340**	**380**	**272**	**-5**	**-15**	**-22**	**-10**	**-5**	**5**	**10**	**25**	**10**	**5**
	12/00	TY	TY	**0**	**97**	**182**	**370**	**298**	**234**	**0**	**-10**	**-17**	**-5**	**0**	**0**	**10**	**20**	**5**	**0**
	12/06	TY	TY	**0**	**97**	**205**	**394**	**310**	**196**	**0**	**-10**	**-12**	**0**	**2**	**0**	**15**	**15**	**0**	**-5**
	12/12	TY	TY	**0**	**107**	**276**	**405**	**344**	**281**	**5**	**-5**	**-2**	**2**	**4**	**-5**	**10**	**5**	**-5**	**-5**
	12/18	TY	TY	**0**	**126**	**337**	**376**	**263**	**323**	**0**	**-7**	**0**	**2**	**2**	**0**	**15**	**0**	**-5**	**0**
	13/00	TY	TY	**0**	**124**	**351**	**304**	**223**	**258**	**-5**	**-7**	**0**	**6**	**-8**	**5**	**15**	**0**	**-10**	**10**
	13/06	TY	TY	**0**	**136**	**320**	**231**	**147**		**-5**	**-7**	**0**	**6**		**10**	**10**	**0**	**-10**	

continued on the next page

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

‡Position error of provisional analysis

continued from the previous page

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
								Chanthu(2114)										
13/12	TY	TY	**0**	**149**	**249**	**157**	**167**		**-10**	**-7**	**0**	**-2**		**15**	**10**	**0**	**5**	
13/18	TY	TY	**0**	**109**	**163**	**115**	**293**		**-12**	**-5**	**0**	**-4**		**15**	**5**	**0**	**5**	
14/00	TY	TY	**0**	**89**	**111**	**104**	**329**		**-12**	**-5**	**0**	**-10**		**15**	**5**	**0**	**15**	
14/06	STS	STS	**0**	**87**	**82**	**148**			**-2**	**0**	**0**			**5**	**0**	**0**		
14/12	STS	TS	**0**	**40**	**45**	**179**			**0**	**2**	**-4**			**0**	**-5**	**5**		
14/18	TS	TS	**0**	**15**	**38**	**227**			**6**	**6**	**-6**			**-10**	**-10**	**5**		
15/00	TS	TS	**0**	**24**	**45**				**6**	**-2**				**-10**	**0**			
15/06	TS	TS	**0**	**40**	**48**				**2**	**-2**				**-5**	**0**			
15/12	TS	TS	**0**	**28**	**33**				**2**	**-2**				**-5**	**0**			
15/18	STS	TS	**10**	**11**	**67**				**2**	**-4**				**-5**	**0**			
16/00	STS	STS	**0**	**29**	**65**				**0**	**-6**				**0**	**5**			
16/06	STS	STS	**0**	**22**					**0**					**0**				
16/12	STS	STS	**0**	**30**					**-2**					**5**				
16/18	STS	STS	**0**	**66**					**2**					**-5**				
17/00	STS	STS	**0**	**132**					**-4**					**5**				
17/06	STS	STS	**0**															
17/12	TS	TS	**0**															
17/18	TS	TS	**0**															
18/00	TS	TS	**0**															
Initial: TS/STS/TY		**mean**	**1**	**89**	**159**	**210**	**227**	**217**	**6**	**6**	**3**	**1**	**-5**	**-4**	**-3**	**-1**	**2**	**6**
Valid: TS/STS/TY		**sample**	**47**	**43**	**39**	**34**	**31**	**27**	**43**	**39**	**34**	**31**	**27**	**43**	**39**	**34**	**31**	**27**
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
								Dianmu(2115)											
Sep.	23/00	TD	TD	*57*	*268*	*183*				*-4*	*0*				*5*	*0*			
	23/06	TS	TS	**11**															
	23/12	TS	TS	**11**															
	23/18	TD	TS																
	24/00	TD	TS																
	24/06	TD	TD																
Initial: TS/STS/TY			**mean**	**11**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Initial: TD(before upg.)			*mean*	*57*	*268*	*183*	--	--	--	*-4*	*0*	--	--	--	*5*	*0*	--	--	--
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		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
								Mindulle(2116)											
Sep.	23/06	TD	TD	*0*	*31*	*119*	*11*	*81*	*241*	*4*	*20*	*35*	*-15*	*-15*	*-10*	*-20*	*-25*	*10*	*10*
	23/12	TS	TS	0	15	77	148	201	178	-2	20	35	-15	-15	0	-20	-25	10	10
	23/18	TS	TS	0	35	46	94	172	245	5	20	35	-15	-20	-10	-20	-25	10	15
	24/00	TS	TS	0	22	15	126	229	283	5	15	-10	-25	-20	-10	-15	5	15	15
	24/06	TS	TS	21	11	48	11	23	75	15	30	-15	-30	0	-15	-15	15	20	10
	24/12	STS	STS	11	24	62	47	54	91	15	20	-35	-35	-10	-15	-15	20	20	10
	24/18	STS	STS	21	44	54	43	49	87	0	5	-35	-30	-10	-5	-5	20	20	10
	25/00	TY	TY	11	77	80	76	75	172	20	0	-40	-30	-10	-15	5	25	20	10
	25/06	TY	TY	31	77	46	23	24	68	20	-30	-40	-20	-20	-10	20	25	15	15
	25/12	TY	TY	11	70	25	30	69	139	15	-30	-40	-20	-20	-5	20	25	15	15
	25/18	TY	TY	0	15	42	65	80	166	0	-40	-35	-20	-10	0	25	25	15	10
	26/00	TY	TY	0	21	62	62	115	190	-25	-45	-35	-20	-10	15	30	25	15	10
	26/06	TY	TY	0	54	83	91	112	135	-40	-45	-25	-20	-10	25	30	20	15	10
	26/12	TY	TY	0	53	38	91	88	67	-40	-45	-30	-20	-15	25	30	25	15	15
	26/18	TY	TY	0	57	56	50	44	54	-40	-40	-25	-10	-15	25	30	20	10	15
	27/00	TY	TY	0	46	60	60	66		-30	-35	-20	-10		20	25	15	10	
	27/06	TY	TY	0	59	98	139	130		-35	-30	-20	-10		20	20	15	10	
	27/12	TY	TY	0	47	78	90	147		-35	-30	-20	-10		20	20	15	10	
	27/18	TY	TY	11	66	74	119	175		-20	-20	-10	-5		15	15	10	10	
	28/00	TY	TY	0	61	71	124			-20	-20	0			15	15	5		
	28/06	TY	TY	21	55	59	96			-10	-30	-5			10	20	5		
	28/12	TY	TY	0	42	31	152			-20	-20	5			15	15	0		
	28/18	TY	TY	10	30	22	156			-10	-5	10			10	5	-5		
	29/00	TY	TY	11	24	36				-10	0				10	5			
	29/06	TY	TY	11	23	56				-20	-10				15	5			
	29/12	TY	TY	24	11	100				-20	0				15	0			
	29/18	TY	TY	0	10	112				-5	0				5	0			
	30/00	TY	TY	0	36					0					5				

continued on the next page

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

‡Position error of provisional analysis

continued from the previous page

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
							Mindulle(2116)											
30/06	TY	TY	**23**	**83**					**-10**					**5**				
30/12	TY	TY	**0**	**125**					**-15**					**10**				
30/18	TY	TY	**10**	**89**					**-10**					**10**				
Oct. 01/00	TY	TY	**0**															
01/06	TY	TY	**14**															
01/12	TY	TY	**35**															
01/18	TY	TY	**0**															
Initial: TS/STS/TY		**mean**	**8**	**46**	**59**	**86**	**103**	**139**	**-11**	**-14**	**-16**	**-19**	**-13**	**7**	**9**	**12**	**14**	**12**
Valid: TS/STS/TY		**sample**	**34**	**30**	**26**	**22**	**18**	**14**	**30**	**26**	**22**	**18**	**14**	**30**	**26**	**22**	**18**	**14**
Initial: TD(before upg.)		*mean*	*0*	*31*	*119*	*11*	*81*	*241*	*4*	*20*	*35*	*-15*	*-15*	*-10*	*-20*	*-25*	*10*	*10*
Valid: TD/TS/STS/TY		*sample*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

†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
								Lionrock(2117)											
Oct.	07/00	TD	TD	*31*	*15*	*89*	*135*			*-4*	*-9*	*-18*			*0*	*10*	*15*		
	07/06	TD	TD	*40*	*64*	*25*	*152*			*-2*	*-4*	*-15*			*0*	*10*	*20*		
	07/12	TD	TD	*11*	*11*	*64*	*163*			*-2*	*-4*	*-12*			*0*	*10*	*15*		
	07/18	TS	TS	**69**	**49**	**56**				**-2**	**-6**				**5**	**10**			
	08/00	TS	TS	**25**	**0**	**108**				**-2**	**-8**				**5**	**10**			
	08/06	TS	TS	**59**	**39**					**-2**					**5**				
	08/12	TS	TS	**24**	**54**					**-2**					**5**				
	08/18	TS	TS	**43**	**70**					**-6**					**5**				
	09/00	TS	TS	**0**	**90**					**-8**					**5**				
	09/06	TS	TS	**0**															
	09/12	TS	TS	**0**															
	09/18	TS	TS	**25**															
	10/00	TS	TS	**0**															
	10/06	TD	TD																
Initial: TS/STS/TY			**mean**	**25**	**50**	**82**	**--**	**--**	**--**	**-4**	**-7**	**--**	**--**	**--**	**5**	**10**	**--**	**--**	**--**
Valid: TS/STS/TY			**sample**	**10**	**6**	**2**	**0**	**0**	**0**	**6**	**2**	**0**	**0**	**0**	**6**	**2**	**0**	**0**	**0**
Initial: TD(before upg.)			*mean*	*27*	*30*	*59*	*150*	*--*	*--*	*-3*	*-6*	*-15*	*--*	*--*	*0*	*10*	*17*	*--*	*--*
Valid: TD/TS/STS/TY			*sample*	*3*	*3*	*3*	*3*	*0*	*0*	*3*	*3*	*3*	*0*	*0*	*3*	*3*	*3*	*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
							Kompasu(2118)												
Oct.	07/12	TD	TD	*693*	*203*	*76*	*109*	*161*	*168*	*4*	*6*	*7*	*10*	*17*	*0*	*-5*	*0*	*0*	*-10*
	07/18	TD	TD	*492*	*97*	*86*	*130*	*201*	*177*	*6*	*6*	*12*	*15*	*15*	*-5*	*-5*	*-5*	*-5*	*-5*
	08/00	TS	TD	**335**	**118**	**116**	**134**	**126**	**39**	**4**	**4**	**5**	**10**	**10**	**-5**	**-5**	**0**	**-5**	**-5**
	08/06	TS	TS	**166**	**174**	**67**	**139**	**39**	**219**	**2**	**0**	**5**	**10**	**10**	**0**	**0**	**0**	**-5**	**-5**
	08/12	TS	TS	**141**	**122**	**96**	**161**	**147**	**306**	**4**	**5**	**5**	**10**	**0**	**-5**	**0**	**0**	**-5**	**5**
	08/18	TS	TS	**157**	**130**	**140**	**249**	**309**	**421**	**2**	**5**	**10**	**10**	**-7**	**0**	**0**	**-5**	**-5**	**10**
	09/00	TS	TS	**194**	**125**	**131**	**207**	**233**	**207**	**0**	**5**	**10**	**10**	**-13**	**0**	**0**	**-5**	**-5**	**15**
	09/06	TS	TS	**257**	**125**	**146**	**74**	**224**	**67**	**0**	**5**	**10**	**10**	**-10**	**0**	**0**	**-5**	**-5**	**10**
	09/12	TS	TS	**218**	**49**	**15**	**62**	**177**		**-5**	**0**	**5**	**-5**		**5**	**0**	**-5**	**5**	
	09/18	TS	TS	**210**	**22**	**33**	**57**	**31**		**0**	**5**	**5**	**-7**		**0**	**-5**	**-5**	**5**	
	10/00	TS	TS	**164**	**24**	**46**	**44**	**138**		**0**	**5**	**5**	**-8**		**0**	**-5**	**-5**	**10**	
	10/06	TS	TS	**24**	**31**	**64**	**59**	**291**		**0**	**10**	**10**	**-2**		**0**	**-5**	**-5**	**-5**	
	10/12	TS	TS	**11**	**31**	**25**	**34**			**0**	**10**	**5**			**0**	**-5**	**0**		
	10/18	STS	TS	**62**	**39**	**70**	**44**			**5**	**10**	**0**			**-5**	**0**	**5**		
	11/00	STS	STS	**24**	**55**	**61**	**130**			**10**	**10**	**-6**			**-5**	**0**	**10**		
	11/06	STS	STS	**24**	**63**	**25**	**148**			**5**	**10**	**-4**			**0**	**0**	**5**		
	11/12	STS	STS	**0**	**21**	**33**				**0**	**5**				**5**	**5**			
	11/18	STS	STS	**39**	**49**	**24**				**-5**	**-7**				**5**	**10**			
	12/00	STS	STS	**39**	**31**	**67**				**-5**	**-8**				**5**	**10**			
	12/06	STS	STS	**54**	**24**	**90**				**-5**	**-10**				**5**	**10**			
	12/12	STS	STS	**70**	**61**					**0**					**0**				
	12/18	STS	STS	**15**	**25**					**-2**					**0**				
	13/00	STS	STS	**31**	**70**					**-2**					**0**				
	13/06	STS	STS	**22**	**88**					**-4**					**0**				
	13/12	TS	STS	**0**															
	13/18	TS	TS	**21**															
	14/00	TS	TS	**21**															
	14/06	TS	TS	**0**															

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

‡Position error of provisional analysis

continued from the previous page

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
Kompasu(2118)																		
14/12	TD	TD																
Initial: TS/STS/TY		**mean**	**88**	**67**	**69**	**110**	**172**	**209**	**0**	**4**	**5**	**4**	**-2**	**0**	**1**	**-1**	**-2**	**5**
Valid: TS/STS/TY		**sample**	**26**	**22**	**18**	**14**	**10**	**6**	**22**	**18**	**14**	**10**	**6**	**22**	**18**	**14**	**10**	**6**
Initial: TD(before upg.)		*mean*	*593*	*150*	*81*	*120*	*181*	*173*	*5*	*6*	*10*	*13*	*16*	*-3*	*-5*	*-3*	*-3*	*-8*
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
								Namtheun(2119)											
Oct.	09/12	TD	TD	*0*	*81*	*54*	*130*	*587*	*1102*	*0*	*-13*	*-23*	*-23*	*-23*	*0*	*20*	*25*	*25*	*25*
	09/18	TD	TD	*0*	*39*	*81*	*84*	*450*	*845*	*0*	*-13*	*-23*	*-23*	*-23*	*0*	*20*	*25*	*25*	*25*
	10/00	TS	TS	**11**	**24**	**105**	**76**	**285**	**424**	**-4**	**-13**	**-23**	**-23**	**-13**	**5**	**20**	**25**	**25**	**10**
	10/06	TS	TS	**58**	**32**	**109**	**53**	**476**	**497**	**-6**	**-13**	**-13**	**-13**	**-8**	**10**	**20**	**15**	**15**	**5**
	10/12	TS	TS	**39**	**15**	**94**	**215**	**593**	**623**	**-6**	**-13**	**-13**	**-8**	**-6**	**10**	**20**	**15**	**10**	**0**
	10/18	TS	TS	**22**	**24**	**63**	**502**	**826**	**804**	**-4**	**-8**	**-8**	**-6**	**2**	**5**	**15**	**15**	**5**	**-15**
	11/00	TS	TS	**0**	**25**	**250**	**812**	**1147**	**1325**	**-4**	**-8**	**-6**	**-2**	**6**	**5**	**15**	**10**	**-5**	**-20**
	11/06	TS	TS	**0**	**70**	**446**	**1074**	**1193**	**1357**	**-4**	**-6**	**0**	**0**	**6**	**5**	**10**	**0**	**-10**	**-20**
	11/12	TS	TS	**57**	**115**	**640**	**1130**	**1212**		**-4**	**-4**	**0**	**2**		**5**	**5**	**0**	**-15**	
	11/18	TS	TS	**77**	**135**	**680**	**1048**	**1072**		**-4**	**-4**	**2**	**4**		**5**	**5**	**-5**	**-15**	
	12/00	TS	TS	**105**	**240**	**751**	**1034**	**1200**		**0**	**0**	**2**	**6**		**0**	**0**	**-10**	**-20**	
	12/06	TS	TS	**0**	**363**	**928**	**1024**	**1139**		**0**	**0**	**2**	**6**		**0**	**0**	**-10**	**-20**	
	12/12	TS	TS	**0**	**354**	**901**	**919**			**0**	**2**	**4**			**0**	**-5**	**-15**		
	12/18	TS	TS	**62**	**283**	**606**	**785**			**0**	**2**	**4**			**0**	**-5**	**-15**		
	13/00	TS	TS	**0**	**326**	**521**	**718**			**0**	**0**	**4**			**0**	**-5**	**-15**		
	13/06	TS	TS	**0**	**397**	**547**	**800**			**2**	**2**	**6**			**0**	**-5**	**-15**		
	13/12	TS	TS	**23**	**409**	**495**	**711**			**0**	**0**	**2**			**0**	**-5**	**-10**		
	13/18	TS	TS	**45**	**252**	**304**	**601**			**2**	**2**	**4**			**0**	**-5**	**-10**		
	14/00	TS	TS	**23**	**144**	**334**				**0**	**4**				**0**	**-10**			
	14/06	TS	TS	**0**	**82**	**307**				**-2**	**4**				**5**	**-10**			
	14/12	TS	TS	**42**	**95**	**348**				**-2**	**0**				**5**	**0**			
	14/18	TS	TS	**0**	**99**	**333**				**-2**	**-2**				**5**	**5**			
	15/00	TS	TS	**11**	**153**					**2**					**-5**				
	15/06	TS	TS	**0**	**153**					**2**					**-5**				
	15/12	TS	TS	**0**	**159**					**0**					**0**				
	15/18	TS	TS	**0**	**108**					**-2**					**5**				
	16/00	STS	TS	**0**															
	16/06	STS	STS	**0**															

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

‡Position error of provisional analysis

continued from the previous page

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
Namtheun(2119)																		
16/12	TS	TS	**47**															
16/18	TS	TS	**19**															
Initial: TS/STS/TY		**mean**	**23**	**169**	**438**	**719**	**914**	**839**	**-2**	**-3**	**-2**	**-3**	**-2**	**3**	**3**	**-2**	**-3**	**-7**
Valid: TS/STS/TY		**sample**	**28**	**24**	**20**	**16**	**10**	**6**	**24**	**20**	**16**	**10**	**6**	**24**	**20**	**16**	**10**	**6**
Initial: TD(before upg.)		*mean*	*0*	*60*	*67*	*107*	*518*	*974*	*0*	*-13*	*-23*	*-23*	*-23*	*0*	*20*	*25*	*25*	*25*
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	(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
							Malou(2120)												
Oct.	23/12	TD	TD	*33*	*76*	*140*	*252*	*282*	*375*	*-8*	*-10*	*-12*	*5*	*0*	*5*	*15*	*10*	*-5*	*0*
	23/18	TD	TD	*0*	*155*	*185*	*298*	*267*	*415*	*-4*	*-8*	*-5*	*10*	*0*	*0*	*10*	*5*	*-10*	*0*
	24/00	TD	TD	*11*	*81*	*168*	*207*	*276*	*434*	*-4*	*-19*	*-25*	*-15*	*-15*	*5*	*20*	*20*	*10*	*10*
	24/06	TD	TD	*22*	*113*	*133*	*129*	*252*	*586*	*-2*	*-17*	*-25*	*-15*	*-20*	*5*	*15*	*20*	*10*	*15*
	24/12	TD	TD	*46*	*118*	*199*	*144*	*302*		*-6*	*-17*	*-20*	*-20*		*10*	*15*	*15*	*15*	
	24/18	TS	TD	**87**	**170**	**237**	**234**	**428**		**-4**	**-10**	**-15**	**-20**		**5**	**10**	**10**	**15**	
	25/00	TS	TS	**21**	**187**	**201**	**204**	**308**		**-2**	**-10**	**-15**	**-20**		**5**	**10**	**10**	**15**	
	25/06	TS	TS	**46**	**107**	**76**	**52**	**22**		**-12**	**-25**	**-15**	**-10**		**15**	**20**	**10**	**10**	
	25/12	TS	TS	**59**	**92**	**45**	**67**			**-7**	**-5**	**-20**			**10**	**5**	**15**		
	25/18	TS	TS	**67**	**62**	**23**	**37**			**0**	**0**	**-20**			**5**	**0**	**15**		
	26/00	TS	TS	**81**	**39**	**70**	**63**			**5**	**-10**	**-5**			**0**	**5**	**5**		
	26/06	STS	TS	**52**	**46**	**73**	**76**			**0**	**-10**	**-10**			**5**	**5**	**10**		
	26/12	STS	STS	**15**	**54**	**35**				**5**	**-15**				**0**	**10**			
	26/18	STS	STS	**79**	**67**	**92**				**10**	**-15**				**-5**	**10**			
	27/00	STS	STS	**81**	**70**	**103**				**10**	**-15**				**-5**	**10**			
	27/06	STS	STS	**38**	**15**	**67**				**0**	**-20**				**0**	**15**			
	27/12	TY	STS	**15**	**23**					**-10**					**5**				
	27/18	TY	TY	**0**	**24**					**-10**					**5**				
	28/00	TY	TY	**24**	**31**					**-5**					**0**				
	28/06	TY	TY	**0**	**78**					**-10**					**5**				
	28/12	TY	TY	**11**															
	28/18	TY	TY	**15**															
	29/00	TY	TY	**0**															
	29/06	TY	TY	**39**															
Initial: TS/STS/TY			**mean**	**38**	**71**	**93**	**105**	**253**	**--**	**-2**	**-12**	**-14**	**-17**	**--**	**3**	**9**	**11**	**13**	**--**
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*	*22*	*109*	*165*	*206*	*276*	*452*	*-5*	*-14*	*-17*	*-7*	*-9*	*5*	*15*	*14*	*4*	*6*
Valid: TD/TS/STS/TY			*sample*	*5*	*5*	*5*	*5*	*5*	*4*	*5*	*5*	*5*	*5*	*4*	*5*	*5*	*5*	*5*	*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
								Nyatoh(2121)											
Nov.	29/12	TD	TD	*46*	*55*	*89*	*169*	*558*		*4*	*23*	*42*	*35*		*-5*	*-25*	*-35*	*-30*	
	29/18	TD	TD	*45*	*11*	*102*	*168*	*759*		*8*	*28*	*67*	*12*		*-10*	*-30*	*-50*	*-15*	
	30/00	TS	TS	**103**	**68**	**117**	**259**			**8**	**22**	**60**			**-10**	**-20**	**-40**		
	30/06	TS	TS	**39**	**58**	**117**	**341**			**7**	**30**	**40**			**-10**	**-25**	**-30**		
	30/12	TS	TS	**16**	**68**	**170**	**460**			**15**	**25**	**25**			**-15**	**-20**	**-20**		
	30/18	TS	TS	**16**	**55**	**67**	**322**			**15**	**45**	**5**			**-15**	**-30**	**-5**		
Dec.	01/00	STS	STS	**33**	**39**	**68**				**0**	**30**				**0**	**-20**			
	01/06	STS	STS	**11**	**11**	**76**				**10**	**20**				**-5**	**-15**			
	01/12	TY	STS	**22**	**39**	**129**				**15**	**20**				**-10**	**-15**			
	01/18	TY	TY	**0**	**21**	**287**				**40**	**5**				**-25**	**-5**			
	02/00	TY	TY	**0**	**47**					**40**					**-25**				
	02/06	TY	TY	**22**	**61**					**30**					**-20**				
	02/12	TY	TY	**11**	**142**					**20**					**-15**				
	02/18	TY	TY	**10**	**272**					**-5**					**5**				
	03/00	TY	TY	**11**															
	03/06	TY	TY	**11**															
	03/12	TY	TY	**30**															
	03/18	STS	TY	**83**															
Initial: TS/STS/TY			**mean**	**26**	**73**	**129**	**345**	**--**	**--**	**16**	**25**	**33**	**--**	**--**	**-12**	**-19**	**-24**	**--**	**--**
Valid: TS/STS/TY			**sample**	**16**	**12**	**8**	**4**	**0**	**0**	**12**	**8**	**4**	**0**	**0**	**12**	**8**	**4**	**0**	**0**
Initial: TD(before upg.)			*mean*	*45*	*33*	*95*	*169*	*659*	*--*	*6*	*26*	*55*	*24*	*--*	*-8*	*-28*	*-43*	*-23*	*--*
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	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
									Rai(2122)										
Dec.	12/00	TD	TD	120	50	89	84	25	110	-4	-10	0	25	5	10	5	-5	-20	-5
	12/06	TD	TD	89	11	105	50	25	114	-2	-5	10	35	5	5	0	-10	-25	-5
	12/12	TD	TD	133	60	89	11	57	99	0	-5	-5	30	10	0	0	0	-25	-10
	12/18	TD	TD	44	121	110	62	113	122	4	5	0	20	5	-5	-10	-5	-20	-5
	13/00	TD	TD	66	171	88	94	160	164	2	5	20	15	0	-5	-10	-15	-15	-5
	13/06	TS	TS	22	102	89	98	181	229	5	10	30	10	15	-5	-10	-20	-10	-15
	13/12	TS	TS	0	123	55	157	252	305	0	-5	10	10	25	-5	0	-10	-10	-20
	13/18	TS	TS	25	111	99	220	300	371	5	0	-5	10	35	-10	-5	0	-10	-25
	14/00	STS	STS	31	84	99	219	300	373	5	25	10	15	45	-5	-15	-10	-15	-30
	14/06	STS	STS	50	55	131	200	255	288	15	35	10	30	35	-10	-20	-10	-25	-25
	14/12	STS	STS	22	71	160	212	239	218	10	15	10	25	20	-5	-10	-10	-20	-15
	14/18	TY	STS	56	46	56	94	124	167	5	15	5	35	10	-5	-15	-5	-25	-10
	15/00	TY	TY	0	25	40	40	55	200	30	10	10	35	0	-20	-10	-10	-25	-5
	15/06	TY	TY	0	40	77	62	93	217	40	10	15	40	-10	-25	-10	-15	-30	5
	15/12	TY	TY	16	22	74	31	89	242	20	10	30	35	-10	-15	-5	-20	-30	10
	15/18	TY	TY	25	31	46	16	126		15	15	50	25		-10	-10	-30	-25	
	16/00	TY	TY	11	56	50	24	126		0	0	50	10		0	0	-30	-15	
	16/06	TY	TY	0	22	46	35	162		-5	5	40	-5		5	-5	-25	0	
	16/12	TY	TY	16	40	35	56	188		-5	15	25	-15		5	-10	-20	15	
	16/18	TY	TY	25	56	59	132			-5	40	10			5	-25	-10		
	17/00	TY	TY	11	69	89	139			5	50	15			-5	-30	-15		
	17/06	TY	TY	22	69	58	165			20	50	7			-15	-35	-10		
	17/12	TY	TY	11	65	87	172			15	30	-8			-10	-20	10		
	17/18	TY	TY	46	45	87				25	20				-15	-15			
	18/00	TY	TY	25	43	74				35	10				-20	-10			
	18/06	TY	TY	16	35	54				25	0				-15	0			
	18/12	TY	TY	11	44	25				10	-15				-5	20			
	18/18	TY	TY	11	46					-15					10				

continued on the next page

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

‡Position error of provisional analysis

continued from the previous page

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
								Rai(2122)										
19/00	TY	TY	**0**	**24**					**-5**					**5**				
19/06	TY	TY	**22**	**15**					**-10**					**10**				
19/12	TY	TY	**22**	**33**					**-15**					**20**				
19/18	TY	TY	**22**															
20/00	TY	TY	**11**															
20/06	STS	STS	**15**															
20/12	TS	TD	**11**															
Initial: TS/STS/TY		**mean**	**18**	**53**	**72**	**115**	**178**	**261**	**9**	**16**	**17**	**19**	**17**	**-5**	**-11**	**-13**	**-16**	**-13**
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*	*91*	*83*	*96*	*60*	*76*	*122*	*0*	*-2*	*5*	*25*	*5*	*1*	*-3*	*-7*	*-21*	*-6*
Valid: TD/TS/STS/TY		*sample*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*

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

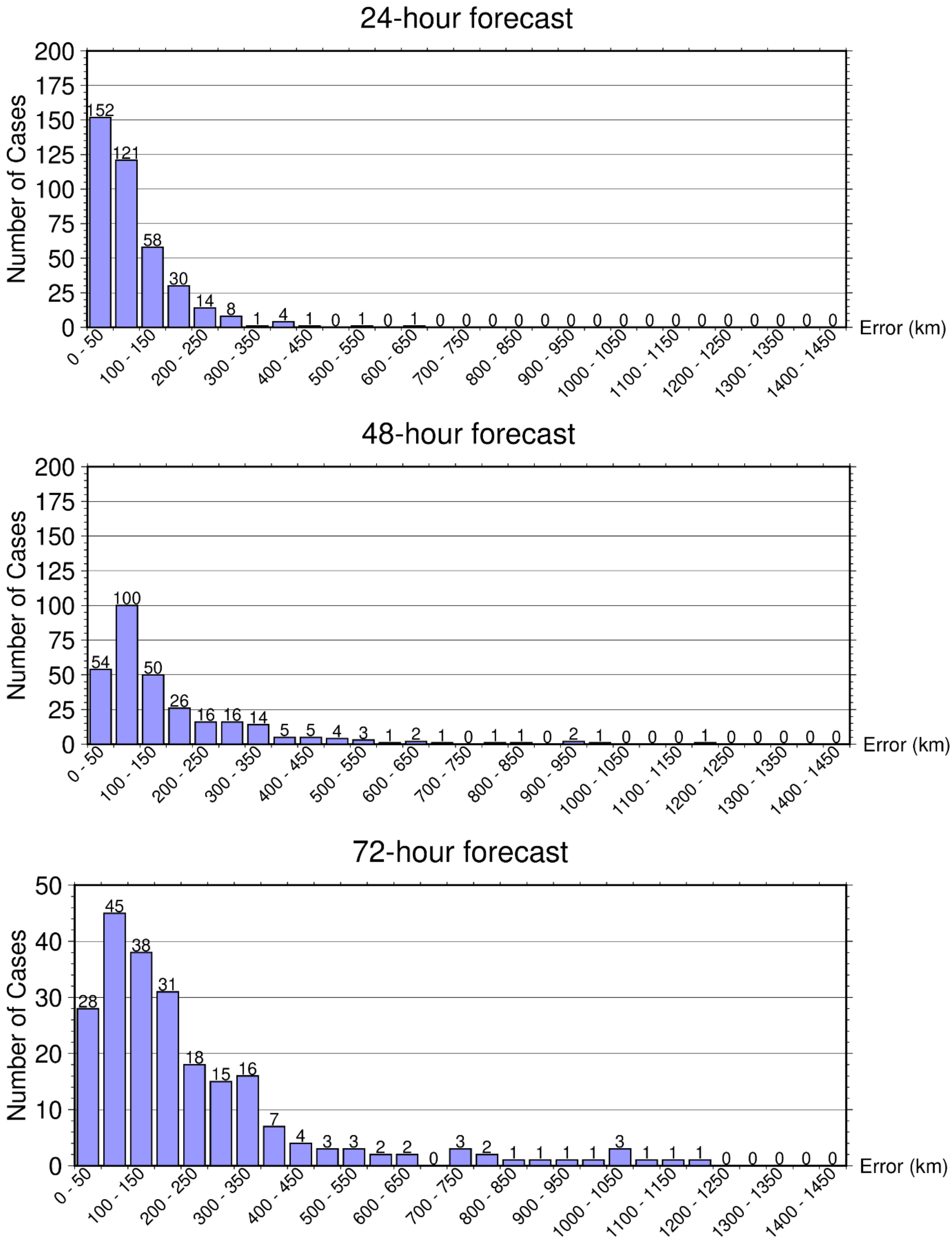
‡Position error of provisional analysis

Appendix 4
Monthly and Annual Frequencies of Tropical Cyclones

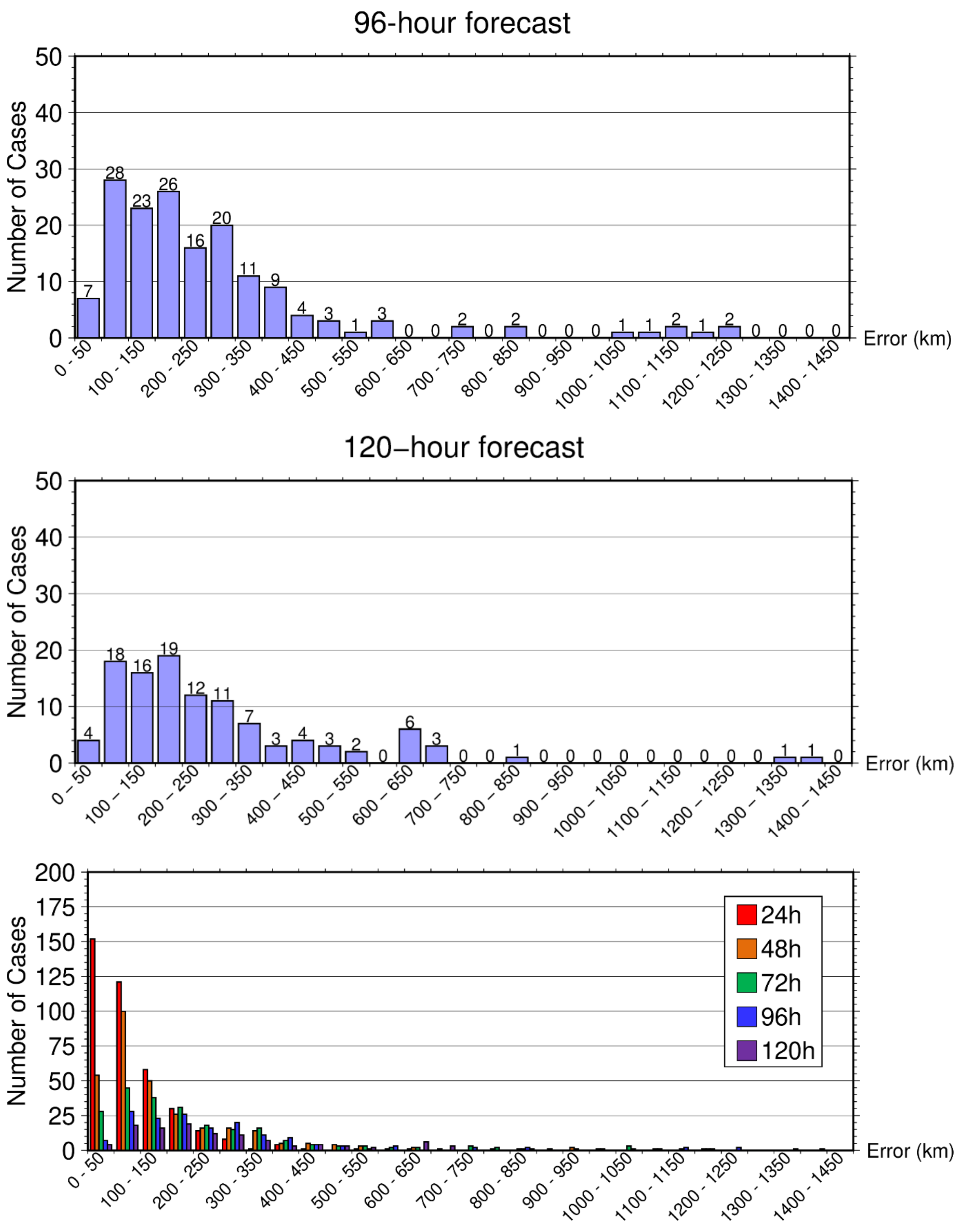
Monthly and annual frequencies of tropical cyclones that attained TS intensity or higher in the western North Pacific and the South China Sea for 1951 - 2021

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
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

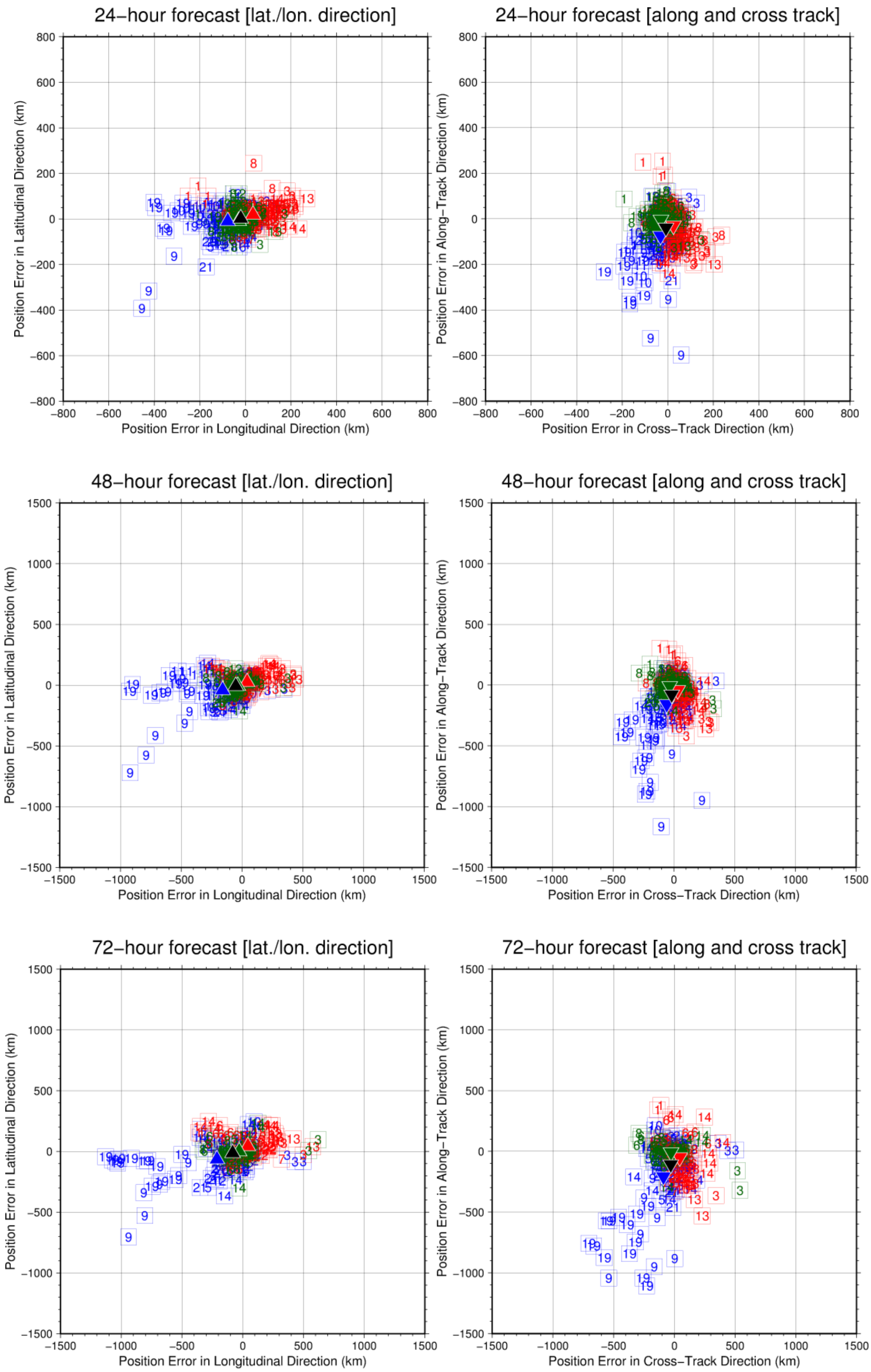
Appendix 5
Other Verification Charts



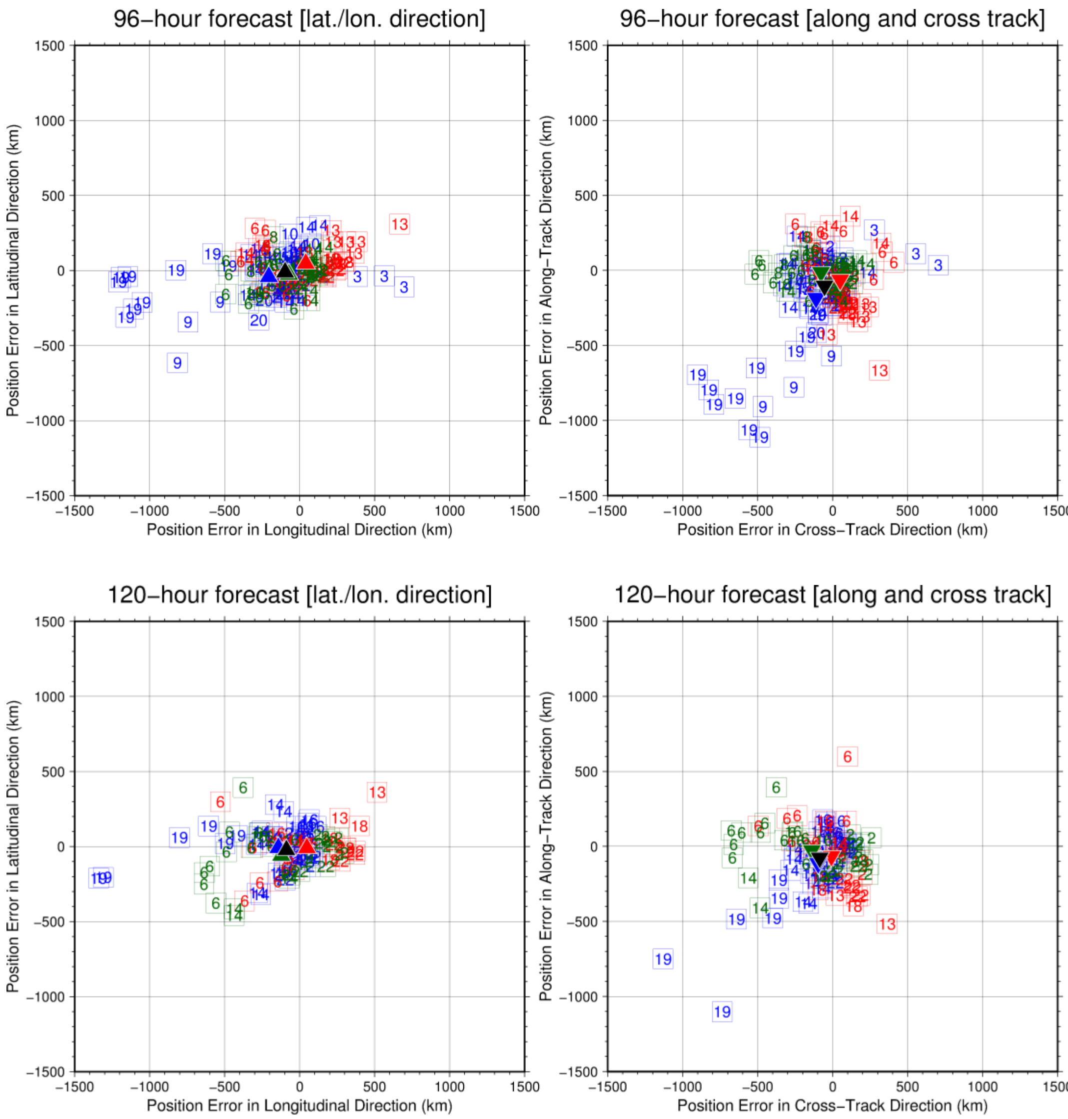
Histograms of RSMC 24-, 48- and 72 hour forecast position errors



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



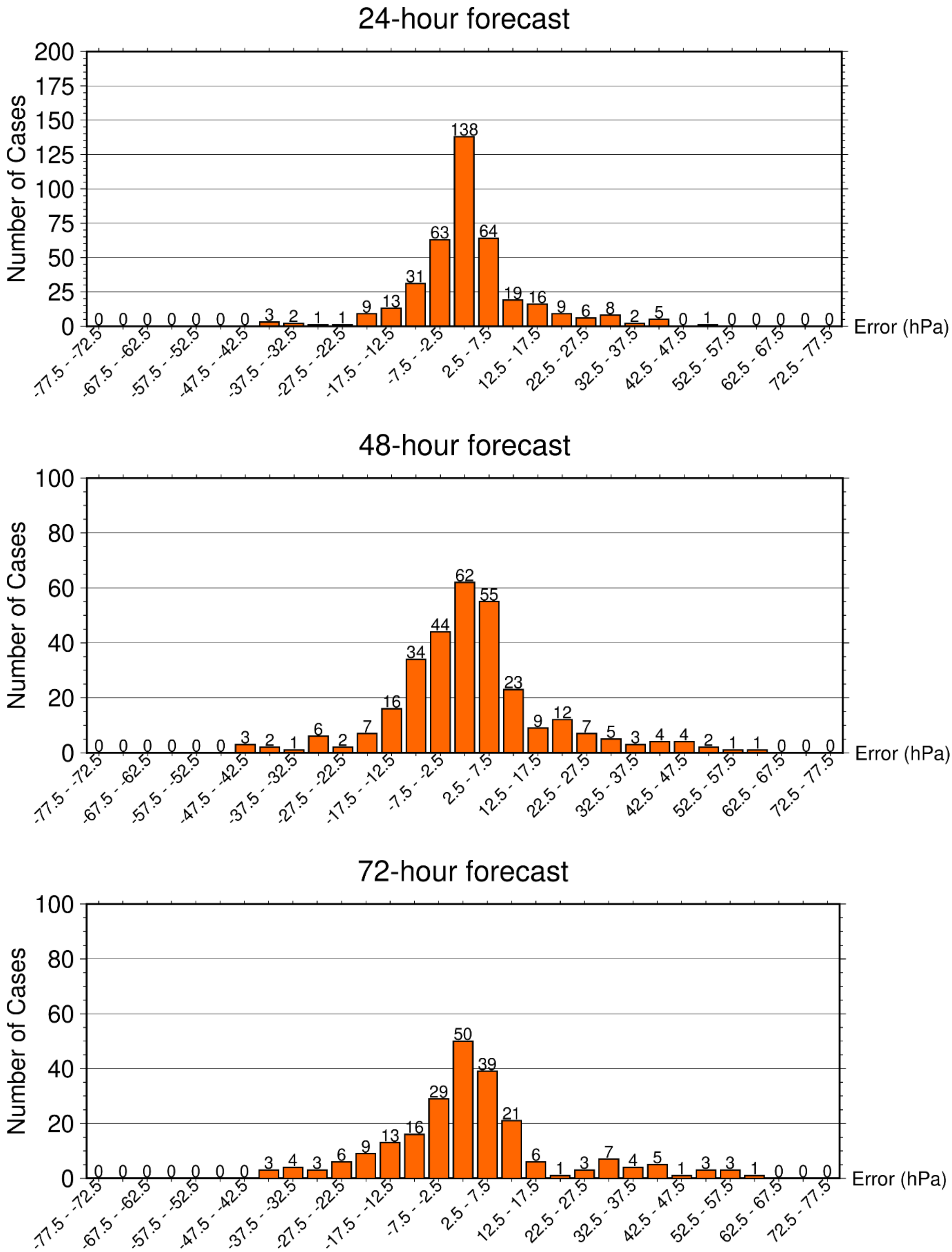
Scatter diagrams of RSMC position errors for 24-, 48- and 72-hour forecast in longitudinal/latitudinal and cross/along-track directions: Red, green and blue squares with TC number and triangles denote biases for each initial time and mean biases in the stages before, during and after recurvature, respectively.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



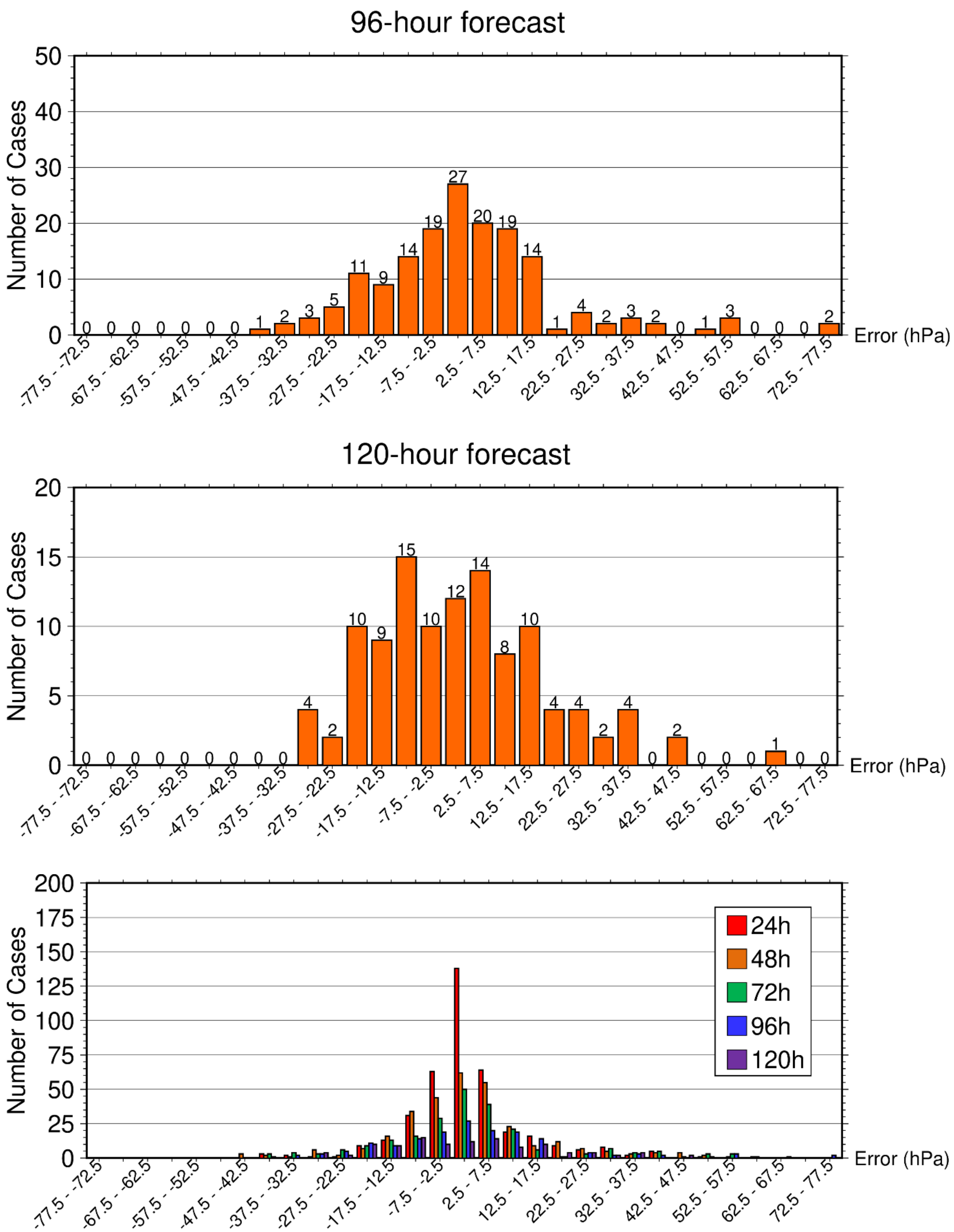
Scatter diagrams of RSMC position errors in longitudinal/latitudinal and cross/along-track directions (continued): Red, green and blue squares with TC number and triangles denote biases for each initial time and mean biases in the stages before, during and after recurvature, respectively. Black triangles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

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

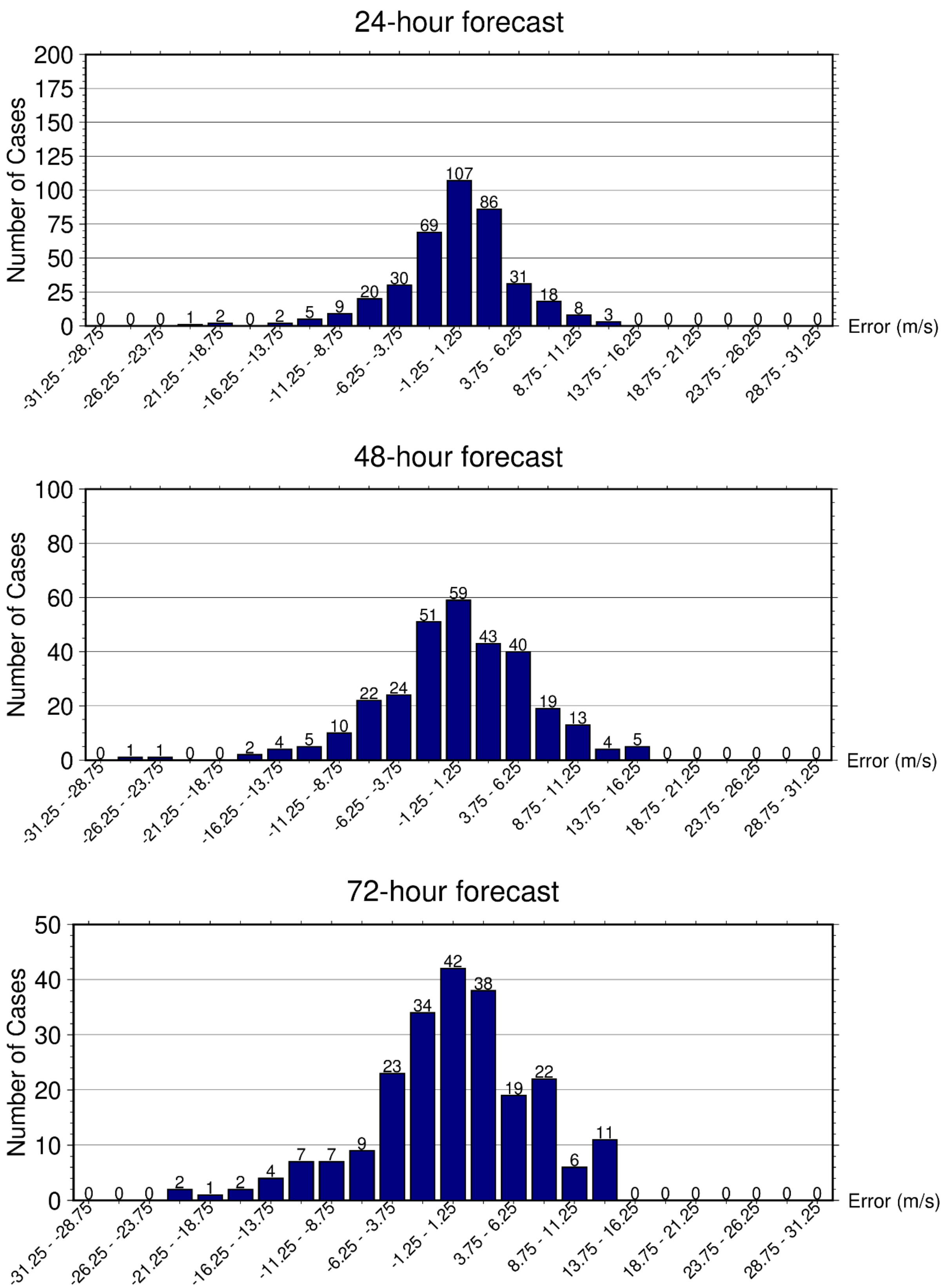
Tropical Cyclone	24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast			
	Error (m/s)	RMSE (m/s)	Num	Impr. (%)	Error (m/s)	RMSE (m/s)	Num	Impr. (%)	Error (m/s)	RMSE (m/s)	Num	Impr. (%)	Error (m/s)	RMSE (m/s)	Num	Impr. (%)	Error (m/s)	RMSE (m/s)	Num	Impr. (%)
TS Dujuan (2101)	1.3	2.2	10	30	6.4	6.7	6	-5	7.7	7.7	2	-5	-	-	0	-	-	-	0	-
TY Surigae (2102)	-1.0	5.7	41	24	-1.5	6.3	37	52	-0.9	7.0	33	59	1.1	7.3	29	60	3.0	6.0	25	64
TS Choi-wan (2103)	-1.7	3.3	18	3	-0.9	3.5	9	53	-2.6	3.9	6	60	-4.3	4.5	3	58	-	-	0	-
TS Koguma (2104)	2.6	2.6	2	-18	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY Champi (2105)	3.1	6.3	15	-32	3.3	8.3	11	-13	4.4	6.6	7	9	5.1	5.6	3	47	-	-	0	-
TY In-fa (2106)	0.5	3.6	37	31	0.9	4.3	33	53	-0.4	2.9	29	76	-3.5	4.2	25	68	-6.6	8.5	21	29
TY Cempaka (2107)	-5.4	7.9	9	19	-2.1	2.8	5	68	-2.6	2.6	1	38	-	-	0	-	-	-	0	-
TS Nepartak (2108)	0.7	1.6	15	-11	0.7	2.1	11	32	2.2	2.4	7	53	0.0	0.0	3	100	-	-	0	-
TS Lupit (2109)	-0.3	1.6	16	25	-0.5	3.3	11	-2	0.3	2.4	8	32	-0.6	1.3	4	28	-	-	0	-
STS Mirinae (2110)	0.2	2.0	15	23	-1.4	1.9	11	37	-2.2	2.7	7	-23	-0.9	1.5	3	21	-	-	0	-
STS Nida (2111)	-5.1	6.4	7	-65	-8.6	8.7	3	-50	-	-	0	-	-	-	0	-	-	-	0	-
TS Omais (2112)	-0.8	2.4	10	24	-3.0	3.2	6	58	-2.6	2.6	2	74	-	-	0	-	-	-	0	-
STS Conson (2113)	1.7	3.2	18	36	2.9	5.5	14	36	1.3	4.5	10	56	0.4	4.6	6	59	0.0	7.7	2	42
TY Chanthu (2114)	-2.0	7.4	43	-18	-1.5	8.8	39	1	-0.4	9.4	34	8	0.8	11.1	31	-8	3.1	10.7	27	-37
TS Dianmu (2115)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-
TY Mindulle (2116)	3.5	7.3	30	-17	4.8	9.6	26	0	6.1	9.6	22	5	7.3	7.5	18	23	6.2	6.4	14	41
TS Lionrock (2117)	2.6	2.6	6	-9	5.1	5.1	2	14	-	-	0	-	-	-	0	-	-	-	0	-
STS Kompasu (2118)	0.1	1.6	22	58	0.3	2.6	18	50	-0.6	2.5	14	55	-0.8	2.9	10	53	2.6	4.7	6	40
STS Namtheun (2119)	1.3	2.3	24	36	1.7	5.4	20	27	-0.8	6.7	16	34	-1.5	7.9	10	34	-3.4	7.1	6	38
TY Malou (2120)	1.7	3.1	15	23	4.7	5.4	11	15	5.5	5.8	7	28	6.9	7.0	3	-18	-	-	0	-
TY Nyatoh (2121)	-6.2	7.7	12	15	-9.6	10.3	8	21	-12.2	13.9	4	9	-	-	0	-	-	-	0	-
TY Rai (2122)	-2.8	6.1	26	30	-5.6	8.1	22	26	-6.9	8.5	18	22	-8.3	10.4	14	8	-6.7	9.3	10	35



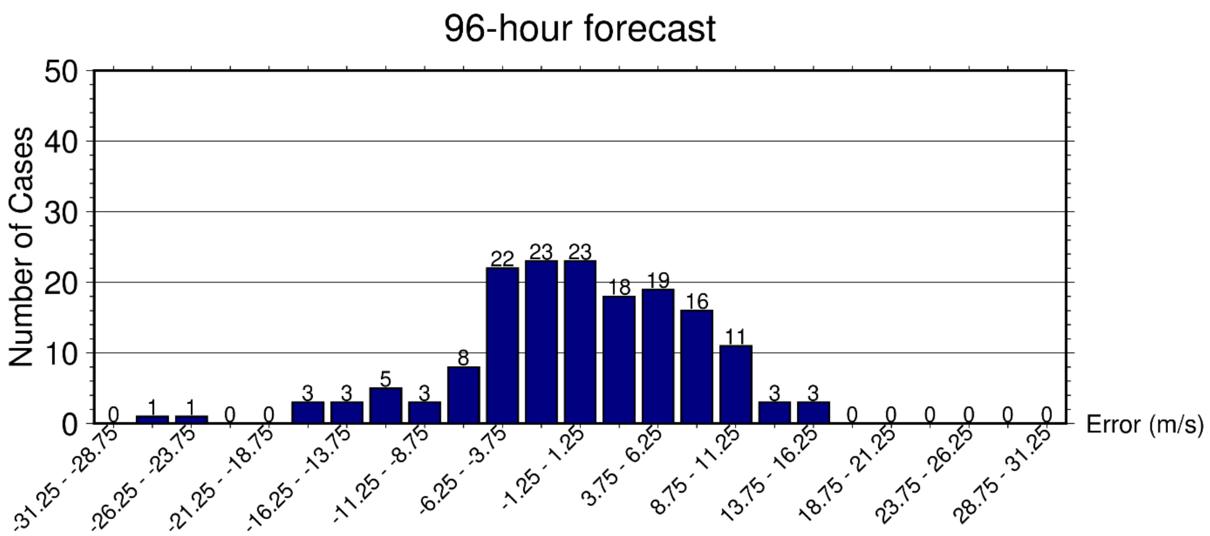
Histograms of RSMC 24-, 48- and 72-hour pressure forecast errors

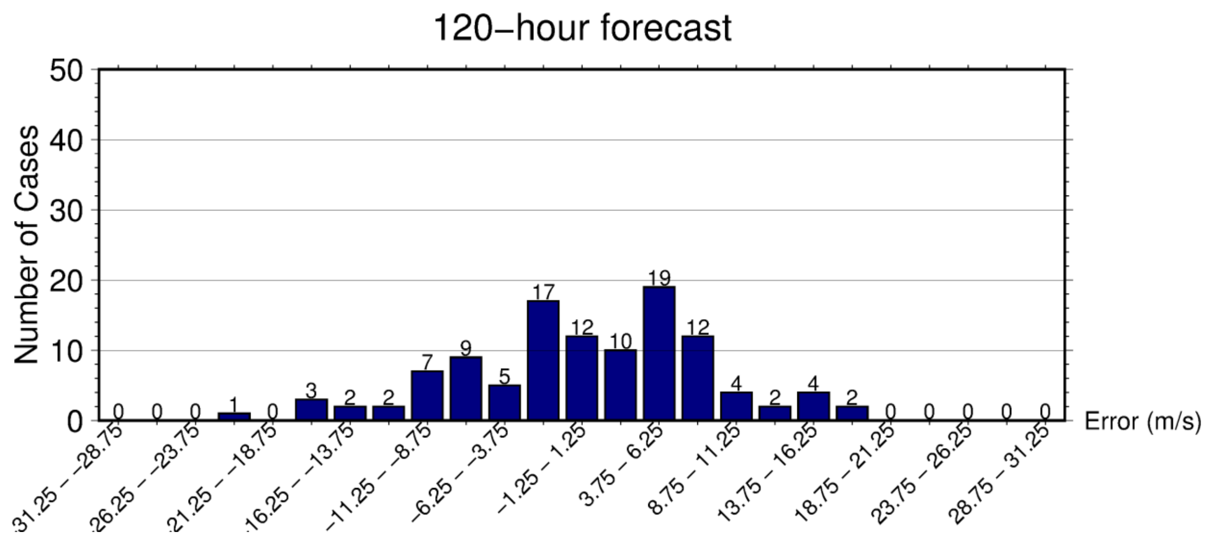


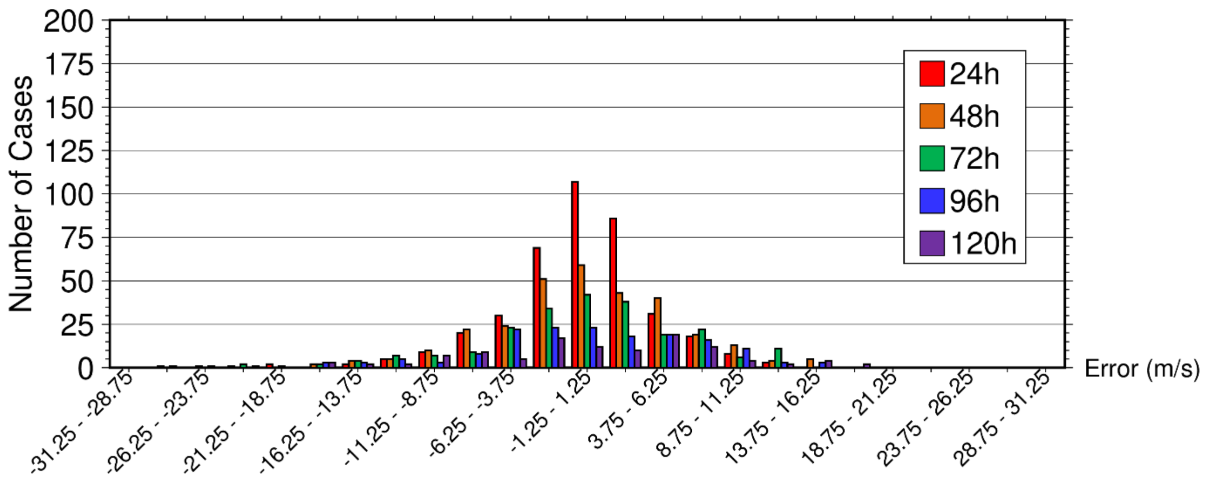
Histograms of RSMC 96-hour, 120-hour and all lead time pressure forecast errors



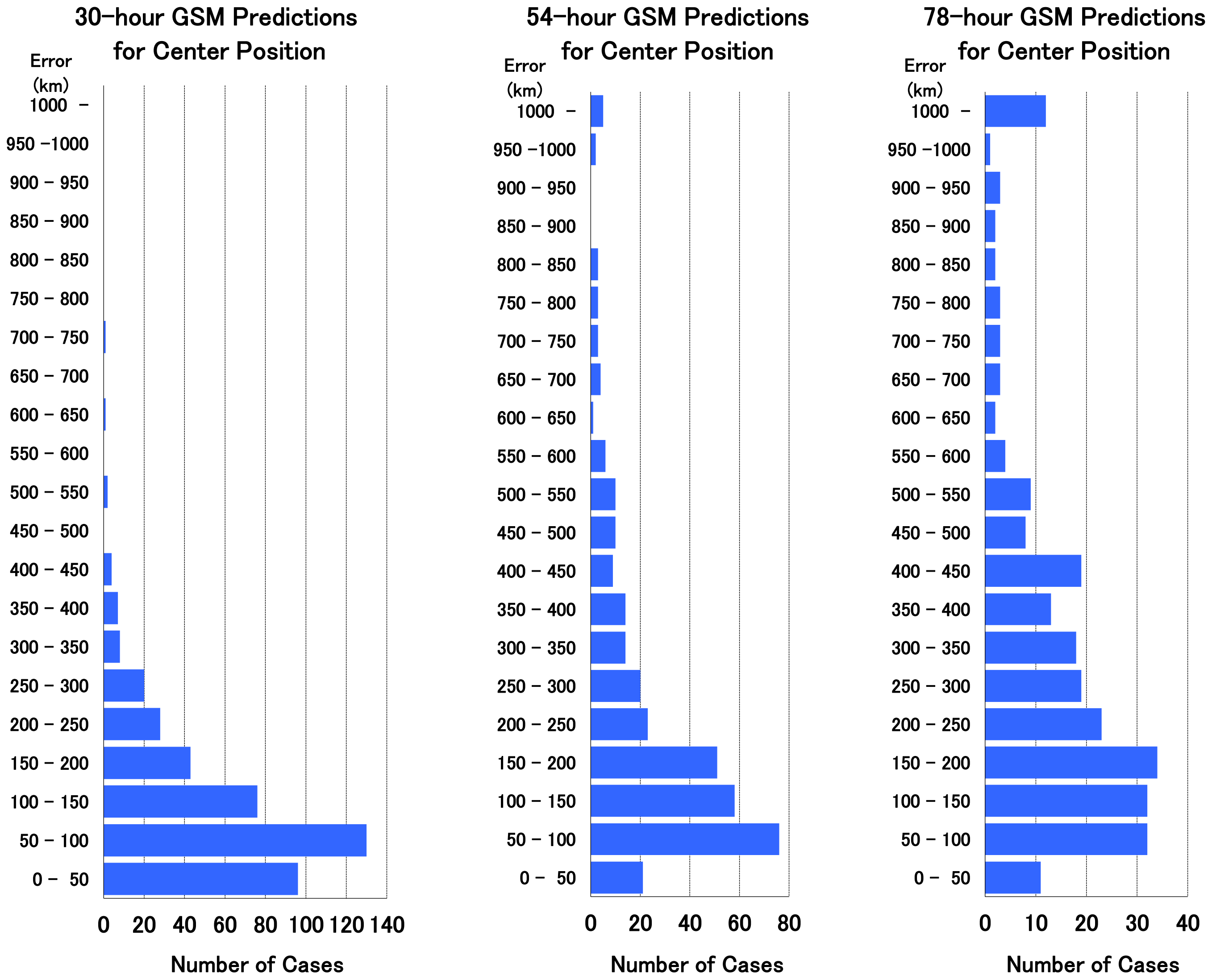
Histograms of RSMC 24-, 48- and 72-hour maximum wind speed forecast errors



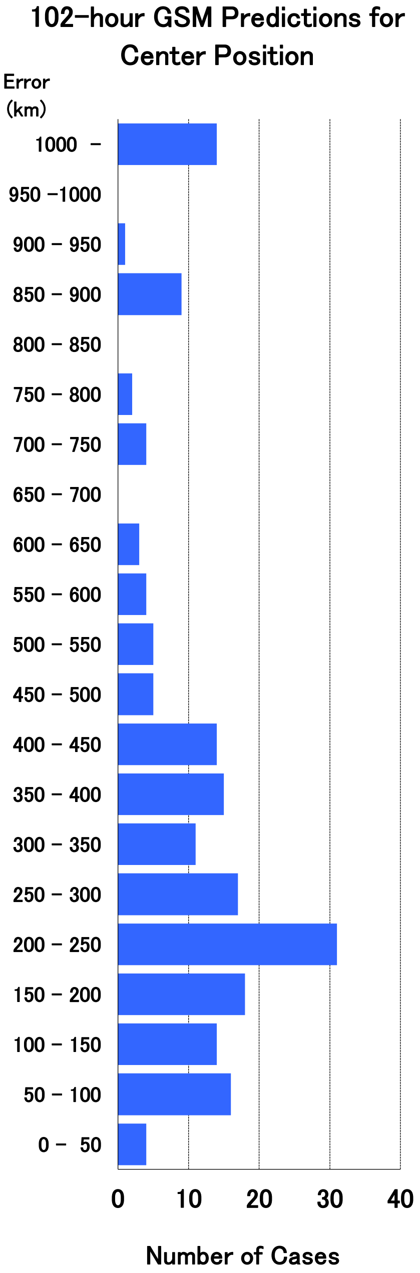


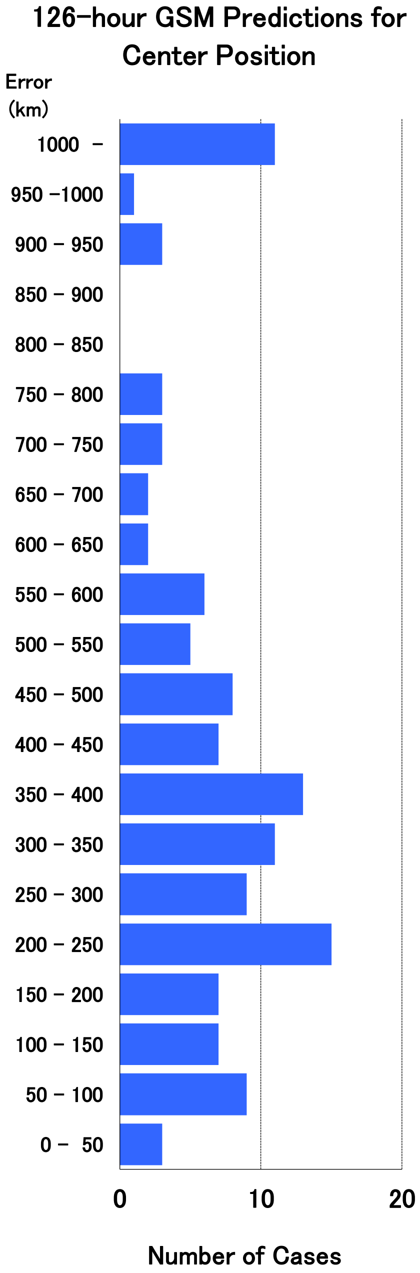


Histograms of RSMC 96-hour, 120-hour and all lead time maximum wind speed forecast errors

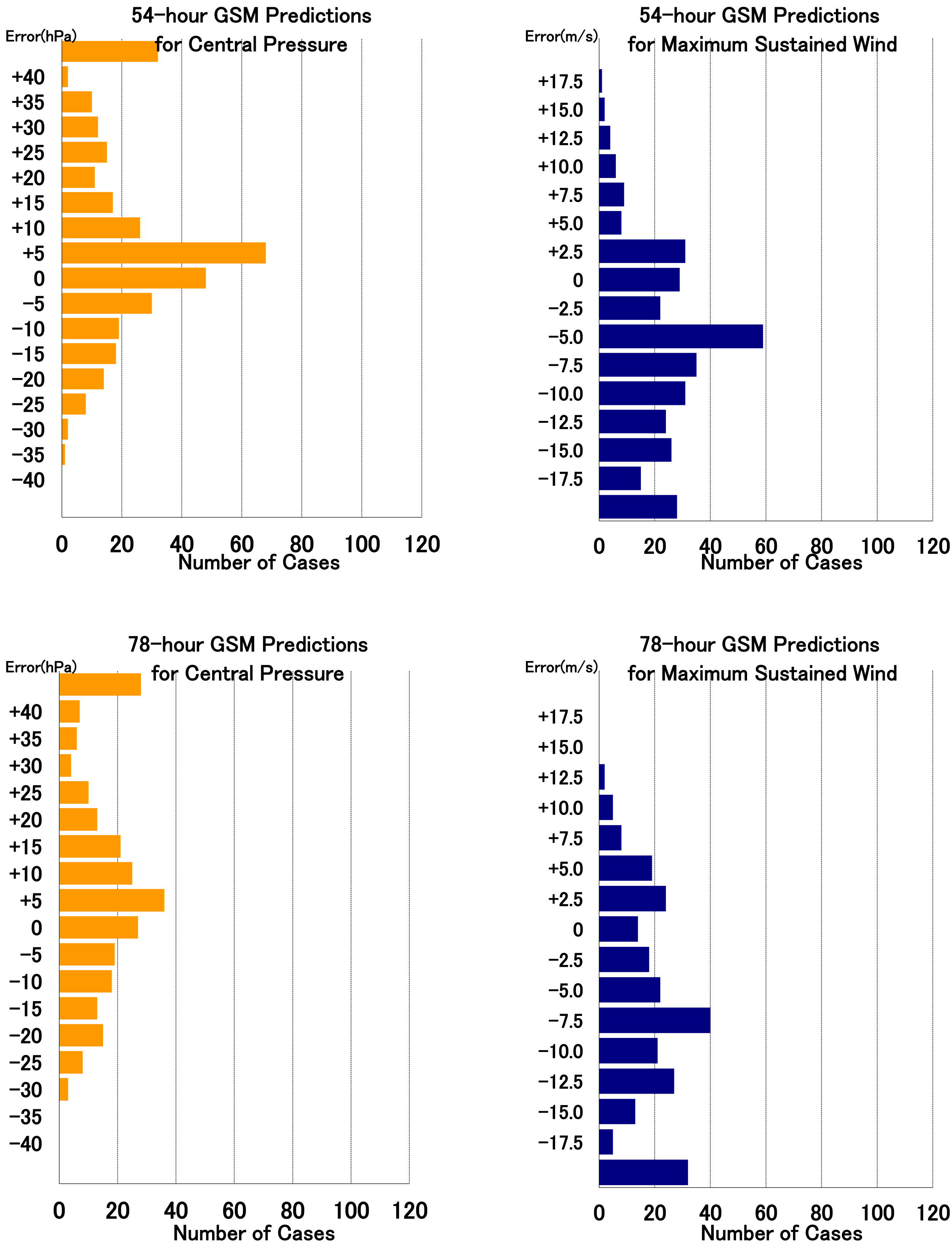


Histograms of GSM position errors for 30-, 54-, and 78-hour prediction

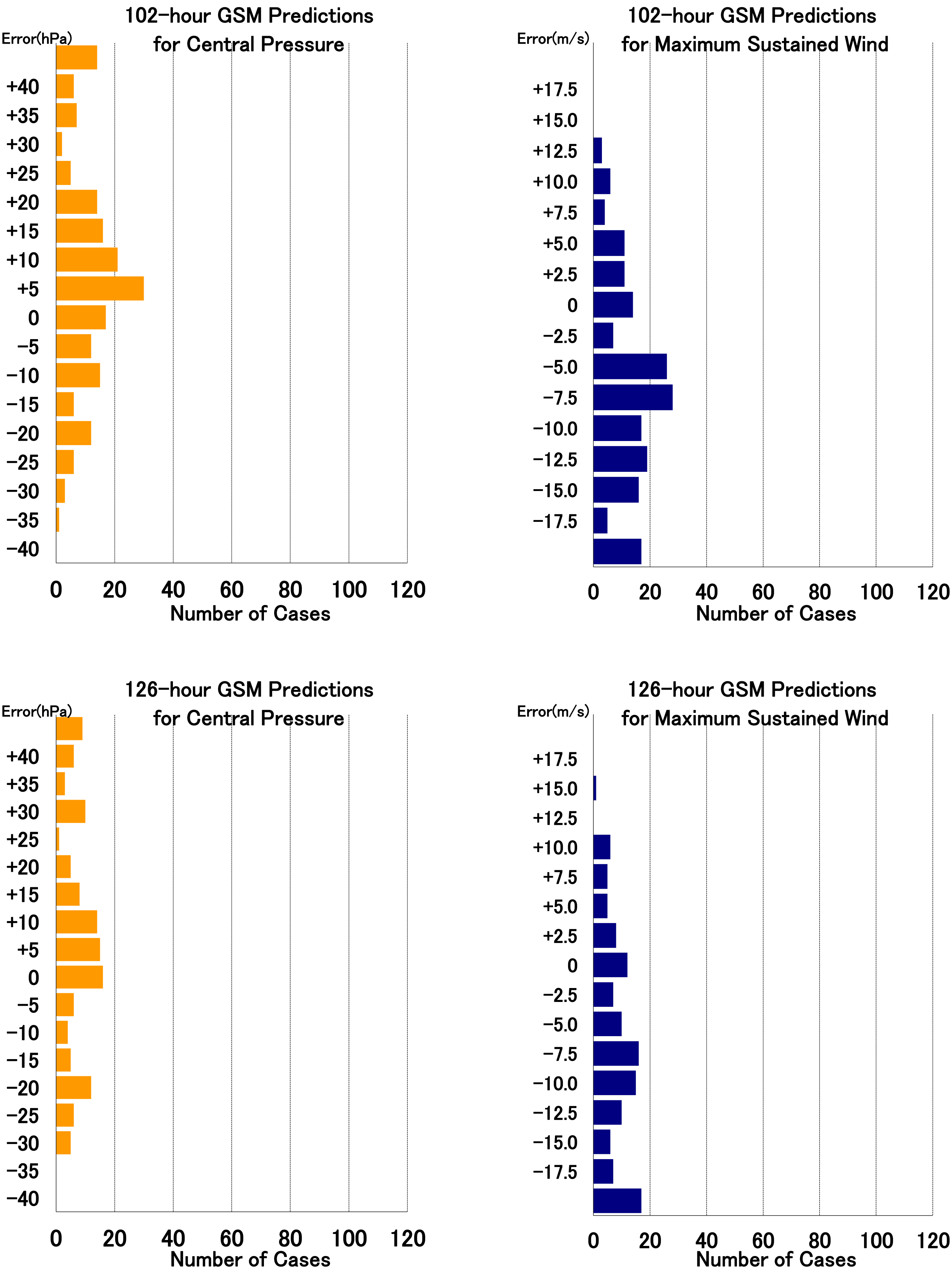




Histograms of GSM position errors for 102- and 26-hour prediction



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 for Three-day Forecasts (WTPQ20-25 RJTD)

WTPQ i i RJTD YYGGgg
RSMC TROPICAL CYCLONE ADVISORY
NAME class ty-No. name (common-No.)
ANALYSIS
PSTN YYGGgg UTC LaLa.La N LoLoLo.Lo E (or W) confidence
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
50KT RdRdRd NM (or 50KT RdRdRd NM octant RdRdRd NM octant)
30KT RdRdRd NM (or 30KT RdRdRd NM octant RdRdRd NM octant)
FORECAST
24HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
Ft1Ft1HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
GUST VgVgVg KT
MXWD VmVmVm KT
Ft2Ft2HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT =

Notes:

a. Underlined parts are fixed.

b. Abbreviations

PSTN	:	Position
MOVE	:	Movement
PRES	:	Pressure
MXWD	:	Maximum wind
HF	:	Hour forecast

c. Symbolic letters

i i	:	'20', '21', '22', '23', '24' or '25'
YYGGgg	:	Time of observation submitting the data for analysis in UTC
class	:	Intensity classification of the tropical cyclone 'TY', 'STS', 'TS' or 'TD'
ty-No.	:	Domestic identification number of the tropical cyclone adopted in Japan given in four digits (same as the international identification number)
name	:	Name assigned to the tropical cyclone from the name list prepared by the Typhoon Committee
common-No.	:	International identification number of the tropical cyclones given in four digits
LaLa.La	:	Latitude of the center position in "ANALYSIS" part
LoLoLo.Lo	:	Longitude of the center position in "ANALYSIS" part
confidence	:	Confidence of the center position. 'GOOD', 'FAIR' or 'POOR'
direction	:	Direction of movement given in 16 azimuthal direction such as 'N', 'NNE', 'NE' and 'ENE'
SpSpSp	:	Speed of movement
PPPP	:	Central pressure
VmVmVm	:	Maximum sustained wind

VgVgVg	:	Maximum gust wind
RdRdRd	:	Radii of 30knots and 50knots wind
octant	:	Eccentric distribution of wind given in 8 azimuthal direction such as 'NORTH', 'NORTHEAST' and 'EAST'
Ft1Ft1	:	48 (00, 06, 12 and 18 UTC) or 45 (03, 09, 15 and 21 UTC)
Ft2Ft2	:	72 (00, 06, 12 and 18 UTC) or 69 (03, 09, 15 and 21 UTC)
YYGGgg$_F$	:	Time in UTC on which the forecast is valid
LaLa.La$_F$	:	Latitude of the center of 70% probability circle in "FORECAST" part
LoLoLo.Lo$_F$	:	Longitude of the center of 70% probability circle in "FORECAST" part
FrFrFr	:	Radius of 70% probability circle

d. MOVE is optionally described as 'ALMOST STATIONARY' or '(direction) SLOWLY', depending on the speed of movement.

Example:

```
WTPQ20 RJTD 150000
RSMC TROPICAL CYCLONE ADVISORY
NAME    STS 0320 NEPARTAK (0320)
ANALYSIS
PSTN    150000UTC 12.6N 117.8E FAIR
MOVE    WNW 13KT
PRES    980HPA
MXWD    055KT
GUST    080KT
50KT    40NM
30KT    240NM NORTHEAST 160NM SOUTHWEST
FORECAST
24HF    160000UTC 14.7N 113.7E 110NM 70%
MOVE    WNW 11KT
PRES    965HPA
MXWD    070KT
GUST    100KT
48HF    170000UTC 16.0N 111.0E 170NM 70%
MOVE    WNW 07KT
PRES    970HPA
MXWD    065KT
GUST    095KT
72HF    180000UTC 19.5N 110.0E 250NM 70%
MOVE    NNW 09KT
PRES    985HPA
MXWD    050KT
GUST    070KT =
```

(2) RSMC Tropical Cyclone Advisory (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 YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
Ft1Ft1HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
GUST VgVgVg KT
MXWD VmVmVm KT
Ft2Ft2HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%

MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
Ft3Ft3HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT
Ft4Ft4Ft4HF YYGGgg$_F$ UTC LaLa.La$_F$ N LoLoLo.Lo$_F$ E (or W) FrFrFr NM 70%
MOVE direction SpSpSp KT
PRES PPPP HPA
MXWD VmVmVm KT
GUST VgVgVg KT=

Notes:

a. Underlined parts are fixed.

b. Abbreviations 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 =
```

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

FXPQ i i RJTD YYGGgg
RSMC GUIDANCE FOR FORECAST
NAME class ty-No. name (common-No.)
PSTN YYGGgg UTC LaLa.La N LoLoLo.Lo E (or W)

PRES PPPP HPA
MXWD WWW KT
FORECAST BY GLOBAL MODEL
TIME PSTN PRES MXWD
(CHANGE FROM T=0)
T=006 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=012 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
T=018 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT
:
T=132 LaLa.La N LoLoLo.Lo E (or W) appp HPA awww KT=

Notes:

a. Underlined parts are fixed.

b. Symbolic letters

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

Example:

FXPQ20 RJTD 180600
RSMC GUIDANCE FOR FORECAST
NAME TY 0001DAMREY (0001)
PSTN 180000UTC 15.2N 126.3E
PRES 905HPA
MXWD 105KT
FORECAST BY GLOBAL MODEL
TIME PSTN PRES MXWD
(CHANGE FROM T=0)
T=006 15.4N 125.8E +018HPA -008KT
T=012 15.5N 125.6E +011HPA -011KT
T=018 15.8N 125.7E +027HPA -028KT
:
:
T=132 20.7N 128.8E +021HPA -022KT=

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

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=

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

Example:

WTPQ30 RJTD 231200
RSMC TROPICAL CYCLONE PROGNOSTIC REASONING
REASONING NO.10 FOR TY 1826 YUTU (1826)
1.GENERAL COMMENTS
TY YUTU IS LOCATED AT 12.0N, 149.6E. INFORMATION ON THE CURRENT POSITION IS BASED ON ANIMATED MSI. POSITIONAL ACCURACY IS GOOD. THE SYSTEM IS IN A FAVORABLE ENVIRONMENT FOR DEVELOPMENT UNDER THE INFLUENCE OF HIGH SSTS, HIGH TCHP AND WEAK VWS. THIS HAS CAUSED THE SYSTEM TO DEVELOP OVER THE LAST SIX HOURS. HOWEVER, THE INFLUENCE OF DRY AIR IS UNFAVORABLE FOR SYSTEM DEVELOPMENT. INFORMATION ON CURRENT INTENSITY IS BASED ON DVORAK INTENSITY ANALYSES.
2.SYNOPTIC SITUATION
THE SYSTEM IS MOVING WESTWARD ALONG THE SOUTHERN PERIPHERY OF A MID-LEVEL SUB-TROPICAL HIGH. ANIMATED MSI SHOWS THE APPEARANCE OF AN EYE. WATER VAPOR IMAGERY SHOWS DRY AIR IN THE DIRECTION OF THE MOVEMENT. DMSP-F18/SSMIS 89 GHZ MICROWAVE IMAGERY SHOWS THE SYSTEM HAS A BAND WITH CURVATURE INDICATING THE CSC.
3.TRACK FORECAST
THE SYSTEM WILL MOVE NORTHWESTWARD ALONG THE PERIPHERY OF A MID-LEVEL SUB-TROPICAL HIGH UNTIL FT12. THE SYSTEM WILL THEN MOVE WEST-NORTHWESTWARD ALONG THE PERIPHERY OF A MID-LEVEL SUB-TROPICAL HIGH UNTIL FT120. THE JMA TRACK FORECAST IS BASED ON GSM PREDICTIONS, AND REFERENCE TO OTHER NWP MODELS. JMA TRACK FORECAST CONFIDENCE IS FAIR UNTIL FT48 BUT LOW THEREAFTER DUE TO SIGNIFICANT DIFFERENCES AMONG NUMERICAL MODEL OUTPUTS.
4.INTENSITY FORECAST
THE SYSTEM WILL DEVELOP UNTIL FT48 DUE TO THE INFLUENCE OF INTERACTION WITH HIGH SSTS, HIGH TCHP, WEAK VWS AND GOOD UPPER LEVEL OUTFLOW. THE SYSTEM WILL THEN MAINTAIN ITS INTENSITY UNTIL FT72 DUE TO THE INFLUENCE OF INTERACTION WITH HIGH SSTS, HIGH TCHP AND DRY AIR. THE JMA INTENSITY FORECAST IS BASED ON GUIDANCE DATA. =

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

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

:

:

DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT DDTT LaLa.LaN LoLoLo.LoE PPPHPA WWWKT
REMARKS[1)]
TD FORMATION AT MMMDDTTUTC
FROM TD TO TS AT MMMDDTTUTC

:

:

DISSIPATION AT MMMDDTTUTC=

Notes:

a. Underlined parts are fixed.

b. [1)] REMARKS is given optionally.

c. Symbolic letters

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

Example:

```
AXPQ20 RJTD 020600

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

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

FKPQ i i RJTD YYGGgg
TC ADVISORY

DTG:	yyyymmdd/time Z
TCAC:	TOKYO
TC:	name
NR:	number
PSN:	N LaLa.LaLa E LoLoLo.LoLo
MOV:	direction SpSpSp KT
C:	PPPP HPA
MAX WIND:	WWW KT
FCST PSN +6HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo*
FCST MAX WIND +6HR:	WWW KT*
FCST PSN +12HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo
FCST MAX WIND +12HR:	WWW KT
FCST PSN +18HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo*

FCST MAX WIND +18HR:	YY/GGgg Z NLaLa.LaLa ELoLoLo.LoLo*
FCST PSN +24HR:	YY/GGgg Z N LaLa.LaLa E LoLoLo.LoLo
FCST MAX WIND +24HR:	WWW KT
RMK:	NIL =
NXT MSG:	yyyymmdd/time Z

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

Notes:

a. Underlined parts are fixed.

b. Abbreviations

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

c. Symbolic letters

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

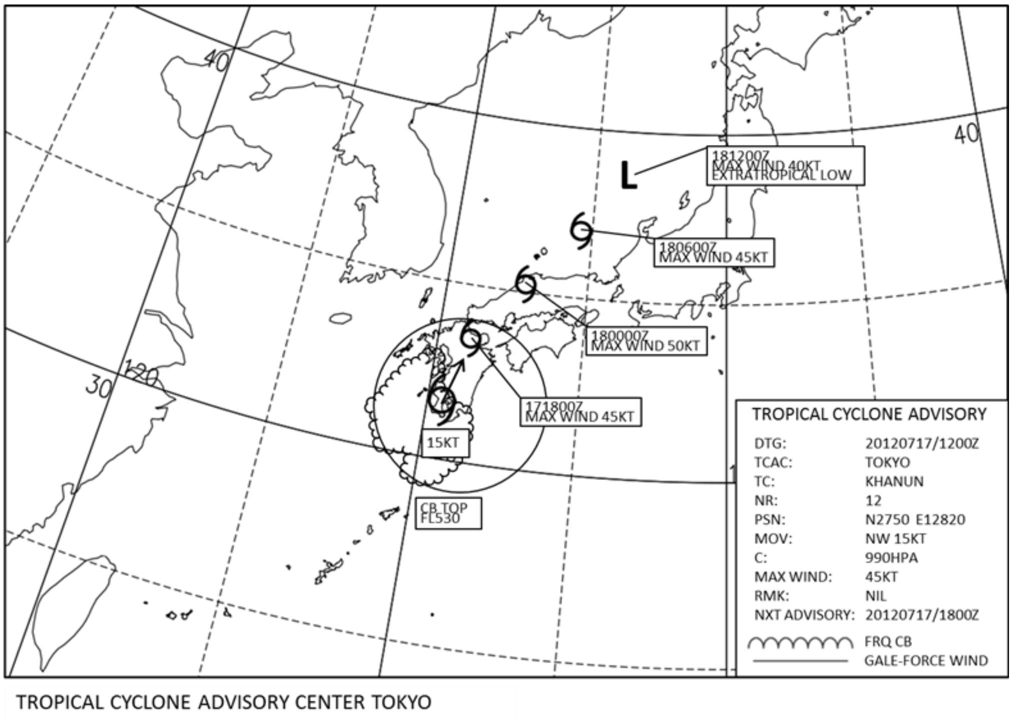
Example:

FKPQ30 RJTD 271200
TC ADVISORY

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

(8) Graphical Tropical Cyclone Advisory for SIGMET

Example:



Appendix 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), TL479L128
Resolution	20 km, 128 layers (Top: 0.01hPa)	40 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	30 March 2021

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 (TL479L128) 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 40 km along with 128 vertical layers for the first 18 days of forecasts. Details of the system can be found in JMA (2022) and Yamaguchi et al. (2021). 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]
GSM:

- Number of vertical layers increased from 100 to 128 (March 2021).
- Global snow analysis revised (March 2021).
- Global soil moisture analysis introduced (March 2021).

Global Data Assimilation System:

- Assimilation of AMSU-A and MHS from Metop-C started (September 2020).
- Ensemble-based background error covariances of hybrid 4D Var improved: ensemble size from 50 to 100, hybrid covariance weight from 0.15 to 0.5 (March 2021).
- All-sky assimilation of microwave water-vapor sounder data from GMI/GPM, ATMS/NOAA-20, Suomi-NPP, SSMIS/DMSP-F17, F18, SAPHIR/Megha-Tropiques, and MWHS-2/FY-3C was started (June 2021).
- Assimilation of AMV and CSR data from GOES-17 started (June 2021).
- Bias correction for aircraft-based observation revised (June 2021).

GEPS:

- Recent GSM development incorporated (March 2021).
- Ensemble size for forecasts with lead times up to 264 hours increased from 27 to 51 (March 2021).
- Initial perturbations improved (March 2021).

[References]

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

Japan Meteorological Agency, 2022: 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.

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Yamaguchi, H., M. Ikegami, T. Iwahira, K. Ochi, R. Sekiguchi, and T. Takakura, 2021: Upgrade of JMA's Global Ensemble Prediction System, WGNE Res. Activ. Earth system Modell., 51, 06.13 – 14.

Yokota, S., T. Kadowaki, M. Oda, Y. Ota, 2021: Improving ensemble-based background error covriances of the hybrid 4DVar in JMA's global analysis, WGNE Res. Activ. Earth system Modell., 51, 01.27-28.

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

Appendix 9
RSMC Tokyo Products and Services Provided Through the Internet

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

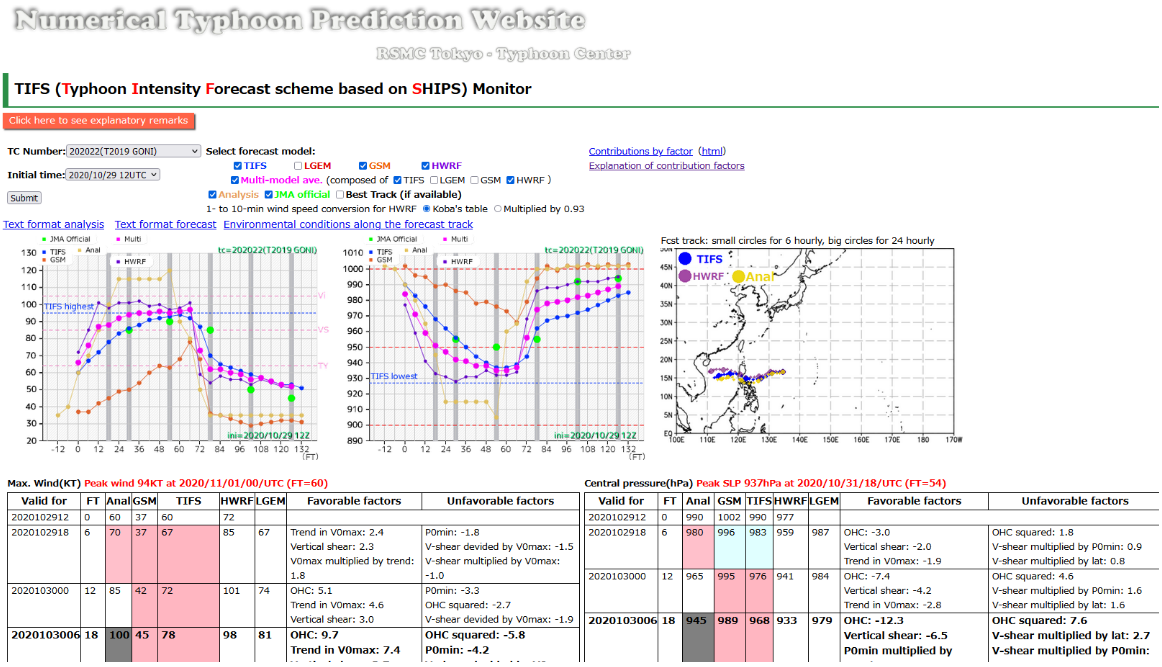
Products	Frequency	Details
RSMC Advisories		
RSMC TC Advisory	At least 8 times/day	• The Center's TC analysis and forecasts up to 120 hours ahead (linked to the JMA website at https://www.jma.go.jp/en/typh/)
Storm Wind Probability Map	4 times/day	• Probabilistic forecast map for sustained wind of 50-kt 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

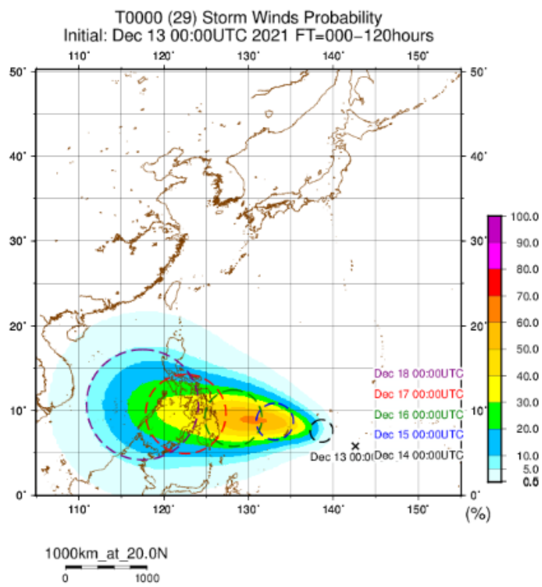
Services	Details
Advance notice	• Advance notice on TC status change from the Centre *Supplemental information to RSMC advisories (It may not be provided in certain situations and should not be considered as an official RSMC advisory and/or its replacement)
Enhanced communication	• A platform on which 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.

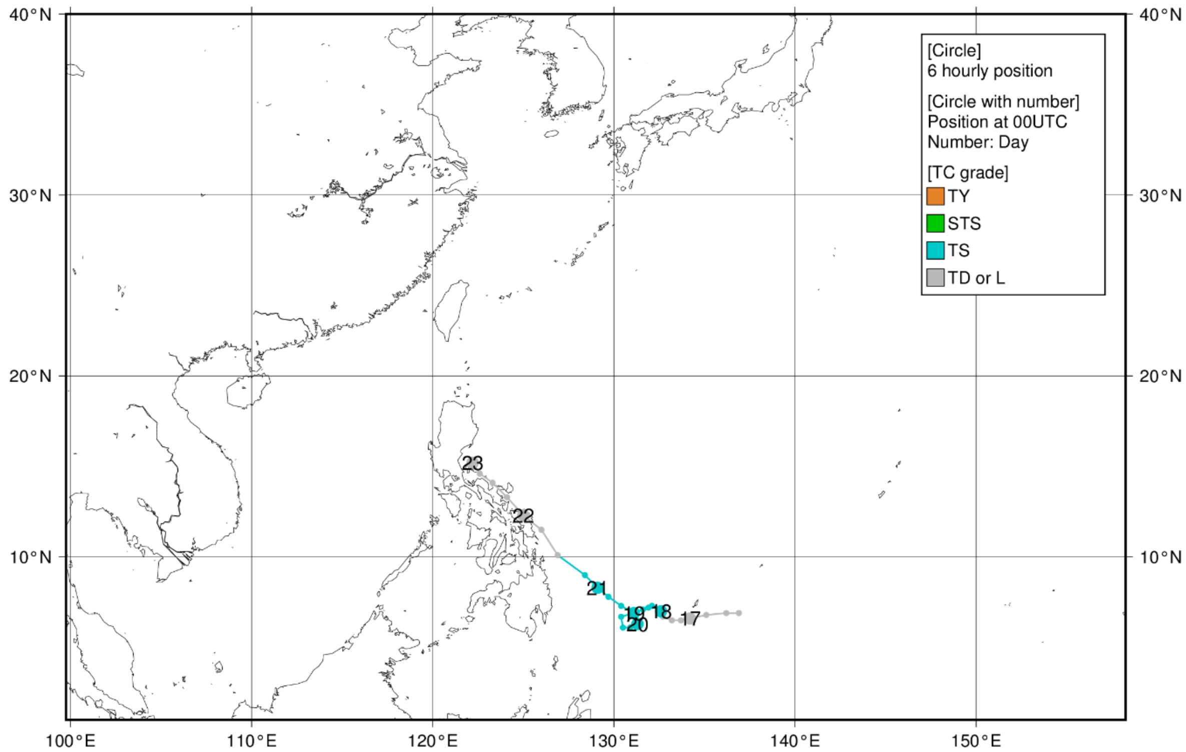


Five-day storm wind product probability (50 kt and above)
for Tropical Depressions (TDs) expected to reach tropical storm (TS) intensity or higher within 24 hours.

Appendix 10
Tropical Cyclones in 2021

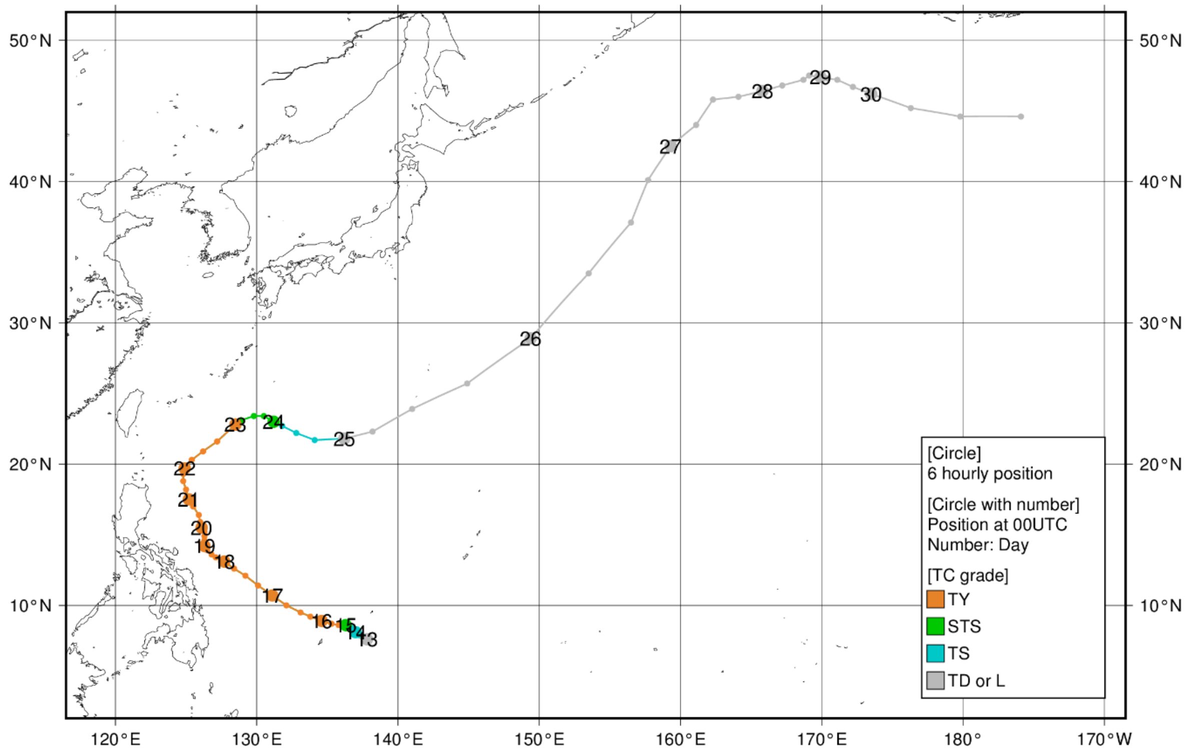
DUJUAN (2101)

DUJUAN formed as a tropical depression (TD) over the sea around the Caroline Islands at 06 UTC on 16 February 2021 and moved westward. DUJUAN was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 18 February. It reached its peak intensity with maximum sustained winds of 40 kt and a central pressure of 996 hPa east of Mindanao Island 12 hours later. DUJUAN turned in a counterclockwise direction to circle over the same waters from 19 to 20 February and then accelerated northwestward. It weakened to TD intensity off the eastern coast of the Philippines at 12 UTC on 21 February. It continuously moved northwestward and dissipated around the eastern coast of Luzon Island at 06 UTC on 23 February.



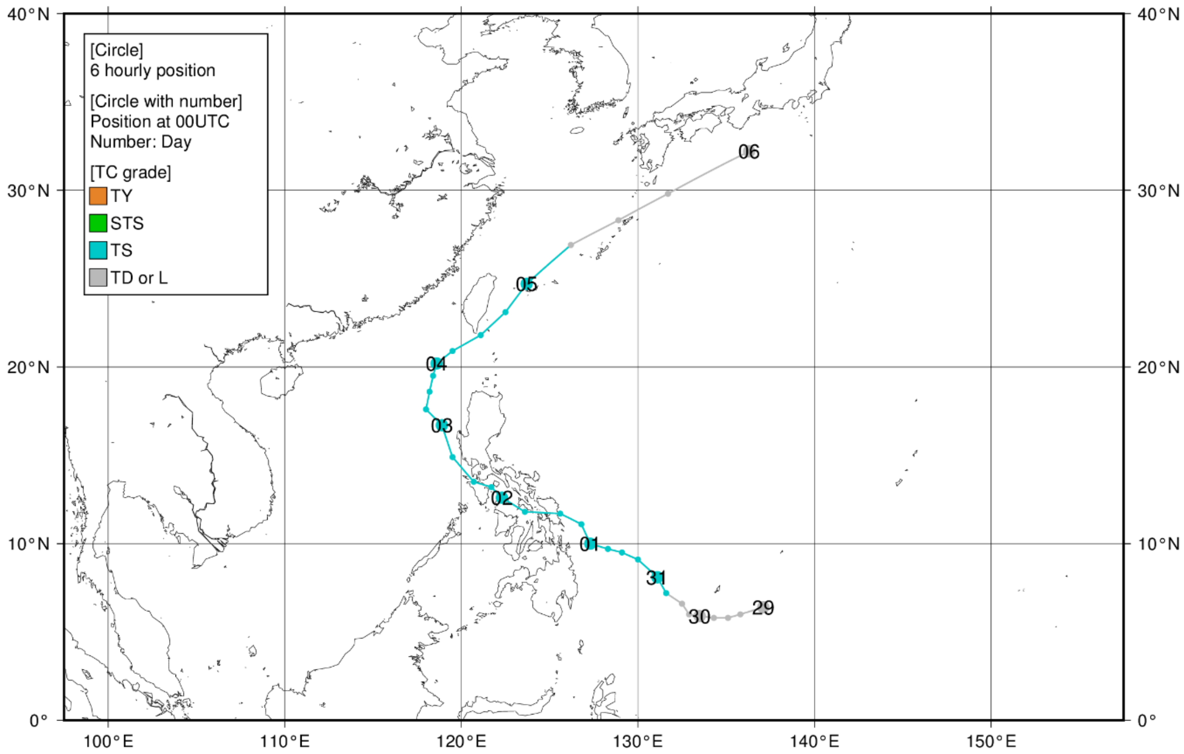
SURIGAE (2102)

SURIGAE formed as a tropical depression (TD) over the sea around the Caroline Islands at 18 UTC on 12 April 2021. It moved northwestward and was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on 13 April. Keeping its northwestward track, SURIGAE was upgraded to typhoon (TY) intensity northeast of the Palau Islands at 12 UTC on 15 April. It reached its peak intensity with maximum sustained winds of 120 kt and a central pressure of 895 hPa over the sea east of the Philippines at 18 UTC on 17 April. SURIGAE started to weaken slowly on 18 April, and turned northward around 00 UTC on 19 April. It turned northeastward around 00 UTC on 22 April over the sea northeast of Luzon Island, and then turned southeastward around 12 UTC on 23 April over the sea south of Okinawa Island. SURIGAE transitioned into an extratropical cyclone over the sea south of Japan by 00 UTC on 25 April. After accelerating northeastward, it turned eastward over the sea east of the Kuril Islands around 00 UTC on 28 April and crossed longitude 180 degrees east before 18 UTC on 30 April.



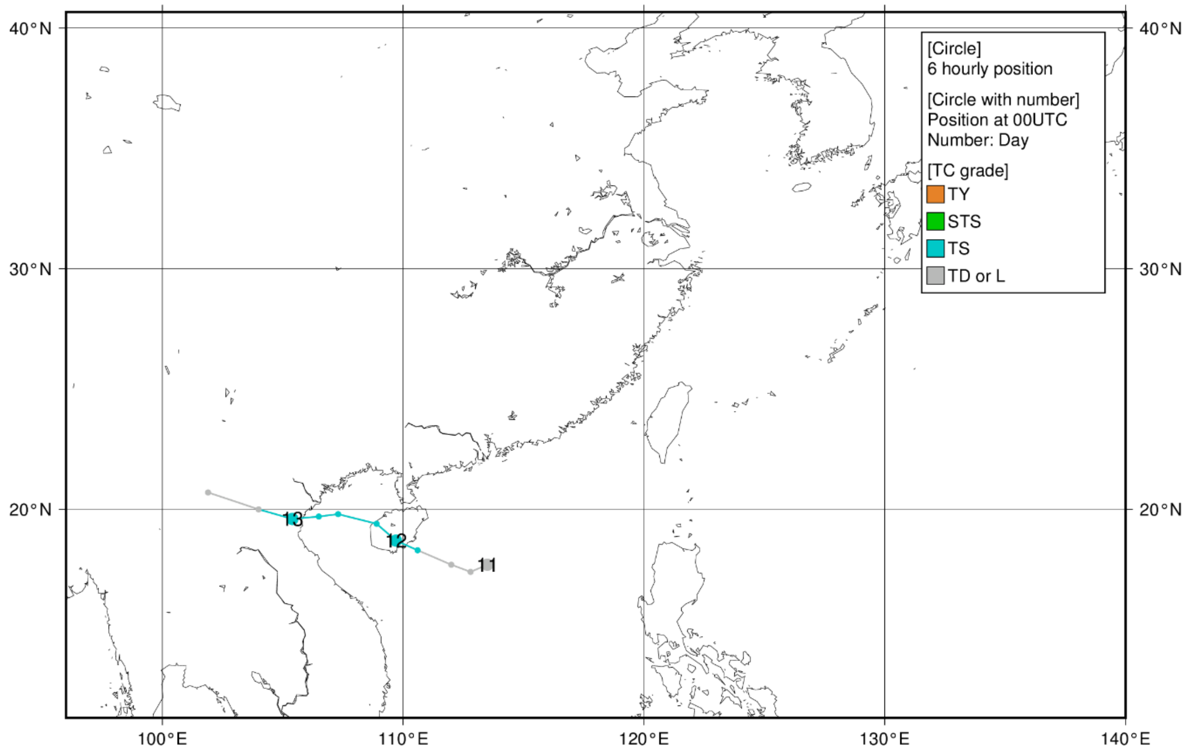
CHOI-WAN (2103)

CHOI-WAN formed as a tropical depression (TD) over the sea around the Caroline Islands at 00 UTC on 29 May 2021 and moved westward. It turned northwestward over the same waters on 30 May, and was upgraded to tropical storm (TS) intensity over the sea east of Mindanao at 18 UTC the same day. CHOI-WAN reached its first peak intensity with maximum sustained winds of 40 kt and a central pressure of 998 hPa over the same waters at 18 UTC on 31 May. After passing over the central part of the Philippines with weakened maximum sustained winds of 35 kt, it entered the South China Sea late on 2 June. Subsequently, it reached its second peak intensity with maximum sustained winds of 40 kt and a central pressure of 998 hPa at 00 UTC on 3 June. The next day, it turned northeastward over the same waters and transitioned into an extratropical cyclone over the East China Sea by 06 UTC on 5 June. It dissipated over the sea south of Japan at 06 UTC on 6 June.



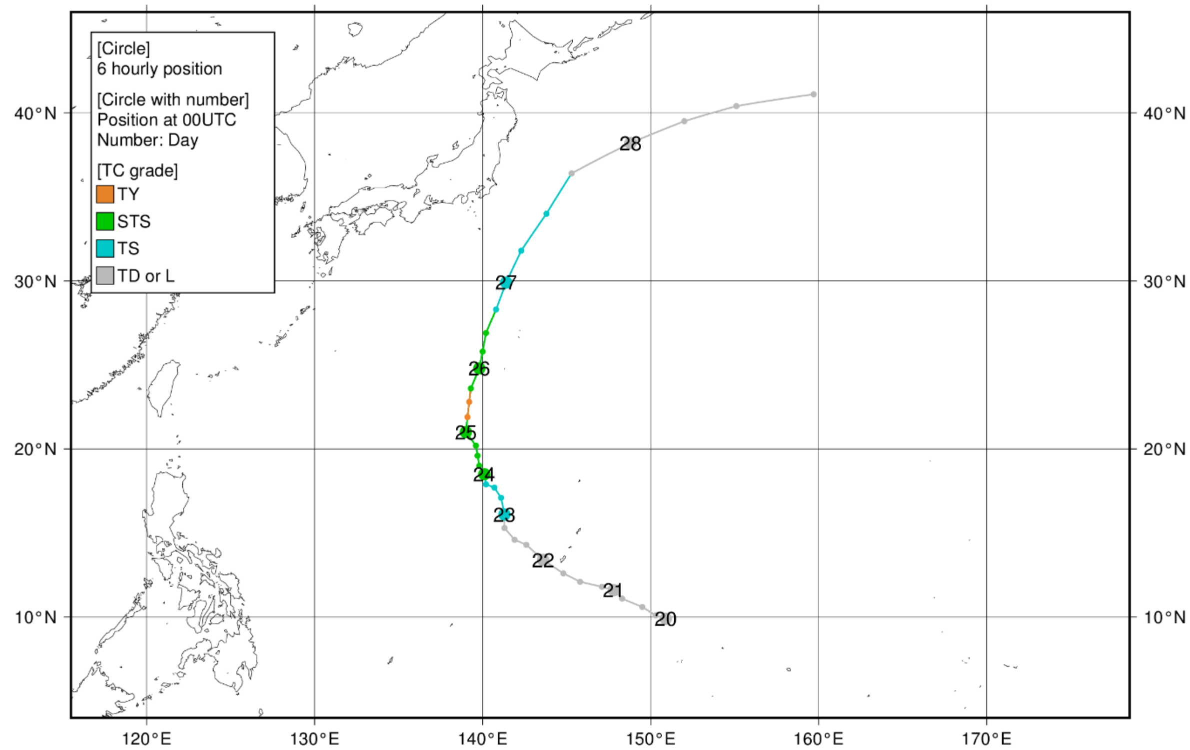
KOGUMA (2104)

KOGUMA formed as a tropical depression (TD) over the South China Sea at 00 UTC on 11 June 2021 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity over the same waters 18 hours later. It crossed Hainan Island with TS intensity early on 12 June and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 996 hPa at 06 UTC on the same day. KOGUMA subsequently entered the Gulf of Tonkin and hit northern Viet Nam with TS intensity late on 12 June. It weakened to TD intensity in Laos at 06 UTC on 13 June and dissipated 12 hours later.



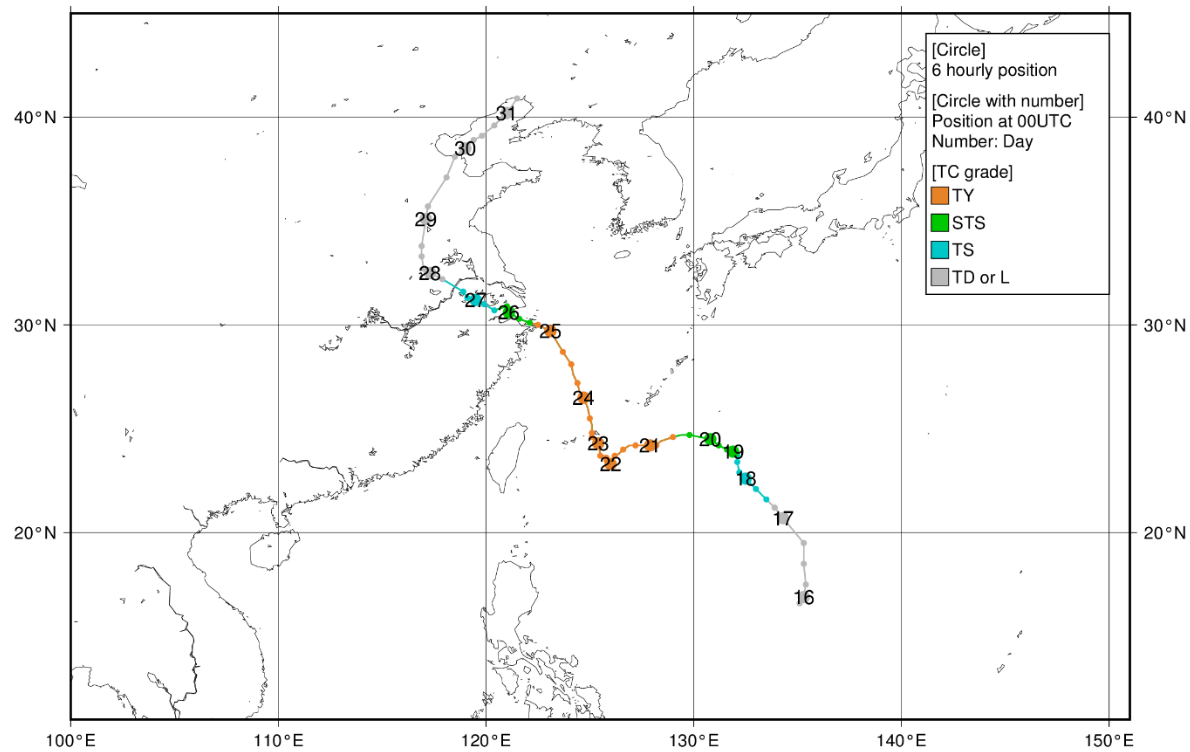
CHAMPI (2105)

CHAMPI formed as a tropical depression (TD) around the Chuuk Islands at 00 UTC on 20 June 2021. The TD moved west-northwestward and then gradually turned northward around the Mariana Islands. It was upgraded to tropical storm (TS) intensity over the sea west of the Mariana Islands at 00 UTC on 23 June. After moving over the same waters, CHAMPI reached Severe Tropical Storm (STS) intensity 24 hours later. It subsequently moved northward and reached typhoon (TY) intensity with maximum sustained winds of 65 kt and a central pressure of 980 hPa over the sea south of Japan at 06 UTC on 25 June. It gradually downgraded to TS intensity over the same waters by 18 UTC on 26 June. It then accelerated north-northeastward and transitioned into an extratropical cyclone over the sea east of Japan by 18 UTC on 27 June. CHAMPI turned northeastward and dissipated over the sea far off east of Japan at 00 UTC on 29 June.



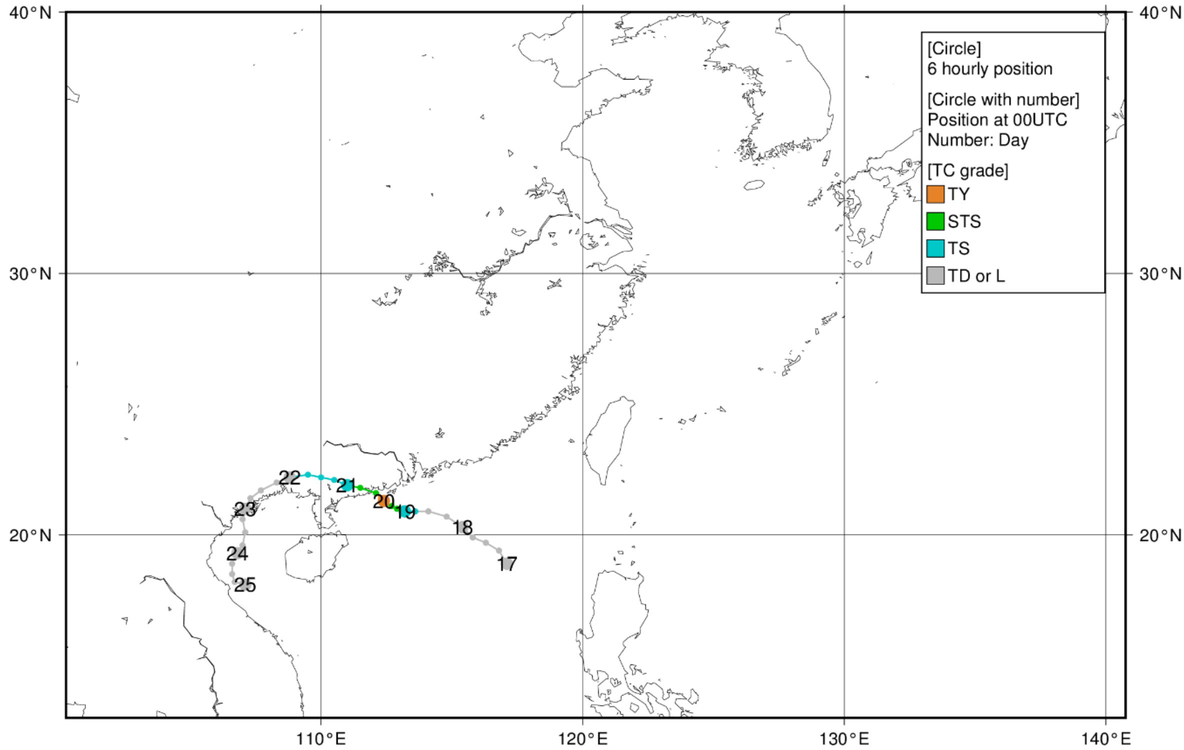
IN-FA (2106)

IN-FA formed as a tropical depression (TD) over the sea east of the Philippines at 18 UTC on 15 July 2021 and moved northward. It was upgraded to tropical storm (TS) intensity near Minamidaitojima Island over the sea south of Japan at 12 UTC on 17 July and moved northwestward. Changing its move westward, it was further upgraded to typhoon (TY) intensity over the sea south of Okinawa Island at 12 UTC on 20 July. Before sharply turning northwestward, IN-FA reached its peak intensity with maximum sustained winds of 85 kt and a central pressure of 950 hPa over the same waters at 18 UTC on 21 July. After turning northwestward and entering the East China Sea, it hit the coast of central China with severe tropical storm (STS) intensity late on 25 July. IN-FA weakened to TD intensity in the central part of China at 18 UTC on 27 July and it transitioned into an extratropical cyclone by 18 UTC on 29 July. After moving northeastward, it dissipated in northeastern China at 12 UTC on 31 July.



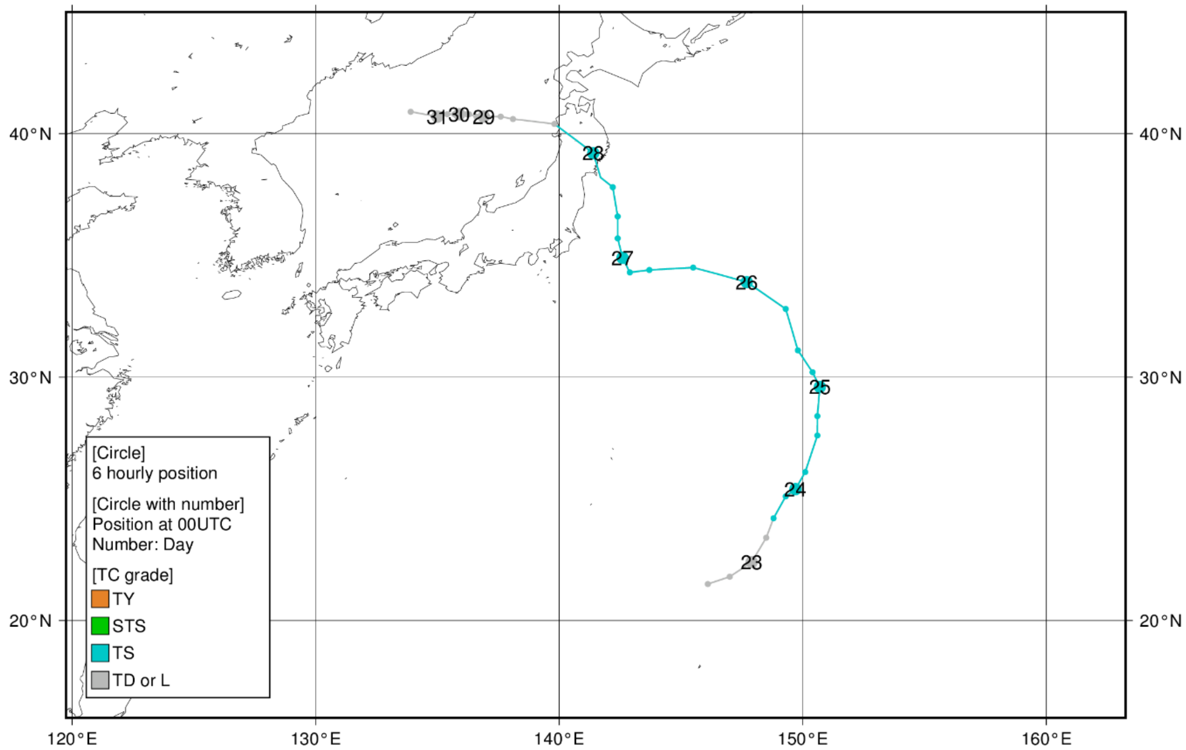
CEMPAKA (2107)

CEMPAKA formed as a tropical depression (TD) over the South China Sea at 00 UTC on 17 July 2021 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 18 UTC on 18 July. Keeping its west-northwestward track, CEMPAKA was upgraded to typhoon (TY) intensity near the coast of southern China at 18 UTC on 19 July and reached its peak intensity with maximum sustained winds of 70 kt and a central pressure of 980 hPa six hours later. It hit southern China with severe tropical storm (STS) intensity after 12 UTC on 20 July. It moved westward and weakened to TD intensity in southern China at 00 UTC on 22 July. It entered the Gulf of Tonkin and dissipated over the same waters at 06 UTC on 25 July.



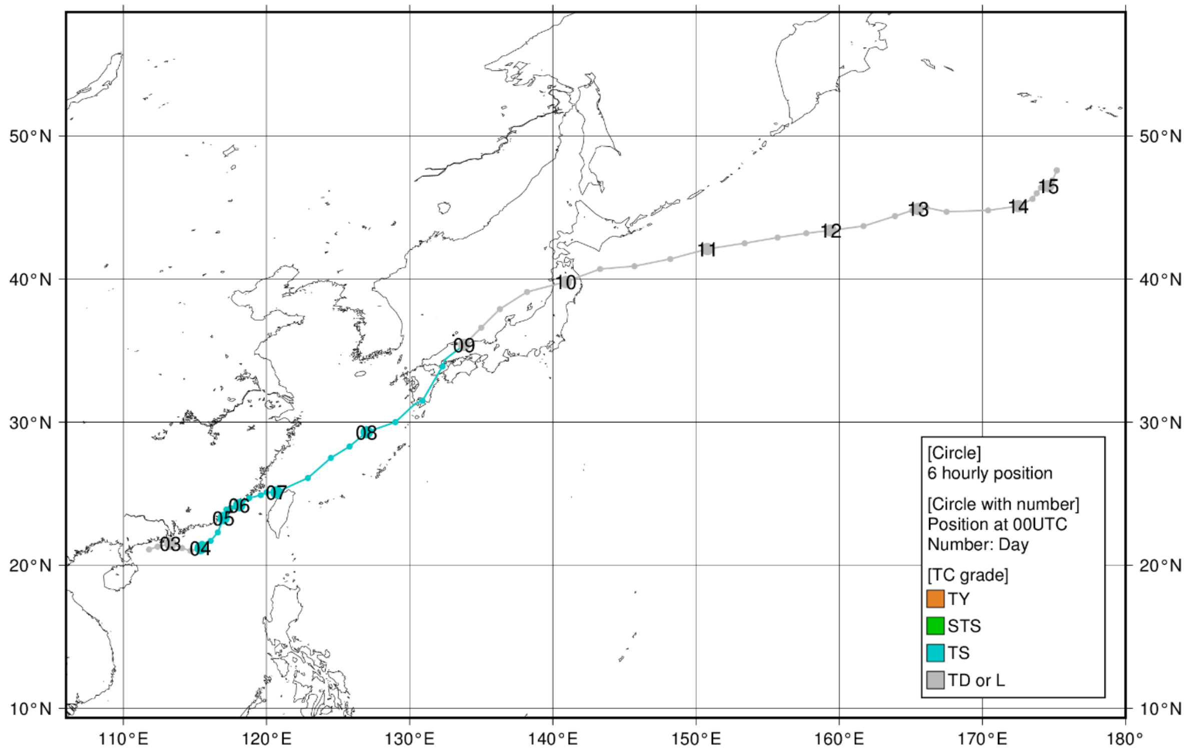
NEPARTAK (2108)

NEPARTAK formed as a tropical depression (TD) over the sea around the Ogasawara Islands at 12 UTC on 22 July 2021 and moved north-eastward. It was upgraded to tropical storm (TS) intensity west of Minamitorishima Island at 12 UTC on 23 July. It reached its peak intensity with maximum sustained winds of 40 kt 24 hours later and moved north-westward afterwards. Its central pressure was 994 hPa at 12 UTC on 24 July and lowered to 990 hPa at 18 UTC on 26 July when it turned northward over the sea east of Japan. NEPARTAK landed around Ishinomaki City, Miyagi Prefecture with TS intensity before 21 UTC on 27 July and changed its move north-westward on the next day. It transitioned into an extratropical cyclone over the Sea of Japan by 06 UTC on 28 July and dissipated over the same waters at 12 UTC on 31 July.



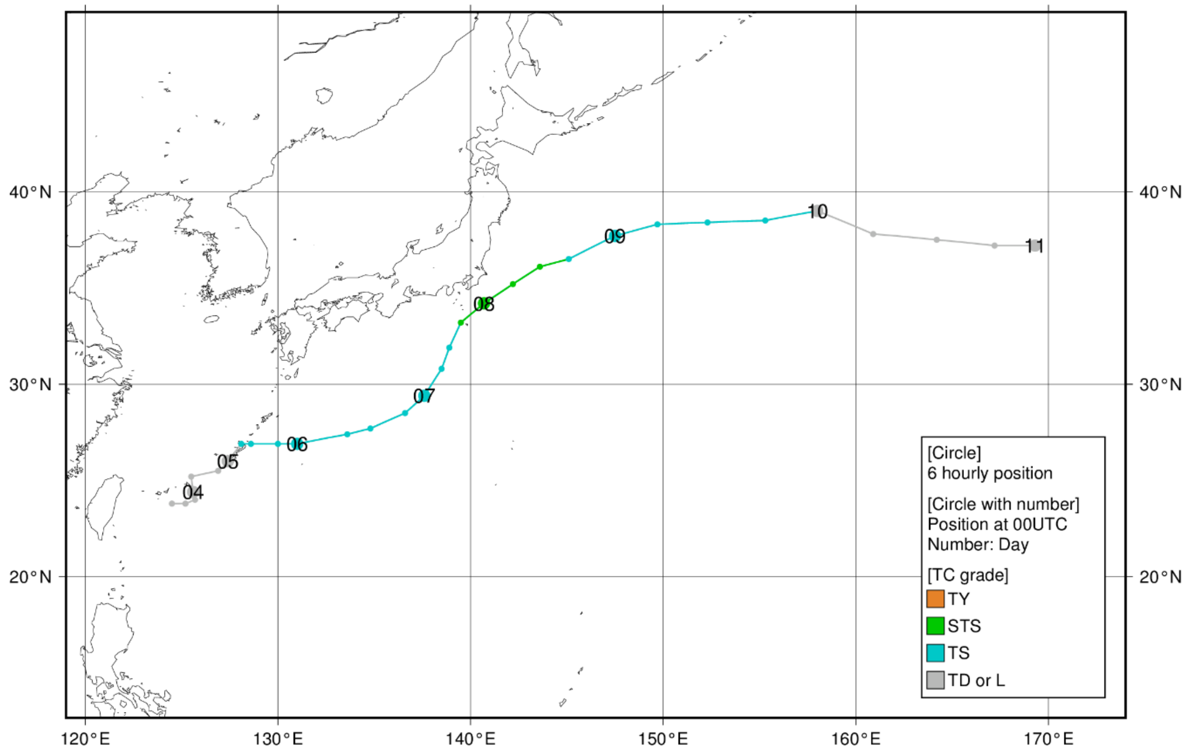
LUPIT (2109)

LUPIT formed as a tropical depression (TD) over the South China Sea at 12 UTC on 2 August 2021 and moved eastward. It was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 4 August. It gradually turned north-northeastward and hit southern China with TS intensity early on 5 August and moved northeastward. Crossing the Taiwan Strait on 6 August, it entered the East China Sea at around 00UTC on 7 August. Keeping its northeastward track and TS intensity, LUPIT made landfall near Makurazaki City, Kagoshima Prefecture after 11 UTC on 8 August. It reached its peak intensity with maximum sustained winds of 45 kt and a central pressure of 984 hPa over the sea between Honshu Island and Shikoku Island 7 hours later. LUPIT made landfall again near Kure City, Hiroshima Prefecture with TS intensity after 20 UTC on the same day and transitioned into an extratropical cyclone in Tottori Prefecture by 00 UTC on 9 August. It entered the Sea of Japan and after crossing the northern part of Honshu Island, it moved east-northeastward and dissipated over the sea south of the Aleutian Islands at 00 UTC on 16 August.



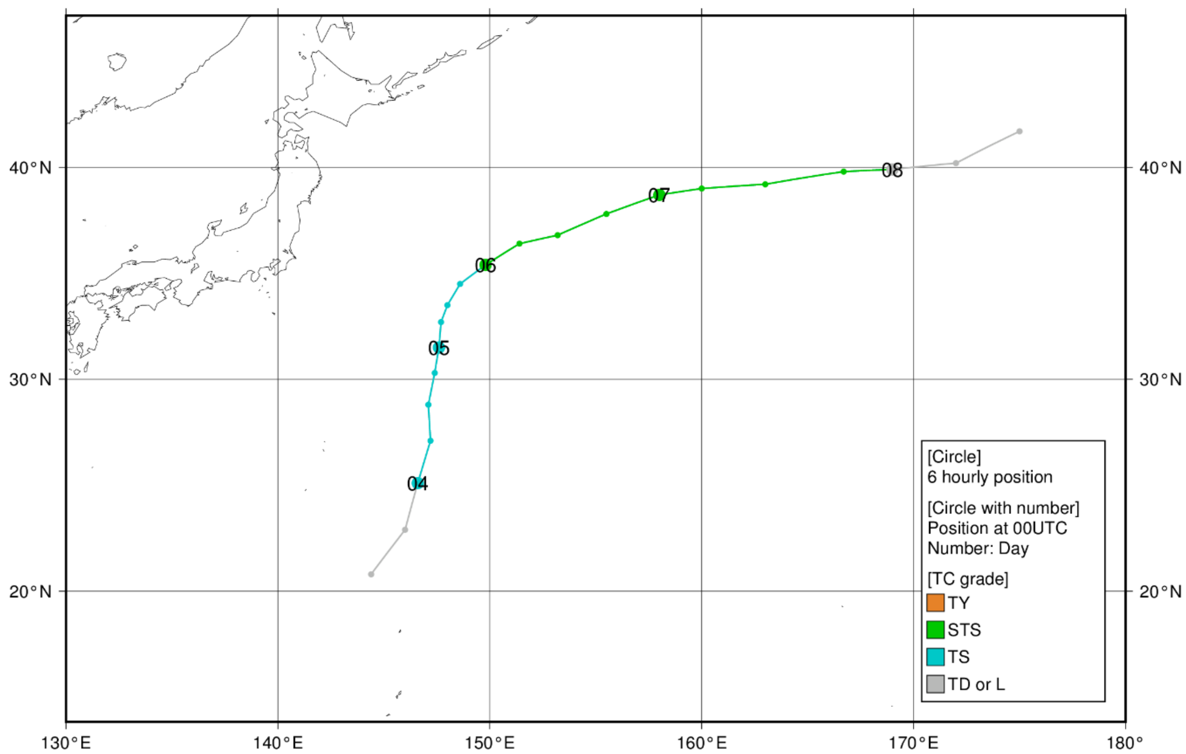
MIRINAE (2110)

MIRINAE formed as a tropical depression (TD) over the sea south of Okinawa at 06 UTC on 3 August 2021 and moved northeastward. It was upgraded to tropical storm (TS) intensity around Okinawa Island at 06 UTC on 5 August, and moved eastward. Gradually turning northeastward, MIRINAE reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 980 hPa around Hachijojima Island at 18 UTC on 7 August. MIRINAE gradually turned eastward and transitioned into an extratropical cyclone over the sea far off east of Japan by 00 UTC on 10 August. It dissipated over the same waters at 06 UTC on 11 August.



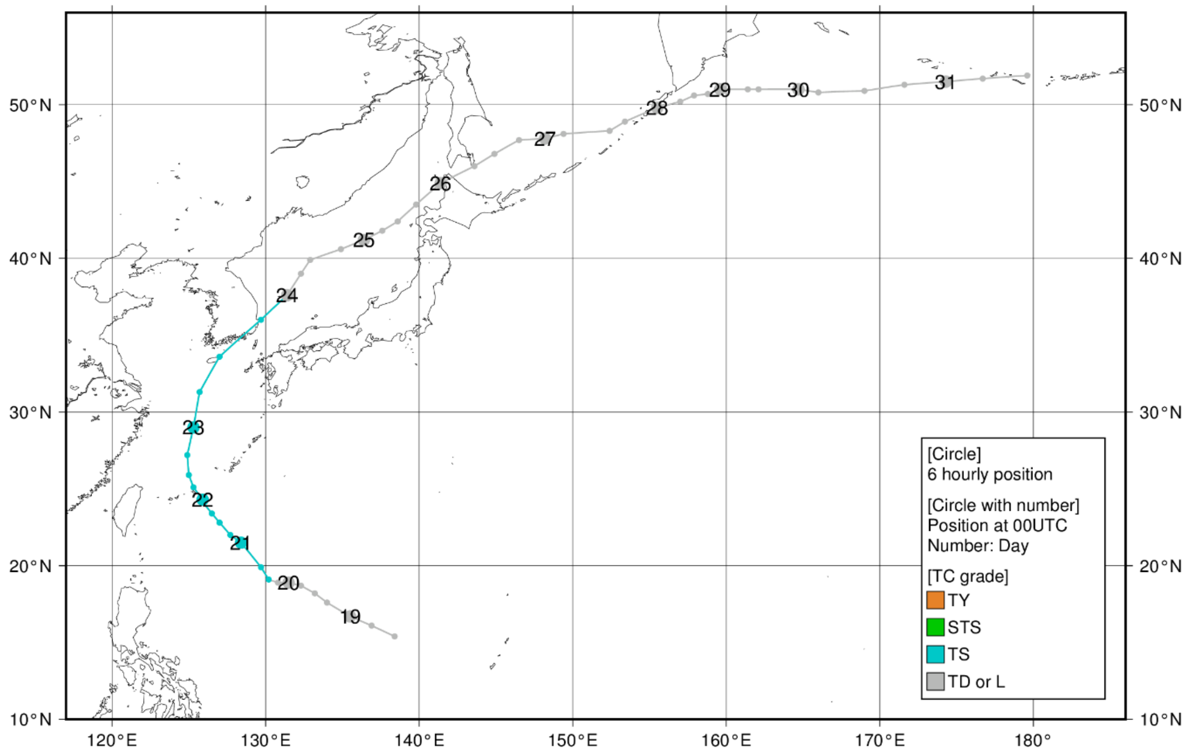
NIDA (2111)

NIDA formed as a tropical depression (TD) over the sea around the Ogasawara Islands at 12 UTC on 3 August 2021. It moved northeastward and was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 4 August. After gradually turning east-northeastward, NIDA reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 992 hPa over the sea far off east of Japan at 18 UTC on 6 August. Keeping its east-northeastward track, NIDA transitioned into an extratropical cyclone over the same waters by 00 UTC on 8 August, and dissipated over the sea south of the Aleutian Islands at 18 UTC the same day.



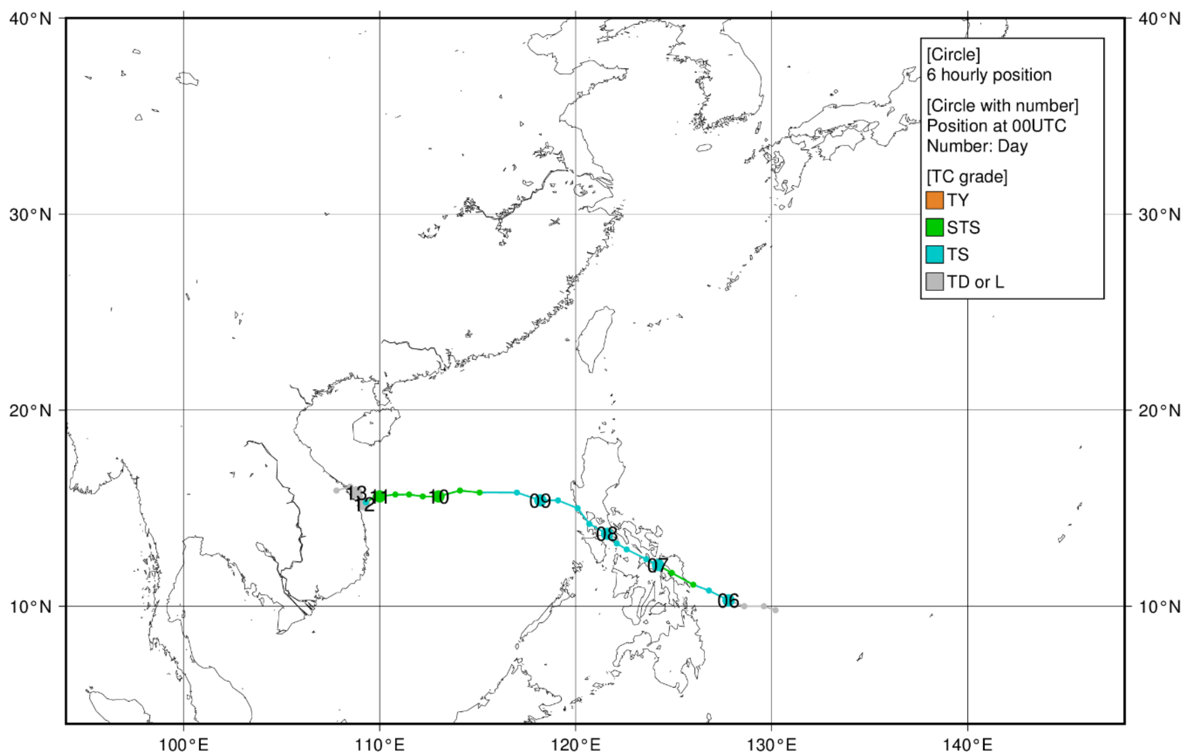
OMAIS (2112)

OMAIS formed as a tropical depression (TD) over the sea east of the Philippines at 12 UTC on 18 August 2021 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on 20 August and moved northwestward afterwards. OMAIS reached its peak intensity with maximum sustained winds of 45 kt south of Okinawa Island 24 hours later. Its central pressure was 998 hPa at that time and lowered to 994 hPa nine hours later. OMAIS changed its move northward over the East China Sea and gradually turned northeastward. After crossing the southern part of the Korean Peninsula late on 23 August, OMAIS transitioned into an extratropical cyclone over the Sea of Japan by 00 UTC on 24 August. It gradually turned eastward and finally dissipated over the sea around the Aleutian Islands at 18 UTC on 31 August.



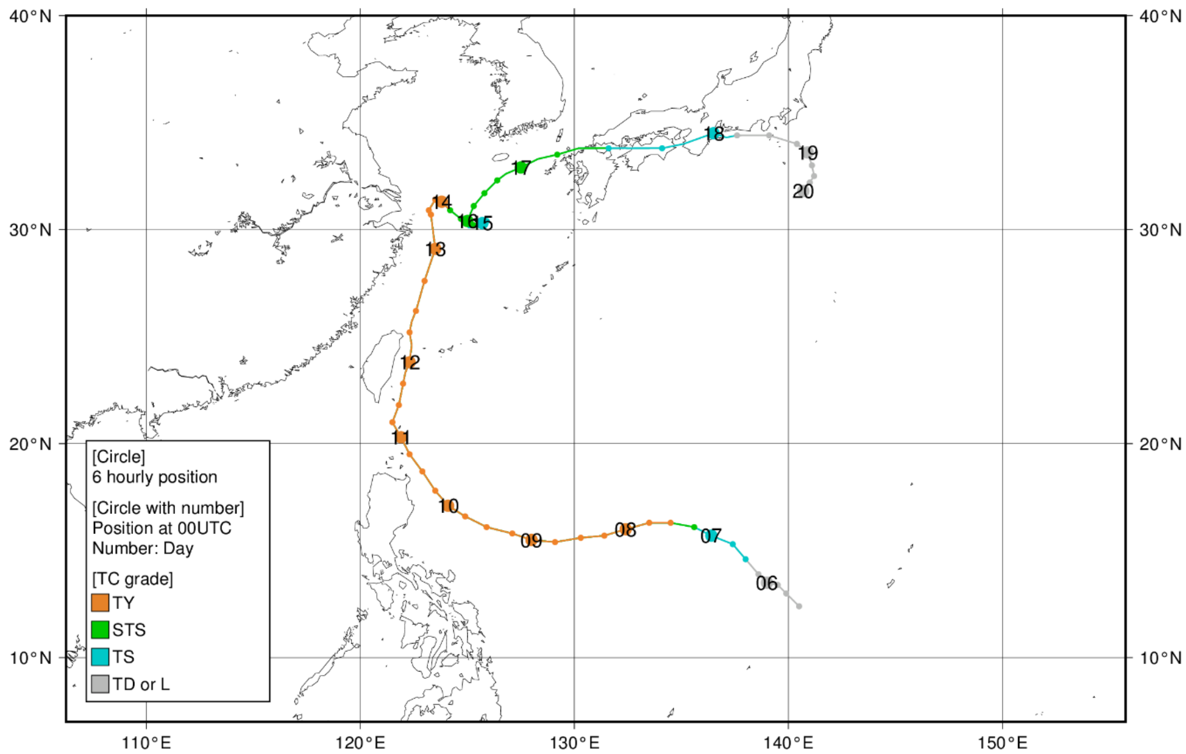
CONSON (2113)

CONSON formed as a tropical depression (TD) over the sea east of Mindanao Island at 06 UTC on 5 September 2021 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity over the sea east of the Philippines at 00 UTC on 6 September. It reached its first peak intensity with maximum sustained winds of 50 kt and a central pressure of 994 hPa at 12 UTC on 6 September. It weakened to maximum sustained winds of 45 kt and a central pressure of 998 hPa 12 hours later. After crossing the Philippines, it entered the South China Sea, and reached its second peak intensity with maximum sustained winds of 50 kt and a central pressure of 992 hPa at 12 UTC on 9 September. It weakened to TD intensity over the same waters at 18 UTC on 11 September and dissipated in Viet Nam at 18 UTC on 13 September.



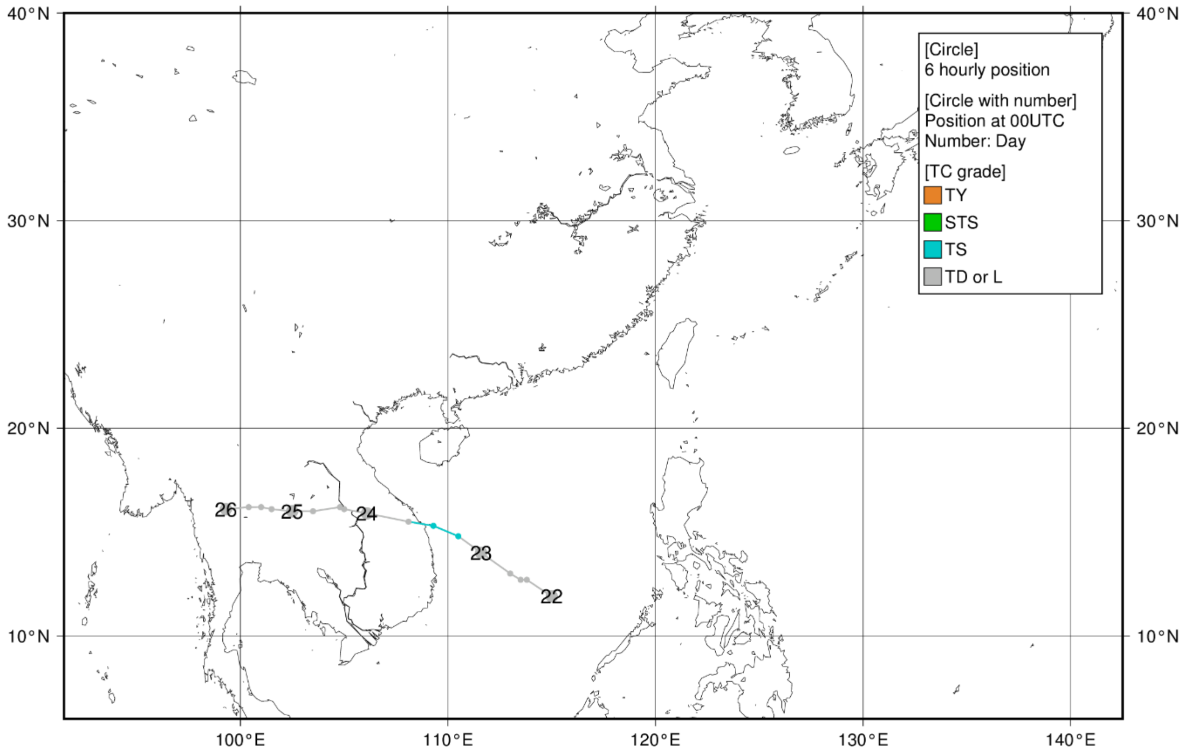
CHANTHU (2114)

CHANTHU formed as a tropical depression (TD) over the sea around the Mariana Islands at 06 UTC on 5 September 2021 and moved northwestward. It was upgraded to tropical storm (TS) intensity over the sea east of the Philippines at 12 UTC on 6 September. It gradually turned westward developing rapidly, and was upgraded to typhoon (TY) intensity over the same waters at 12 UTC on 7 September. It gradually turned northwestward and reached its peak intensity with maximum sustained winds of 115 kt east of the Luzon Island at 06 UTC on 10 September. Its central pressure was 910 hPa at that time and lowered to 905 hPa over the Bashi Channel 12 hours later. It moved northward and entered the East China Sea. Gradually weakening and keeping its northward track, it turned sharply southeastward over the same waters at around 18 UTC on 13 September and remained almost stationary until late on 15 September and turned northeastward afterwards. While then, it was downgraded to TS intensity at 18 UTC on 14 September, but was upgraded to severe tropical storm (STS) intensity again at 18 UTC on 15 September. It made landfall near Fukutsu City, Fukuoka Prefecture with STS intensity before 10 UTC on 17 September. It crossed the northern part of Kyushu Island and made landfall again near Matsuyama City, Ehime Prefecture with TS intensity after 15 UTC on 17 September. After crossing the Shikoku Island, it made its third landfall near Arida City, Wakayama Prefecture with TS intensity after 21 UTC on 17 September. It crossed the Kii peninsula and entered the Pacific Ocean at 03 UTC on 18 September and transitioned into an extratropical cyclone by 06 UTC on 18 September. It dissipated over the waters southeast of Hachijojima Island at 06 UTC on 20 September.



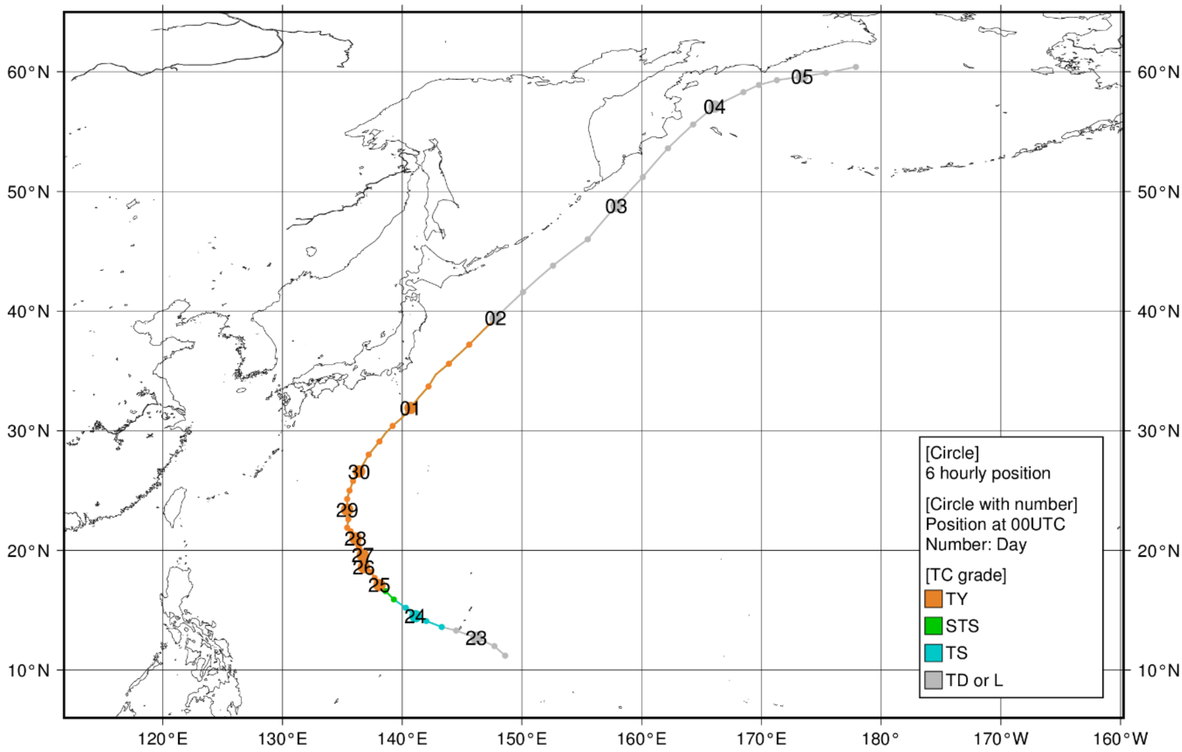
DIANMU (2115)

DIANMU formed as a tropical depression (TD) over the South China Sea at 00 UTC on 22 September 2021. It moved northwestward and was upgraded to tropical storm (TS) intensity and reached its peak intensity with maximum sustained winds of 35 kt and a central pressure of 1000 hPa over the same waters at 06 UTC on 23 September. After moving westward, it hit Viet Nam late on the same day and weakened to TD intensity at 18 UTC on 23 September. It continued moving westward and crossed longitude 100 degrees east before 00 UTC on 26 September.



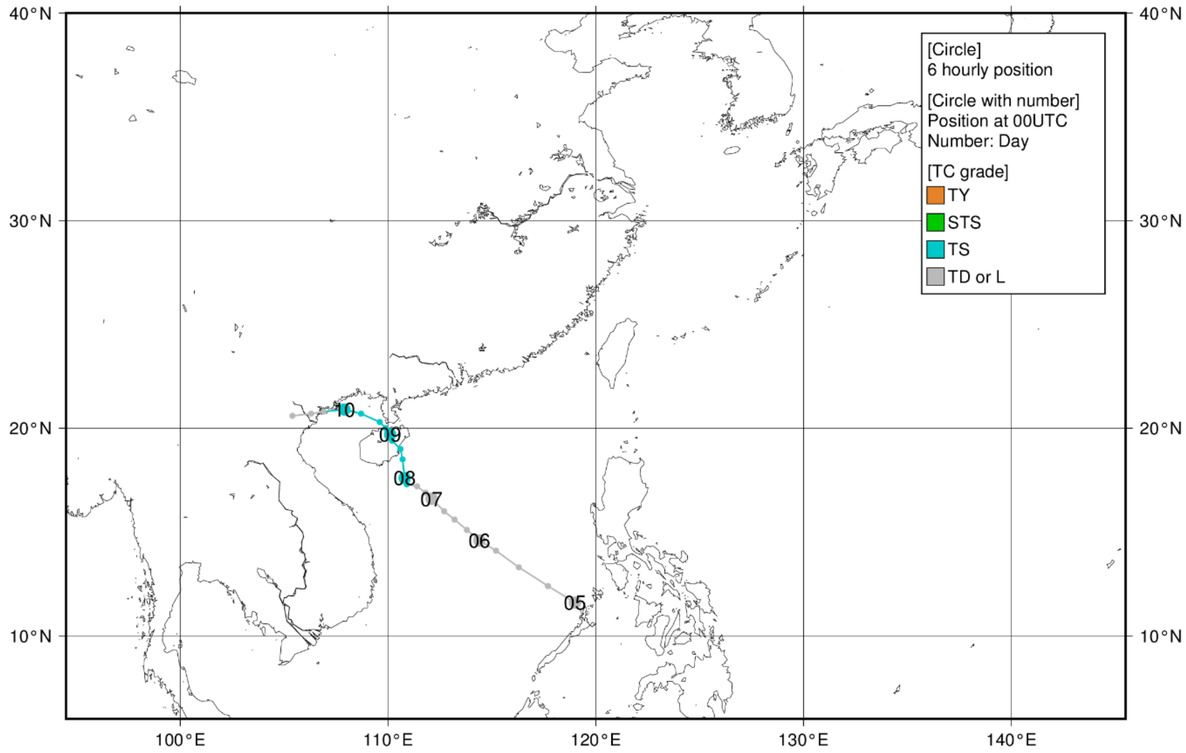
MINDULLE (2116)

MINDULLE formed as a tropical depression (TD) over the waters near the Mariana Islands at 12 UTC on 22 September 2021 and moved west-northwestward. It was upgraded to tropical storm (TS) intensity over the same waters at 12 UTC on 23 September and continued moving west-northwestward. Changing its move northwestward, it was further upgraded to typhoon (TY) intensity over the sea east of the Philippines at 00 UTC on 25 September. It gradually changed its move northward and reached its peak intensity with maximum sustained winds of 105 kt and a central pressure of 920 hPa over the same waters at 06 UTC on 26 September. It accelerated northeastward over the sea east of Japan and transitioned into an extratropical cyclone over the same waters by 00 UTC on 2 October. It crossed latitude 60 degrees north before 12 UTC on 5 October.



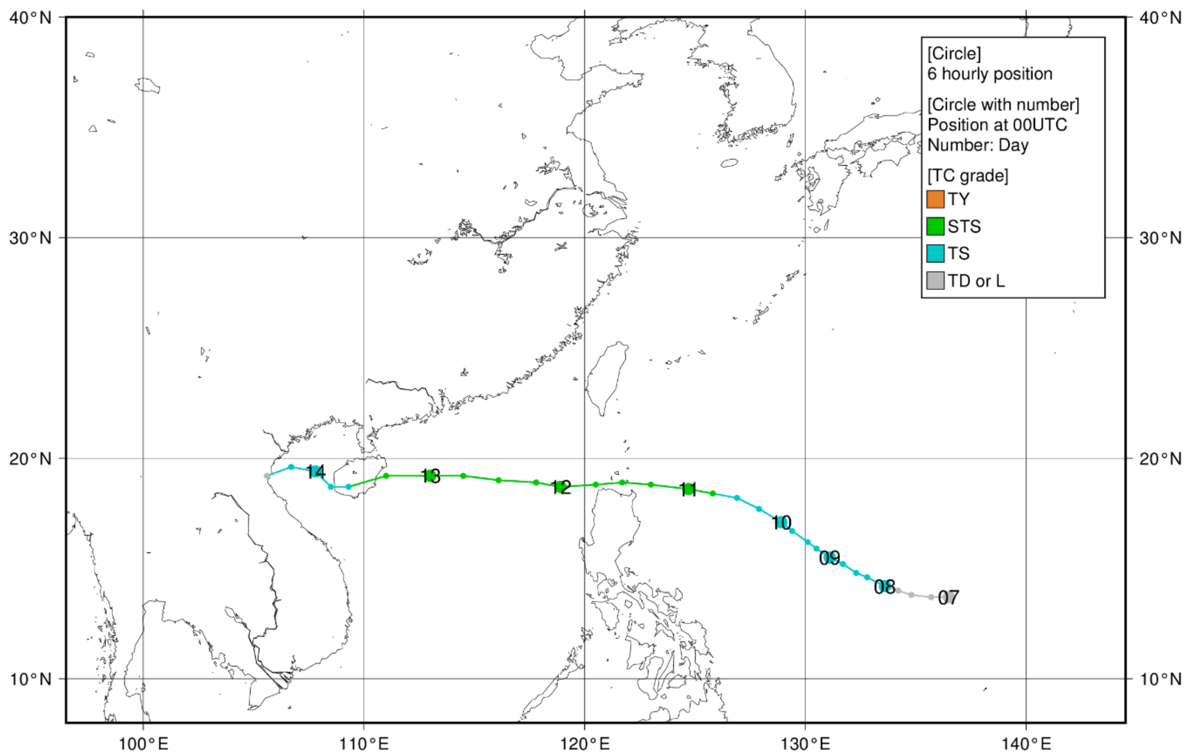
LIONROCK (2117)

LIONROCK formed as a tropical depression (TD) over the South China Sea at 00 UTC on 5 October 2021 and moved northwestward. It 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 994 hPa over the same waters at 18 UTC on 7 October. Moving northward, it crossed Hainan Island with TS intensity on 8 October and entered the Gulf of Tonkin on 9 October. Moving westward, it hit northern Viet Nam and weakened to TD intensity at 06 UTC on 10 October and dissipated 18 hours later.



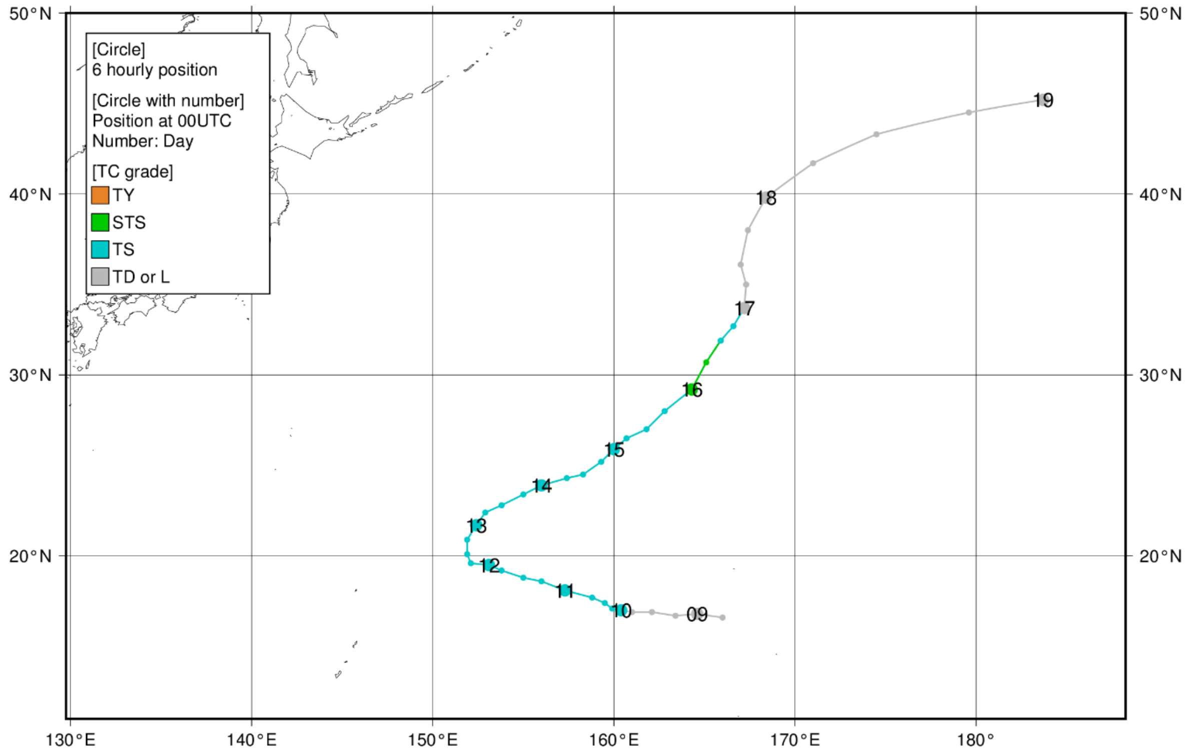
KOMPASU (2118)

KOMPASU formed as a tropical depression (TD) over the sea east of the Philippines at 00 UTC on 7 October 2021. It moved westward and was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 8 October. After turning northwestward and then westward, it was upgraded to severe tropical storm (STS) intensity at 18 UTC on 10 October. It reached its peak intensity with maximum sustained winds of 55 kt and a central pressure of 975 hPa over the South China Sea at 18 UTC on 11 October. Keeping its westward track, it crossed Hainan Island on 13 October, hit the coast of Viet Nam on 14 October and weakened to TD intensity at 12 UTC on 14 October. It dissipated at 18 UTC the same day.



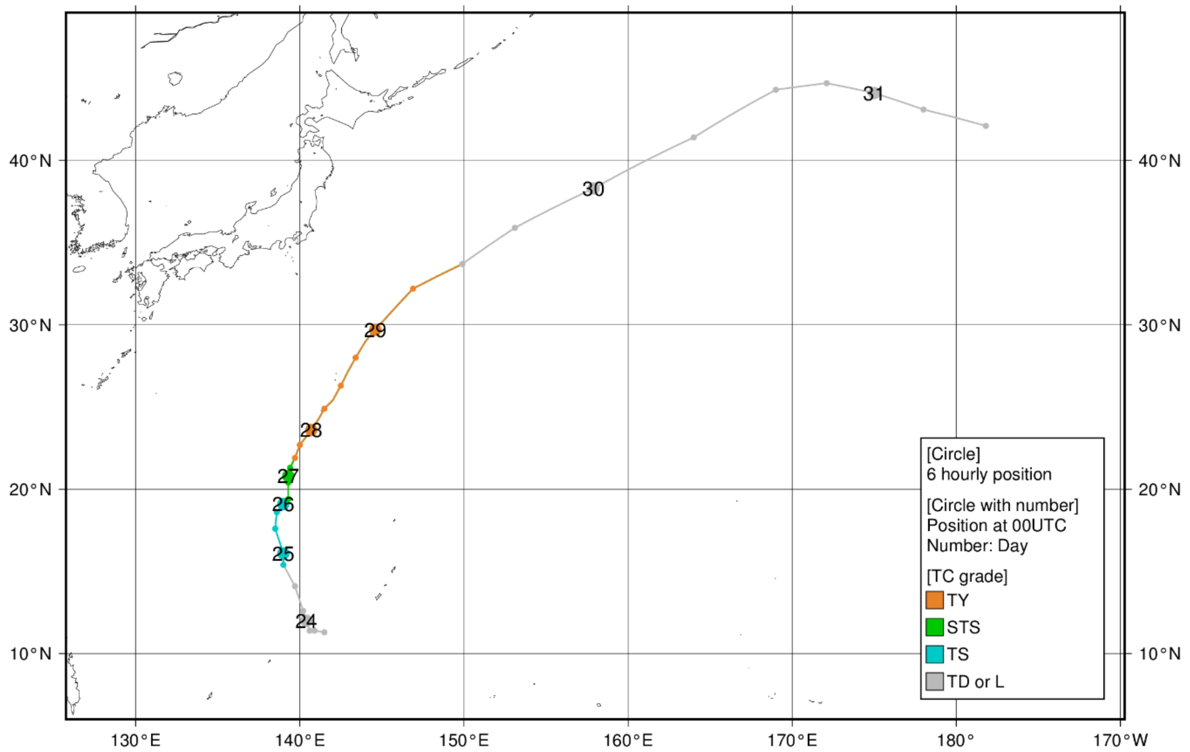
NAMTHEUN (2119)

NAMTHEUN formed as a tropical depression (TD) over the sea south-southwest of Wake Island at 18 UTC on 8 October 2021 and moved westward. It was upgraded to tropical storm (TS) intensity over the same waters at 00 UTC on 10 October and turned west-northwestward. It turned sharply northward over the waters south-southwest of Minamitorishima Island at 06 UTC on 12 October and then gradually turned northeastward. It was upgraded to severe tropical storm (STS) intensity and reached its peak intensity with maximum sustained winds of 50 kt and a central pressure of 996 hPa over the sea north-northeast of Wake Island at 00 UTC on 16 October. It transitioned into an extratropical cyclone over the sea far off east of Japan by 00 UTC on 17 October and crossed longitude 180 degrees east before 00 UTC on 19 October.



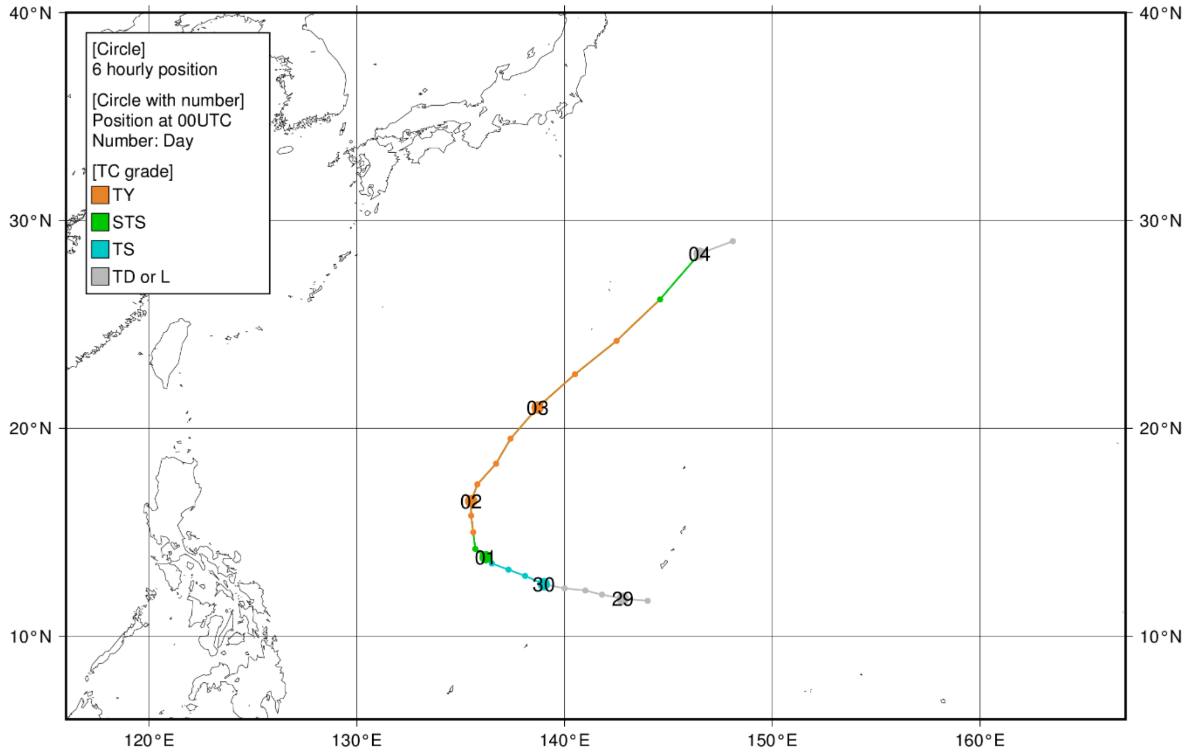
MALOU (2120)

MALOU formed as a tropical depression (TD) over the sea southwest of Guam Island at 06 UTC on 23 October 2021 and moved westward. It turned north-northwestward after 18 UTC on the same day, and it was upgraded to tropical storm (TS) intensity over the sea east of the Philippines at 18 UTC on 24 October. Gradually turning northward, it was upgraded to typhoon (TY) intensity over the sea south of Japan at 12 UTC on October 27. It reached its peak intensity with maximum sustained winds of 75 kt and a central pressure of 965 hPa over the sea southwest of the Ogasawara Islands six hours later. Gradually accelerating northeastward, it transitioned into an extratropical cyclone over the sea east of Japan by 12 UTC on 29 October. Keeping its northeastward track, it gradually turned east-southeastward late on 30 October over the sea east of the Kuril Islands and crossed longitude 180 degrees east before 12 UTC on the next day.



NYATOH (2121)

NYATOH formed as a tropical depression (TD) over the sea south-southwest of Guam Island at 18 UTC on 28 November 2021 and moved westward. It was upgraded to tropical storm (TS) intensity over the sea east of the Philippines at 00 UTC on 30 November and gradually changed its move northwestward. After it was upgraded to severe tropical storm (STS) intensity over the same waters at 00 UTC on 1 December, it moved northward and was further upgraded to typhoon (TY) intensity over the same waters at 12 UTC on 1 December. It developed rapidly while accelerating northeastward on 2 December, and reached its peak intensity with maximum sustained winds of 100 kt and a central pressure of 925 hPa over the same waters at 18 UTC the same day. It transitioned into an extratropical cyclone over the sea east-northeast of the Ogasawara Islands by 00 UTC on 4 December, and dissipated over the same waters at 12 UTC 12 hours later.



RAI (2122)

RAI formed as a tropical depression (TD) over the sea around the Caroline Islands at 18 UTC on 11 December 2021 and moved westward. It was upgraded to tropical storm (TS) intensity at 06 UTC on 13 December and further upgraded to typhoon (TY) intensity at 18 UTC on 14 December over the same waters. It reached its first peak intensity with maximum sustained winds of 105 kt and a central pressure of 915 hPa over Siargao Islands of the Philippines at 06 UTC on 16 December. After passing over the central part of the Philippines with weakened maximum sustained winds of 80 kt or more, it reached its second peak intensity with maximum sustained winds of 105 kt and a central pressure of 915 hPa over the South China Sea at 18 UTC on 18 December. It turned northeastward over the same waters and weakened to TD intensity at 18 UTC on 20 December. It dissipated over the same waters at 12 UTC on the next day.