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CHAPTER 1
GENERAL

1.1 Introduction

Typhoons have always been a major threat to the Typhoon Committee region. As a result, they are a common target for meteorological services in the region to monitor, analyse, forecast and warn against.

Under the spirit of international co-operation, a regional programme to mitigate the damage due to tropical cyclones was launched by the Typhoon Committee which was established in 1968. Since its establishment under the auspices of ESCAP in co-operation with the World Meteorological Organization (WMO), the Typhoon Committee has developed its area of activities to consist of three components, i.e., meteorological, hydrological and disaster prevention and preparedness.

Of these components, the meteorological component aims at improving and upgrading the analysis and forecast used for the routine operation. For this purpose, the Typhoon Committee has arranged a variety of co-operation efforts. One of the epoch-making events in the history of the Committee was the Typhoon Operational Experiment (TOPEX), which was organized for all three components. The third component was specifically organized as Warning Dissemination and Information Exchange Component.

The Meteorological Component of TOPEX had a co-operation programme where concerted efforts were exerted to analyze and forecast specified typhoons using common technical procedures. The procedures were described in the TOPEX Operational Manual which had been utilized in meteorological services in the Typhoon Committee region during the operational phase of TOPEX.

Activities of the Meteorological Component of the Typhoon Committee – including execution of the meteorological component of TOPEX for three years – had been planned and organized under the Tropical Cyclone Programme (TCP) of the WMO. The main long-term objective of the TCP is to assist Members in upgrading the capabilities of National Meteorological and Hydrological Services (NMHSs) to provide better tropical cyclone, related flood and storm surge forecasts and more effective warnings through regionally coordinated systems, and to encourage Members to establish national disaster prevention and preparedness measures.

As a result of international cooperation and coordination, and with the aid of meteorology and modern technology, such as satellites, weather radars and computers, all tropical cyclones around the globe are now being monitored from their early stages of formation and throughout their lifetime. Six centres designated by WMO as Regional Specialized Meteorological Centres (RSMCs) located in Honolulu, La Reunion, Miami, Nadi (Fiji), New Delhi and Tokyo, as well as other centres of National Meteorological Services (NMSs) carry out these activities. These centres also provide forecasts on the behaviour of tropical cyclones, their movement and changes in intensity and on associated phenomena – principally storm surges and flash floods.

The responsibility of the RSMC Tokyo - Typhoon Center is the provision of information on tropical cyclones for Members of the Typhoon Committee. Information should
include formation, movement and development of tropical cyclones and associated meteorological phenomena. In addition, synoptic scale atmospheric situation which affects the behaviour of tropical cyclones should also be prepared by the RSMC Tokyo - Typhoon Center and disseminated to National Meteorological Centers (NMCs) in the appropriate format for operational processing. The RSMC Tokyo - Typhoon Center should be operational throughout the year and be manned round the clock when a tropical cyclone exists over the region concerned. The RSMC Tokyo - Typhoon Center should also carry out non-operational functions such as training.

In order to implement the RSMC Tokyo - Typhoon Center in the Typhoon Committee region, the Regional Co-operation Programme was discussed and adopted by the Typhoon Committee at its Extraordinary Session (Manila, March 1986). At the same time, the Committee approved a draft of the Typhoon Committee Operational Manual which specifies in more detail the extent and type of activity of the RSMC Tokyo - Typhoon Center and shows the direction of realizing the regional co-operation between Members.

The Operational Manual consists of the text and the appendices. Items included in the text relate to the Typhoon Committee agreement, in particular, basic information for executing meteorological operation, whilst the appendices contain national practices and procedures (it is felt that the Member concerned should have the right to be able to change without having to get prior formal agreement of the Typhoon Committee) together with detailed and technical information for meteorological operation. Information described in WMO official publications such as Manuals is only referred to and not included in this Manual.

Since March 1986, the draft of the Operational Manual has been revised and is still subject to further refinement and revision through experience gained in the use of the Operational Manual. It is also intended that the text of the Manual be updated or revised from time to time by the Typhoon Committee and that each item of information given in the appendices relating to the Manual be kept up to date by the Members concerned.

1.2 Terminology used in the region

1.2.1 General

Typhoon Committee Members

1.2.2 Classification of tropical cyclones

(i) Low pressure area (L)
(ii) Depression or tropical depression (TD)
(iii) Tropical storm (TS)
(iv) Severe tropical storm (STS)
(v) Typhoon (TY)

1.2.3 Tropical cyclone characteristics

(i) position of centre
(ii) confidence in the centre position
(iii) size and shape of eye, if any
(iv) central pressure
(v) direction of movement
(vi) speed of movement

1 Details are shown in 4.2.
(vii) maximum sustained wind
(viii) gusts
(ix) storm radius
(x) gale radius
(xi) storm surge potential for a particular coastal location
(xii) storm tide potential for a particular coastal location

1.2.4 Terms related to the warning and warning system

(i) typhoon season
(ii) tropical cyclone advisory
(iii) tropical cyclone information bulletin
(iv) gale warning
(v) storm warning
(vi) typhoon warning
(vii) visual storm signals
(viii) high sea bulletin
(ix) coastal weather bulletin
(x) bulletin or cyclone warning bulletin

1.3 Meaning of terms used for regional exchange

Average wind speed: Speed of the wind averaged over the previous 10 minutes (mean surface wind) as read from the anemogram or the 3 minutes mean determined with the non-recording anemometer or wind averaged over the previous 1 minute (mean surface wind) at 10 meter height or estimated wind at sea by mariners using the Beaufort scale.

Bulletin: Cyclone warning bulletin

Central pressure of a tropical cyclone: Surface pressure at the centre of the tropical cyclone as measured or estimated.

Centre fix of the tropical cyclone: The estimated location of the centre of a tropical cyclone.

Centre of the tropical cyclone: The centre of the cloud eye, or if not discernible, of the wind/pressure centre.

Confidence in the centre position: Degree of confidence in the centre position of a tropical cyclone expressed as the radius of the smallest circle within which the centre may be located by the analysis. "Position good" implies a radius of 30 nautical miles (55 kilometres) or less. "Position fair", a radius of 30 to 60 nautical miles (55 to 110 km) and "Position poor", a radius of greater than 60 nautical miles (110 km).

Cyclone: Tropical cyclone

Cyclone warning bulletin: A priority message for exchange of tropical cyclone information and advisories.

Direction of movement of the tropical cyclone: The direction towards which the centre of the tropical cyclone is moving.

Extra-tropical cyclone: A former tropical cyclone that has gone through extra-tropical transition and lost its initial tropical characteristics.
Extra-tropical transition: is an evolutionary process by which a symmetric warm core tropical cyclone transforms to an asymmetric cold core extratropical cyclone. This process includes a change in the distribution of clouds, winds, and precipitation. Also, the primary energy source changes from latent heat release in deep convective clouds of the tropical cyclone to baroclinic conversion of available potential energy in the extratropical cyclone.

Eye of the tropical cyclone: The relatively clear and calm area inside the circular wall of convective clouds, the geometric centre of which is the centre of the tropical cyclone.

Gale force: Average wind speed in the range of 34 knots (17.2 m/s, 62 km/h) to 47 knots (24.4 m/s, 88 km/h), or wind force 8 or 9 in the Beaufort scale.

Gale warning: Meteorological message intended to warn those concerned of the occurrence or expected occurrence of gale force wind.

Gust: Instantaneous peak value of surface wind speed.

Low pressure area: Region of the atmosphere in which the pressures are lower than those of the surrounding region at the same level. (On the weather map, the low pressure area is denoted with the capital L within the innermost isobar without showing the centre position.)

Maximum sustained wind: Maximum value of the average wind speed at the surface.

Mean wind speed: Average wind speed.

Reconnaissance aircraft centre fix of the tropical cyclone vortex fix: The location of the centre of a tropical cyclone obtained by reconnaissance aircraft penetration.

Severe tropical storm: A tropical cyclone with the maximum sustained winds at storm force near the centre.

Speed of movement of the tropical cyclone: Speed of movement of the centre of the tropical cyclone.

Storm force: Average wind speed of 48 knots (24.5 m/s, 89 km/h) to 63 knots (32.6 m/s, 117 km/h), or wind force 10 or 11 in the Beaufort scale.

Storm surge: The difference between the actual water level under the influence of a meteorological disturbance (storm tide) and the level which would have been attained in the absence of the meteorological disturbance (i.e. astronomical tide). (Storm surge results mainly from the shoreward movement of water under the action of wind stress. A minor contribution is also made by the hydrostatic rise of water resulting from the lowered barometric pressure.)

Storm tide: The actual sea level as influenced by a weather disturbance. The storm tide consists of the normal astronomical tide and the storm surge.

Storm warning: Meteorological message intended to warn those concerned of the occurrence or expected occurrence of storm force wind.

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2 For converting the wind speeds of different averaging periods such as 1-min, 2-min, 3-min and 10-min, Tropical Cyclone Programme of WMO recommends to follow the guidelines as shown in the Appendix 1-A.
Sub-tropical cyclone: A low pressure system, developing over sub-tropical waters which initially contains few tropical characteristics. With time the sub-tropical cyclone can become tropical.

Sustained wind speed: Average wind speed. Average period of one, three or ten minutes is depending upon the regional practices.

Tropical cyclone: Generic term for a non-frontal synoptic scale cyclone originating over tropical or sub-tropical waters with organized convection and definite cyclonic surface wind circulation. (The term is also used for a storm in the South-West Indian Ocean in which the maximum of the sustained wind speed* is estimated to be in the range of 64 to 90 knots and in the South Pacific and South-East Indian Ocean with the maximum of the sustained over 33 knots.)

Tropical cyclone advisory: A priority message for exchanging information, internationally, on tropical cyclones.

Tropical cyclone coastal crossing: Cyclone centre passage across the coast.

Tropical depression: A tropical cyclone with the maximum sustained winds of 33 knots (17.1 m/s, 61 km/h) or less near the centre.

Tropical disturbance: A non-frontal synoptic scale cyclone originating in the tropics or sub-tropics with enhanced convection and light surface winds.

Tropical cyclone impact: Evidence of damage or disruption caused by tropical cyclone-generated hazard(s) either direct or indirect. (includes damaging large swells from distant tropical cyclones).

Tropical cyclone island crossing: Cyclone centre passage across the island.

Tropical cyclone landfall: refer to tropical cyclone coastal crossing.

Tropical storm: A tropical cyclone with the maximum sustained winds at gale force near the centre.

Tropical wave: A trough or cyclonic curvature maximum in the trade wind easterlies or equatorial westerlies. The wave may reach maximum amplitude in the lower middle troposphere, or may be the reflection of an upper-troposphere cold low or equatorial extension of a mid-latitude trough.

Typhoon: A tropical cyclone with the maximum sustained winds at typhoon force near the centre.

Typhoon force: Average wind speed of 64 knots (32.7 m/s, 118 km/h) or more, or wind force 12 in the Beaufort scale.

Typhoon warning: Meteorological message intended to warn those concerned of the occurrence or expected occurrence of typhoon force wind.

Visual storm signals: Visual signals displayed at coastal points to warn ships of squally winds, gales and tropical cyclones.
Weather warning: Meteorological message issued to provide appropriate warnings or hazardous weather conditions.

Zone of disturbed weather: A zone in which the pressure is low relative to the surrounding region and there are convective cloud masses which are not organized.

1.4 Units used for regional exchange

(a) The following units/indicators are used for marine purposes:

(i) Distance in nautical miles, the unit (nm) being stated;

(ii) Location (position) by degrees and where possible tenths of degrees of latitude and longitude preferably expressed by words;

(iii) Direction to the nearest sixteen points of the compass or in degree to the nearest ten, given in words;

(iv) Speed (wind speed and speed of movement of tropical cyclones) in knots, the unit (kt) being stated;

(v) Confidence in the centre position in nautical miles (nm) or in position good, fair or poor;

(b) The following units/indicators are used in non-coded segments of exchanges, other than marine bulletins:

(i) Distance in kilometres (km) or nautical miles (nm);

(ii) Location (position) by degrees and tenths of degrees in figures of latitude and longitude and/or bearing on the sixteen point compass and distance from well-known fixed place(s);

(iii) Direction in sixteen points of compass given in figures;

(iv) Speed (wind speed and speed of movement of system) in knots (kt), metres per second (m/s) or kilometres per hour (km/h);

(v) Confidence in the centre position in kilometres (km), nautical miles (nm) or in position good, fair or poor.

1.5 Identification of tropical cyclones

As soon as the wind speed in a tropical cyclone in the responsible area of the RSMC Tokyo - Typhoon Center (between 0°N and 60°N and between 100°E and 180°E) attains 34 knots, it will be given an identification name with a 4-digit number by the RSMC Tokyo - Typhoon Center. Each tropical cyclone should be identified by one of the names in Appendix 1-B, followed by the 4-digit number in brackets, whose number will consist of a year identification and a serial number identification (in two digits each). For example, the first tropical cyclone attaining the 34 knots threshold value in 2000 in the responsible area of the RSMC Tokyo-Typhoon Center will be identified as Damrey (0001). If the life of a tropical cyclone spans two calendar years, it will be accounted for in the year in which it has intensified to the stage where the wind speed has attained the 34 knots threshold value.
1.6 Acronyms

A list of acronyms used in this Operational Manual is shown in Appendix 1-C.
CHAPTER 2

OBSERVING SYSTEM AND OBSERVING PROGRAMME

2.1 Networks of synoptic land stations

The surface and upper-air stations in the regional basic synoptic network are those of the Typhoon Committee Members and are registered in Weather Reporting Volume A - Observing stations (WMO Publication No. 9).

The RSMC Tokyo - Typhoon Center and all Typhoon Committee Members should initiate enhanced observation programmes for their stations in the area within 300 km of the centre of a tropical cyclone of TS intensity or higher. All the observations should be made available to the RSMC Tokyo - Typhoon Center and all Members. Enhanced observations should include:

(i) surface observations - hourly;
(ii) buoy observations - hourly;
(iii) radar observations - hourly;
(iv) upper-air observations - 6-hourly.

2.1.1 Surface observations

All surface stations included in the regional basic synoptic network should make surface observations at the four main standard times of observation, i.e., 0000, 0600, 1200 and 1800 UTC, and at the four intermediate standard times of observation, i.e., 0300, 0900, 1500 and 2100 UTC. Any surface station that cannot carry out the full observational programme should give priority to carrying out the observations at the main standard times. Additional surface observations at hourly intervals may be requested by any Member, whenever a tropical cyclone becomes an imminent threat to the Member, from the stations shown in Appendix 2-A.

2.1.2 Upper-air synoptic observations

All the upper-air stations included in the regional basic synoptic network should carry out radiosonde and radiowind observations at 0000 and 1200 UTC, and radiowind observations at 0600 and 1800 UTC. The radiosonde/radiowind observations carried out at 0000 and 1200 UTC should reach the 30 hPa level for more than 50 per cent of the ascents. The carrying out of the radiosonde/radiowind observations at 0000 and 1200 UTC should receive priority over the radiowind observations at 0600 and 1800 UTC.

Upper-air stations in the areas affected by tropical cyclones of TS intensity or higher should also make radiowind observations at 0600 and 1800 UTC which should aim at reaching the 70 hPa level.

Enhanced upper-air observations given in Appendix 2-B will be made as appropriate whenever a tropical cyclone of TS intensity or higher is centred within 300 km of the station. The minimum required is two observations per day, but for a better understanding of the ambient wind field three or even four ascents per day on some days should be made when possible. All data of these enhanced upper-air observations will be distributed among the Members.
In addition to the upper-air synoptic observations, newly developed observations such as wind profiler observations should be carried out when possible and the data should be made available to the Members.

2.2   Ship and buoy observations

Hourly marine meteorological observations are made by the JMA research vessels (call signs of them are: JPBN and JGQH) in the seas adjacent to Japan and in the western North Pacific.

Upper-air observations are usually made twice a day (00, 12 UTC) on board the JMA research vessel JGQH. Enhanced upper-air observations are carried out six-hourly when the vessel is in the vicinity of a tropical cyclone of TS intensity or higher.

Marine meteorological observations are made by the Voluntary Observing Ships which are recruited by the Members in accordance with the WMO Voluntary Observing Ship's Scheme. These are generally carried out every six hours and transmitted over the GTS. In addition, marine meteorological observations are reported hourly by on-board automatic weather stations on some of the Voluntary Observing Ships.

Marine meteorological observations, such as air pressure, sea surface temperature, significant wave height and period, are also made by the drifting ocean data buoys by the Members. All reports are coded in the BUFR code (FM-94) with drifting buoys Template (TM315009), and immediately put onto the GTS. A list of the drifting buoy observations by the Members is shown in Appendix 2-C.

2.3   Radar observations

It is essential that radar observations continue as long as a tropical cyclone of TS intensity or higher remains within the detection range of the radar. All meteorological centres should co-operate to ensure that the radar observations are transmitted through the GTS to the RSMC Tokyo - Typhoon Center and all Members. Reports will be coded in the BUFR code (FM-94) with RADOB Template (TM316050) and/or the RADOB code (FM 20-VIII).

In case the report is in plain language, the full range of information available at the radar station should be given. The message will therefore include, where available, the confirmation of the determination of the centre, the shape, definition, size and character tendency of the eye, the distance between the end of the outermost band and the centre of the cyclone and the direction and speed of movement with a statement of the interval of time over which the movement was calculated.

Distribution of the radar stations and detailed information on the radar equipment of the Typhoon Committee Members are given in Appendices 2-D and 2-E.

2.4   Meteorological satellite observations

2.4.1 Satellite imagery data and related products

Satellite imagery data and related products are essential for monitoring and analyzing tropical cyclones. RSMC Tokyo – Typhoon Center, operating Himawari-8/9, has been providing their imagery data and related products to the Asia-Oceania region to support their operations on tropical cyclones. Other Members which also operate satellites are expected to provide those data and/or products to the Members.
Detailed information on the satellites operated by Typhoon Committee Members is given in Appendix 2-F.

A list of satellite imagery receiving facilities at meteorological centres of the Typhoon Committee Members is given in Appendix 2-G.

### 2.4.2 SAREP reports

SAREP reports (Part A) are disseminated eight times a day in the following cases from the RSMC Tokyo - Typhoon Center to Typhoon Committee Members through the GTS under the heading of IUCC10 RJTD in the BUFR code (FM 94):

(i) when a tropical cyclone of TS intensity or higher is located in the responsible area of the RSMC Tokyo - Typhoon Center;

(ii) when a tropical depression existing in the responsible area is forecasted to have an intensity of TS or higher within 24 hours; or

(iii) when an area of wind speed of 34 knots or higher caused by a tropical cyclone is forecasted to be in the responsible area within 24 hours.

SAREP reports are also issued by other Typhoon Committee Members. A list of SAREP reports issued by the RSMC Tokyo – Typhoon Center and other Typhoon Committee Members is shown in Appendix 2-H.

### 2.5 Aircraft observations

States within the ICAO Asia and Pacific Regions exchange reports from aircraft in flight prepared in conformity with ICAO requirements for meteorological reporting (known as air-reports or AIREPs) in accordance with the Regional OPMET Bulletin Exchange (ROBEX) scheme. AIREPs in the north-east Pacific area are also collected by the centres at Honolulu, Washington, etc., and relayed to Tokyo.

AM DAR (Aircraft Meteorological Data Relay) reports are collected by the NMHSs involved in respective AMDAR Programmes and relayed via the GTS to the centre at Tokyo.

All reports will be disseminated in real-time to the RSMC Tokyo - Typhoon Center and to other Members through GTS and AFTN circuits.

The Members conduct reconnaissance flights for selected tropical cyclones. Detailed information of reconnaissance flights conducted by the Members is given in Appendix 2-I.

### 2.6 Tropical cyclone passage report

Each Member's tropical cyclone forecast center should compile reliable passage, landfall, near-buoy passage and near-ship passage data, tabulate that data and send it to the Typhoon Committee Secretariat (TCS) within a week after cyclone passage for distribution to other Members. The task is assigned to the focal point for the meteorological component of each Member. A proposed tropical cyclone passage report form is shown in Appendix 2-J.

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3 The ICAO Asia Pacific Region ROBEX Handbook describes the ROBEX scheme, which consists of a number of Regional OPMET Centres (ROCs), Regional OPMET Data Banks (RODBs) and Inter-regional OPMET Gateways (IROGs) to deliver to the aviation users the required OPMET information in the form of predefined bulletins.
CHAPTER 3
TROPICAL CYCLONE ANALYSIS AND FORECAST

3.1 Analysis at RSMC Tokyo - Typhoon Center

The RSMC Tokyo - Typhoon Center should produce analyses of various meteorological parameters in chart form and/or in grid point value depending on the facilities of NMCs to process these products. These analyses should include pressure distribution at the sea level and temperature, geo-potential height, humidity and wind at selected pressure levels.

The streamline analysis is indispensable over the tropical region for forecasting tropical cyclones. The RSMC Tokyo - Typhoon Center should produce streamline analyses of the upper and lower atmospheric levels utilizing cloud motion wind, aircraft reports, as well as upper-air observations. Furthermore, the RSMC Tokyo - Typhoon Center should issue analyses of ocean wave and sea surface temperature for the western North Pacific. A list of products provided by the RSMC Tokyo - Typhoon Center is given in Appendix 3-A.

The RSMC Tokyo - Typhoon Center should produce additional analyses of the tropical cyclone when it is in the responsible area, based on the enhanced observations. Such analyses should be disseminated in the form of additional bulletins consisting of information on:

(i) position of the tropical cyclone;

(ii) direction and speed of movement;

(iii) central pressure;

(iv) maximum wind and wind distribution.

Various analyses based on Himawari data other than cloud imagery itself should be produced by the RSMC Tokyo - Typhoon Center. Analysis of sea surface temperature combining satellite data and in-situ measurements should be prepared every day. These analyses are useful for the better understanding of the tropical atmosphere and medium-range assessment of forecasting tropical cyclones.

3.2 Forecast at RSMC Tokyo - Typhoon Center

The RSMC Tokyo - Typhoon Center should prepare the products for numerical weather prediction shown in the WMO Manual on the Global Data-Processing and Forecasting System (GDPFS). These products should be made available to Members in real-time, and should include the following:

(i) deterministic forecast products of a high resolution global model to predict the change in large-scale atmospheric circulation patterns as well as the tropical cyclone movement and intensity

(ii) ensemble forecast products using a lower resolution version of the global model to enable estimation of uncertainties in tropical cyclone movement and intensity as well as to reduce forecast errors by using statistical methods such as ensemble mean.
The RSMC Tokyo - Typhoon Center should also prepare several statistical models for predicting the track of the tropical cyclone and apply the Dvorak method for the prediction of the intensity change of the tropical cyclone. Other relevant synoptic methods should also be applied for predicting the tropical cyclone.

The RSMC Tokyo - Typhoon Center should summarize in a consolidated form all available information and prepare the final forecasts of the tropical cyclone when it exists in the responsible area. These forecasts should include:

(i) 24, 48, 72, 96 and 120-hour forecast position;
(ii) 24, 48, 72, 96 and 120-hour forecast intensity and wind distribution;
(iii) prognostic reasoning;
(iv) tendency assessment if possible.

Furthermore, the RSMC Tokyo - Typhoon Center should prepare a 24-hour ocean wave forecast twice a day for the western North Pacific. Storm surge products suitable for the Typhoon Committee region should be provided by the RSMC Tokyo - Typhoon Center. A list of forecast products of the RSMC Tokyo - Typhoon Center, other than alphanumeric form, is shown in Appendix 3-A.

3.3 Operational analysis and forecast at centres of Typhoon Committee Members

The NMSs of Typhoon Committee Members are performing analysis and forecasting development and movement of tropical cyclones in the region. The final responsibility for the operational analysis and forecasting will be with the NMSs of each of the Members.
CHAPTER 4
TROPICAL CYCLONE WARNINGS AND ADVISORIES

4.1 General

The responsibility for warning the human settlements on land which are threatened by a tropical cyclone rests in all cases with the NMSs. These national responsibilities are not subject to regional agreement. Therefore, only the cyclone warning systems intended for international users and exchanges among the Typhoon Committee Members are described in this chapter.

4.2 Classification of tropical cyclones

Classifications of tropical cyclones for the exchange of messages among the Typhoon Committee Members are given below:

(i) Low pressure area (L) Central position cannot be accurately assessed
(ii) Tropical depression (TD) Central position can be identified, but the maximum sustained wind is 33 kt or less.
(iii) Tropical storm (TS) Maximum sustained wind is between 34 and 47 kt.
(iv) Severe tropical storm (STS) Maximum sustained wind is between 48 and 63 kt.
(v) Typhoon (TY) Maximum sustained wind is 64 kt or more.

4.3 Tropical cyclone advisories

The RSMC Tokyo - Typhoon Center should disseminate six to three-hourly analyses and forecasts of tropical cyclones in the form of bulletins (tropical cyclone advisories - see examples in Appendix 4-B):

(i) analysis of the central position, intensity and wind distribution;
(ii) 24, 48, 72, 96 and 120-hour forecasts of the central position;
(iii) 24, 48, 72, 96 and 120-hour forecasts of intensity and wind distribution;
(iv) prognostic reasoning;
(v) tendency assessment if possible.

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4 “Tropical cyclone” is a generic term that includes tropical depression, tropical storm, severe tropical storm and typhoon.
5 Classifications internally used by Members are shown in Appendix 4-A.
4.4 Tropical cyclone warnings for the high seas

The WMO in its Manual on Marine Meteorological Services sets out the issue of weather and sea bulletins for the high seas in six parts. The first part relates to storm warnings in plain language. Areas of responsibility of each nation for issuing the storm warnings are pre-assigned. The pre-assigned forecast areas of Typhoon Committee Members were agreed upon by Regional Associations II and V (Res. 17 (IV-RA II; WMO-181, 1966) and Res. 10 (IV-RA V; WMO-187, 1966)). Weather forecast areas fixed nationally by individual Typhoon Committee Members are shown in WMO Publication No. 9, Weather Reporting Volume D - Information for Shipping.

The radio stations broadcasting tropical cyclone forecasts and warnings for the benefit of the ships on the high seas in the Typhoon Committee Members are listed in Appendix 4-C, where are shown the names of coastal radio stations with their call signs and the area covered by their bulletins. The details are shown in WMO Publication No. 9, Weather Reporting Volume D - Information for Shipping.

4.5 Tropical cyclone SIGMET and advisory information for international aviation

In accordance with the International Civil Aviation Organization (ICAO) Annex 3 - Meteorological Service for International Air Navigation/WMO No. 49 Technical Regulations, Volume II: Meteorological Service for International Air Navigation (WMO-No. 49 Vol. 2), SIGMET is information issued by a (designated) meteorological watch office (MWO) concerning the occurrence or expected occurrence of specified en-route weather and other phenomena in the atmosphere (including tropical cyclone) that may affect the safety of aircraft operations and of the development of those phenomena in time and space.

Each designated MWO is required to maintain continuous watch over meteorological conditions affecting flight operations within one or more designated flight information regions (FIRs) and prepare, supply and disseminate SIGMET information (including for tropical cyclone as necessary) relating to its designated area of responsibility. The ICAO Asia and Pacific Regions Air Navigation Plan (Doc 9673) describes the FIRs in the Asia and Pacific Regions and lists the designated MWOs and the requirements for the issuance of SIGMET information (including for tropical cyclone).

SIGMET information (for tropical cyclone) shall be prepared, formatted and disseminated in accordance with ICAO Annex 3/WMO-No. 49 Vol. 2. The data type designator to be used in the WMO abbreviated heading of such messages shall be T1T2 = WC (WMO-No. 386, Manual on GTS refers).

In accordance with ICAO Annex 3/WMO-No. 49 Vol. 2 and the ICAO Asia and Pacific Regions Air Navigation Plan, the designated Tropical Cyclone Advisory Centre (TCAC) Tokyo shall:

a) monitor the development of tropical cyclones in its area of responsibility;

b) issue advisory information concerning the position of the cyclone centre, its direction and speed of movement, central pressure and maximum surface wind near the centre, in abbreviated plain language to:

1) MWOs in its area of responsibility;

2) other TCACs whose areas of responsibility may be affected; and
3) World Area Forecast Centres (WAFCs) [London and Washington], and international OPMET databanks; and

c) issue updated advisory information to MWOs for each tropical cyclone, as necessary, but at least every six hours.

The tropical cyclone advisory information shall be prepared, formatted and disseminated in accordance with the technical specifications and detailed criteria in ICAO Annex 3/WMO-No. 49 Vol. 2. The data type designator to be used in the WMO abbreviated heading of such messages shall be T1T2 = FK (WMO-No. 386, Manual on GTS, refers).
CHAPTER 5
TELECOMMUNICATIONS

5.1 General

The basic meteorological telecommunication network for the exchange of forecasts, warnings and observational data will be the Global Telecommunication System (GTS).

*Note: With respect to meteorological service for international air navigation (as described in sections 2.5 and 4.5), the telecommunications facilities used for the exchange of operational meteorological information should be the aeronautical fixed service (AFS)*.

5.2 Dissemination of data and products

The RSMC Tokyo - Typhoon Center should have adequate telecommunication facilities for the real-time collection and dissemination of data and products. A large amount of grid point data produced at the RSMC Tokyo - Typhoon Center should be exchanged between the RSMC Tokyo - Typhoon Center and NMCs where adequate circuits for this purpose exist, such as GTS and Internet.

Conventional radio facsimile broadcasts are widely used in the region, though they have some disadvantages, i.e., it takes a long time to transmit a number of charts and received charts are sometimes distorted due to noises. Nevertheless, facsimile broadcasts and reception facilities shall be retained in full operation until telecommunications via satellite is introduced to transmit products both in chart and grid point value form.

5.3 Schedule for exchange of cyclone advisories

Tropical cyclone advisories issued by the RSMC Tokyo - Typhoon Center shall be transmitted at intervals of six to three hours. These messages shall be given high priority.

5.4 Meteorological telecommunication network for the Typhoon Committee region

The network is shown in Appendix 5-A and its present status is summarized in Appendix 5-B.

5.5 Addresses, telex/cable and telephone numbers of the tropical cyclone warning centres

A list of addresses of the tropical cyclone warning centres of the Typhoon Committee Members, together with their telex/cable and telephone numbers and e-mail addresses, is given in Appendix 5-C.

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6 The AFS is comprised of a number of systems and applications that are used for ground-ground (i.e. point-to-point and/or point-to-multipoint) communications in the international aeronautical telecommunication service. In accordance with the ROBEX scheme, the (AFS) systems used to disseminate SIGMET/tropical cyclone advisory information and air-reports include the aeronautical fixed telecommunications network (AFTN) and the air traffic services message handling system (AMHS).
5.6 Abbreviated headings of tropical cyclone advisories and warnings

The abbreviated headings of meteorological messages containing tropical cyclone advisories issued by the RSMC Tokyo - Typhoon Center shall be:

(i) analysis and three-day forecast - WTPQ20 RJTD through WTPQ25 RJTD;
(ii) prognostic reasoning - WTPQ30 RJTD through WTPQ35 RJTD;
(iii) analysis and five-day forecast - WTPQ50 RJTD through WTPQ55 RJTD;
(iv) numerical prediction by global deterministic model - FXPQ20 RJTD through FXPQ25 RJTD;
(v) numerical prediction by global ensemble model - FXPQ30 RJTD through FXPQ35 RJTD.

The abbreviated headings of meteorological bulletins used for the exchange of tropical cyclone warnings by the Typhoon Committee Members are given in Appendix 5-D.

5.7 Exchange of information related to tropical cyclones

Collection and dissemination of observational and processed data plus warnings related to tropical cyclones at Regional Telecommunication Hubs (RTHs) and NMCs are summarized in Appendix 5-E.

The meanings of the symbols used in abbreviated headings in the meteorological messages transmitted to the GTS are listed in Appendix 5-F. The details are described in the Manual on the Global Telecommunication System (WMO Publication No. 386) and Weather Reporting Volume C - Transmissions, Chapter I Catalogue of Meteorological Bulletins (WMO Publication No. 9).
CHAPTER 6
MONITORING AND QUALITY CONTROL OF DATA

6.1 Quality control of observational data

NMCs will make additional efforts to ensure that all observational data disseminated during periods of cyclone threat to the area are specifically free from errors. Wherever appropriate, verification of reports or of elements of reports will be requested of the observing station and communication channels will be kept open to facilitate this, particularly in cases where an enhanced observing programme is being carried out.

In the exchange of data during periods of cyclone threat, queries concerning reports on which there is doubt should be addressed to the relevant NMC.

Examples of message format for inquiry on doubtful and garbled reports are shown in Appendix 6-A.

6.2 Monitoring of exchange of information

Monitoring will be carried out by the RSMC Tokyo - Typhoon Center and all Typhoon Committee Members in accordance with their standard procedures. Special attention will be given to identification of deficiencies during the cyclone season in the flow of observational data and processed information relating to cyclone analysis and forecast with a view to appropriate remedial action.

The Members will inform the RSMC Tokyo - Typhoon Center of any shortcomings in the flow of data (raw and processed) and also indicate any requirements over and above those already agreed upon for tropical cyclone warning purposes.

Regular monitoring at the RSMC Tokyo - Typhoon Center should be made twice a year for appropriate periods when enhanced observations are carried out. Special monitoring may be made depending on the situation.

The procedure of regular monitoring is shown in Appendix 6-B.

6.3 Verification

Immediately after the dissipation of a tropical cyclone of TS grade or stronger, the RSMC Tokyo - Typhoon Center should disseminate a report on the tropical cyclone in the form of bulletins to provide Members with data needed for verification, such as position and intensity of the tropical cyclone (see the example in Appendix 6-C):

After the end of each typhoon season, each Member will conduct the verification for its analyses and forecasts and send the report to the RSMC Tokyo - Typhoon Center in accordance with the standard procedure as shown in Appendix 6-D. Verification sheets for positioning of the centre, prediction of movement, and analysis and forecast of intensity of a tropical cyclone are shown in Appendix 6-E.

The RSMC Tokyo - Typhoon Center should summarize the reports issued in a year and the results of verification conducted by Members. It should publish an annual report with respect to tropical cyclones and activities of the RSMC Tokyo - Typhoon Center
and Members. The report should also identify specific areas where further co-operative research needs to be carried out by Members.
CHAPTER 7
ARCHIVAL OF DATA

7.1 Data to be archived by Typhoon Committee Members

Members should establish tropical cyclone data files and information services nationally, archiving all appropriate available data.

7.2 Data to be archived by RSMC Tokyo - Typhoon Center

The RSMC Tokyo - Typhoon Center should archive as far as possible tropical cyclone related data received at the centre. The data set should be produced during the period when tropical cyclone(s) is (are) in the range of 1,000 km around Typhoon Committee Members. Except for satellite imagery data, all data should be recorded by the RSMC Tokyo - Typhoon Center preferably on electronic media. A proposed list of data to be archived by the RSMC Tokyo - Typhoon Center is shown in Appendix 7-A.

7.3 Exchange of archived data

Whenever possible Members should supply the RSMC Tokyo - Typhoon Center with all additional data requested by the RSMC Tokyo - Typhoon Center. The RSMC Tokyo - Typhoon Center should make available the archived data to Members on request for use in research, studies, investigations and training. As to distribution, similar arrangements should be made as for the TOPEX data sets which were provided by the Japan Meteorological Agency to Typhoon Committee Members (one set each) with financial assistance from UNDP. The detailed arrangements for exchange of data should be agreed upon bilaterally. Request for data sets by non-Typhoon Committee Members should be made through the WMO Secretariat upon payment of net cost (for electronic media, copying, handling, postal fees, etc.) by the requesting WMO Members.

In accordance with the directive of the WMO Executive Council (EC-XLV), (Geneva, June 1993) an international format for the archiving of tropical cyclone data is to be used by all RSMCs with activity specialization in tropical cyclones.

Complete historical data using the international format given in Appendix 7-B will be made available for research applications. RSMC Tokyo - Typhoon Center will provide such data to the Director of the National Climatic Data Center (NCDC), USA.

The Tropical Cyclone Programme (TCP) Division of the WMO Secretariat has the responsibility for the maintenance of the format, including assignment of the source codes to appropriate organizations, and authorizing additions and changes.
CHAPTER 8
CAPACITY DEVELOPMENT

8.1 Tropical Cyclone Forecast Competency in the Typhoon Committee Region

Tropical Cyclone Forecast Competency in the Typhoon Committee Region is shown in Appendix 8-A.

8.2 Capacity development activities conducted by RSMC Tokyo - Typhoon Center

The RSMC Tokyo - Typhoon Center should carry out capacity development activities in accordance with the Tropical Cyclone Forecast Competency in the Typhoon Committee Region.

8.3 Capacity development activities conducted by Members

Members should establish and maintain capacity development strategy and conduct necessary training activities or give opportunities to participate in activities conducted by other centers, to develop, maintain and enhance capacity of staff members for tropical cyclone analysis, forecast and related activities, in accordance with the Tropical Cyclone Forecast Competency in the Typhoon Committee Region.
GUIDELINES FOR CONVERTING BETWEEN VARIOUS WIND AVERAGING PERIODS IN TROPICAL CYCLONE CONDITIONS

This note is based on recommendations from Harper et al. (2010) and extracts from Knaff and Harper (2010), providing advice on why, when and how “wind averaging conversions” can be made.

a) Why Convert Wind Speeds?

From the observational perspective, the aim is to process measurements of the wind so as to extract an estimate of the mean wind at any time and its turbulence properties. From the forecasting viewpoint, the aim is, given a specific wind speed metric derived from a process or product, to usefully predict other metrics of the wind. Typically these needs revolve around the concept of the mean wind speed and an associated peak gust wind speed; such that the statistical properties of the expected level of wind turbulence under different exposures can be used to permit useful conversions between peak gust wind speed estimates.

b) When to Convert Wind Speeds?

Wind speed conversions to account for varying averaging periods only apply in the context of a maximum (peak gust) wind speed of a given duration observed within some longer interval. Simply measuring the wind for a shorter period of time at random will not ensure that it is always higher than the mean wind (given that there are both lulls and gusts). It is important that all wind speed values be correctly identified as an estimate of the mean wind or an estimate of a peak gust.

Once the mean wind is reliably estimated, the random effects of turbulence in producing higher but shorter-acting wind gusts, typically of greater significance for causing damage, can be estimated using a “gust factor”. In order for a gust factor to be representative, certain conditions must be met, many of which may not be exactly satisfied during a specific weather event or at a specific location:

- Wind flow is turbulent with a steady mean wind speed (statistically stationary);
- Constant surface features exist within the period of measurement, such that the boundary layer is in equilibrium with the underlying surface roughness (exposure);
- The conversion assumes the mean wind speed and the peak gust wind speed are at the same height (e.g. the WMO standard observation height +10 m) above the surface.

c) How to Convert Individual Point-Specific Wind Speeds

Firstly, the mean wind speed estimate \( V \) should be explicitly identified by its averaging period \( T \) in seconds, described here as \( V_{To} \), e.g.
- \( V_{600} \) is a 10-min averaged mean wind estimate;
- \( V_{60} \) is a 1-min averaged mean wind estimate;
- \( V_{3} \) is a 3-sec averaged mean wind estimate.

Next, a peak gust wind speed should be additionally prefixed by the gust averaging period \( \tau \), and the time period over which it is observed (also termed the reference period), described here as \( V_{\tau,To} \), e.g.
- \( V_{60,600} \) is the highest 1-min mean (peak 1-min gust) within a 10-min observation period;
- \( V_{3,60} \) is the highest 3-sec mean (peak 3-sec gust) within a 1-min observation period.

The “gust factor” \( G_{\tau,To} \) then relates as follows to the mean and the peak gust:

\[
V_{\tau,To} = G_{\tau,To} V
\]

where the (true) mean wind \( V \) is estimated on the basis of a suitable sample, e.g. \( V_{600} \) or \( V_{3600} \).

On this basis, Table 1 provides the recommended near-surface (+10 m) conversion factors \( G_{\tau,To} \) between typical peak gust wind averaging periods, which are a strong function of the exposure class because the turbulence level varies depending on the surface roughness. Table 1 only provides a range of indicative exposures for typical forecasting environments and Harper et al. (2010) or WMO (2008) should be consulted for more specific advice regarding particular types of exposures - especially if it is intended to calibrate specific measurement sites to “standard exposure”.

2019 Edition
Table 1 Wind speed conversion factors for tropical cyclone conditions (after Harper et al. 2010).

<table>
<thead>
<tr>
<th>Exposure at +10 m</th>
<th>Reference Period</th>
<th>Gust Factor $G_{t,T_o}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>Description</td>
<td>$T_o$ (s)</td>
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<tr>
<td>In-Land</td>
<td>Roughly open terrain</td>
<td>3600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600</td>
</tr>
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<td></td>
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<tr>
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</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Off-Land</td>
<td>Offshore winds at a coastline</td>
<td>3600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600</td>
</tr>
<tr>
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<td>Off-Sea</td>
<td>Onshore winds at a coastline</td>
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</tr>
<tr>
<td></td>
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<td>600</td>
</tr>
<tr>
<td></td>
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<td>180</td>
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</tr>
<tr>
<td>At-Sea</td>
<td>&gt; 20 km offshore</td>
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</tr>
<tr>
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</tr>
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<td></td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
</tr>
</tbody>
</table>

Some example applications of the above recommendations are:
- To estimate the expected “off-land” 3-sec peak gust in a 1-min period, multiply the estimated “off-land” mean wind speed by 1.36.
- To estimate the expected “off-sea” 3-sec peak gust in a 10-min period, multiply the estimated “off-sea” mean wind speed by 1.38.
- To estimate an “at-sea” 1-min peak gust in a 10-min period, multiply the estimated “at-sea” mean wind speed by 1.05.

Note that it is not possible to convert from a peak gust wind speed back to a specific time-averaged mean wind – only to the estimated true mean speed. Hence to estimate the “off-sea” mean wind speed given only a peak observed gust of 1-min duration ($\tau = 60$ s) measured in a 10-min period ($T_o = 600$ s), multiply the observed 1-min peak gust by $(1/1.11) = 0.90$. This does not guarantee that the estimated mean wind will be the same as the 10-min averaged wind at that time but, because the 10-min average is normally a reliable estimate of the true mean wind, it will likely be similar. In all cases, measurement systems should aim to reliably measure the mean wind speed and the standard deviation using a sample duration of not less than 10-min (WMO 2008), i.e. $V_{600}$. Additional shorter averaging periods and the retaining of peak information should then be targeted at operational needs.

d) Converting Between Agency Estimates of Storm Maximum Wind Speed $V_{max}$

This is a slightly different situation from converting a point specific wind estimate because the concept of a storm-wide maximum wind speed $V_{max}$ is a metric with an associated spatial context (i.e. anywhere within or associated with the storm) as well as a temporal fix context (at this moment in time or during a specific period of time). While it may be expressed in terms of any wind averaging period it remains important that it be unambiguous in terms of representing a mean wind or a peak gust. Agencies that apply the WMO standard 10-min averaged $V_{max}$ wind have always applied a wind-averaging conversion to reduce the maximum “sustained” 1-min wind value (a 1-min peak gust) that has been traditionally associated with the Dvorak method (Dvorak 1984, Atkinson and Holliday 1977). As noted in the previous section, it is technically not possible to convert from a peak gust back to a specific

7 As detailed in Harper et al. (2010), this traditional assumption is without a firm basis.
time-averaged mean wind – only to the estimated true mean wind speed. However, in Harper et al. (2010) a practical argument is made for nominal conversion between $V_{\text{max}60}$ and $V_{\text{max}600}$ values via an hourly mean wind speed reference, and the recommendations are summarised in Table 2.

It can be noted that the recommended conversion for at-sea exposure is about 5% higher than the “traditional” value of 0.88 (WMO 1993), which is more appropriate to an off-land exposure. This has special implications for the Dvorak method because “at sea” is the typical exposure of interest where such conversions have been traditionally applied.

Table 2 Conversion factors between agency estimates of maximum 1-min and maximum 10-min averaged tropical cyclone wind speed $V_{\text{max}}$. (after Harper et al. 2010).

<table>
<thead>
<tr>
<th>$V_{\text{max}600} = K V_{\text{max}60}$</th>
<th>At-Sea</th>
<th>Off-Sea</th>
<th>Off-land</th>
<th>In-Land</th>
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<tr>
<td>$K$</td>
<td>0.93</td>
<td>0.90</td>
<td>0.87</td>
<td>0.84</td>
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e) References


### List of Names for Tropical Cyclones Adopted by the Typhoon Committee for the Western North Pacific Ocean and the South China Sea

**Valid as of 2019**

<table>
<thead>
<tr>
<th>Contributed by</th>
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<td>Sinlaku</td>
<td>Nepartak</td>
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<td>Danas</td>
<td>Hagupit</td>
<td>Lupit</td>
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<td>Jangmi</td>
<td>Mirinae</td>
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<td>Wipha</td>
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<td>Higos</td>
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<td>Haishen</td>
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<td>Jongdari</td>
<td>Podul</td>
<td>Noul</td>
<td>Mindulle</td>
<td>Nalge</td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>Shanshan</td>
<td>Lingling</td>
<td>Dolphin</td>
<td>Lionrock</td>
<td>Banyan</td>
</tr>
<tr>
<td>Japan</td>
<td>Yagi</td>
<td>Kajiki</td>
<td>Kujira</td>
<td>Kompasu</td>
<td>Yamaneko</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>Leepi</td>
<td>Faxai</td>
<td>Chan-hom</td>
<td>Namtheun</td>
<td>Pakhar</td>
</tr>
<tr>
<td>Macao, China</td>
<td>Bebinca</td>
<td>Peipah</td>
<td>Linfa</td>
<td>Malou</td>
<td>Sanvu</td>
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<td>Malaysia</td>
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<td>Tapah</td>
<td>Nangka</td>
<td>Nyatoth</td>
<td>Mawar</td>
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<td>Micronesia</td>
<td>Soulik</td>
<td>Mitag</td>
<td>Saudel</td>
<td>Rai</td>
<td>Gucho</td>
</tr>
<tr>
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<td>Hagibis</td>
<td>Molave</td>
<td>Malakas</td>
<td>Talim</td>
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<td>Jebi</td>
<td>Neoguri</td>
<td>Goni</td>
<td>Megi</td>
<td>Doksuri</td>
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<td>Bualoi</td>
<td>Atsani</td>
<td>Chaba</td>
<td>Khanun</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>Barijat</td>
<td>Matmo</td>
<td>Etau</td>
<td>Aere</td>
<td>Lan</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>Trami</td>
<td>Halong</td>
<td>Vamco</td>
<td>Songda</td>
<td>Saola</td>
</tr>
</tbody>
</table>

**Replaced names**

- Aere for Kodo (2002)
- Morakot for Hanuman (2002)
- Noul for Pongsona (2006)
- Dolphin for Yanyan (2006)
- Mujigae for Maemi (2006)
- Lionrock for Tingting (2006)
- Fanapi for Rananim (2006)
- Pakhar for Matsu (2007)
- Doksi for Nabi (2007)
- Haikui for Longwang (2007)
- Sanba for Changhu (2008)
- Maliksi for Bilis (2008)
- SonTinh for Saomai (2008)
- Leepi for Xangsane (2008)

**Corrected spelling**

- Mulan for Haima (2018)
- Yamaneko for Hato (2019)
- Koinu for Tembin (2019)

- Megkhla to Mekkhala (2002)
- Kularb to Kulap (2002)
- Ramasoon to Rammasun (2002)
- Vipa to Wipha (2002)
- Kaemi to Gaemi (2008)
- Chebi to Jebi (2008)
- Noguri to Neoguri (2008)
- Changmi to Jangmi (2008)
- Koni to Goni (2008)
- SonTinh to Son-Tinh (2008)

**Note:** Corrected spellings appear in parentheses.
OPERATIONAL PROCEDURES FOR THE ASSIGNMENT OF NAMES OF TROPICAL CYCLONES

(a) RSMC Tokyo – Typhoon Center will assign a name each time a 4-digit identification number is to be assigned. That is, names on the Typhoon Committee list will only be given to tropical cyclones of tropical storm strength or above. Each tropical cyclone should be identified by its name followed by the 4-digit number in brackets. The same names and numbers should also be used in bulletins issued by the Tokyo Tropical Cyclone Advisory Centre under the umbrella of the International Civil Aviation Organization (ICAO) as well as in bulletins for Meteorological Area (METAREA)-XI of the Global Maritime Distress and Safety System (GMDSS) issued by both China and Japan. This would contribute to the standardization of the usage of names of tropical cyclones as was desired by the Typhoon Committee.

(b) The exchange of observational data should be promoted as much as possible in addition to what is already exchanged among the warning centres and the meteorological services in the region, to ensure that RSMC Tokyo – Typhoon Center would benefit from the best possible data and information needed for it to carry out its work.

(c) On the operation of the name list, the names will be assigned following the pre-determined order. The name would remain unchanged throughout the life history of the tropical cyclone. To avoid confusion, tropical cyclones given a name before crossing the Date Line and entering the western North Pacific should be assigned a number by RSMC Tokyo – Typhoon Center but should not be assigned a new name in the Typhoon Committee list. RSMC Honolulu Hurricane Center will continue the use of the tropical cyclone names assigned by RSMC Tokyo – Typhoon Center when tropical cyclones cross the Date Line from west to east.

(d) The names and numbers assigned by RSMC Tokyo – Typhoon Center will be used by all Typhoon Committee Members when issuing warning bulletins intended for the international community including the press, aviation and shipping.

(e) The Typhoon Committee, as the authority to maintain the list, shall review the list of names and its operation regularly at its annual sessions as the need arises.

(f) Members may request the retirement of a name from the list particularly in case of tropical cyclones causing extensive destruction or for other reasons. Such notification shall be made preferably within a year of the event. The decision to retire names should be made at the regular review at annual sessions of the Typhoon Committee.
# List of Acronyms Used in the Operational Manual

## Meteorological Component

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFTN</td>
<td>Aeronautical Fixed Telecommunication Network</td>
</tr>
<tr>
<td>AIREP</td>
<td>Air-report</td>
</tr>
<tr>
<td>AMeDAS</td>
<td>Automated Meteorological Data Acquisition System</td>
</tr>
<tr>
<td>AMV</td>
<td>Atmospheric Motion Vector</td>
</tr>
<tr>
<td>APT</td>
<td>Automatic Picture Transmission</td>
</tr>
<tr>
<td>ASCAT</td>
<td>Advanced SCATterometer</td>
</tr>
<tr>
<td>ASDAR</td>
<td>Aircraft to Satellite Data Relay</td>
</tr>
<tr>
<td>BOM</td>
<td>Bureau of Meteorology</td>
</tr>
<tr>
<td>BUFR</td>
<td>Binary Universal Form for the Representation of meteorological data</td>
</tr>
<tr>
<td>BUOY</td>
<td>Report of a buoy operation</td>
</tr>
<tr>
<td>CAPPI</td>
<td>Constant Altitude Plan Position Indicator</td>
</tr>
<tr>
<td>CMA</td>
<td>China Meteorological Administration</td>
</tr>
<tr>
<td>CMC</td>
<td>Canadian Meteorological Centre</td>
</tr>
<tr>
<td>CSR</td>
<td>Clear Sky Radiance</td>
</tr>
<tr>
<td>DDN</td>
<td>DataDirect Networks</td>
</tr>
<tr>
<td>DWD</td>
<td>Deutscher Wetterdienst</td>
</tr>
<tr>
<td>ECMWF</td>
<td>European Centre for Medium-Range Weather Forecasts</td>
</tr>
<tr>
<td>EPS</td>
<td>Ensemble Prediction System</td>
</tr>
<tr>
<td>ESCAP</td>
<td>Economic and Social Commission for Asia and the Pacific</td>
</tr>
<tr>
<td>FAX</td>
<td>Facsimile</td>
</tr>
<tr>
<td>FTP</td>
<td>File Transfer Protocol</td>
</tr>
<tr>
<td>GEPS</td>
<td>Global EPS</td>
</tr>
<tr>
<td>GMS</td>
<td>Geostationary Meteorological Satellite</td>
</tr>
<tr>
<td>GNSS</td>
<td>Global Navigation Satellite System</td>
</tr>
<tr>
<td>GRIB</td>
<td>General regularly distributed information in binary form</td>
</tr>
<tr>
<td>GSM</td>
<td>Global Spectral Model</td>
</tr>
<tr>
<td>GTS</td>
<td>Global Telecommunication System</td>
</tr>
<tr>
<td>HKO</td>
<td>Hong Kong Observatory</td>
</tr>
<tr>
<td>HRPT</td>
<td>High Resolution Picture Transmission</td>
</tr>
<tr>
<td>ICAO</td>
<td>International Civil Aviation Organization</td>
</tr>
<tr>
<td>IR</td>
<td>Infrared</td>
</tr>
<tr>
<td>JCOMM</td>
<td>Joint Technical Commission for Oceanography and Marine Meteorology</td>
</tr>
<tr>
<td>JCSAT</td>
<td>Japan Communications Satellite</td>
</tr>
<tr>
<td>JMA</td>
<td>Japan Meteorological Agency</td>
</tr>
<tr>
<td>JTWC</td>
<td>Joint Typhoon Warning Center</td>
</tr>
<tr>
<td>KMA</td>
<td>Korea Meteorological Administration</td>
</tr>
<tr>
<td>METAR</td>
<td>Aerodrome/aviation routine meteorological report</td>
</tr>
<tr>
<td>MPLS</td>
<td>Multi-Protocol Label Switching</td>
</tr>
<tr>
<td>MSTP</td>
<td>Multiple Spanning Tree Protocol</td>
</tr>
<tr>
<td>MTI</td>
<td>Moving Target Indicator</td>
</tr>
<tr>
<td>MTSAT</td>
<td>Multi-functional Transport Satellite</td>
</tr>
<tr>
<td>NCEP</td>
<td>National Centers for Environmental Prediction</td>
</tr>
<tr>
<td>NESDIS</td>
<td>National Environmental Satellite, Data and Information Service</td>
</tr>
<tr>
<td>NMC</td>
<td>National Meteorological Centre</td>
</tr>
<tr>
<td>NMHS</td>
<td>National Meteorological and Hydrological Service</td>
</tr>
<tr>
<td>NMS</td>
<td>National Meteorological Service</td>
</tr>
<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>NWP</td>
<td>Numerical Weather Prediction</td>
</tr>
<tr>
<td>OPMET</td>
<td>Operational Meteorological information</td>
</tr>
<tr>
<td>PILOT</td>
<td>Upper-wind report from a fixed land station</td>
</tr>
<tr>
<td>PNG</td>
<td>Portable Network Graphics</td>
</tr>
<tr>
<td>PWV</td>
<td>Precipitable Water Vapour</td>
</tr>
<tr>
<td>R/A</td>
<td>Radar/raingauge-Analyzed precipitation</td>
</tr>
<tr>
<td>RADOB</td>
<td>Report of ground radar weather observations</td>
</tr>
<tr>
<td>RO</td>
<td>Radio Occultation</td>
</tr>
<tr>
<td>ROBEX</td>
<td>Regional OPMET Bulletin Exchange</td>
</tr>
<tr>
<td>RSMC</td>
<td>Regional Specialized Meteorological Centre</td>
</tr>
<tr>
<td>RTH</td>
<td>Regional Telecommunication Hub</td>
</tr>
<tr>
<td>S.VISSR</td>
<td>Stretched VISSR</td>
</tr>
<tr>
<td>SAREP</td>
<td>Report of synoptic interpretation of cloud data obtained by a meteorological satellite</td>
</tr>
<tr>
<td>SATEM</td>
<td>Report of satellite remote upper-air soundings of pressure, temperature and humidity</td>
</tr>
<tr>
<td>SATOB</td>
<td>Report of satellite observations of wind, surface temperature, cloud, humidity and radiation</td>
</tr>
<tr>
<td>SHIP</td>
<td>Report of surface observation from a sea station</td>
</tr>
<tr>
<td>SST</td>
<td>Sea Surface Temperature</td>
</tr>
<tr>
<td>SYNOP</td>
<td>Report of surface observation from a fixed land station</td>
</tr>
<tr>
<td>TAC</td>
<td>Traditional Alphanumeric Code Form</td>
</tr>
<tr>
<td>TBB</td>
<td>Temperature Black Body</td>
</tr>
<tr>
<td>TC</td>
<td>Typhoon Committee</td>
</tr>
<tr>
<td>TCAC</td>
<td>Tropical Cyclone Advisory Centre</td>
</tr>
<tr>
<td>TCP</td>
<td>Tropical Cyclone Programme</td>
</tr>
<tr>
<td>TCP/IP</td>
<td>Transmission Control Protocol / Internet Protocol</td>
</tr>
<tr>
<td>TCS</td>
<td>Typhoon Committee Secretariat</td>
</tr>
<tr>
<td>TDCF</td>
<td>Table-Driven Code Form</td>
</tr>
<tr>
<td>TEMP</td>
<td>Upper-level pressure, temperature, humidity and wind report from a fixed land station</td>
</tr>
<tr>
<td>TOPEX</td>
<td>Typhoon Operational Experiment</td>
</tr>
<tr>
<td>TS</td>
<td>Tropical Storm</td>
</tr>
<tr>
<td>UKMO</td>
<td>United Kingdom Met Office</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>UTC</td>
<td>Universal Time Coordinated</td>
</tr>
<tr>
<td>VIS</td>
<td>Visible</td>
</tr>
<tr>
<td>VISSR</td>
<td>Visible and Infrared Spin Scan Radiometer</td>
</tr>
<tr>
<td>VPN</td>
<td>Virtual Private Network</td>
</tr>
<tr>
<td>WMO</td>
<td>World Meteorological Organization</td>
</tr>
<tr>
<td>WV</td>
<td>Water Vapour</td>
</tr>
</tbody>
</table>
LIST OF STATIONS FROM WHICH ENHANCED SURFACE OBSERVATIONS ARE AVAILABLE

The following stations will make hourly surface observations when they are within 300 km of the centre of a tropical cyclone of TS intensity or higher:

**Cambodia**

**China**

<table>
<thead>
<tr>
<th>Station Numbers</th>
<th>Cambodia</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>(58): 040, 141, 150, 238, 251, 265, 345, 362, 457, 472, 477, 543, 556, 569, 646, 652, 666, 752, 754, 834, 847, 911, 921, 926, 931, 944</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Democratic People’s Republic of Korea**

<table>
<thead>
<tr>
<th>Station Numbers</th>
<th>Democratic People’s Republic of Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td>(47): 003, 005, 008, 014, 016, 020, 022, 025, 028, 031, 035, 037, 039, 041, 045, 050, 052, 055, 058, 060, 061, 065, 067, 068, 069</td>
<td></td>
</tr>
</tbody>
</table>

**Hong Kong, China**

<table>
<thead>
<tr>
<th>Station Numbers</th>
<th>Hong Kong, China</th>
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</thead>
<tbody>
<tr>
<td>(45): 007</td>
<td></td>
</tr>
</tbody>
</table>

**Japan**

<table>
<thead>
<tr>
<th>Station Numbers</th>
<th>Japan</th>
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</thead>
<tbody>
<tr>
<td>(47): 401, 407, 409, 412, 418, 420, 421, 426, 430, 570, 575, 582, 584, 590, 600, 604, 605, 610, 624, 629, 636, 648, 651, 655, 662, 675, 678, 740, 741, 746, 750, 765, 772, 778, 800, 807, 815, 817, 827, 830, 843, 887, 891, 893, 895, 909, 918, 927, 936, 945, 971, 991</td>
<td></td>
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</table>

**Lao People’s Democratic Republic**

**Macao, China**

<table>
<thead>
<tr>
<th>Station Numbers</th>
<th>Macao, China</th>
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</thead>
<tbody>
<tr>
<td>(45): 011</td>
<td></td>
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</tbody>
</table>

**Malaysia**

<table>
<thead>
<tr>
<th>Station Numbers</th>
<th>Malaysia</th>
</tr>
</thead>
<tbody>
<tr>
<td>(48): 601, 615, 620, 647, 650, 657, 665</td>
<td></td>
</tr>
<tr>
<td>(96): 413, 421, 441, 449, 465, 471, 481, 491</td>
<td></td>
</tr>
</tbody>
</table>
Philippines


Republic of Korea


Thailand


USA


Vietnam

(48):  820, 826, 839, 845, 848, 855, 870, 877, 900, 914, 917, 918, 920

Note: Name, latitude, longitude and elevation of these stations are included in Weather Reporting, Volume A - Observing Stations (WMO Publication No. 9).
LIST OF STATIONS FROM WHICH ENHANCED UPPER-AIR OBSERVATIONS ARE AVAILABLE

The following stations will make 6-hourly upper-air observations when they are within 300 km of the centre of a tropical cyclone of TS intensity or higher:

Cambodia

China

(54): 511, 727, 857
(57): 083, 494, 972
(58): 150, 362, 457, 665, 847, 968
(59): 134, 316, 758, 981

Democratic People's Republic of Korea

(47): 041, 058

Hong Kong, China

(45): 004
# upper-air observations are made by wind profiler at 06 and 18 UTC normally, but radiosondes will be launched when warranted by local wind conditions

Japan

(47): 401, 412, 418, 582, 600, 646, 678, 741, 778, 807, 827, 909, 918, 945, 971*, 991*
* except 18 UTC

Lao People's Democratic Republic

Macao, China

Malaysia

(48): 601, 615, 650, 657
(96): 413, 441, 471, 481

Philippines

(98): 223, 433, 444, 618, 646, 573

Republic of Korea

(47): 102, 104, 122, 138, 158, 169, 186
Thailand

(48): 327, 378, 381, 407, 431, 453, 480, 500, 551, 565, 568

USA

(91): 212, 334, 348, 366, 376, 408, 413

Viet Nam

(48): 820, 855, 900

Note: Name, latitude, longitude and elevation of these stations are included in Weather Reporting, Volume A - Observing Stations (WMO Publication No. 9).
### LIST OF BUOY OBSERVATIONS
**BY TYPHOON COMMITTEE MEMBERS**

<table>
<thead>
<tr>
<th>Member</th>
<th>Area</th>
<th>Observation Elements</th>
<th>Frequency</th>
<th>Heading in the BUFR code (FM 94)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong, China</td>
<td>South China Sea</td>
<td>Air pressure and sea surface temperature</td>
<td>Every hour during tropical cyclone seasons</td>
<td>IOBC01 VHHH for buoys operated solely by Hong Kong, China</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>IOBX02 KWBC for buoys operated under the Barometer Upgrade Scheme of the Global Drifter Programme of Data Buoy Cooperation Panel of JCOMM</td>
</tr>
<tr>
<td>Japan</td>
<td>Western North Pacific</td>
<td>Air pressure, sea surface temperature, significant wave height and period</td>
<td>Every 3 hours (Every hour when waves are higher than thresholds set beforehand)</td>
<td>IOBC11 RJTD</td>
</tr>
</tbody>
</table>
APPENDIX 2-D

DISTRIBUTION OF THE RADAR STATIONS OF TYPHOON COMMITTEE MEMBERS
### TECHNICAL SPECIFICATIONS OF RADARS OF TYPHOON COMMITTEE MEMBERS

**Name of the Member** | **China**
---|---

<table>
<thead>
<tr>
<th>NAME OF STATION</th>
<th>Shanghai</th>
<th>Wenzhou</th>
<th>Fuzhou</th>
<th>Shantou</th>
<th>Xis hadao</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPECIFICATIONS</strong></td>
<td>Unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index number</td>
<td>58367</td>
<td>58659</td>
<td>58941</td>
<td>59316</td>
<td>59981</td>
</tr>
<tr>
<td>Location of station</td>
<td>31° 02’ N 121° 57’ E</td>
<td>27° 51’ N 120° 49’ E</td>
<td>25° 59’ N 119° 32’ E</td>
<td>23° 17’ N 116° 44’ E</td>
<td>16° 50’ N 112° 20’ E</td>
</tr>
<tr>
<td>Antenna elevation</td>
<td>m</td>
<td>68</td>
<td>294</td>
<td>652.5</td>
<td>196.7</td>
</tr>
<tr>
<td>Wave length</td>
<td>cm</td>
<td>10.6</td>
<td>10.6</td>
<td>10.4</td>
<td>10.4</td>
</tr>
<tr>
<td>Peak power of transmitter</td>
<td>kW</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Pulse length</td>
<td>µ s</td>
<td>1</td>
<td>3.0</td>
<td>1.0</td>
<td>1</td>
</tr>
<tr>
<td>Sensitivity minimum of receiver</td>
<td>dBm</td>
<td>-110</td>
<td>-110</td>
<td>-119</td>
<td>-109</td>
</tr>
<tr>
<td>Beam width (Width of over -3dB antenna gain of maximum)</td>
<td>deg</td>
<td>2.0</td>
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### DATA PROCESSING

| MTI processing | 1.Yes, 2.No | 2 | 2 | 2 | 2 | 2 |
| Doppler processing | 1.Yes, 2.No | 2 | 2 | 1 | 1 | 2 |
| Display | 1.Digital, 2.Analog | 1 | 1 | 1 | 1 | 2 |

### OPERATION MODE (When tropical cyclone is within range of detection)

| 1.Hourly | 1 | 1 | 1 | 1 | 1 |
| 2.3-hourly | | | | | |
| 3.Others | | | | | |

### PRESENT STATUS

| 1.Operational | 1 | 1 | 1 | 1 | 1 |
| 2.Not operational (for research etc.) | | | | | |
### Name of the Member
Democratic People's Republic of Korea

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<td>2.3-hourly</td>
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**Scan mode in observation**
1. Fixed elevation
2. CAPPI
3. Manually controlled

**DATA PROCESSING**

**MTI processing**
1. Yes, 2. No
1 | 1 | 1 | 1 | 1 | 1 |

**Doppler processing**
1. Yes, 2. No
1 | 1 | 1 | 1 | 1 |

**Display**
1. Digital, 2. Analog
1 | 1 | 1 | 1 | 1 |

**OPERATION MODE** (When tropical cyclone is within range of detection)
1. Hourly
2. 3-hourly
3. Others
1 | 1 | 1 | 1 | 1 |

**PRESENT STATUS**
1. Operational
2. Not operational (for research etc.)
1 | 1 | 1 | 1 | 1 | 1 |
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**DATA PROCESSING**

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**OPERATION MODE**

1. Hourly  
2. 3-hourly  
3. Others

**PRESENT STATUS**

1. Operational  
2. Not operational (for research etc.)
### NAME OF STATION

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### DATA PROCESSING

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### OPERATION MODE (When tropical cyclone is within range of detection)

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<td>2.3-hourly</td>
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## APPENDIX 2-E, p.7

Name of the Member **Japan - 4**

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2019 Edition
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### OPERATION MODE (When tropical cyclone is within range of detection)

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## APPENDIX 2-E, p.12

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Name of the Member Republic of Korea - 2

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### OPERATION MODE (When tropical cyclone is within range of detection)

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### PRESENT STATUS

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2. Not operational (for research etc.)
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<td>(When tropical cyclone is within range of detection)</td>
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2019 Edition
### Name of the Member: Singapore

#### Specifications

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<td>μs</td>
<td>1 or 3</td>
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<td>dBm</td>
<td>-110</td>
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**Scan mode in observation**

1. Fixed elevation
2. CAPPI
3. Manually controlled

**Data Processing**

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**Operation Mode (When tropical cyclone is within range of detection)**

1. Hourly
2. 3-hourly
3. Others (continuous)

**Present Status**

1. Operational
2. Not operational (for research etc.)
### APPENDIX 2-E, p. 19

**Name of the Member**  
**Thailand - 1**

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<thead>
<tr>
<th>NAME OF STATION</th>
<th>Chiang Rai</th>
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<th>Khon Khaen</th>
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#### DATA PROCESSING

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#### OPERATION MODE  
(When tropical cyclone is within range of detection)

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<th>3. Others</th>
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2019 Edition
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<th>Chainat</th>
<th>Ubon Ratchathani</th>
<th>Samut Songkram</th>
<th>Hua Hin</th>
<th>Chumporn</th>
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<td>13° 24’ N</td>
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<td>105° 01’ E</td>
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DATA PROCESSING

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OPERATION MODE (When tropical cyclone is within range of detection)

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PRESENT STATUS

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2019 Edition
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<td>1, 3</td>
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<td>3.Others</td>
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<td>PRESENT STATUS</td>
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## SPECIFICATIONS

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<td>Wave length</td>
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<td>Peak power of transmitter</td>
<td>kW</td>
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<td>Pulse length</td>
<td>µ s</td>
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### Scan mode in observation
1. Fixed elevation
2. CAPPI
3. Manually controlled

## DATA PROCESSING

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## OPERATION MODE (When tropical cyclone is within range of detection)

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## PRESENT STATUS

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### Name of the Member

**Viet Nam - 2**

### NAME OF STATION

| NAME OF STATION | Nha Be |

### SPECIFICATIONS

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<td>Peak power of transmitter</td>
<td>kW</td>
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<tr>
<td>Pulse length</td>
<td>µs</td>
</tr>
<tr>
<td>Sensitivity minimum of receiver</td>
<td>dBm</td>
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<tr>
<td>Beam width (Width of over -3dB antenna gain of maximum)</td>
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<td>Detection range</td>
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### DATA PROCESSING

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<td>Doppler processing</td>
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### OPERATION MODE (When tropical cyclone is within range of detection)

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<th>Mode</th>
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<td>2.3-hourly</td>
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### PRESENT STATUS

<table>
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<td>2.Not operational(for research etc.)</td>
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</table>
TECHNICAL SPECIFICATIONS OF SATELLITE
OPERATED BY TYPHOON COMMITTEE MEMBERS

1. Himawari-8/9 (RSMC Tokyo – Typhoon Center)
   (a) Observations
      (i) full-disk observations: every 10 minutes
      (ii) target area observations: every 2.5 minutes

   (b) Products
      (i) full disk data: every 10 minutes
      (ii) target area data: every 2.5 minutes;
      (iii) AMV data: hourly
      (iv) Clear Sky Radiance (CSR) data: hourly

   (c) Dissemination ways
      (i) HimawariCloud (Internet cloud service)
          Service via which distributes full-spec imagery derived from the Himawari-series satellites

      (ii) HimawariCast (communication satellite dissemination service)
          Service which disseminates primary sets of imagery from the Himawari-series satellites via a
          communication satellite

      (iii) Internet Service for National Meteorological and Hydrological Services (NMHSs)
          [JMA real-time satellite imagery webpage]

          [MSC (Meteorological Satellite Center) real-time satellite imagery webpage]
          https://www.data.jma.go.jp/mscweb/data/himawari/

          [SATAID (Satellite Animation and Interactive Diagnosis) Service]
          https://www.wis-jma.go.jp/cms/sataid/

          [JDDS (JMA Data Dissemination Service)]
## SATELLITE IMAGERY RECEIVING FACILITIES
### AT TYPHOOON COMMITTEE MEMBERS

<table>
<thead>
<tr>
<th>Member</th>
<th>Station</th>
<th>Himawari 1. Himawari Cloud 2. Himawari Cast</th>
<th>NOAA 1. HRPT 2. APT</th>
<th>Meteosat 1. P-DUS</th>
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<td>Cambodia</td>
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<tr>
<td>China</td>
<td>Beijing</td>
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<td>Shanghai</td>
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<td>Shenyang</td>
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<td></td>
<td>Guangzhou Cheng-chou</td>
<td>(23.1°N, 113.3°E)</td>
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<td></td>
<td>Cheng-tu</td>
<td>(34.7°N, 113.7°E)</td>
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<td></td>
<td>Lan-chou</td>
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<td>Kunming</td>
<td>(36.1°N, 103.9°E)</td>
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<td>Changsha</td>
<td>(25.0°N, 102.7°E)</td>
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<td></td>
<td>Nanjing</td>
<td>(28.2°N, 113.1°E)</td>
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<td></td>
<td>Harbin</td>
<td>(32.0°N, 118.8°E)</td>
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<td></td>
<td></td>
<td>(45.8°N, 126.8°E)</td>
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<td>Pyongyang</td>
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<tr>
<td>Hong Kong, China*</td>
<td>Kowloon</td>
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*Hong Kong, China receives AQUA (MODIS), SNPP (CrIs, VIIRS, ATMS), FY-2 (S-VISSR), and TERRA (MODIS), METOP-A and METOP-B (AMSU-A, AVHRR, HIRS, MHS).

* Macao, China receives FY-2D, FY-2E (S-VISSR) Stretched VISSR.
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<tr>
<th>Member</th>
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<th>Himawari 1. Himawari Cloud 2. Himawari Cast</th>
<th>NOAA 1. HRPT 2. APT</th>
<th>Meteosat 1. P-DUS</th>
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<td>Munsan</td>
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<td>Seosan</td>
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<td>Cheju</td>
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</table>

* Republic of Korea receives AQUA (MODIS, AIRS, AMSU, AMSR-E), FY-1 (CHRPT) and TERRA (MODIS).
* Singapore receives AQUA (MODIS), FY2B (S-VISSR), FY-1 (CHRPT) and TERRA (MODIS).
APPENDIX 2-H

LIST OF SAREP REPORTS
ISSUED BY TYPHOON COMMITTEE MEMBERS

<table>
<thead>
<tr>
<th>Member</th>
<th>Frequency</th>
<th>Heading in the BUFR code (FM 94)</th>
<th>Issuance Condition</th>
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<tbody>
<tr>
<td>RSMC Tokyo – Typhoon Center</td>
<td>8 times/day</td>
<td>IUCC10 RJTD</td>
<td>(i) When a tropical cyclone of TS intensity or higher is located in the responsible area of the RSMC Tokyo - Typhoon Center;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(ii) When a tropical depression existing in the responsible area is forecasted to have an intensity of TS or higher within 24 hours; or</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(iii) When an area of wind speed of 34 knots or higher caused by a tropical cyclone is forecasted to be in the responsible area within 24 hours.</td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>8 times/day</td>
<td>IUCC01 VHHH IUCC02 VHHH IUCC03 VHHH IUCC04 VHHH</td>
<td>When a tropical cyclone is located within 10N to 30N and 105E to 125E.</td>
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</tbody>
</table>
APPENDIX 2-I

RECONNAISSANCE FLIGHTS
CONDUCTED BY TYPHOON COMMITTEE MEMBERS

HKO conducts dropsonde reconnaissance flights for selected tropical cyclones over the northern part of the South China Sea. Data is disseminated in BUFR format through GTS circuit.
## TROPICAL CYCLONE PASSAGE REPORT FORM

TC Name (RSMC No.) ______________

<table>
<thead>
<tr>
<th>Station/buoy/ship Number</th>
<th>Minimum Sea Level Pressure (hPa)</th>
<th>Maximum Sustained Wind (m/sec) (10-min ave.)</th>
<th>Peak Gust Wind (m/sec) (UTC)</th>
<th>Rainfall (mm)</th>
<th>Date Observed</th>
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</thead>
<tbody>
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2019 Edition
## PRODUCTS PROVIDED BY RSMC TOKYO - TYPHOON CENTER

Chart-form products provided by RSMC Tokyo - Typhoon Center for regional purposes

<table>
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<th>Area</th>
<th>Contents and Level</th>
<th>Forecast hours</th>
<th>Initial time</th>
<th>Availability</th>
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</thead>
<tbody>
<tr>
<td>A’ (Far East)</td>
<td>500hPa (Z, ζ)</td>
<td>Analysis</td>
<td>00, 12UTC</td>
<td>GTS</td>
</tr>
<tr>
<td>C (East Asia)</td>
<td>300hPa (Z, T, W, A)</td>
<td>Analysis</td>
<td>00UTC</td>
<td>GTS</td>
</tr>
<tr>
<td>O (Asia)</td>
<td>500hPa (Z, ζ), 850hPa (T), Surface (P)</td>
<td>96, 120, 144, 168, 192</td>
<td>12UTC</td>
<td>GTS</td>
</tr>
<tr>
<td>Q (Asia Pacific)</td>
<td>200hPa (Z, T, W), Tropopause (Z)</td>
<td>Analysis</td>
<td>00, 12UTC</td>
<td>GTS</td>
</tr>
<tr>
<td>D (N.H.)</td>
<td>500hPa (Z, T)</td>
<td>24</td>
<td>00, 12UTC</td>
<td>GTS</td>
</tr>
<tr>
<td>W (NW Pacific)</td>
<td>Ocean Wave (J, M, G and observation plots)</td>
<td>Analysis</td>
<td>00, 12UTC</td>
<td>GTS, JMH</td>
</tr>
<tr>
<td>C’ (NW Pacific)</td>
<td>Ocean Wave (J, M, G)</td>
<td>Analysis, 24</td>
<td>00, 12UTC</td>
<td>GTS, JMH</td>
</tr>
<tr>
<td>C’2 (NW Pacific)</td>
<td>Sea Surface Temperature</td>
<td>Daily analysis</td>
<td>-</td>
<td>GTS, JMH</td>
</tr>
<tr>
<td>C (Asia Pacific)</td>
<td>Surface (P)</td>
<td>Analysis</td>
<td>00, 06,12, 18UTC</td>
<td>GTS, JMH</td>
</tr>
<tr>
<td></td>
<td>Surface (Typhoon Forecast)</td>
<td>12, 24, 48, 72</td>
<td>00, 06, 12, 18UTC</td>
<td>JMH</td>
</tr>
</tbody>
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Notes:
(a) Area A’, C, O, Q, D, W, X, C’’, C’’2 and C’2 are illustrated in figure of the next page.
(b) Contents
Z: geopotential height  ζ: vorticity  T: temperature
D: dewpoint depression  ω: vertical velocity  W: wind speed by isotach
A: wind arrows  P: sea level pressure  R: rainfall
J: wave height  M: wave period  G: arrow for prevailing wave direction
Output areas for facsimile charts transmitted through GTS and radio facsimile JMH
## NWP products (GSM and EPS) provided by RSMC Tokyo - Typhoon Center

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

<table>
<thead>
<tr>
<th>Model</th>
<th>GSM</th>
<th>GSM</th>
<th>GSM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area and resolution</strong></td>
<td>Whole globe, 1.25°×1.25°</td>
<td>20°S–60°N, 60°E–160°W</td>
<td>Whole globe, 2.5°×2.5°</td>
</tr>
<tr>
<td><strong>Levels and elements</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 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

### Initial times

- 00, 06, 12, 18UTC

---

<table>
<thead>
<tr>
<th>Model</th>
<th>Global EPS</th>
</tr>
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<tbody>
<tr>
<td><strong>Area and resolution</strong></td>
<td>Whole globe, 2.5°×2.5°</td>
</tr>
<tr>
<td><strong>Levels and elements</strong></td>
<td>250 hPa: µU, σU, µV, σV</td>
</tr>
<tr>
<td></td>
<td>500 hPa: µZ, σZ</td>
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<tr>
<td></td>
<td>850 hPa: µU, σU, µV, σV, µT, σT</td>
</tr>
<tr>
<td></td>
<td>1000 hPa: µZ, σZ</td>
</tr>
<tr>
<td></td>
<td>Surface: µP, σP</td>
</tr>
<tr>
<td><strong>Forecast hours</strong></td>
<td>0–192 every 12 hours</td>
</tr>
<tr>
<td><strong>Initial times</strong></td>
<td>00, 12UTC</td>
</tr>
</tbody>
</table>

---

2019 Edition
<table>
<thead>
<tr>
<th>Model</th>
<th>GSM</th>
<th></th>
<th>GSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area and resolution</td>
<td>5S-90N and 30E-165W, Whole globe 0.25° x 0.25°</td>
<td>5S-90N and 30E-165W, Whole globe 0.5° x 0.5°</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>70 hPa: Z, U, V, T, H, ω</td>
<td>100 hPa: Z, U, V, T, H, ω</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface: U, V, T, H, P, Ps, R, Cla, Clh, Clm, Cll</td>
<td>Surface: U, V, T, H, P, Ps, R, Cla, Clh, Clm, Cll</td>
</tr>
<tr>
<td>Forecast hours</td>
<td>0–84 (every 3 hours)</td>
<td>0–84 (every 3 hours)</td>
<td>90–264 (every 6 hours) are available for 12 UTC Initial</td>
</tr>
<tr>
<td>Initial times</td>
<td>00, 06, 12, 18 UTC</td>
<td>00, 06, 12, 18 UTC</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Z: geopotential height U: eastward wind V: northward wind
T: temperature D: dewpoint depression H: relative humidity
ω: vertical velocity ζ: vorticity ψ: stream function
χ: velocity potential P: sea level pressure Ps: pressure
R: rainfall Cla: total cloudiness Clh: cloudiness (upper layer)
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.
## List of other products provided by RSMC Tokyo - Typhoon Center

(Available at the Global Information System Center Tokyo server: https://www.wis-jma.go.jp/cms/)

<table>
<thead>
<tr>
<th>Data</th>
<th>Contents / frequency (initial time)</th>
</tr>
</thead>
</table>
| **Satellite products** | High density atmospheric motion vectors (BUFR)  
Himawari-8 (VIS, IR, WVv3: 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 18 UTC)  
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/) |
List of other products provided by RSMC Tokyo - Typhoon Center
(Available at the Numerical Typhoon Prediction Website: https://tynwp-web.kishou.go.jp/)

<table>
<thead>
<tr>
<th>Products</th>
<th>Frequency</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td><strong>Advisories</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prognostic Reasoning</td>
<td>4 times/day</td>
<td>• RSMC Tokyo Tropical Cyclone Prognostic Reasoning (WTPQ)</td>
</tr>
<tr>
<td>RSMC TC Advisory</td>
<td>At least 8 times/day</td>
<td>• RSMC Tokyo – Typhoon Center’s TC analysis, track forecast up to 120-hours and intensity forecast up to 72-hours (linked to JMA’s website: <a href="https://www.jma.go.jp/en/typh/">https://www.jma.go.jp/en/typh/</a>)</td>
</tr>
<tr>
<td>Graphical TC Advisory</td>
<td>4 times/day</td>
<td>• Graphical TC Advisory including RSMC Tokyo – Typhoon Center’s TC analysis, track and intensity forecast up to 24-hours and horizontal extent of cumulonimbus cloud and cloud top height associated with TCs potentially affecting aviation safety (linked to Tropical Cyclone Advisory Center Tokyo Website: <a href="https://www.data.jma.go.jp/fcd/tca/data/index.html">https://www.data.jma.go.jp/fcd/tca/data/index.html</a>)</td>
</tr>
<tr>
<td>Operational Remarks</td>
<td></td>
<td>• Advance notice on TC status change from RSMC Tokyo – Typhoon Center</td>
</tr>
</tbody>
</table>
| Track Bulletin                                | 4 times/day     | • RSMC Tokyo Tropical Cyclone Track Forecast Bulletin  
- Track forecast by deterministic GSM (FXPQ2X)  
- Track forecast by GEPS (FXPQ3X)                                                                                                           |
| **Observation/Analysis**                      |                 |                                                                                                           |
| TC Analysis                                   | At least 4 times/day | • Results and historical logs of RSMC Tokyo – Typhoon Center’s TC analysis conducted using satellite images (Conventional Dvorak analysis and Early-stage Dvorak analysis) |
| Satellite Microwave Products                  |                 | • TC snapshot images                                                                                                                                                |
|                                               |                 | • Warm-core-based TC intensity estimates                                                                                                                                   |
|                                               |                 | • Weighted consensus TC intensity estimates made using Dvorak analysis and satellite microwave warm-core-based intensity estimates                                                                 |
| Radar                                         | Every hour      | • Radar composite imagery of the Typhoon Committee Regional Radar Network                                                                                                                          |
| Weather Maps                                  | 4 times/day     | • Weather maps for surface analysis, 24- and 48-hour forecast (linked to JMA’s website: https://www.jma.go.jp/en/g3/)                                                                            |
| Upper-Air Analysis                            | 4 times/day     | • Upper-air analysis based on GSM initial field data  
- Streamlines at 850 and 200 hPa  
- Vertical wind shear between 200 and 850 hPa  
- Divergence at 200 hPa  
- Vorticity at 850 hPa                                                                                              |
| Ocean Analysis                                | Once/day        | • Sea surface temperature and difference from 24 hours ago  
• Tropical cyclone heat potential and difference from 24 hours ago                                                                                                                         |
| **Forecasting/NWP**                           |                 |                                                                                                           |
| TC Track Prediction                            | 4 times/day     | • TC track prediction of deterministic NWP models from nine centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP, UKMO and JMA)  
and a related consensus                                                                                                           |
|                                               |                 | • TC track prediction of ensemble NWP models from four centers (ECMWF, NCEP, UKMO and JMA)                                                                                                           |
| NWP Weather Maps                              | Twice/day       | • Mean sea level pressure and 500 hPa Geopotential height (up to 72 hours at 00 UTC, up to 168 hours at 12 UTC) of deterministic NWP models from nine centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP, UKMO and JMA) |
| TC Activity Prediction                         | Twice/day       | • Two- and five-day TC activity prediction maps based on ensemble NWP models from four centers (ECMWF, UKMO, NCEP and JMA)  
and a related consensus                                                                                                           |
## Storm Surge/Waves

<table>
<thead>
<tr>
<th>Storm Surge Forecasts</th>
<th>4 times/day</th>
<th>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 ahead)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>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 ahead)</td>
</tr>
<tr>
<td>Ocean Wave Forecasts</td>
<td>Twice/day</td>
<td>Distribution maps of ensemble mean, maximum, probability of exceeding various thresholds and ensemble spread of wave height and period based on Wave Ensemble System (WENS) (up to 264 hours ahead)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time-series of box-and-whisker plots of wave height and period, and probability of exceeding various thresholds of wave height and period based on WENS (up to 264 hours ahead)</td>
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## Classifications of Tropical Cyclones in the Western North Pacific

Internally Used by Members

<table>
<thead>
<tr>
<th>Maximum sustained winds (knots)</th>
<th>≤33</th>
<th>34 - 47</th>
<th>48 - 63</th>
<th>≥ 64</th>
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<tbody>
<tr>
<td>Typhoon Committee (10 min)</td>
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<tr>
<td></td>
<td></td>
<td>Tropical Depression (TD)</td>
<td>Tropical Storm (TS)</td>
<td>Severe Tropical Storm (STS)</td>
</tr>
<tr>
<td>China (2 min)</td>
<td>TD</td>
<td>TS</td>
<td>STS</td>
<td>64 - 80 TY</td>
</tr>
<tr>
<td>Hong Kong, China (10 min)</td>
<td>TD</td>
<td>TS</td>
<td>STS</td>
<td>64 - 80 TY</td>
</tr>
<tr>
<td>Japan (10 min)</td>
<td>TD</td>
<td>TS</td>
<td>STS</td>
<td>64 - 84 TY</td>
</tr>
<tr>
<td>Macao, China (10 min)</td>
<td>TD</td>
<td>TS</td>
<td>STS</td>
<td>64 - 80 TY</td>
</tr>
<tr>
<td>U.S. (1 min)</td>
<td>TD</td>
<td>TS</td>
<td></td>
<td>64 - 129 TY</td>
</tr>
</tbody>
</table>
EXAMPLES OF ADVISORIES ISSUED FROM RSMC TOKYO - TYPHOON CENTER

RSMC Tropical Cyclone Advisory

WTPQ20 RJTD 231200
RSMC TROPICAL CYCLONE ADVISORY
NAME TY 1826 YUTU (1826)
ANALYSIS
PSTN 231200UTC 12.0N 149.6E GOOD
MOVE W 11KT
PRES 965HPA
MXWD 075KT
GUST 105KT
50KT 60NM
30KT 270NM NORTHEAST 210NM SOUTHWEST
FORECAST
24HF 241200UTC 14.4N 146.2E 50NM 70%
MOVE WNW 10KT
PRES 925HPA
MXWD 100KT
GUST 140KT
48HF 251200UTC 16.2N 143.2E 95NM 70%
MOVE WNW 09KT
PRES 915HPA
MXWD 105KT
GUST 150KT
72HF 261200UTC 17.4N 139.8E 130NM 70%
MOVE WNW 09KT
PRES 915HPA
MXWD 105KT
GUST 150KT

RSMC Guidance for Forecast by Global Model

FXPQ20 RJTD 231200
RSMC GUIDANCE FOR FORECAST
NAME TY 1826 YUTU (1826)
PSTN 231200UTC 12.0N 149.6E
PRES 965HPA
MXWD 75KT
FORECAST BY GLOBAL MODEL
TIME PSTN PRES MXWD
(CHANGE FROM T=0)
T=006 12.8N 149.0E -007HPA +007KT
T=012 13.5N 148.4E -012HPA +015KT
T=018 14.0N 147.5E -016HPA +011KT
T=024 14.5N 146.7E -018HPA +017KT
T=030 15.2N 145.8E -025HPA +023KT
T=036 15.7N 144.9E -025HPA +027KT
T=042 16.2N 144.0E -032HPA +028KT
T=048 16.3N 143.2E -032HPA +031KT
T=054 16.6N 142.4E -037HPA +035KT
T=060 16.7N 141.4E -035HPA +033KT
T=066 16.7N 140.3E -041HPA +033KT

2019 Edition
RSMC Guidance for Forecast by Global Ensemble Prediction Model

<table>
<thead>
<tr>
<th>TIME</th>
<th>PSTN</th>
<th>PRES</th>
<th>MXWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>006</td>
<td>12.7N 149.1E</td>
<td>-002HPA +001KT</td>
<td></td>
</tr>
<tr>
<td>012</td>
<td>13.2N 148.3E</td>
<td>-001HPA +004KT</td>
<td></td>
</tr>
<tr>
<td>018</td>
<td>13.8N 147.6E</td>
<td>-005HPA +004KT</td>
<td></td>
</tr>
<tr>
<td>024</td>
<td>14.3N 146.7E</td>
<td>-005HPA +006KT</td>
<td></td>
</tr>
<tr>
<td>030</td>
<td>14.9N 145.9E</td>
<td>-009HPA +009KT</td>
<td></td>
</tr>
<tr>
<td>036</td>
<td>15.4N 145.0E</td>
<td>-009HPA +010KT</td>
<td></td>
</tr>
<tr>
<td>042</td>
<td>15.8N 144.2E</td>
<td>-013HPA +010KT</td>
<td></td>
</tr>
<tr>
<td>048</td>
<td>16.1N 143.5E</td>
<td>-012HPA +011KT</td>
<td></td>
</tr>
<tr>
<td>054</td>
<td>16.3N 142.7E</td>
<td>-015HPA +012KT</td>
<td></td>
</tr>
<tr>
<td>060</td>
<td>16.5N 141.9E</td>
<td>-014HPA +013KT</td>
<td></td>
</tr>
<tr>
<td>066</td>
<td>16.7N 141.0E</td>
<td>-018HPA +017KT</td>
<td></td>
</tr>
<tr>
<td>072</td>
<td>16.9N 139.8E</td>
<td>-017HPA +018KT</td>
<td></td>
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<tr>
<td>078</td>
<td>17.2N 138.6E</td>
<td>-020HPA +018KT</td>
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<tr>
<td>084</td>
<td>17.4N 137.3E</td>
<td>-020HPA +021KT</td>
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<tr>
<td>090</td>
<td>17.7N 136.0E</td>
<td>-024HPA +021KT</td>
<td></td>
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<tr>
<td>096</td>
<td>17.8N 134.9E</td>
<td>-023HPA +021KT</td>
<td></td>
</tr>
<tr>
<td>102</td>
<td>17.9N 133.9E</td>
<td>-027HPA +023KT</td>
<td></td>
</tr>
<tr>
<td>108</td>
<td>17.9N 132.9E</td>
<td>-026HPA +026KT</td>
<td></td>
</tr>
<tr>
<td>114</td>
<td>18.0N 132.1E</td>
<td>-031HPA +028KT</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>17.9N 131.3E</td>
<td>-031HPA +030KT</td>
<td></td>
</tr>
<tr>
<td>126</td>
<td>17.9N 130.6E</td>
<td>-034HPA +030KT</td>
<td></td>
</tr>
<tr>
<td>132</td>
<td>18.0N 129.9E</td>
<td>-033HPA +030KT</td>
<td></td>
</tr>
</tbody>
</table>

APPENDIX 4-B, p.2
RSMC Prognostic Reasoning

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

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.

RSMC Tropical Cyclone Advisory for Five-day Forecast

WTPQ50 RJTD 231200
RSMC TROPICAL CYCLONE ADVISORY
NAME TY 1826 YUTU (1826)

ANALYSIS
PSTN 231200UTC 12.0N 149.6E GOOD
MOVE W 11KT
PRES 965HPA
MXWD 075KT
GUST 105KT
50KT 60NM
30KT 270NM NORTHEAST 210NM SOUTHWEST

FORECAST
24HF 241200UTC 14.4N 146.2E 50NM 70%
MOVE WNW 10KT
PRES 925HPA
MXWD 100KT
GUST 140KT
48HF 251200UTC 16.2N 143.2E 95NM 70%
MOVE WNW 09KT
PRES 915HPA
MXWD 105KT

2019 Edition
GUST 150KT
72HF 261200UTC 17.4N 139.8E 130NM 70%
MOVE WNW 09KT
PRES 915HPA
MXWD 105KT
GUST 150KT
96HF 271200UTC 18.7N 135.6E 240NM 70%
MOVE WNW 11KT
PRES 935HPA
MXWD 95KT
GUST 135KT
120HF 281200UTC 19.6N 132.6E 375NM 70%
MOVE WNW 07KT
PRES 935HPA
MXWD 90KT
GUST 130KT =
## Stations Broadcasting Cyclone Warnings for Ships on the High Seas

<table>
<thead>
<tr>
<th>Member</th>
<th>Station</th>
<th>Call sign of coastal radio station</th>
<th>Area covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>Shanghai</td>
<td>XSG</td>
<td>Bohai Sea, Huanghai Sea, Donghai Sea, Shanghai Port, Taiwan Straits and sea around Taiwan province</td>
</tr>
<tr>
<td></td>
<td>Tianjin</td>
<td>XSZ</td>
<td>North and Central Huanghai Sea and Bohai Sea, Taiwan Straits, Bashi Channel, Nanhai Sea and Beibu Wan Gulf</td>
</tr>
<tr>
<td></td>
<td>Guangzhou</td>
<td>XSQ</td>
<td></td>
</tr>
<tr>
<td>Hong Kong, China</td>
<td>Hong Kong</td>
<td>Broadcast via NAVTEX on 518 kHz*</td>
<td>Waters inside the boundary line: 30N 105E to 30N 125E to 10N 125E, to 10N 105E, to 30N 105E</td>
</tr>
<tr>
<td>Japan</td>
<td>Hokkaido</td>
<td>JNL</td>
<td>Hokkaido area</td>
</tr>
<tr>
<td></td>
<td>Shiogama</td>
<td>JNN</td>
<td>Sendai area</td>
</tr>
<tr>
<td></td>
<td>Yokohama</td>
<td>JGC</td>
<td>Tokyo area</td>
</tr>
<tr>
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<td>Nagoya</td>
<td>JNT</td>
<td>Nagoya area</td>
</tr>
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<td>Kobe</td>
<td>JGD</td>
<td>Kobe area</td>
</tr>
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<td>Hiroshima</td>
<td>JNE</td>
<td>Hiroshima area</td>
</tr>
<tr>
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<td>Niigata</td>
<td>JNV</td>
<td>Niigata area</td>
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<td>Maizuru</td>
<td>JNC</td>
<td>Maizuru area</td>
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<td>Mojo</td>
<td>JNR</td>
<td>Fukuoka area</td>
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<td>Kagoshima</td>
<td>JNN</td>
<td>Kagoshima area</td>
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<td>Okinawa</td>
<td>JNB</td>
<td>Okinawa area</td>
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<tr>
<td>Malaysia</td>
<td>Klang</td>
<td>SSB 5</td>
<td>Strait of Malacca</td>
</tr>
<tr>
<td></td>
<td>Labuan</td>
<td>SSB 16</td>
<td>South China Sea</td>
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<tr>
<td></td>
<td>Kuching</td>
<td>SSB 5</td>
<td>South China Sea</td>
</tr>
<tr>
<td>Philippines</td>
<td>Manila</td>
<td>DZR, DZG, DSP, DZD, DZF, DFH, DZO, DZN, DZS</td>
<td>Pacific waters inside the boundary line: 25N 120E to 25N 135E, to 5N 135E, to 5N 115E, to 15N 115E, to 21N 120E, to 20N 120E</td>
</tr>
<tr>
<td></td>
<td>San Miguel</td>
<td>NPO</td>
<td>North Pacific waters east of 160E; Philippine Sea, Japan Sea, Yellow Sea, East China Sea, South China Sea</td>
</tr>
<tr>
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<td>Dannang</td>
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*Coast station VRX closed on 1 October 2006.*
METEOROLOGICAL TELECOMMUNICATION NETWORK
FOR THE TYPHOON COMMITTEE

Circuits of Main Telecommunication Network
Main regional circuits
Regional circuits
Inter-regional circuits
# Present Operational Status
## Of the Meteorological Telecommunication Network
### For the Typhoon Committee Region

1. **Main Telecommunication Network**
   - **Beijing - Tokyo**
     - Cable (MPLS), WMO FTP
     - Beijing 16 Mbps/Tokyo 10 Mbps
   - **Beijing - Offenbach**
     - Cable (MPLS), TCP/IP
     - Beijing 16 Mbps/Offenbach 50 Mbps
   - **Washington - Tokyo**
     - Cable (MPLS), TCP/IP
     - Washington 50 Mbps/Tokyo 10 Mbps

2. **Main Regional Circuit**
   - **Tokyo - Bangkok**
     - Cable (MPLS), TCP/IP
     - Tokyo 6 Mbps/Bangkok 128 kbps

3. **Regional Circuits**
   - **Bangkok - Beijing**
     - 64 kbps leased line
     - CMACast (Satellite broadcast)
   - **Bangkok - Hanoi**
     - 64 kbps leased line, FTP protocol
   - **Bangkok – Hong Kong**
     - Internet, FTP protocol
   - **Bangkok - Phnom Penh**
     - Internet (VPN), TCP/IP
   - **Bangkok - Vientiane**
     - Cable (DDN), 64 kbps, FTP protocol
     - and Internet, FTP protocol
   - **Beijing - Hanoi**
     - 64 kbps leased line,
     - CMACast (Satellite broadcast)
   - **Beijing - Hong Kong**
     - Cable (MSTP), 4 Mbps TCP/IP
     - CMACast (Satellite broadcast)
   - **Beijing - Macao**
     - 20Mbps leased line
     - CMACast (Satellite broadcast)
   - **Beijing - Pyongyang**
     - 64 kbps leased line,;
     - CMACast (Satellite broadcast)
   - **Beijing - Seoul**
     - Cable (MPLS), TCP/IP
     - Beijing 16 Mbps/Seoul 4 Mbps
   - **Beijing - Vientiane**
     - CMACast (Satellite broadcast)
Hong Kong - Macao: Internet (VPN) and Mobile leased line

Tokyo - Hong Kong: Cable (MPLS), TCP/IP
Tokyo 6 Mbps/Hong Kong 1 Mbps

Tokyo - Seoul: Cable (MPLS), WMO FTP
Tokyo 10 Mbps/Seoul 4 Mbps

4. **Inter-regional circuits**

- Bangkok - Kuala Lumpur: Cable (MPLS), TCP/IP 64 kbps
- Bangkok - Singapore: Cable (MPLS), TCP/IP 64 kbps
- Tokyo - Manila: Cable (MPLS), TCP/IP
Tokyo 6 Mbps/Manila 64 kbps

5. **RTH radio broadcast**

- Bangkok: 1 FAX
- Tokyo: 1 FAX

6. **Satellite broadcast**

Operated by China: Asiasat-4 (122.2°E)
Operational observations, warnings, NWP products, satellite image and fax distribution

Operated by Japan: HimawariCast
(JCSAT-2, 154°E)
Operational satellite image, NWP products, in-situ observation data and ASCAT ocean surface wind data distribution

7. **Internet Cloud Service**

Operated by Japan: HimawariCloud
Operational satellite image in full resolutions and bands
## LIST OF ADDRESSES, TELEX/CABLE AND TELEPHONE NUMBERS
**OF THE TROPICAL CYCLONE WARNING CENTERS IN THE REGION**

<table>
<thead>
<tr>
<th>Centre numbers</th>
<th>Mailing address</th>
<th>Telex/cable, Telephone, fax</th>
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<tr>
<td><strong>Cambodia</strong></td>
<td></td>
<td></td>
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</tbody>
</table>
| Attn. Mr Ly Chana | Norodom Boulevard | Tel.: (+855) 15 913081  
                    |                  | Fax: (+855) 23 26345 |
| Deputy Director | Department of Agricultural Hydraulics and Hydrometeorology |  |
| Attn. Mr Hun Kim Hak | Pochentong | Tel/Fax:(+855) 23 66193  
                        |                  | 66192 NMC  
                        |                  | 66191 Airport |
| **China**      |                 |                             |
| National Meteorological Center | No. 46 Zhongguancun  
                        | Nandajie, Beijing 100081 | Tel.: (+86) (10) 5899 3198  
                        |                  | Cable: 2894  
                        |                  | Fax: (+86) (10) 6217 2909  
                        |                  | E-mail: wangjj@cma.gov.cn |
| China Meteorological Adm. (Director: Wang Jianjie) |                  |                             |
| **Democratic People's Republic of Korea** |                 |                             |
| Mr Ko Sang Bok | Oesong-dong | Telex: 38022 TCT KP  
                        | Central District | Tel.: (+850) (2) 321 4539  
                        |                  | Fax: (+850) (2) 381 4410 |
| Director |                 |                             |
| Central Forecast Research Institute |                  |                             |
| State Hydrometeorological Adm. |                 |                             |
| **Hong Kong, China** |                 |                             |
| Central Forecasting Office | 134A Nathan Road  
                        | Tsim Sha Tsui  
                        | Kowloon  
                        | Hong Kong, China | Tel.: (+852) 2926 8371  
                        | (Office hours)  
                        | (+852) 2368 1944  
                        | (24 hours)  
                        | Fax: (+852) 2311 9448  
                        | (24 hours)  
                        | E-mail: lslee@hko.gov.hk |
| Hong Kong Observatory (Attn. Mr. L.S. Lee) |                 |                             |
| **Japan**      | 1-3-4 Otemachi  
                        | Chiyoda-ku  
                        | Tokyo 100-8122 | Telex: 2228080 METTOKJ  
                        | Tokyo 100-8122 | Tel.: (+81) (3) 3211 8303  
                        |                  | (00 - 09 UTC on weekdays)  
                        |                  | (+81) (3) 3211 7617  
                        |                  | (24 hours)  
                        |                  | Fax: (+81) (3) 3211 8303  
                        |                  | (24 hours)  
                        |                  |                             |
| Forecast Division |                 |                             |
| Forecast Department |                 |                             |
| Japan Meteorological Agency (Director: Y. Kajihara) |                 |                             |

2019 Edition
Lao People’s Democratic Republic

Ministry of Agriculture and Forestry, Department of VIENTIANE Meteorology and Hydrology

P.O. Box 811 Vientiane
Telex: 4306 ONU VTELS
Cable: UNDEVPRO

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WFFC Bldg., BIR Road, Diliman, Quezon City 1100
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T C S
Secretary: Yu Jixin
Avenida de 5 de Outubro Coloane, Macau
Tel: (853) 8 8010531 Fax: (853) 8 8010530
E-mail: yujx@typhooncommittee.org

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2 Seoseongro 810-gil, Namwon-eup, Seogwipo, Jeju, 63614, Republic of Korea
Tel.: (+82) (70) 7850-6351 Fax: (+82) (64) 805-0368
Thailand

Thai Meteorological Department
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Bangna, Bangkok 10260
Tel.: (+66) (2) 398 9875
Fax: (+66) (2) 398 9875
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Weather Forecast Division
Thai Meteorological Department
4353 Sukhumvit Road
Bangna, Bangkok 10260
Tel&Fax:(+66) (2) 399 4001
E-mail: sugunyanee@hotmail.com
(Director: Dr. Sugunyanee Yavinchan)
Telecommunications Division
Thai Meteorological Department
4353 Sukhumvit Road
Bangna, Bangkok 10260
Tel.: (+66) (2) 399 4555
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E-mail: tmd_inter@tmd.go.th
(Director: Mr. Sumreang Monkong)

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National Weather Service
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Barrigada
Guam 96913
Tel.: (+1-671) 472 0944
Fax: (+1-671) 472 7405
(RSMC Honolulu
2525 Correa Road Suite
250 Honolulu, HI 96822
Tel.: (+1-808) 973-5272
Fax: (+1-808) 973-5271
(Director: Raymond Tanabe)

Viet Nam

Forecast Division
4 Dan Thai Than
Hanoi
Tel.: (+84) (4) 264020
Fax: (+84) (4) 254278
Forecast Department
Hydro-Meteorological Service
(Hydro-Meteorological Service
2019 Edition
# Abbreviated Headings for the Tropical CycloneWarnings

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2019 Edition
Note: Meaning of abbreviation

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**CCC CCCC Location indicator**

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2019 Edition
EXAMPLE OF THE MESSAGE FORMAT FOR INQUIRY ON DOUBTFUL AND GARBLED REPORTS

Example 1. Inquiry on a doubtful report

BMBB01 VTBB 220245
RJTD
PLEASE CHECK THE FOLLOWING REPORT

BULLETIN SNTH20 VTBB
DATE AND TIME 210200
LOCATION 48300
CONTENT SECTION 1, 2ND GROUP: 80540

REGARDS
RSMC TOKYO =

Example 2. Inquiry on a garbled report

BMRR01 RPMM 210425
RJTD
AHD SNPH20 RPMM 210400 =
PROCEDURES OF REGULAR MONITORING
AT RSMC TOKYO - TYPHOON CENTER

1. Monitoring period

The two appropriate periods are selected from the one year starting on 1st January and ending on 31st December. Each period will be up to five consecutive days.

2. Items of monitoring

The reception time of reports at RSMC Tokyo - Typhoon Center should be monitored. The types of reports to be monitored are:

(i) hourly surface observations (SYNOP code),
(ii) hourly ship and buoy observations (SHIP and BUOY codes),
(iii) 6-hourly upper-air observations (TEMP and PILOT codes),
(iv) hourly radar observations (BUFR and/or RADOB codes).

3. Format of monitoring results

Samples of format of monitoring results are shown in Fig. 6-B.1 to Fig 6-B.4.

4. Distribution of monitoring results

The monitoring results should be distributed once a year by RSMC Tokyo - Typhoon Center to Typhoon Committee Secretariat and its Members by the end of March every year. A copy will be forwarded to WMO Secretariat. Members can also retrieve the data from the Internet server of JMA (https://www.wis-jma.go.jp/monitoring/data/monitoring/) by using HTTPS.
**APPENDIX 6-B, p.2**

### RECEPTION TIME OF SYNOP REPORTS

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Fig. 6-B.1 Format of monitoring results for SYNOP

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### RECEPTION TIME OF SHIP/BUOY REPORTS

**Nov. 11 2001**

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Fig. 6-B.2 Format of monitoring results for SHIP and BUOY
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EXAMPLE OF BEST TRACK REPORT

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RSMC TROPICAL CYCLONE BEST TRACK
NAME 9009 TASHA (9009)
PERIOD FROM JUL2612UTC TO AUG0100UTC
2612 20.0N 119.6E 1002HPA //KT 2618 19.6N 120.0E 1000HPA //KT
2700 19.2N 120.2E 1000HPA //KT 2706 18.8N 120.2E 1000HPA //KT
2712 18.6N 119.8E 1000HPA //KT 2718 18.6N 119.2E 1000HPA //KT
2800 18.6N 118.3E 996HPA 35KT 2806 18.6N 118.0E 992HPA 40KT
2812 18.7N 117.6E 990HPA 45KT 2818 18.8N 117.4E 990HPA 45KT
2900 18.9N 117.2E 990HPA 45KT 2906 18.8N 116.5E 985HPA 50KT
2912 18.8N 116.0E 985HPA 50KT 2918 19.0N 116.0E 985HPA 50KT
3000 19.4N 115.5E 980HPA 55KT 3006 20.1N 115.8E 980HPA 55KT
3012 21.4N 115.8E 980HPA 55KT 3018 22.0N 116.0E 980HPA 55KT
3100 23.6N 115.1E 985HPA 50KT 3106 25.0N 114.7E 990HPA 45KT
3112 25.5N 114.4E 996HPA 35KT 3118 25.8N 114.3E 998HPA //KT
0100 26.2N 114.6E 1000HPA //KT
REMARKS
TD FORMATION AT JUL2612UTC
FROM TD TO TS AT JUL2800UTC
FROM TS TO STS AT JUL2906UTC
FROM STS TO TS AT JUL3106UTC
FROM TS TO TD AT JUL3118UTC
DISSIPATION AT AUG0106UTC=
STANDARD PROCEDURES FOR THE VERIFICATION OF TYPHOON ANALYSIS AND FORECAST AT NATIONAL METEOROLOGICAL CENTRES

1. General

Each Member will verify each typhoon which affects it and summarize the verification made in a year.

2. Basis for verification

The best initial typhoon position, central pressure and maximum sustained wind as determined from a post-analysis conducted by the RSMC.

3. Points for verification

(1) Error statistics in each method (bias and standard deviation) by using common work sheets as shown in Appendix 6-E. Statistical computations involve positioning of the centre, prediction of movement, and analysis and forecast of intensity of a tropical cyclone.

(2) Discussion of following points:

(i) relative merits of each technique,
(ii) effects of inaccuracies on the forecast,
(iii) effects of meagreness of available relevant real-time observations,
(iv) variation from one geographical area to another,
(v) climatological factors in climatological and/or statistical method,
(vi) large-scale circulation pattern for giving rise to extremely poor prediction performance.
Verification sheet for positioning of the centre, prediction of movement, and analysis and forecast of intensity of tropical cyclones

- Typhoon: ..............................................
- Method: ................................................

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\Delta R = \sqrt{\left( \cos \phi_A \cdot \Delta \lambda \cdot \frac{\pi}{180} \right)^2 + \left( \Delta \phi \cdot \frac{\pi}{180} \right)^2} \text{ (km)}
\]

- \(\Delta R\); Error in analysed position (km)
- \(a\); Radius of the earth, 6371 km
- \(\phi\), \(\lambda\); Latitude and longitude
- \(\phi, \lambda, \Delta \phi, \Delta \lambda\) are measured in degree.

Remark: For RADOB and RADAR position verification, interpolated position of revised track at fixed observation time should be used.

Note: \(\Delta R\) can also be measured directly on the verification map.
Verification sheet for positioning of the centre, prediction of movement, and analysis and forecast of intensity of tropical cyclones

<table>
<thead>
<tr>
<th>Typhoon</th>
<th>Method</th>
<th>Forecast period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>24-hour (check one)</td>
</tr>
<tr>
<td>Initial Date</td>
<td>Initial position</td>
<td>Forecast position</td>
</tr>
<tr>
<td>$\phi_i$</td>
<td>$\lambda_i$</td>
<td>$\phi_F$</td>
</tr>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

\[
\Delta R = a \sqrt{\left( \cos \phi_F \cdot \Delta \lambda \cdot \frac{\pi}{180} \right)^2 + \left( \Delta \phi \cdot \frac{\pi}{180} \right)^2} \, (km)
\]

\[
\Delta \alpha = \tan^{-1} \frac{\Delta \phi'}{\cos \phi_i \cdot \Delta \lambda'} - \tan^{-1} \frac{\Delta \phi'}{\cos \phi_i \cdot \Delta \lambda'}
\]

\[
\Delta SP = a \left\{ \sqrt{\left( \cos \phi_i \cdot \Delta \lambda'' \right)^2 + \left( \Delta \phi'' \right)^2} - \sqrt{\left( \cos \phi_F \cdot \Delta \lambda' \right)^2 + \left( \Delta \phi' \right)^2} \right\} / \Delta t \, (km/hour)
\]

- $\Delta R$; Error in prediction position (km)
- $\Delta \alpha$; error in predicted direction of movement in degrees in azimuth angle
- $\Delta SP$; Error in the speed of movement
- $\Delta \phi'$, $\Delta \phi''$, $\Delta \lambda'$, $\Delta \lambda''$ are measured in degrees.
- $\Delta t$; forecast period (hour)
- $\Delta \alpha$ is positive if forecast is to the right of the actual path.

Note: $\Delta R$, $\Delta \alpha$ and $\Delta SP$ can also be measured directly on the verification map.
Verification sheet for positioning of the centre, prediction of movement, and analysis and forecast of intensity of tropical cyclones

Typhoon ......................................................(........)

<table>
<thead>
<tr>
<th>Method</th>
<th>Analysis</th>
<th>24-hour forecast</th>
<th>48-hour forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>P_a</td>
<td>P_r</td>
<td>ΔP_a</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
</tbody>
</table>

Note:

P_r: Revised central pressure
P_a: Analysed central pressure, \( ΔP_a = P_a - P_r \)
P_l: Predicted central pressure, \( ΔP_l = P_l - P_r \)
LIST OF DATA ARCHIVED BY RSMC TOKYO - TYPHOON CENTER

(a) Observation data (except for Himawari imagery data)

Kinds of data: SYNOP, AMeDAS, SHIP, BUOY, TEMP, PILOT, Aircraft, Wind Profiler, AMV, Scatterometer, MW Sounder, MW Imager, CSR, GNSS-RO, GNSS-PWV, Radar Reflectivity, Radial Velocity, R/A, Typhoon Bogus

(b) Himawari imagery data

Himawari Standard Data (HSD):

Kind of data: Himawari full-spec imagery data


Meteorological Satellite Center Monthly Report (DVD):


Area coverage:
SATAID: 115°E ~ 150°E and 15°N ~ 50°N
PNG: Full earth disk as seen from 140°E

(c) Objective Analysis data

Global Surface/Atmospheric Analysis data

Kinds of data: Grid point data of the objective surface/atmospheric analysis

Area coverage: Global area covered by 1.25 X 1.25 latitude-longitude grid system.

Time of analysis: 00, 06, 12 and 18 UTC

Element and layer:

Surface: Sea surface pressure (Ps), temperature (Ts), Dew point depression (Ts - Tds), wind (Us, Vs);

Specific pressure levels (1000 - 0.4 hPa):

Geopotential height (Z), temperature (T), wind (U, V), Dew point depression (T-Td)
Western North Pacific Sea Surface Temperature Analysis data

**Kinds of data:** Grid point data of the objective sea surface temperature analysis

**Area coverage:** Western North Pacific area (100°E ~ 180°E and 0° ~ 60°N) covered by 0.1 X 0.1 latitude-longitude grid system.

**Time of analysis:** 18 UTC

**Element:** SST, SST anomalies from the JMA climatology
GLOBAL TROPICAL CYCLONE TRACK AND INTENSITY DATA SET
- REPORT FORMAT

Position            Content
1-9                Cyclone Identification code composed by 2 digit numbers in order within the cyclone
                   season, area code and year code. 01SWI2000 shows the 1st system observer in South-
                   West Indian Ocean basin during the 2000/2001 season.
                   Area codes are as follows:
                   ARB = Arabian Sea
                   ATL = Atlantic Ocean
                   AUB = Australian Region (Brisbane)
                   AUD = Australian Region (Darwin)
                   AUP = Australian Region (Perth)
                   BOB = Bay of Bengal
                   CNP = Central North Pacific Ocean
                   ENP = Eastern North Pacific Ocean
                   ZEA = New Zealand Region
                   SWI = South-West Indian Ocean
                   SWP = South-West Pacific Ocean
                   WNP = Western North Pacific Ocean and South China Sea

10-19               Storm Name
20-23               Year
24-25               Month (01-12)
26-27               Day (01-31)
28-29               Hour-universal time (at least every 6 hourly position -00Z, 06Z, 12Z and 18Z)
                   Latitude indicator:
                   1=North latitude;
                   2=South latitude
31-33               Latitude (degrees and tenths)
34-35               Check sum (sum of all digits in the latitude)
36                   Longitude indicator:
                   1=West longitude;
                   2=East longitude
37-40               Longitude (degrees and tenths)
41-42               Check sum (sum of all digits in the longitude)
43                   Position confidence*
                   1 = good (<30nm; <55km)
                   2 = fair (30-60nm; 55-110km)
                   3 = poor (>60nm; >110km)
                   9 = unknown
                   Note* Confidence in the center position: Degree of confidence in the center position of a tropical
                   cyclone expressed as the radius of the smallest circle within which the center may be
                   located by the analysis. “position good” implies a radius of less than 30nm, 55km;
                   “position fair”, a radius of 30 to 60nm, 55 to 110km; and “position poor”, radius of greater
                   than 60nm, 110km.
44-45               Dvorak T-number (99 for no report)
46-47               Dvorak CI-number (99 for no report)
48-50               Maximum average wind speed (whole values) (999 for no report)
51                   Units 1=kt, 2=m/s, 3=km per hour.
52-53               Time interval for averaging wind speed (minutes for measured or derived wind speed, 99
                   if unknown or estimated).
54-56               Maximum Wind Gust (999 for no report)
57                   Gust Period (seconds, 9 for unknown)
58                   Quality code for wind reports:
                   1=Aircraft or Dropsonde observation
                   2=Over water observation (e.g. buoy)
                   3=Over land observation
                   4=Dvorak estimate
                   5=Other
<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>59-62</td>
<td>Central pressure (nearest hectopascal) (9999 if unknown or unavailable)</td>
</tr>
<tr>
<td>63</td>
<td>Quality code for pressure report (same code as for winds)</td>
</tr>
<tr>
<td>64</td>
<td>Units of length: 1=nm, 2=km</td>
</tr>
<tr>
<td>65-67</td>
<td>Radius of maximum winds (999 for no report)</td>
</tr>
</tbody>
</table>
| 68     | Quality code for RMW:  
1=Aircraft observation 
2=Radar with well-defined eye 
3=Satellite with well-defined eye 
4=Radar or satellite, poorly-defined eye 
5=Other estimate |
| 69-71  | Threshold value for wind speed (gale force preferred, 999 for no report) |
| 72-75  | Radius in Sector 1: 315°-45° |
| 75-79  | Radius in Sector 2: 45°-135° |
| 80-83  | Radius in Sector 3: 135°-225° |
| 84-87  | Radius in Sector 4: 225°-315° |
| 88     | Quality code for wind threshold  
1=Aircraft observations 
2=Surface observations 
3=Estimate from outer closed isobar 
4=Other estimate |
| 89-91  | Second threshold value for wind speed (999 for no report) |
| 92-95  | Radius in Sector 1: 315°-45° |
| 95-99  | Radius in Sector 2: 45°-135° |
| 100-103| Radius in Sector 3: 135°-225° |
| 104-107| Radius in Sector 4: 225°-315° |
| 108    | Quality code for wind threshold (code as for row 88) |
| 109-110| Cyclone type:  
01= tropics; disturbance (no closed isobars)  
02= <34 knot winds, <17m/s winds and at least one closed isobar  
03= 34-63 knots, 17-32m/s  
04= >63 knots, >32m/s  
05= extratropical  
06= dissipating  
07= subtropical cyclone (nonfrontal, low pressure system that comprises initially baroclinic circulation developing over subtropical water)  
08= overland  
09= unknown |
| 111-112| Source code (2 – digit code to represent the country or organization that provided the data to NCDC USA. WMO Secretariat is authorized to assign number to additional participating centers, organizations)  
01 RSMC Miami-Hurricane Center  
02 RSMC Tokyo-Typhoon Center  
03 RSMC-tropical cyclones New Delhi  
04 RSMC La Reunion-Tropical Cyclone Centre  
05 Australian Bureau of Meteorology  
06 Meteorological Service of New Zealand Ltd.  
07 RSMC Nadi-Tropical Cyclone Centre  
08** Joint Typhoon Warning Center, Honolulu  
09** Madagascar Meteorological Service  
10** Mauritius Meteorological Service  
11** Meteorological Service, New Caledonia  
12 Central Pacific Hurricane Center, Honolulu |

Note** no longer used

Headings  
1-19 Cyclone identification code and name; 20-29 Date time group;  
30-43 Best track positions;  
44-110 Intensity, Size and Type;  
111-112 Source code.
TROPICAL CYCLONE FORECAST COMPETENCY
IN THE TYPHOON COMMITTEE REGION

Category 1
This competency unit is relevant to dedicated or specialized TC forecasters working in a TC office at an unsupervised level. It includes:
• analyzing broad-scale environment and determine TC position, intensity and structure;
• forecasting TC track, intensity and structure;
• determining potential TC-related hazards;
• formulating and issuing TC-related warning products;
• communicating relevant TC information to internal and external stakeholders.

Category 2
This competency unit is relevant to general forecasters who provide a range of TC forecast services based on information from the ‘parent’ RSMC or other agencies, and/or available data. It includes:
• accessing, interpreting, and adapting TC analysis and forecast;
• determining potential TC-related hazards;
• formulating and issuing TC-related warning products;
• communicating relevant TC information to internal and external stakeholders.
<table>
<thead>
<tr>
<th><strong>Analyze broad-scale environment and determine TC position, intensity and structure (for Category 1)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>A range of observational information is analysed to interpret the synoptic scale environment, the position, intensity and structure of the tropical circulation</td>
</tr>
<tr>
<td><strong>Performance criteria</strong></td>
</tr>
<tr>
<td>analyzes the synoptic scale environment to assess the likely influence on the disturbance in a range of situations</td>
</tr>
<tr>
<td>determines TC centre location and current movement in accordance with standard operating procedures in a range of situations</td>
</tr>
<tr>
<td>determines TC intensity in accordance with standard operating procedures in a range of situations</td>
</tr>
<tr>
<td>determines TC structure in accordance with standard operating procedures in a range of situations</td>
</tr>
<tr>
<td><strong>Knowledge</strong></td>
</tr>
<tr>
<td>standard operating procedures for TC analysis</td>
</tr>
<tr>
<td>basic TC climatology and general impacts of ENSO on TC behaviors</td>
</tr>
<tr>
<td>capabilities and limitations of different observational data types</td>
</tr>
<tr>
<td>TC structure dynamics and conceptual models</td>
</tr>
<tr>
<td>synoptic scale factors that affect the tropical cyclone intensity including shear, ocean temperatures, upper-level flow, stability, landfall, vorticity and low to mid-level moisture</td>
</tr>
<tr>
<td>strengths and limitations of intensity analysis methods including Dvorak technique and other ones, such as ADT, CLOUD, AMSU intensity estimation, and SATCON.</td>
</tr>
<tr>
<td><strong>Background</strong></td>
</tr>
<tr>
<td>uses data viewing software and other applications in the forecast process</td>
</tr>
<tr>
<td>interprets observations, weather radar and satellite derived information such as scatterometry and cloud drift winds</td>
</tr>
<tr>
<td>interprets satellite imagery including water vapor, visible, infra-red, and microwave for TC analysis</td>
</tr>
<tr>
<td><strong>Skills</strong></td>
</tr>
<tr>
<td>uses Dvorak technique for TC centre location and intensity estimation.</td>
</tr>
<tr>
<td>estimates the intensity from a number of inputs</td>
</tr>
<tr>
<td>interprets wind shear from shear analyses and prognoses</td>
</tr>
<tr>
<td>assesses the environment for motion and intensity changes</td>
</tr>
<tr>
<td>interprets NWP guidance material</td>
</tr>
</tbody>
</table>
### Forecast TC track, intensity and structure (for Category 1)

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A range of information including numerical weather prediction NWP and objective aids in addition to an understanding of conceptual synoptic forecast approaches are used to forecast the track, intensity and structure in warning products that are issued in accordance with documented procedures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>interprets NWP-predicted synoptic scale environment to assess the likely influence on the disturbance in a range of situations</td>
</tr>
<tr>
<td>determines TC forecast track in accordance with standard operating procedures in a range of situations</td>
</tr>
<tr>
<td>determines TC forecast intensity in accordance with standard operating procedures in a range of situations</td>
</tr>
<tr>
<td>determines TC forecast structure in accordance with standard operating procedures and timelines in a range of situations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>standard operating procedures for TC forecasts</td>
</tr>
<tr>
<td>relative strengths and limitations of NWP in predicting cyclone movement, structure and intensity</td>
</tr>
<tr>
<td>basic concept of rapid intensification/weakening, landfall process, and extra tropical transition</td>
</tr>
<tr>
<td>verification results of official TC forecasts and NWP guidance</td>
</tr>
<tr>
<td>basic theory of TC ensemble forecasts</td>
</tr>
<tr>
<td>synoptic factors that affect TC genesis, motion, intensity, and structure</td>
</tr>
<tr>
<td>track forecasting techniques including consensus and ensemble forecasts</td>
</tr>
<tr>
<td>intensity forecasting methods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>evaluates model predictions against observed conditions to assess the most likely forecast environment for motion and intensity changes</td>
</tr>
<tr>
<td>evaluates TC genesis potential using observations and NWP guidance including ensembles</td>
</tr>
<tr>
<td>interprets NWP guidance material including ensemble output to determine forecast uncertainty</td>
</tr>
<tr>
<td>uses software systems to determine forecast parameters</td>
</tr>
<tr>
<td><strong>Access, interpret, and adapt TC analysis and forecast (for Category 2)</strong></td>
</tr>
<tr>
<td>---</td>
</tr>
</tbody>
</table>

**Description**
Guidance products from RSMC and other agencies are appropriately interpreted and assessed. Technical information including satellite and other observational information are interpreted taking into consideration the guidance products.

**Performance criteria**
- evaluates and adapt TC analysis and forecast based on information from RSMCs or other TC forecast agencies, and/or available data
- interprets technical forecast guidance in order to assess impact potential upon forecast region of responsibility
- interprets observational and satellite information appropriately

**Knowledge**
- standard operating procedures for TC analysis and forecasts
- capabilities and limitations of different observational data types
- TC structure dynamics and conceptual models
- synoptic scale factors that affect the tropical cyclone intensity including shear, ocean temperatures, upper-level flow, stability, landfall, vorticity and low to mid-level moisture
- relative strengths and limitations of NWP in predicting cyclone movement, structure and intensity
- synoptic factors that affect TC genesis, motion, intensity, and structure
- track forecasting techniques including consensus and ensemble forecasts
- intensity forecasting methods
- strengths and limitations of Dvorak technique, and other intensity analysis guidance, such as ADT, CLOUD, AMSU intensity estimation, and SATCON

**Skills**
- uses data viewing software and other applications in the forecast process
- interprets observations, weather radar, satellite and satellite derived information at a general level
- assesses the environment for impact on the TC at a general level
- interprets NWP guidance material
- interprets official TC forecast products from official agencies
<table>
<thead>
<tr>
<th>Determine potential TC-related hazards (for Category 1 &amp; 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>Potential TC-related hazards such as high winds, rainfall, waves and storm surge are determined, taking also into consideration mesoscale weather phenomena, for key locations according to appropriate thresholds and including estimates of uncertainty.</td>
</tr>
<tr>
<td><strong>Performance criteria</strong></td>
</tr>
<tr>
<td>forecasts extent of cyclonic winds (e.g. gales, storm force) and onset times for key locations using available guidance in a range of situations.</td>
</tr>
<tr>
<td>forecasts rainfall using available guidance in a range of situations and liaise with relevant organizations to determine potential flooding and landslide.</td>
</tr>
<tr>
<td>forecasts waves in accordance with standard operating procedures.</td>
</tr>
<tr>
<td>forecasts storm tide potential considering various TC forecast scenarios and confidence levels (worst case, most likely, alternate TC forecast scenario).</td>
</tr>
<tr>
<td><strong>Knowledge Background</strong></td>
</tr>
<tr>
<td>standard operating procedures for TC-related hazards including wave and storm surge associated with tropical cyclones.</td>
</tr>
<tr>
<td>potential TC-related hazards in a range of synoptic and mesoscale situations</td>
</tr>
<tr>
<td>basic theory of wave and storm surge</td>
</tr>
<tr>
<td><strong>Skills</strong></td>
</tr>
<tr>
<td>interprets guidance material of NWP and/or other Centres such as RSMCs.</td>
</tr>
<tr>
<td>assesses rainfall potential using probabilistic rainfall guidance, such as eTRaP and consensus model guidance (OCF, PME).</td>
</tr>
<tr>
<td>determines onset, duration, coverage and associated uncertainties of weather phenomena</td>
</tr>
<tr>
<td>interprets TC storm surge forecast guidance</td>
</tr>
</tbody>
</table>
### Formulate and issue TC-related warning products (for Category 1 & 2)

**Description**
Forecast production systems are used to produce and disseminate a range of TC-related warning products according to operating procedures.

<table>
<thead>
<tr>
<th>Performance criteria</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>liaises effectively with internal staff in the development of TC forecast scenarios and impact on other services.</td>
<td></td>
</tr>
<tr>
<td>formulates TC-related warning products, in consideration of potential impacts, in accordance with standard operating procedures in a range of situations.</td>
<td></td>
</tr>
<tr>
<td>determines the appropriate key messages for general and technical audiences in a range of situations.</td>
<td></td>
</tr>
<tr>
<td>issues the range of TC-related warning products in accordance with standard operating procedures and timelines in a range of situations.</td>
<td></td>
</tr>
</tbody>
</table>

**Knowledge**
- standard operating procedures for warning issuance and contingency plans of relevant DRR authorities such as local governments.
- local characteristics of potential impacts of tropical cyclones
- level of threat posed by storm tide
- user needs and significant impact thresholds
- product styles and standards

**Skills**
- uses appropriate software to determine range of potential impacts and produce warning products
- communicates with colleagues to formulate warning products
- compiles products and key messages for different audiences
- converts technical concepts into concise and easy to understand language

### Communicate relevant TC information to internal and external stakeholders (for Category 1 & 2)

**Description**
Forecasters are required to communicate information to internal and external users appropriate to their needs.

<table>
<thead>
<tr>
<th>Performance criteria</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>logically structures briefings and presentations to contain relevant, timely, and understandable information</td>
<td></td>
</tr>
<tr>
<td>delivers briefings, presentations and interviews to suit the intended audience explaining technical information in concise, clear and easy to understand language</td>
<td></td>
</tr>
<tr>
<td>communicate with related internal and external parties, such as DRR emergency managers, RSMCs, other TC forecast centres and weather services in neighboring areas</td>
<td></td>
</tr>
<tr>
<td>responds to requests for information appropriately</td>
<td></td>
</tr>
</tbody>
</table>

**Knowledge**
- principles of effective communication, including presentation and interviews
- presentation and meeting formats and requirements
- legislation, regulations, policies, procedures and guidelines relating to workplace communication in the public sector such as privacy, confidentiality, freedom of information

**Skills**
- compiles products and key messages for different audiences
- converts technical concepts into concise and easy to understand language
- facilitates and engages in communication exchanges
- uses equipment for presentations

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**2019 Edition**