**APPENDIX VI**

**UPDATE OF THE TYPHOON COMMITTEE OPERATIONAL MANUAL**

1. The Typhoon Committee Operational Manual - Meteorological Component (TOM) has been reviewed and updated every year since its first issue in 1987. The 2019 edition was completed and posted on the WMO website in March 2019 in accordance with the approval of amendments to the 2018 edition by the Typhoon Committee 51st session (26 February to 1 March 2019, Guangzhou, China).

2. At the 51st session, the Committee decided that the rapporteur of the RSMC Tokyo - Typhoon Center in Japan Meteorological Agency (JMA) continues arrangements for updating the TOM. In this connection, on 10 July 2019 in advance of the annual revision of TOM, the rapporteur, Dr. EITO Hisaki of the RSMC Tokyo - Typhoon Center requested the focal points of the meteorological component of the Members not only input on tropical cyclone analysis and forecast procedure by the NMSs as attached in Annex 1, which was approved at the Typhoon Committee 51st session, but confirmation of description on geostationary meteorological satellites which Typhoon Committee members operate, which was drafted by the rapporteur as attached in Annex 2.

3. Input on analysis and forecast procedure were submitted by six focal points of China; Hong Kong, China; Macao, China; Malaysia; Philippines and Republic of Korea. Proposal for revision of draft on geostationary meteorological satellites were also submitted by two focal points of China and Republic of Korea.

4. On 17 December 2019, the rapporteur proposed some revisions, including reflection of the inputs on TC analysis and forecast procedure from the members and proposal for revision of draft on geostationary meteorological satellites, to the focal points of the meteorological component of the Members and invited them to provide comments for the revision and proposals for updates.

5. Proposed revisions by the RSMC Tokyo - Typhoon Center are attached in Annex 3. The major points of the revisions are given below:

* Revision of the information on Tropical Cyclone warnings for the high seas (Section 4.4) and modification of the contents (Section 1.3, 1.4, Appendix 1-B) to go along with the WMO Manual on Marine Meteorological Services (WMO No.558).
* Revision of description on operational procedure for the assignment of names of TCs (Appendix 1-B)
* Amendments of the draft on geostationary meteorological satellites operated by TC members according to the proposals by two focal points of China and Republic of Korea. (Appendix 2-F).
* Addition of information on SAREP report by China (Appendix 2-H)
* Update of the list of the products and addition of example of the products provided by RSMC Tokyo - Typhoon Center available at the Numerical Typhoon Prediction Website (Appendix 3-A).
* Addition of the list of NWP models and Ensemble Prediction Systems used in the Numerical Typhoon Prediction Website (Appendix 3-A).
* Addition of the information on tropical cyclone analysis and forecast procedure by the NMSs of Typhoon Committee Members (Section 3-3, Appendix 3-B).
* Proposal of new format for satellite imagery receiving facilities for 2021 edition as shown in Annex 4 (Appendix 2-G)

6. Proposals for updates and amendments to the revised TOM were submitted by the five focal points of Hong Kong, China; Japan; Macao, China; Republic of Korea and Thailand as attached in Annex 5. The major points of the amendments are given below:

* Revision of the description on tropical cyclone passage report (Section 2.6)
* Revision of the description on forecast at RSMC Tokyo -Typhoon Center (Section 3.2)
* Revision of the description on tropical cyclone warnings for the high seas (Section 4.4)
* Revision of the description on tropical cyclone SIGMET and advisory information for international aviation (Section 4.5)
* Update of the information on surface observation stations (Appendix 2-A)
* Update of the distribution map of the radar stations (Appendix 2-D)
* Update of the information on the radar stations (Appendix 2-E)
* Update of the information on the meteorological geostationary satellite (Appendix 2-F)
* Update of the information on the satellite imagery receiving facilities (Appendix 2-G)
* Update of the information on NWP products provided by RSMC Tokyo - Typhoon Center and revision of the information on NWP models used in Numerical Typhoon Prediction website (Section 3-A)
* Update of the information on the analysis methods, forecasting methods and NWP (Appendix 3-B)
* Update of the information on the broadcasting stations on cyclone warnings for ships on the high seas(Appendix 4-C)
* Update of the information on the meteorological telecommunication network (Appendix 5-B)
* Update of the contact details (Appendix 5-C)
* Update of the list of collection and distribution of information related to tropical cyclones (Appendix 5-E)

## Annex 1

**Format of tropical cyclone analysis and forecast procedure by the NMSs of Typhoon Committee Members**

**-----------------------------------------------------------**

**APPENDIX 3-B**

**Analysis methods, forecasting methods and NWP system for forecasting currently used by the NMSs of Typhoon Committee Members**

Name of the Member: **[***Please specify***]**

**1 Tropical Cyclone Analysis**

*[Please describe analyzed Tropical Cyclone (TC) parameters and methods used for analysis by filling out the below table.]*

| **Parameter** | **Time** | **Methods** | **Other Sources** |
| --- | --- | --- | --- |
| *[Please specify analyzed TC parameters (e.g. position, speed, central pressure, maximum sustainable wind)]* | *[Please specify analysis time]* | *[Please describe both satellite-based and non satellite-based methods used for analysis of respective parameters (e.g. satellite imagery and radar image for position, Dvorak technique for intensity estimate.).]* | *Although TC analysis including Dvorak technique is still challenging for some Members, analytical results made by other centers, including those by RSMCs, are available via GTS and/or the Internet on a real-time basis. If your Service refers to such products by other centers, please specify them.* |
|  |  |  |  |

**2 Tropical Cyclone Forecasting**

*[Please describe forecasted Tropical Cyclone (TC) parameters and methods used for forecast by filling out the below table.]*

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Issuance Time** | **Lead Time** | **Methods** |
| *[Please specify forecast TC parameters (e.g. track, central pressure, maximum sustainable wind, strong wind areas, cyclogenesis).]* | *[Please specify issuance time]* | *[Please specify lead time]* | *[Nowadays, operational TC track forecasts are generally based on numerical weather prediction (NWP) guidance. Such NWP guidance products of major numerical centers are available for WMO Members (e.g. JMA provides numerical track guidance of major numerical centers for Western North Pacific to Typhoon Committee Members at JMA’s Numerical Typhoon Prediction Website (https://tynwp-web.kishou.go.jp/)). If your Service refers to such numerical track guidance products of other centers, please specify sources and how you use them for your forecasts.*  *As for TC Intensity forecasting, it still remains a difficult task, while TC track forecasts have been steadily improved because of advances in NWP guidance. If your Service issues intensity forecasts, please describe how they are produced. If your Service refers to TC intensity forecasts of other centers, please specify them.*  *If you issue any forecasts such as cyclogenesis other than track and intensity, please specify them.]* |
|  |  |  |  |

**3 NWP Systems in Operational Use**

*[Please describe NWP systems in operational use at your Service. In the rightmost column, please specify whether your Service runs NWP model/EPS on your own or uses systems provided by other centers.]*

| **System** | **Domain** | **Horizontal Resolution** | **Number of Vertical Level** | **Forecast Range (Initial Time)** | **Number of Ensemble Members** | **Run by**  **(own/other centers)** |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

**Reference**

*[If any, please specify]*

## Annex 2

**Draft of technical information on geostationary meteorological satellites Typhoon Committee members operate**

**-----------------------------------------------------------**

**APPENDIX 2-G**

**TECHNICAL SPECIFICATIONS OF SATELLITE OPERATED BY TYPHOON COMMITTEE MEMBERS**

1. **FY-2F (operational since 2012) / FY-2G (operational since 2015) / FY-2H (operational since 2019) [China]**
   1. **Observations**
      1. Full-Disk Observations (FY-2G/H): Every hour
      2. Regional Observations (FY-2F): Every 6 minutes
      3. *[if any other observation (e.g. request-based observation), please specify]*
   2. **Products**
      1. Full-Disk Observation Data (FY-2G/H): Every hour
      2. Regional Observation Data (FY-2F): Every 6 minutes
      3. Full-Disk AMV Product:
      4. *[if any other product, please specify]*
   3. **Dissemination ways**
      1. Direct Broadcast Services
      2. CMAcast (communication satellite dissemination service)
      3. Internet Services

[National Satellite Meteorological Center Portal Site]

http://www.nsmc.gov.cn/en

[FengYun Satellite Data Center Site]

http://satellite.nsmc.org.cn

* + 1. *[if any other service, please specify]*

1. **FY-4A (operational since 2018) [China]**
   1. **Observations**
      1. Full-Disk Observations: Every hour
      2. 3 Continuous Full-Disk Observations: Every 3 hours
      3. China Area Observations: Every 5 minutes
      4. *[if any other observation (e.g. request-based observation), please specify]*
   2. **Products**
      1. Full-Disk Observation Data: Every hour
      2. 3 Continuous Full-Disk Observation Data: Every 3 hours
      3. China Area Observation Data: Every 5 minutes
      4. *[if any other product, please specify]*
   3. **Dissemination ways**
      1. Direct Broadcast Service
      2. CMACast (communication satellite dissemination service)
      3. Internet Services

[FTP-based Service]

http://fy4.nsmc.org.cn/data/en/data/realtime.html

[National Satellite Meteorological Center Portal Site]

http://www.nsmc.gov.cn/en

[FengYun Satellite Data Center Site]

http://satellite.nsmc.org.cn

* + 1. *[if any other service, please specify]*

1. **Himawari-8 (operational since 2015) / Himawari-9 (operational since 2017)[[1]](#footnote-1) [Japan]**
   1. **Observations**
      1. Full-Disk Observations: Every 10 minutes
      2. Japan Area Observations: Every 2.5 minutes
      3. Target Area Observations including those Based on Request by NMHSs (HimawariRequest)[[2]](#footnote-2): Every 2.5 minutes
   2. **Products**
      1. Full-Disk Observation Data: Every 10 minutes
      2. Japan Area Observation Data: Every 2.5 minutes
      3. Target Area Observation Data: Every 2.5 minutes
      4. Full-Disk AMV: Every hour
      5. Full-Disk Clear Sky Radiance (CSR): Every hour
   3. **Dissemination ways**
      1. HimawariCloud (Internet Cloud Service)

Service which distributes full-spec imagery derived from the Himawari-series satellites

(https://www.data.jma.go.jp/mscweb/en/himawari89/cloud\_service/cloud\_service.html)

* + 1. HimawariCast (communication satellite dissemination service)

Service which disseminates primary sets of imagery from the Himawari-series satellites via a communication satellite

(https://www.data.jma.go.jp/mscweb/en/himawari89/himawari\_cast/himawari\_cast.html)

* + 1. Internet Services for National Meteorological and Hydrological Services (NMHSs)

[JMA real-time satellite imagery webpage]

https://www.jma.go.jp/en/gms/

[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)]

https://www.data.jma.go.jp/mscweb/en/himawari89/JDDS\_service/JDDS\_service.html

1. **COMS (operational since 2011) [Republic of Korea]**
   1. **Observations**
      1. Full-Disk Observations: Every 3 hours
      2. Extended North Hemisphere Observations: Every 15 minutes
      3. *[if any other observation, please specify]*
   2. **Products**
      1. Full-Disk Observation Data: Every 3 hours
      2. Extended North Hemisphere Observation Data: Every 15 minutes
      3. Full-Disk AMV: Every 3 hours
      4. *[if any other observation, please specify]*
   3. **Dissemination ways**
      1. Direct Broadcast Service

(http://nmsc.kma.go.kr/html/homepage/en/ver2/static/selectStaticPage.do?view=datacenter.dataService)

* + 1. Internet Services

[National Meteorological Satellite Center website]

http://nmsc.kma.go.kr/jsp/homepage/eng/main.do

[Data Collection or Production Centre website]

http://dcpc.nmsc.kma.go.kr/openwis-user-portal/srv/en/main.home

* + 1. *[if any other service, please specify]*

1. **GEO-KOMPSAT-2A (operational since 2019) [Republic of Korea]**
   1. **Observations**
      1. Full-Disk Observations: Every 10 minutes
      2. Extended Local Area Observations: Every 2 minutes
      3. Local Area Observations: Every 2 minutes
      4. *[if any other observation (e.g. request-based observation), please specify]*
   2. **Products**
      1. Full-Disk Observation Data: Every 10 minutes
      2. Extended Local Area Observation Data: Every 2 minutes
      3. Local Area Observation Data: Every 2 minutes
      4. *[if any other product, please specify]*
   3. **Dissemination ways**
      1. Direct Broadcast Service

(http://nmsc.kma.go.kr/html/homepage/en/ver2/static/selectStaticPage.do?view=satellites.gk2a.dataServicePlan)

* + 1. Internet Services

[FTP-based Service]

All sixteen channels data of full-disk image will be put on KMA’s FTP server designated for GEO-KOMPSAT-2A data dissemination in every 10 minutes.

[National Meteorological Satellite Center website]

http://nmsc.kma.go.kr/jsp/homepage/eng/main.do

[Data Collection or Production Centre website]

http://dcpc.nmsc.kma.go.kr/openwis-user-portal/srv/en/main.home

* + 1. *[if any other service, please specify]*

## Annex 3

**Draft Revisions to**

**the Typhoon Committee Operational Manual – Meteorological Component (TOM)**

**proposed by the RSMC Tokyo – Typhoon Center (except for editorial changes)**

|  |  |  |  |
| --- | --- | --- | --- |
| Page | Line | Proposed Revision | Comments |
| Section 1.3 | |  |  |
| 4 | L13 | Gale-force wind warning: 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.  Hurricane force: Average wind speed of 64 knots (32.7 m/s, 118 km/h) and above, or wind force 12 in the Beaufort scale.  Hurricane-force wind warning: Meteorological message intended to warn those concerned of the occurrence or expected occurrence of hurricane-force wind. | Modification of the description in accordance with the WMO Manual on Marine Meteorological Services (WMO No.558) |
| 4 | L35 | 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-force wind warning: Meteorological message intended to warn those concerned of the occurrence or expected occurrence of storm force wind.  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.~~ | Modification of the description in accordance with the WMO Manual on Marine Meteorological Services (WMO No.558) |
| Section 1.4 | | | |
| 6 | L9 | (a) The following units/indicators are used for marine (WWMIWS) purposes, in accordance with the WMO Manual on Marine Meteorological Services (WMO No.558):  (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~~ e.g. "12.2S, 168.4E";  (iii) Direction of motion to the nearest sixteen points of the compass or in degree to the nearest ten, given in ~~words~~ figures, e.g. "SOUTHSOUTHEAST" or "160 DEGREES";  (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;  (vi) Pressure in hectopascals (hPa), the unit being stated;  (vii) Time in Universal Time Co-ordinated (UTC), the unit being stated. | Modification of the description in accordance with the WMO Manual on Marine Meteorological Services (WMO No.558) |
| Section 3.3 | | | |
| 12 | L27 | The NMSs of Typhoon Committee Members are performing analysis and forecasting development and movement of tropical cyclones in the region. The analysis methods, the forecasting methods and NWP systems for forecasting currently used by the NMSs of Typhoon Committee Members are given in Appendix 3-B.  The final responsibility for the operational analysis and forecasting will be with the NMSs of each of the Members. | Addition of description related to Appendix 3-B |
| Section 4.4 | |  |  |
| 14 | L1 | 4.4 Tropical cyclone warnings for the high seas (WWMIWS)  The IMO/WMO Worldwide Met-Ocean Information and Warning Service (WWMIWS) is the internationally coordinated service for the promulgation of meteorological warnings and forecasts.  The WWMIWS produces marine meteorological maritime safety information messages for issuance on Enhanced Group Call (EGC) satellite systems (SafetyNET), NAVTEX and High-frequency Narrow-band Direct Printing (HF NBDP) communication systems covering the following areas:   * warnings and forecasts for the High Seas; * warnings and forecasts for coastal, offshore and local waters (including ports, lakes and harbour areas).   Operational guidance for handling and formatting meteorological information is given in detail in the Annex IV of the WMO Technical Regulations (Manual on Marine Meteorological Services - WMO-No. 558).  The provision of warnings for weather systems that produce average wind speeds of 34 knots and greater are a mandatory requirement of the WWMIWS.  In relation to international marine requirements, the WWMIWS coordinates the broadcast of forecasts and warnings to vessels at sea through the Global Maritime Distress and Safety System (GMDSS), which includes SafetyNET EGC satellite communications.  As part of the WWMIWS coordination, there are the following types of Centres:  Issuing service means a National Meteorological Service which has accepted responsibility for ensuring that meteorological warnings and forecasts for shipping are disseminated through approved EGC satellite systems to the designated area (METAREA) for which the Service has accepted responsibility under the WWMIWS.  Preparation service means a National Meteorological Service which has accepted responsibility for the preparation of warnings and forecasts for parts of or an entire designated area (METAREA) in the WMO system for the dissemination of meteorological forecasts and warning to shipping under the WWMIWS and for their transfer to the relevant Issuing Service for broadcast.  The METAREA Coordinator is responsible for ensuring that Tropical Cyclone warnings for the WWMIWS in their METAREA are issued onto the appropriate GMDSS communication system.  Areas of responsibility  Members having official responsibility as an Issuing Service within the WWMIWS for issuing warnings on approved EGC satellite systems are Japan (METAREA XI North) and China (METAREA XI South).  ~~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.  Format and content of bulletins  The format and content of warnings issued for the WWMIWS, as outlined below, has been derived from guidance provided in the Manual on Marine Meteorological Services (WMO No.558).  Tropical Cyclone warnings for the WWMIWS shall use the following wind warning category labels:   * Gale force wind warning (Beaufort force 8 or 9); * Storm-force wind warning (Beaufort force 10 or 11); * Typhoon-force/Hurricane-force wind warning (Beaufort force 12 or over).   Any Tropical Cyclone related wind warning issued for the WWMIWS should include the following content (excluding any relevant system metadata requirements):  (a) Header label for marine radio broadcast purposes (“SECURITE”)  Note: This label needs to be visible on any product provided to mariners with the potential to be read out on marine radio systems.  (b) Type of wind warning (GALE-FORCE, STORM-FORCE, TYPHOON-FORCE/HURRICANE-FORCE WIND WARNING)  (c) Name of the issuing centre  (d) Name of the system and name of the basin  (e) Date and time of reference in UTC  (f) Type of disturbance (Tropical cyclone)  (g) Location of disturbance (latitude and longitude)  (h) Central pressure (hPa)  (i) Intensity (maximum 10-minute average winds in knots)  (j) Direction and speed of movement of the disturbance  (k) Extent of affected area in nautical miles  (l) Wind speed (knots) and direction in the affected areas  (m) Sea and swell condition in affected areas (in qualitative terms)  (n) Expected location and intensity at 12 and 24 hour time periods.  (o) Indication of when next warning will be issued.  When no warnings are to be issued, that fact shall be stated in the bulletins. | Revision of the information on Tropical Cyclone warnings for the high seas in accordance with the WMO Manual on Marine Meteorological Services (WMO No.558) |
| Appendix 1-B | |  |  |
| 26 | L7 | (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 IMO/WMO Worldwide Met-Ocean Information and Warning Service (WWMIWS), ~~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. | Modification of the description in accordance with the WMO Manual on Marine Meteorological Services (WMO No.558) |
| 26 | L22 | (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 or 100°E 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 and RSMC New Delhi 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 or 100°E from east to west, respectively. | Update of the description of naming procedure for TCs crossing the border line of responsible area of RSMCs |
| Appendix 1-C | |  |  |
| 24 |  | To be updated by Annex 3-1. | Revision of list of acronyms related to procedure of analysis and forecast of TCs etc. |
| Appendix 2-F | |  |  |
| 59 |  | To be replaced by Annex 3-2 | Revision of the description according to the comments from members. |
| Appendix 2-G | |  |  |
| 60 |  | To be replaced by Annex 3-3 | Update the list of satellite imagery receiving system |
| 60 |  | To be replaced in the future by Annex 4 | Revision of the list of satellites |
| Appendix 2-H | |  |  |
| 62 |  | To be replaced by Annex 3-4 | Update of the list of SAREP reports |
| Appendix 3-A | | List of other products provided by RSMC Tokyo - Typhoon Center | |
| 70 |  | To be replaced by Annex 3-5 | Update of the list of products available at Numerical Typhoon Prediction Website: |
| Appendix 3-A | | | |
| After 71 |  | To be added by Annex 3-6 | Addition of “Example of the products provided by RSMC Tokyo - Typhoon Center”, “Deterministic NWP models used in the Numerical Typhoon Prediction website” and ”EPS used in the Numerical Typhoon Prediction website” |
| Appendix 3-B | |  |  |
| After 71 |  | To be added by Annex 3-7 | Addition of explanation about products and NWP/EPS at available at NTP web site. |
| Appendix 4-C | |  |  |
| 77 |  | To be replaced by Annex 3-8 | Revision of the area name |
| Appendix 5-B | |  |  |
| 80 | 29 | Operated by China:  ~~Asiasat-4 (122.2°E)~~CMAcast Operational observations, warnings, NWP products, satellite image and fax distribution | Revision of the satellite name to service name |

## Annex 3-1

**APPENDIX 1-C**

**LIST OF ACRONYMS USED IN THE OPERATIONAL MANUAL - METEOROLOGICAL COMPONENT -**

AFTN Aeronautical Fixed Telecommunication Network

AIREP Air-report

AMeDAS Automated Meteorological Data Acquisition System

AMV Atmospheric Motion Vector

APT Automatic Picture Transmission

ASCAT Advanced SCATterometer

~~ASDAR Aircraft to Satellite Data Relay~~

Bo~~O~~M Bureau of Meteorology

BUFR Binary Universal Form for the Representation of meteorological data

BUOY Report of a buoy operation

CAPPI Constant Altitude Plan Position Indicator

CMA China Meteorological Administration

CMC Canadian Meteorological Centre

CSR Clear Sky Radiance

DDN DataDirect Networks

DWD Deutscher Wetterdienst

ECMWF European Centre for Medium-Range Weather Forecasts

EUMETSAT European Organisation for the Exploitation of Meteorological Satellites

EPS Ensemble Prediction System

ESCAP Economic and Social Commission for Asia and the Pacific

FAX Facsimile

FTP File Transfer Protocol

FY Feng-Yun

FY-ESM Feng-Yun Emergency Support Mechanism

GEO-KOMPSAT Geostationary Korea Multi-Purpose Satellite

GEPS Global EPS

~~GMS Geostationary Meteorological Satellite~~

GNSS Global Navigation Satellite System

GRIB General regularly distributed information in binary form

GSM Global Spectral Model

GTS Global Telecommunication System

HKO Hong Kong Observatory

HRPT High Resolution Picture Transmission

HWRF Hurricane Weather Research and Forecast System

ICAO International Civil Aviation Organization

IR Infrared

JCOMM Joint Technical Commission for Oceanography and Marine Meteorology

JCSAT Japan Communications Satellite

JMA Japan Meteorological Agency

JTWC Joint Typhoon Warning Center

KMA Korea Meteorological Administration

METAR Aerodrome/aviation routine meteorological report

MPLS Multi-Protocol Label Switching

MSTP Multiple Spanning Tree Protocol

MTI Moving Target Indicator

~~MTSAT Multi-functional Transport Satellite~~

MWO Meteorological Watch Office

NCEP National Centers for Environmental Prediction

NESDIS National Environmental Satellite, Data and Information Service

NHM Non-Hydrostatic Model

NMC National Meteorological Centre

NMHS National Meteorological and Hydrological Service

NMS National Meteorological Service

NOAA National Oceanic and Atmospheric Administration

NRL Naval Research Laboratory

NWP Numerical Weather Prediction

OLR Outgoing Longwave Radiation

OPMET Operational Meteorological information

OSCAT OceanSat Scatterometer

PAGASA Philippine Atmospheric, Geophysical and Astronomical Services Administration

PBL Planetary Boundary Layer

PILOT Upper-wind report from a fixed land station

PNG Portable Network Graphics

PWV Precipitable Water Vapour

R/A Radar/raingauge-Analyzed precipitation

RADOB Report of ground radar weather observations

RO Radio Occultation

ROBEX Regional OPMET Bulletin Exchange

RSMC Regional Specialized Meteorological Centre

RTH Regional Telecommunication Hub

S-~~.~~VISSR Stretched VISSR

SAREP Report of synoptic interpretation of cloud data obtained by a meteorological satellite

SATAID SATellite Animation and Interactive Diagnosis

SHIP Report of surface observation from a sea station

SHIPS Statistical Hurricane Intensity Prediction Scheme

SST Sea Surface Temperature

SYNOP Report of surface observation from a fixed land station

TAC Traditional Alphanumeric Code Form

~~TBB Temperature Black Body~~

TC Typhoon Committee

TCAC Tropical Cyclone Advisory Centre

TCP Tropical Cyclone Programme

TCP/IP Transmission Control Protocol / Internet Protocol

TCS Typhoon Committee Secretariat

TDCF Table-Driven Code Form

TEMP Upper-level pressure, temperature, humidity and wind report from a fixed land station

TIFS Typhoon Intensity Forecast scheme based on SHIPS

TOPEX Typhoon Operational Experiment

TRAMS Tropical Regional Atmosphere Model for the South China Sea

TS Tropical Storm

TWRF Typhoon Weather Research and Forecast System

UKMO United Kingdom Met Office

UNDP United Nations Development Programme

UTC Universal Time Coordinated

VIS Visible

VISSR Visible and Infrared Spin Scan Radiometer

VPN Virtual Private Network

WMO World Meteorological Organization

WV Water Vapour

WWMIWS IMO/WMO Worldwide Met-Ocean Information and Warning Service

## Annex 3-2

**APPENDIX 2-F**

**TECHNICAL SPECIFICATIONS OF SATELLITE OPERATED BY TYPHOON COMMITTEE MEMBERS**

**1. FY-2F (operational since 2012) / FY-2G (operational since 2015) / FY-2H (operational since 2019) [China]**

* 1. **Observations**
     1. Full-Disk Observations (FY-2G/H): Every hour
     2. Regional Observations (FY-2F):Every 6 minutes
     3. Regional Observations based on request (FY-ESM[[3]](#footnote-3)): Every 6 minutes
  2. **Products**
     1. Full-Disk Observation Data (FY-2G/H): Every hour
     2. Regional Observation Data (FY-2F): Every 6 minutes
     3. Regional Observation Data based on request (FY-ESM3): Every 6 minutes
     4. Full-Disk AMV Product:
  3. **Dissemination ways**
     1. Direct Broadcast Services
     2. CMAcast (communication satellite dissemination service)
     3. Internet Services

[National Satellite Meteorological Center Portal Site]

http://www.nsmc.gov.cn/en

[FengYun Satellite Data Center Site]

http://satellite.nsmc.org.cn

**2. FY-4A (operational since 2018) [China]**

1. **Observations**
2. Full-Disk Observations: Every hour
3. China Area Observations: Every 5 minutes
4. Regional Observations based on request (FY-ESM3): Every 5 minutes
5. **Products**
6. Full-Disk Observation Data: Every hour
7. China Area Observation Data: Every 5 minutes
8. Regional Observations Data based on request (FY-ESM3): Every 5 minutes
9. **Dissemination ways**
10. Direct Broadcast Service
11. CMACast (communication satellite dissemination service)
12. Internet Services

[FTP-based Service]

http://fy4.nsmc.org.cn/data/en/data/realtime.html

[National Satellite Meteorological Center Portal Site]

http://www.nsmc.gov.cn/en

[FengYun Satellite Data Center Site]

http://satellite.nsmc.org.cn

**3. Himawari-8/9 (operational since 2015) / Himawari-9 (operational since 2017) [Japan]**

1. **Observations**
2. Full-Disk Observations: Every 10 minutes
3. Japan Area Observations: Every 2.5 minutes
4. Target Area Observations including those Based on Request by NMHSs (HimawariRequest)[[4]](#footnote-4): Every 2.5 minutes
5. **Products**
6. Full-Disk Observation Data: Every 10 minutes
7. Japan Area Observation Data: Every 2.5 minutes
8. Target Area Observation Data: Every 2.5 minutes
9. Full-Disk AMV: Every hour
10. Full-Disk Clear Sky Radiance (CSR): Every hour
11. **Dissemination ways**
12. HimawariCloud (Internet Cloud Service)

Service which distributes full-spec imagery derived from the Himawari-series satellites

(https://www.data.jma.go.jp/mscweb/en/himawari89/cloud\_service/cloud\_service.html)

1. HimawariCast (communication satellite dissemination service)

Service which disseminates primary sets of imagery from the Himawari-series satellites via a communication satellite

(https://www.data.jma.go.jp/mscweb/en/himawari89/himawari\_cast/himawari\_cast.html)

1. Internet Services for National Meteorological and Hydrological Services (NMHSs)

[JMA real-time satellite imagery webpage]

https://www.jma.go.jp/en/gms/

[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)]

https://www.data.jma.go.jp/mscweb/en/himawari89/JDDS\_service/JDDS\_service.html

**4. COMS (operational since 2011) [Republic of Korea]**

1. **Observations**
2. Full-Disk Observations: Every 3 hours
3. Extended North Hemisphere Observations: Every 15 minutes
4. Local Area Observations: Every 15 minutes
5. **Products**
6. Full-Disk Observation Data: Every 3 hours
7. Extended North Hemisphere Observation Data: Every 15 minutes
8. Full-Disk AMV: Every 3 hours
9. **Dissemination ways**
10. Direct Broadcast Service

(http://nmsc.kma.go.kr/html/homepage/en/ver2/static/selectStaticPage.do?view=datacenter.dataService)

1. Internet Services

[National Meteorological Satellite Center website]

http://nmsc.kma.go.kr/jsp/homepage/eng/main.do

[Data Collection or Production Centre website]

http://dcpc.nmsc.kma.go.kr/openwis-user-portal/srv/en/main.home

**5. GEO-KOMPSAT-2A (operational since 2019) [Republic of Korea]**

1. **Observations**
2. Full-Disk Observations: Every 10 minutes
3. Extended Local Area Observations: Every 2 minutes
4. Local Area Observations: Every 2 minutes
5. **Products**
6. Full-Disk Observation Data: Every 10 minutes
7. Extended Local Area Observation Data: Every 2 minutes
8. Local Area Observation Data: Every 2 minutes
9. **Dissemination ways**
10. Direct Broadcast Service

(http://nmsc.kma.go.kr/html/homepage/en/ver2/static/selectStaticPage.do?view=satellites.gk2a.dataServicePlan)

1. Internet Services

[FTP-based Service]

All sixteen channels data of full-disk image will be put on KMA’s FTP server designated for GEO-KOMPSAT-2A data dissemination in every 10 minutes.

[National Meteorological Satellite Center website]

http://nmsc.kma.go.kr/jsp/homepage/eng/main.do

[Data Collection or Production Centre website]

http://dcpc.nmsc.kma.go.kr/openwis-user-portal/srv/en/main.home

## Annex 3-3

**APPENDIX 2-G****65**

**SATELLITE IMAGERY RECEIVING FACILITIES AT TYPHOON COMMITTEE MEMBERS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Member** | **Station** | | **Himawari**  **1. HimawariCloud**  **2. HimawariCast** | **NOAA**  **1. HRPT**  **2. APT** | **Meteosat**  **1. P-DUS** |
| Cambodia |  |  | 1, 2 |  |  |
| China | Beijing | 39.9°N, 116.4°E | 1 | 1~~, 2~~ |  |
| ~~Shanghai~~ | ~~31.1°N, 121.4°E~~ |  | ~~2~~ |  |
| ~~Shenyan~~ | ~~41.8°N, 123.6°E~~ |  |  |  |
| ~~Guangzhou~~ | ~~23.1°N, 113.3°E~~ |  |  |  |
| ~~Cheng-chou~~ | ~~34.7°N, 113.7°E~~ |  |  |  |
| ~~Cheng-tu~~ | ~~31.2°N, 114.0°E~~ |  |  |  |
| ~~Lan-chou~~ | ~~36.1°N, 103.9°E~~ |  |  |  |
| ~~Kunming~~ | ~~25.0°N, 102.7°E~~ |  |  |  |
| ~~Changsh~~ | ~~28.2°N, 113.1°E~~ |  |  |  |
| ~~Nanjin~~ | ~~32.0°N, 118.8°E~~ |  |  |  |
| ~~Harbin~~ | ~~45.8°N, 126.8°E~~ |  |  |  |
| DPR Korea | Pyongyang | 39.0°N, 125.8°E |  | 1 |  |
| Hong Kong, China[[5]](#footnote-5) | Kowloon | 22.3°N, 114.2°E | 1, 2 | 1 |  |
| Japan | Minamitorishima | 24.3°N, 154.0°E | 2 |  |  |
| Lao PDR |  |  | 2 |  |  |
| Macao, China[[6]](#footnote-6) | Macao | 22.2°N, 113.5°E | 1, 2 | 1 |  |
| Malaysia | Petaling Jaya | 3.1°N, 101.7°E | 1, 2 | 1 |  |
| Philippines | Quezon City | 14.7°N, 121.0°E | 1, 2 | 1 |  |
| Cagayan de Oro City | 8.5°N, 124.6°E |  |  |  |
| Pasay City | 14.5°N, 121.0°E |  |  |  |
| Cebu | 10.3°N, 124.0°E |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Member** | **Station** | | **Himawari**  **1. HimawariCloud**  **2. HimawariCast** | **NOAA**  **1. HRPT**  **2. APT** | **Meteosat**  **1. P-DUS** |
| Republic of Korea[[7]](#footnote-7) | Seoul | 37.6°N, 127.0°E | 1 | 1 |  |
| Incheon Int. Airport | 37.3°N, 126.3°E |  |  |  |
| Munsan | 37.9°N, 126.8°E |  |  | 1 |
| Seosan | 36.8°N, 126.5°E |  | 1 |  |
| Pusan | 35.1°N, 129.0°E |  |  |  |
| Pusan Kimhae Air | 35.2°N, 126.9°E |  |  |  |
| Kwangju | 35.2°N, 126.9°E |  |  |  |
| Taejon | 36.4°N, 127.4°E |  |  |  |
| Kangnung | 37.5°N, 130.9°E |  |  |  |
| Cheju | 33.5°N, 126.5°E |  |  |  |
| Taegu | 35.9°N, 128.6°E |  |  |  |
| Taegu/Air Traffic | 35.9°N, 128.7°E |  |  |  |
| Chonju | 35.8°N, 127.2°E |  |  |  |
| Chongju | 36.6°N, 127.4°E |  |  |  |
| Ullung-Do | 37.5°N, 130.9°E |  |  |  |
| Mokpo | 34.8°N, 126.4°E |  |  |  |
| Chunchon | 37.9°N, 127.7°E |  |  |  |
| Masan | 35.2°N, 128.6°E |  |  |  |
| Tongyong | 34.9°N, 128.4°E |  |  |  |
| Inchon | 37.5°N, 126.6°E |  |  |  |
| Huksando | 34.7°N, 125.5°E |  |  |  |
| Suwon | 37.3°N, 127.0°E |  |  |  |
| Sokcho | 38.3°N, 128.6°E |  |  |  |
| Pohang | 36.0°N, 129.4°E |  |  |  |
| Kunsan | 36.0°N, 126.7°E |  |  |  |
| Baengnyeong-do | 37.9°N, 124.6°E |  |  |  |
| Singapore[[8]](#footnote-8) | Changi Airport | 1.4°N, 104.0°E | 1, 2 | 1 | 1 |
| Thailand | Bangkok | 13.7°N, 100.6°E | 1, 2 | 1 |  |
| USA | Guam | 13.4°N, 144.6°E | 1 | 1 |  |
| Viet Nam | Hanoi | 21.0°N, 105.5°E | 1, 2 | 2 |  |
| Ho Chi Ming City | 10.5°N, 106.4°E |  | 2 |  |

## Annex 3-4

**APPENDIX 2-H**

**LIST OF SAREP REPORTS ISSUED BY TYPHOON COMMITTEE MEMBERS**

|  |  |  |  |
| --- | --- | --- | --- |
| **Member** | **Frequency** | **Heading in the BUFR code (FM 94)** | **Issuance Condition** |
| RSMC Tokyo - Typhoon Center | 8 times/day | IUCC10 RJTD | 1. When a tropical cyclone of TS intensity or higher is located in the responsible area of the RSMC Tokyo - Typhoon Center; 2. When a tropical depression existing in the responsible area is forecasted to have an intensity of TS or higher within 24 hours; or 3. 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. |
| Hong Kong, China | 8 times/day | IUCC01 VHHH  IUCC02 VHHH  IUCC03 VHHH  IUCC04 VHHH | When a tropical cyclone is located within 10°N to 30°N and 105°E to 125°E. |
| China | 8 times/day | TCPQ40 BABJ | When a tropical cyclone is located within 0°N to 50°N and 105°E to 180°E. |

## Annex 3-5

**APPENDIX 3-A**

**List of other products provided by RSMC Tokyo - Typhoon Center**

**(Available at the Numerical Typhoon Prediction Website:**

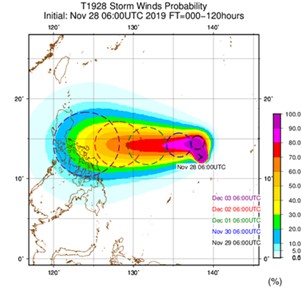
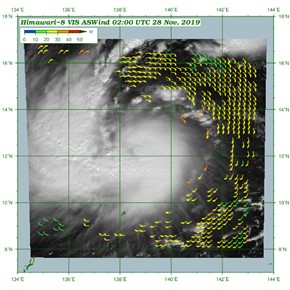
**https://tynwp-web.kishou.go.jp/)**

| Products | Frequency | Details |
| --- | --- | --- |
| RSMC Advisories | | |
| RSMC TC Advisory ~~Prognostic Reasoning~~ | At least  8 times/day  ~~4 times/day~~ | * RSMC Tokyo - Typhoon Center’s TC analysis, track forecast and intensity forecast up to 120-hours (linked to JMA’s website: https://www.jma.go.jp/en/typh/) * ~~RSMC Tokyo Tropical Cyclone Prognostic Reasoning (WTPQ)~~ |
| Storm Wind Probability Map  ~~RSMC TC Advisory~~ | 4 times/day  ~~At least~~  ~~8 times/day~~ | * Probabilistic forecast map for sustained wind upward of 50-kt with forecast time of 1, 2, 3, 4 and 5 days * ~~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: https://www.jma.go.jp/en/typh/)~~ |
| Prognostic Reasoning  ~~Graphical~~  ~~TC Advisory~~ | 4 times/day | * RSMC Tokyo Tropical Cyclone Prognostic Reasoning (WTPQ) * ~~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: https://www.data.jma.go.jp/fcd/tca/data/index.html)~~ |
| Advance notice  ~~Operational Remarks~~ |  | * Advance notice on TC status change from RSMC Tokyo – Typhoon Center |
| Graphical  TC Advisory ~~Track Bulletin~~ | 4 times/day | * 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: https://www.data.jma.go.jp/fcd/tca/data/index.html) * ~~RSMC Tokyo Tropical Cyclone Track Forecast Bulletin~~   + ~~Track forecast by deterministic GSM (FXPQ2X)~~   + ~~Track forecast by GEPS (FXPQ3X)~~ |
| Remote sensing ~~Observation/Analysis~~ | | |
| Satellite 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 imagery  ~~Satellite Microwave Products~~ | Up to 142 times/day | * Satellite imagery of Himawari-8/9 (inked to JMA’s website: https://www.jma.go.jp/en/gms/smallc.html?area=6&element=0&mode=UTC) * ~~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~~ |
| Satellite Microwave Products  ~~Radar~~ | ~~Every hour~~ | * 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 composite imagery of the Typhoon Committee Regional Radar Network~~ |
| Sea-surface AMV  ~~Weather Maps~~ | Every 10 / 30 minutes  ~~4 times/day~~ | * AMV-based Sea-surface Wind in the vicinity of TC (linked to Meteorological Satellite Center’s web site: http://www.data.jma.go.jp/mscweb/en/product/product/aswind/monitor/aswind.php) * ~~Weather maps for surface analysis, 24- and 48-hour forecast (linked to JMA’s website: https://www.jma.go.jp/en/g3/)~~ |
| Radar Composite Imagery  ~~Upper-Air Analysis~~ | Every hour  ~~4 times/day~~ | * Radar composite imagery of the Typhoon Committee Regional Radar Network * ~~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~~ |
| Atmospheric Circulation ~~Forecasting/NWP~~ | | |
| Weather Charts  ~~TC Track Prediction~~ | 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/) * ~~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 Multi Center Weather ~~Maps~~ Charts | 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) |
| JMA GSM Analysis and Forecast  ~~TC Activity Prediction~~ | 4 times/day  ~~Twice/day~~ | * Upper-air analysis and forecast data based on JMA-GSM * Streamlines at 850, 500 and 200 hPa * Divergence at 200 hPa * Velocity potential at 200 hPa * Vertical Velocity in Pressure Coordinate at 500 hPa * Dew Point Depression at 600 hPa * Curvature Vorticity at 850 hPa * Vertical wind shear between 200 and 850 hPa * Sea Level Pressure * Genesis Potential Index * ~~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~~ |
| MJO phase diagram | Monthly | * MJO phase and amplitude diagram and MJO Havmoller diagram (linked to JMA’s web sites) |
| Asian Monsoon Monitoring Indices | Daily | * Time series of vertical wind shear, OLR and other indices associated with SW Asian Monsoon (linked to JMA’s web sites) |
| Ocean Condition ~~Storm Surge/Waves~~ | | |
| SST  ~~Storm Surge Forecasts~~ | Once/day  ~~4 times/day~~ | * Sea surface temperature and its difference from 24 hours ago * ~~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)~~ * ~~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)~~ |
| TCHP  ~~Ocean Wave Forecasts~~ | Once/day  ~~Twice/day~~ | * Tropical cyclone heat potential and its difference from 24 hours ago * ~~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)~~ * ~~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)~~ |
| Numerical TC Prediction | | |
| Track Forecast Bulletin | 4 times/day | * RSMC Tokyo Tropical Cyclone Track Forecast Bulletin   + Track forecast by deterministic GSM (FXPQ2X)   + Track forecast by GEPS (FXPQ3X) |
| 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) |
| 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 |
| Marine Forecast | | |
| Storm Surge  Forecasts | 4 times/day | * Distribution maps of storm surge for RSMC Tokyo - Typhoon Center’s TC track forecast and each of five TC track forecasts selected from GEPS ensemble members and maximum storm surge among these six TC track forecasts (up to 72 hours ahead)   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) |
| Ocean Wave  Forecasts | Twice/day | * 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) * 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) |

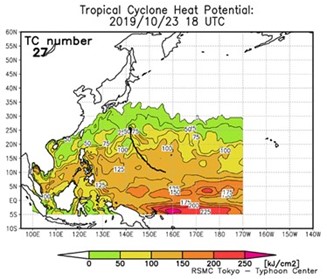
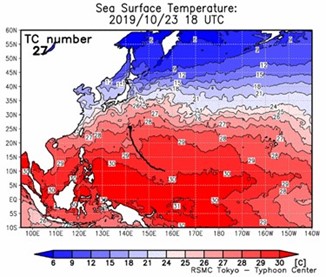
## Annex 3-6

**APPENDIX 3-A**

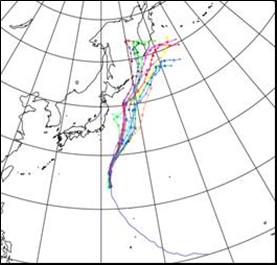
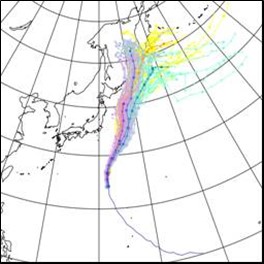
**Example of the products provided by RSMC Tokyo - Typhoon Center**

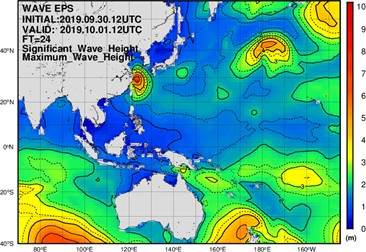
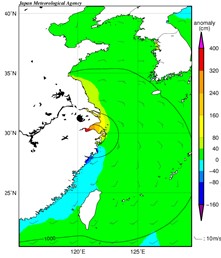
(Left) Storm Wind Probability Map: Probabilistic forecast map for sustained wind upward of 50-kt with forecast time of 1, 2, 3, 4 and 5 days, to grasp the possible impact for areas of interest. (Right) Sea-surface AMV: AMV-based sea-surface wind in the vicinity of TCs estimated from Himawari-8/9 low-level AMVs. Data are available every 30 minutes for full-disk observation and every 10 minutes for Target Area observation, respectively.



(Left) Sea Surface Temperature analysed with observation data of satellites, buoys, ships. "SST > 26°C to a depth of 60 m" is one of the necessary conditions for TC development and genesis. (Right) Tropical cyclone heat potential: Total heat contents from sea surface down to the depth of the 26°C isotherm, operationally used as TC intensity guidance. Minimum threshold for rapid intensification of TC in the western North Pacific is around 40 kJ/cm2.

(Left) Deterministic Track Prediction of global NWP model of BoM, MSC, CMA, DWD, KMA, UKMO, NCEP, ECMWF and JMA. Track prediction of specific NWP models can be selected for display. (Right) Ensemble Track Prediction of NCEP, UKMO, ECMWF and JMA.



(Left) Storm surge forecast derived from EPS for storm surge caused by TCs. The EPS runs for 6 possible TC tracks (RSMC Tokyo - Typhoon Center’s official track forecast and five selected ensemble members that cover a major set of TC track scenarios). (Right) Ocean Wave Height produced by Wave Ensemble System of JMA.

**Deterministic NWP models used in the Numerical Typhoon Prediction website**

| System | Domain | Horizontal Resolution | Number of Vertical Levels | Forecast Range (Initial Time) | Specification of (Model/Data) |
| --- | --- | --- | --- | --- | --- |
| JMA deterministic Global model  (GSM) | Global | TL959 (~20 km) | 100 | 132 hours (00, 06, 18 UTC)  264 hours (12 UTC) | Model |
| BoM deterministic Global model (ACCESS-G) | Global | Lon: 0.35°  Lat: 0.23° | - | 240 hours  (00, 12UTC) | Data |
| CMA deterministic Global model (GRAPES\_GFS) | Global | 0.28° | - | 120 hours  (00, 12, UTC) | Data |
| CMC deterministic Global model (GDPS) | Global | 1.0° | - | 144 hours (00, 12UTC) | Data |
| DWD deterministic Global model (GME) | Global | 0.25° | - | 174 hours  (00, 12UTC) | Data |
| ECMWF deterministic Global model (IFS-HRES) | Global | 0.5° | - | 240 hours (00, 12 UTC) | Data |
| KMA deterministic Global model (GDAPS) | Global | Lon: 0.23°  Lat: 0.16° | - | 168 hours (00, 12UTC), | Data |
| NCEP deterministic Global model (GFS) | Global | 0.5° | - | 192 hours (00, 06, 12, 18 UTC) | Data |
| UKMO deterministic Global model | Global | Lon: 0.83°  Lat: 0.56° | - | 120 hours (00, 12 UTC) | Data |

**EPS used in the Numerical Typhoon Prediction website**

| System | Domain | Horizontal Resolution | Number of Vertical Levels | Forecast Range (Initial Time) | Number of Ensemble Members | Specification of (Model/ Data) |
| --- | --- | --- | --- | --- | --- | --- |
| JMA Global EPS (GEPS) | Global | TL479 (~40 km) | 100 | 132 hours[[9]](#footnote-9) (06, 18 UTC)  264 hours (00, 12 UTC) | 27 | Model |
| ECMWF Global EPS | Global | Only track data | - | 240 hours (00, 12 UTC) | 52 | Data |
| NCEP Global EPS | Global | 1.0° | - | 384 hours (00, 06, 12, 18 UTC) | 21 | Data |
| UKMO Global EPS | Global | Only track data | - | 168 hours (00, 06, 12, 18 UTC) | 36 | Data |

## Annex 3-7

**66**

**APENDIX 3-B**

**Analysis methods, forecasting methods and NWP for forecasting currently used by the NMSs of Typhoon Committee Members**

Name of the Member: **[China]**

**1 Tropical Cyclone Analysis**

| Parameter | Time | Methods | Other Sources |
| --- | --- | --- | --- |
| Dvorak Intensity (CI, T, DT, PT, MET number) | 00, 06, 12, 18 UTC | Dvorak EIR method (Dvorak, 1984) | Satellite observational data from FY-4 (AGRI images, GIIRS sounding data) and FY-3 (Atmospheric vertical temperature profile), other available satellite microwave and sounding data |
| Center Position, Accuracy of center position, Direction and speed of movement | 00, 03, 06, 09, 12, 15, 18, 21 UTC | Satellite images and other estimation methods which utilize surface observations |  |
| Central Pressure (CP), Maximum Sustained Wind speed (MSW), Maximum Gust Wind speed (MGW), 50 kt radii (R50), 30 kt radii (R30) | 00, 03, 06, 09, 12, 15, 18, 21 UTC | (1) Conversion from Dvorak method (Dvorak, 1984) (for CP, MSW and MGW)  (2) Weather map analysis with full utilization of all observational data available (SYNOP, SHIP, BUOY, ASCAT, AMV including sea surface wind estimated from low-level AMV)  (3) Statistical relationship between MSW and R50 selected by TC size |  |

**2 Tropical Cyclone Forecasting**

| Parameter | Issuance Time | Lead Time | Methods |
| --- | --- | --- | --- |
| Likelihood of development of organized convective cloud systems into TSs | 00, 06, 12, 18 UTC | 24 hours | (1) Dvorak Intensity  (2) 850 hPa and 200 hPa streamlines of deterministic Global NWP models and Ensemble Prediction Systems (EPSs) of major centers (e.g. GRAPES, ECMWF, NCEP and UKMO)  (3) 850 hPa and 200 hPa streamlines of deterministic regional NWP models and EPS of GRAPES |
| Center position, Direction and speed of movement, Radius of probability circle | 00, 06, 12, 18 UTC | 24, 48, 72, 96, 120 hours | Center position, Direction and speed of movement:  (1) Simple consensus method using deterministic Global NWP models of GRAPES and other major centers such as ECMWF, NCEP and UKMO  (2) Global EPSs of GRAPES, ECMWF, NCEP and UKMO as reference  (3) Deterministic regional NWP models of GRAPES\_TYM, Shanghai GRAPES Typhoon Model (SGTM), STI - Typhoon Ensemble Data Assimilation and Prediction System (STI-TEDAPS) as reference  (4) OBEST method (a consensus method using EPSs of ECMWF, NCEP and UKMO (Dong and Zhang; 2016,Qi et al, 2014), STI Shanghai Selective Tropical Cyclone (STI-SSTC) , STI- western North Pacific tropical cyclone intensity prediction scheme (STI-WIPS)  Radius of probability circle:  Verification results of past TC track errors according to the ensemble spread of the Global EPSs of GRAPES, ECMWF, NCEP and UKMO (Chen et al, 2018). |
| CP, MSW, MGW, R50 | 00, 06, 12, 18 UTC | 24, 48, 72, 96, 120 hours | CP, MSW and MGW:  (1) Statistical and dynamical guidance (Chen et al, 2018)  (2) Deterministic Global NWP models of GRAPES and other major centers such as ECMWF, NCEP and UKMO as reference  (3) Deterministic Regional NWP models of GRAPES as reference  R50:  MSW-R50 development curve determined by TC size |

**3 NWP Systems in Operational Use**

| System | Domain | Horizontal Resolution | Number of Vertical Levels | Forecast Range (Initial Time) | Number of Ensemble Members | Run by  (own/other centers) |
| --- | --- | --- | --- | --- | --- | --- |
| GRAPES-GFS | Global | 0.25° | 60 | 240h  (00,06,12,18UTC) | \_ | Own |
| GRAPES-GEPS | Global | 0.5° | 60 | 240h  (00,12UTC) | 31 | Own |
| GRAPES\_TYM | 40-180.°E;  15°S-60.0°N | 0.09° | 68 | 120h  (00,06,12,18UTC) | \_ | Own |
| GRAPES-REPS | 70-145°E;15-65°N | 0.1° | 50 | 84h  (00,12UTC) | 15 | Own |
| GRAPES-MESO-3km | 70-145°E  10-60°N | 0.03° | 50 | 36h  (00,06,12,18UTC) | \_ | Own |
| Shanghai GRAPES Typhoon Model (SGTM) | West Pacific Ocean and South China Sea | 0.1° | 50 | up to 72h, interval is 6h | \_ | Own |
| STI - Typhoon Ensemble Data Assimilation and Prediction System (STI-TEDAPS) | West Pacific Ocean and South China Sea | 27 km | 35 | up to 72h, interval is 6h | 21 | Own |
| TRAMS | Longitude:  (70°E-160°E)  Latitude:  (0.8N-54.8°N) | 0.09°  (horizontal grids: 1001 x 601) | 65 | 168hours  (00,12 UTC)  72hours  (06,18 UTC) | \_ | Own |

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Name of the Member: **[Hong Kong, China]**

**1 Tropical Cyclone Analysis**

| Parameter | Time | Methods | Other Sources |
| --- | --- | --- | --- |
| 1. Position, direction and speed of movement 2. Intensity (maximum sustained 10-minute mean wind near TC centre) 3. Central pressure, Wind radii (of strong, gale, storm and hurricane force winds) 4. Wind radii (of strong, gale, storm and hurricane force winds) | Synoptic hour in general (also subject to observation reception time) | 1. Position, direction and speed of movement:    * Satellite imagery    * Radar imagery (reflectivity, zero-isodop on Doppler velocity)    * Weather observation from synoptic stations, automatic weather stations, oil rigs and weather buoys 2. Intensity:    * Dvorak analysis on satellite imagery    * Radar imagery (Doppler wind)    * Weather observation from synoptic stations, automatic weather stations, oil rigs and weather buoys    * Dropsonde observations from reconnaissance flight 3. Central pressure:    * Pressure observation from synoptic stations, automatic weather stations, oil rigs and weather buoys 4. Wind radii:    * Weather observation from synoptic stations, automatic weather stations, oil rigs and weather buoys    * Dropsonde observations from reconnaissance flight | (a) ASCAT observations for analysing position, intensity and wind radii.  (b) NRL Microwave images for analysing position.  (c) NOAA Multiplatform Tropical Cyclone Surface Winds Analysis for analysing intensity and wind radii. |

**2 Tropical Cyclone Forecasting**

| Parameter | Issuance Time | Lead Time | Methods |
| --- | --- | --- | --- |
| Track | Around 1 to 2 hour from the synoptic hour (T) | Forecast positions for:  T + 24 h  T + 48 h  T + 72 h  T + 96 h  T + 120 h | Weighted ensemble forecast track is generated from 5 NWP guidance including JMA, UKMO, NCEP, ECMWF and ECMWF EPS. The ensemble forecast track forms the basis for formulating the operational TC forecast track. The operational TC forecast track may be slightly adjusted considering other NWP guidance (e.g. EPS products from CMC, KMA, JMA, NCEP and UKMO), real-time observations and past NWP performance. |
| Intensity (maximum sustained wind) | Around 1 to 2 hour from the synoptic hour (T) | Forecast intensity for:  T + 24 h  T + 48 h  T + 72 h  T + 96 h  T + 120 h | The intensity forecast makes reference to the NWP intensity guidance products from ECMWF, JMA, NCEP, UKMO, NOAA HWRF, TWRF, and Meso-NHM of HKO.  Factors such as rapid intensification chance deduced from statistical dynamical TC intensity forecast model, and environmental parameters such as sea surface temperature, wind shear, the ocean heat potential and land interactions are also considered in formulating the intensity forecast. |

**3 NWP Systems in Operational Use**

| System | Domain | Horizontal Resolution | Number of Vertical Levels | Forecast Range (Initial time) | Number of Ensemble Members | Run by  (own/other centers) |
| --- | --- | --- | --- | --- | --- | --- |
| ECMWF deterministic Global model | Global | 0.1° | - | 240 hours (00, 12 UTC)  90 hours  (06, 18 UTC) | N. A. | Other |
| ECMWF Global EPS | Global | Only TC track and intensity data | - | 240 hours (00, 12 UTC) | 52 | Other |
| ECMWF Global EPS | Global | Ensemble member forecasts on surface and isobaric levels with horizontal resolution of 0.25 / 0.5° covering selected domains | - | 360 hours | 52 | Other |
| NCEP deterministic Global model | Global | 0.25° | - | 384 hours (00, 06, 12, 18 UTC) | N.A. | Other |
| NCEP Global EPS | Global | Only TC track and intensity data | - | 384 hours (00, 06, 12, 18 UTC) | 21 | Other |
| NCEP deterministic regional model (HWRF) | Domain based on the initial position of the TC | Only TC track and intensity data | - | Up to 126 hours (00, 06, 12, 18 UTC) | N.A. | Other |
| JMA deterministic Global model | Global | 0.25° | - | 132 hours (00, 06, 18 UTC)  264 hours (12 UTC) | N.A. | Other |
| JMA Global EPS (GEPS) | Global | Only TC track and intensity data | - | 132 hours | 27 | Other |
| UKMO deterministic Global model | Global | Lon: 0.23°  Lat: 0.16° | - | 144 hours (00, 12 UTC) | N.A. | Other |
| UKMO Global EPS | Global | Only TC track and intensity data | - | 192 hours (00, 06, 12, 18 UTC) | 36 | Other |
| CMA deterministic Global model | Global | 0.25° | - | 240 hours (00, 12 UTC) | N.A. | Other |
| CMA Global EPS | Global | Only TC track and intensity data | - | 240 hours (00, 12 UTC) | 16 | Other |
| CMC deterministic Global model | Global | 0.24° | - | 240 hours (00, 12 UTC) | N.A. | Other |
| CMC Global EPS | Global | Only TC track data | - | 240 hours (00, 12 UTC) | 21 | Other |
| KMA deterministic Global model | Global | 0.35° | - | 240 hours (00, 12 UTC) | N.A. | Other |
| Meso-NHM | NW: 38.61°N 62.05°E  NE: 37.48°N 168.13°E  SW: 0.91°N 84.42°E  SE: 0.39°N 145.23°E | 10 km | 50 | 72 hours | 1 | Own |
| RAPIDS-NHM | NW: 25.01°N 111.22°E  NE: 25.01°N 117.13°E  SW: 19.54°N 111.22°E  SE: 19.54°N 117.13°E | 2 km | 60 | 15 hours | 1 | Own |

**Meso-NHM and RAPIDS-NHM**

**Name of the method:**

Non-Hydrostatic Model (NHM)

**Description of the method:**

HKO operates the NHM system based on JMA-NHM (Saito *et al.* 2006) with horizontal resolution at 10-km and 2-km to provide forecasts up to 72 hours and 15 hours ahead respectively (Wong 2010).

In NHM, a 3-dimensional variational data assimilation (3DVAR) system is used to generate the initial condition on model levels using the following meteorological observations:

|  |  |  |
| --- | --- | --- |
| (A) | GTS |  |
|  | SYNOP, SHIP and BUOY | synoptic stations, ship and buoy data |
|  | TEMP and PILOT | radiosonde and pilot data |
|  | AMDAR and AIREP | aircraft data |
|  | AMV | atmospheric motion vectors from Himarwai-8 |
|  | ATOVS | retrieved temperature profiles from NOAA |
|  | Ocean surface wind | scatterometer wind retrieval data from ASCAT, RAPID-SCAT and HY2A |
|  | Dropsonde | tropical cyclone wind observations from DOTSTAR |
|  | IASI | temperature and humidity retrieval profile data from EUMETSAT Metop IASI (Infrared Atmospheric Sounding Interferometer) |
|  |  |  |
| (B) | Regional data exchange |  |
|  | Data from automatic weather stations over the south China coastal areas | |
|  |  |  |
| (C) | Local data |  |
|  | (i) Automatic weather station data | |
|  | (ii) Wind profiler data | |
|  | (iii) Doppler weather radar data | |
|  | (iv) Radar retrieved wind data (u and v) on 1-5 km levels based on multiple weather radars in Hong Kong and the Pearl River Delta region, China | |
|  | (v) GNSS total precipitable water vapour | |
|  |  |  |

The 3DVAR analysis for 10-km NHM is produced eight times a day at 00, 03, 06, 09, 12, 15, 18, and 21 UTC. Hourly analysis is performed for the 2-km NHM.

Specifications of the forecast model are given in the following table:

|  |  |
| --- | --- |
| Basic equations | Fully compressible non-hydrostatic governing equations |
| Vertical coordinates | Terrain following height coordinates system |
| Forecast parameters | wind (u,v,w), 3-dimensional pressure, potential temperature, specific humidity of water vapour, cloud water, cloud ice, rain water, hail/graupel and snow |
| Map projection | 10-km NHM: Lambert Conformal  2-km NHM: Mercator |
| Number of grid points | 10-km NHM: 841x515, 50 levels  2-km NHM: 305x305, 60 levels |
| Corners of the model domain | 10-km NHM:  NW: 38.61°N 62.05°E  NE: 37.48°N 168.13°E  SW: 0.91°N 84.42°E  SE: 0.39°N 145.23°E  2-km NHM:  NW: 25.01°N 111.22°E  NE: 25.01°N 117.13°E  SW: 19.54°N 111.22°E  SE: 19.54°N 117.13°E |
| Forecast range | 10-km NHM: 72 hours  2-km NHM: 15 hours |
| Initial condition | Analysis from NHM 3DVAR on model levels |
| Boundary condition | For 10-km NHM, 3-hourly interval boundary data including horizontal wind, temperature, relative humidity, geopotential height and surface pressure from ECMWF IFS forecast at horizontal resolution of 0.125 degree in latitude/longitude and on 25 pressure levels (1000, 950, 925, 900, 850, 800, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10, 7, 5, 3, 2 and 1 hPa)  For 2-km NHM, 3-hourly interval boundary data provided from ECMWF IFS forecasts |
| Nesting configuration | One-way nesting |
| Topography and land-use | USGS GTOPO30 (30 second data smoothed to 1.5 times of horizontal resolution)  USGS Global Land Cover Characterization (GLCC) 30 second data |
| Dynamics | Non-hydrostatic governing equations solved by time-splitting horizontal-explicit-vertical-implicit (HEVI) scheme using 4-order centred finite difference in flux form |
| Moisture process | Tiedtke based bulk mass flux convective parameterization (HKO version)  Three ice bulk microphysics scheme |
| Surface process | Flux and bulk coefficients: Land: Beljaars and Holtslag (1991)  Sea: Wong, Sumdin and Lai (2010)  Stomatal resistance and temporal change of wetness included  4-layer soil model to predict ground temperature and surface heat flux. |
| Turbulence closure model and planetary boundary layer process | Mellor-Yamada-Nakanishi-Niino Level 2.5 (MYNN-2.5) (Nakanishi and Niino, 2004) with partial condensation scheme (PCS) and implicit vertical turbulent solver. Height of PBL calculated from virtual potential temperature profile. |
| Radiation | Long wave radiation process follows Kitagawa (2000)  Short wave radiation process using Yabu and Kitagawa (2005)  Prognostic surface temperature included; Cloud fraction determined from PCS. |

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Name of the Member: **[Japan]**

1 Tropical Cyclone Analysis

| Parameter | Time | Methods | Other Sources |
| --- | --- | --- | --- |
| Dvorak Intensity (CI, T, DT, PT, MET number) | 00, 06, 12, 18 UTC | Dvorak EIR method (Dvorak, 1984) and Early Dvorak Analysis (EDA: Tsuchiya et al., 2001 and Kishimoto, 2008) |  |
| Center Position, Accuracy of center position, Direction and speed of movement | 00, 03, 06, 09, 12, 15, 18, 21 UTC | Satellite images and other estimation methods which utilize surface observations |  |
| Central Pressure (CP), Maximum Sustained Wind speed (MSW), Maximum Gust Wind speed (MGW), 50 kt radii (R50), 30 kt radii (R30) | 00, 03, 06, 09, 12, 15, 18, 21 UTC | (1) Conversion from Dvorak method (Koba et al., 1991) (for CP, MSW and MGW)  (2) Weather map analysis with full utilization of all observational data available (SYNOP, SHIP, BUOY, ASCAT, AMV including sea surface wind estimated from low-level AMV (Nonaka et al., 2019), etc.)  (3) Statistical relationship between MSW and R50 selected by TC size | CPs estimated from TC warm core intensities observed by the Advanced Microwave Sounding Unit-A (AMSU-A) (Oyama, 2014) and MSW estimated from multi-channel microwave imager data (Sakuragi et al., 2014, Hoshino and Nakazawa, 2007) |

**2 Tropical Cyclone Forecasting**

| Parameter | Issuance Time | Lead Time | Methods |
| --- | --- | --- | --- |
| Likelihood of development of organized convective cloud systems into TSs | 00, 06, 12, 18 UTC | 24 hours | (1) EDA  (2) 850 hPa and 200 hPa streamlines of deterministic Global NWP models and Ensemble Prediction Systems (EPSs) of major centers (e.g. JMA, ECMWF, NCEP and UKMO)  (3) 850 hPa and 200 hPa streamlines of deterministic regional NWP models and EPS of JMA |
| Center position, Direction and speed of movement, Radius of probability circle | 00, 06, 12, 18 UTC | 24, 48, 72, 96, 120 hours | Center position, Direction and speed of movement:  (1) Simple consensus method using deterministic Global NWP models of JMA and other major centers such as ECMWF, NCEP and UKMO  (2) Global EPSs of JMA, ECMWF, NCEP and UKMO as reference  (3) Deterministic regional NWP models of JMA and NCEP as reference  Radius of probability circle:  Verification results of past TC track errors according to the ensemble spread of the Global EPSs of JMA, ECMWF, NCEP and UKMO (Fukuda and Yamaguchi, 2019). |
| CP, MSW, MGW, R50 | 00, 06, 12, 18 UTC | 24, 48, 72, 96, 120 hours | CP, MSW and MGW:  (1) Statistical and dynamical guidance (TIFS: Yamaguchi et al., 2018)  (2) Deterministic Global NWP models of JMA and other major centers such as ECMWF, NCEP and UKMO as reference  (3) Deterministic Regional NWP models of JMA and NCEP as reference  R50:  MSW-R50 development curve determined by TC size |

**3 NWP Systems in Operational Use**

| System | Domain | Horizontal Resolution | Number of Vertical Levels | Forecast Range  (Initial Time) | Number of Ensemble Members | Run by (own/other centers) |
| --- | --- | --- | --- | --- | --- | --- |
| JMA deterministic Global model | Global | TL959 (~20 km) | 100 | 132 hours (00, 06, 18 UTC)  264 hours (12 UTC) | - | Own |
| JMA Global EPS | Global | TL479 (~40 km) | 100 | 132 hours[[10]](#footnote-10) (06, 18 UTC)  264 hours (00, 12 UTC) | 27 | Own |
| JMA deterministic regional model (Meso-scale Model: MSM) | Japan and its surrounding areas | 5 km  (horizontal grids: 817 x 661) | 76 | 39 hours  (03, 06, 09, 15, 18, 21 UTC)  51 hours  (00, 12 UTC) | - | Own |
| JMA regional EPS | Japan and its surrounding areas | 5 km  (horizontal grids: 817 x 661) | 76 | 39 hours  (00, 06, 12, 18 UTC) | 21 | Own |
| JMA deterministic regional model (Local Forecast Model: LFM) | Japan and its surrounding areas | 2 km  (horizontal grids: 1531 x 1301) | 58 | 10 hours (Every hour) | - | Own |
| ECMWF deterministic Global model | Global | 0.5° | - | 240 hours (00, 12 UTC) | - | Other |
| ECMWF Global EPS | Global | Only track data | - | 240 hours (00, 12 UTC) | 52 | Other |
| NCEP deterministic Global model | Global | 0.5° | - | 192 hours (00, 06, 12, 18 UTC) | - | Other |
| NCEP Global EPS | Global | 1.0° | - | 384 hours (00, 06, 12, 18 UTC) | 21 | Other |
| NCEP deterministic regional model (HWRF) | Domain based on the initial position of the TC | Only track and intensity data | - | Up to 126 hours (00, 06, 12, 18 UTC) | - | Other |
| UKMO deterministic Global model | Global | Lon: 0.83°  Lat: 0.56° | - | 120 hours (00, 12 UTC) | - | Other |
| UKMO Global EPS | Global | Only track data | - | 168 hours (00, 06, 12, 18 UTC) | 36 | Other |

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Name of the Member: **[Macao, China]**

**1 Tropical Cyclone Analysis**

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Time | Methods | Other Sources |
| Dvorak Intensity (CI, T, DT, PT, MET number) | 00, 06, 12, 18 UTC | Dvorak EIR method (Dvorak, 1984) | / |
| Center Position, Direction and speed of movement | 00, 06, 12, 18 UTC | Satellite images , radar observations and other estimation methods which utilize surface observations | / |
| Central Pressure (CP), Maximum Sustained Wind speed (MSW) | 00, 06, 12, 18 UTC | (1) Conversion from Dvorak method (Koba et al., 1991) (for CP and MSW )  (2) Weather map analysis with full utilization of all observational data available (SYNOP, BUOY) | / |

**2 Tropical Cyclone Forecasting**

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Issuance Time | Lead Time | Methods |
| Center position, Direction and speed of movement | 00, 06, 12, 18 UTC | 24, 48, 72 hours | (1) Simple consensus method using deterministic NWP models of CMA, ECMWF, JMA and NCEP  (2) Global EPSs of ECMWF, JMA and NCEP as reference |

**3 NWP Systems in Operational Use**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| System | Domain | Horizontal Resolution | Number of Vertical Levels | Forecast Range (Initial Time) | Number of Ensemble Members | Run by  (own/other centers) |
| JMA deterministic Global model  (GSM) | Global | TL959 (~50 km) | 11 | 84 hours (00, 06, 18 UTC)  264 hours (12 UTC) | - | Other |
| ECMWF deterministic Global model | Global | 0.25° | - | 240 hours (00, 12 UTC) | - | Other |
| ECMWF Global EPS | Global | Only track data | - | 240 hours (00, 12 UTC) | 50 members  1 high resolution  1 control | Other |
| NCEP deterministic Global model | Global | 0.25° | - | 240 hours (00, 06, 12, 18 UTC) | - | Other |
| NCEP Global EPS | Global | Only track data | - | - | - | Other |

Name of the Member: **[Malaysia]**

**1 Tropical Cyclone Analysis**

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Time | Methods | Other Sources |
| Center Position, Accuracy of center position, Direction & speed of movement | 00, 03, 06, 09, 12, 15, 18, 21 UTC | Satellite images, NWP products and other estimation methods which utilize surface observations | TC information such as central pressure, maximum sustained wind speed, maximum gust wind speed, R50 (50 kt radii), R30 (30 kt radii) from RSMC Tokyo |

**2 Tropical Cyclone Forecasting**

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Issuance Time | Lead Time | Methods |
| Track (center position, distance from nearest town, direction and speed of movement) | 01, 04, 07, 10, 13, 16, 19, 22 UTC | 6, 12, 18, 24 hours | Track (center position, distance from nearest town, direction and speed of movement) refer to RSMC-Tokyo, Japan for South China Sea and Northwest Pacific region, and RSMC-New Delhi, India for Bay of Bengal region. |

**3 NWP Systems in Operational Use**

| System | Domain | Horizontal Resolution | Number of Vertical Levels | Forecast Range (Initial Time) | Number of Ensemble Members | Run by  (own/other centers) |
| --- | --- | --- | --- | --- | --- | --- |
| Mesoscale Deterministic Model:  WRF driven by NCEP GFS model | **[9 km]:**  Lon: 82.27 - 135.18°E  Lat: 5.60°S - 31.34°N  **[3 km]:**  Lon: 97.15 - 121.03°E  Lat: 3.45°S - 8.39°N  **[1 km]:**  Lon: 99.55 - 119.39 °E  Lat: 0.53 – 7.44 °N | **[9 km]:**  655 x 479  **[3 km]:**  886 x 442  **[1 km]:**  2197 x 772 | 51 | 168 hours  (00, 06, 12, 18UTC) | - | Own |
| Mesoscale Deterministic Model:  WRF driven by UKMO model | **[9 km]:**  Lon: 82.27 - 135.18°E  Lat: 5.60°S - 31.34°N  **[3 km]:**  Lon: 97.15 - 121.03°E  Lat: 3.45°S - 8.39°N  **[1 km]:**  Lon: 99.55 -119.39°E  Lat: 0.53 -7.44 °N | **[9 km]:**  655 x 479  **[3 km]:**  886 x 442  **[1 km]:**  2197 x 772 | 51 | 60  (00, 06, 12, 18UTC) | - | Own |
| Mesoscale Ensemble Prediction System:  10-member WRF driven by NCEP GFS | Lon: 97.93 -121.45°E  Lat: 1.77°S - 11.95°N | **[12 km]:**  220 x 130 | 28 | 96 hours  (00, 12UTC) | - | Own |
| ECMWF deterministic Global model | Global | 0.5° | - | 240 hours (00, 12 UTC) | - | Other |
| NCEP deterministic Global model | Global | 0.5° | - | 192 hours (00, 06, 12, 18 UTC) | - | Other |
| JMA deterministic Global model  (GSM) | Global | TL959 (~20 km) | 100 | 132 hours (00, 06, 18 UTC)  264 hours (12 UTC) | - | Other |

Name of the Member: **[Philippines]**

**1 Tropical Cyclone Analysis**

| Parameter | Time | Methods | Other Sources |
| --- | --- | --- | --- |
| Dvorak Intensity (DT, PT, MET, FT and CI numbers) | 00, 06, 12, 18 UTC | * Dvorak EIR method (Dvorak 1984) * Early-stage Dvorak Analysis (Tsuchiya et al. 2001; Kishimoto 2008) | * Satellite fix bulletins from other NMSs via Numerical Typhoon Prediction website or GTS * CIMSS Advanced Dvorak Technique (ADT) (Olander and Velden 2007) |
| Center Position (PSTN), Movement Speed and Direction (MOVE) | 00, 03, 06, 09, 12, 15, 18, 21 UTC | * Estimation of low-level circulation center using a combination of satellite images, weather radar scans, and surface observations (SYNOP, SHIP, BUOY). | * Satellite fix bulletins from other NMSs via Numerical Typhoon Prediction website or GTS * CIMSS Automated Rotational Center Hurricane Eye Retrieval (ARCHER) (Wimmers and Velden 2010) |
| Central Pressure (PRES), Maximum Sustained Winds (MXWD), Maximum Gust (GUST), | 00, 03, 06, 09, 12, 15, 18, 21 UTC | * Conversion of CI number to PRES and MXWD (Koba et al. 1991) * Conversion of MXWD to GUST (Harper et al. 2010) * Weather map analysis using all available observation data (SYNOP, SHIP, BUOY, ASCAT) | * PRES estimates from warm core intensity observations of Advanced Microwave Sounding Unit (AMSU) (Oyama 2014) via Numerical Typhoon Prediction website * Weighted average of PRES analyses from Dvorak, AMSU and ATMS (Oyama et al. 2016) via Numerical Typhoon Prediction website * CIMSS Satellite Consensus (SATCON)(Herndon and Velden 2018) |
| Radius of 30-kt, 50-kt and 64-kt Winds (R30, R50, R64) | 00, 03, 06, 09, 12, 15, 18, 21 UTC | * Weather map analysis using all available observation data (SYNOP, SHIP, BUOY, ASCAT) | * Sea surface winds estimated from low-level AMV (Nonaka et al. 2019)via Numerical Typhoon Prediction website * NOAA/NESDIS Multiplatform Tropical Cyclone Surface Winds Analysis (MTCSWA) (Knaff and DeMaria 2010) * CIMSS real-time wind radii estimates based on Knaff et al. (2016) |

**2 Tropical Cyclone Forecasting**

| Parameter | Issuance Time | Lead Time | Methods |
| --- | --- | --- | --- |
| PSTN, MOVE | 00, 06, 12, 18 UTC | 24, 48, 72, 96, 120 hours | * Simple and selective (subjective) consensus method using global deterministic and EPS models of major centers via Numerical Typhoon Prediction website * Global EPSs of NCEP, ECMWF, JMA and UKMO via Numerical Typhoon Prediction website as reference * Regional deterministic NWP models of PAGASA, NCEP, and HKO as reference * Analysis of environmental steering using actual 00 and 12 UTC upper-air charts (single layer approach) and CIMSS satellite AMV-derived deep-layer mean streamlines (Velden and Leslie 1991; Velden 1993) |
| Category (i.e. TD, TS, STS, TY, STY, LOW, ETC) | 00, 06, 12, 18 UTC | 24, 48, 72, 96, 120 hours | * Bias-corrected intensity prediction using weighted analog technique (Tsai and Elsberry 2014) as baseline intensity guidance * Global deterministic models from major NWP centers via GTS as reference * Regional deterministic NWP models of PAGASA, NCEP, and HKO as reference |
| Radius of 70% Probability Circle | 00, 06, 12, 18 UTC | 24, 48, 72, 96, 120 hours | * Based on the direct positional error corresponding to cumulative ratio of 70% over the last 5 typhoon seasons. |

If landfalling or passing to within 100 km of Philippine coastline, additional forecasts are made at 03, 09, 15, and 21 UTC.

**3 NWP Systems in Operational Use**

| System | Domain | Horizontal Resolution | Number of Vertical Level | Forecast Range (Initial Time) | Number of Ensemble Members | Run by  (own/other centers) |
| --- | --- | --- | --- | --- | --- | --- |
| PAGASA Regional Deterministic Model (WRF-ARW) | 3°N-25°N  115°E-135°E | 12 km (182 x 214 grids) | 42 | 144 hours  (00, 03, 06, 09, 12, 15, 18, 21 UTC) | - | Own |
| PAGASA Regional Deterministic Model (WRF-ARW) | 5°N-21°N  116°E-127°E | 3 km (361 x 593 grids) | 42 | 48 hours  (00, 03, 06, 09, 12, 15, 18, 21 UTC) | - | Own |
| JMA Global Deterministic Model | Global | Trackand intensitydata only | - | 132 hours  (00, 06, 18 UTC)  264 hours  (12 UTC) | - | Other |
| NCEP Global Deterministic Model | Global | Track data only | - | 192 hours  (00, 06, 12, 18 UTC) | - | Other |
| ECMWF Global Deterministic Model | Global | Track data only | - | 240 hours  (00, 12 UTC) | - | Other |
| UKMO Global Deterministic Model | Global | Trackand intensity data only | - | 120 hours  (00, 12 UTC) | - | Other |
| KMA Global Deterministic Model | Global | Trackand intensity data only | - | 168 hours  (00, 12 hours) | - | Other |
| BoM Global Deterministic Model | Global | Trackand intensity data only | - | 240 hours  (00, 12 UTC) | - | Other |
| CMC Global Deterministic Model | Global | Track data only | - | 144 hours  (00, 12 UTC) | - | Other |
| CMA Global Deterministic Model | Global | Track data only | - | 120 hours  (00, 12 UTC) | - | Other |
| DWD Global Deterministic Model | Global | Track data only | - | 84 hours  (00, 12 UTC) | - | Other |
| JMA Global EPS | Global | Track and intensity data only | - | 132 hours  (06, 18 UTC)  264 hours  (00, 12 UTC) | 27 | Other |
| NCEP Global EPS | Global | Track data only | - | 384 hours  (00, 06, 12, 18 UTC) | 21 | Other |
| ECMWF Global EPS | Global | Track data only | - | 240 hours  (00, 12 UTC) | 52 | Other |
| UKMO Global EPS | Global | Track data only | - | 168 hours  (00, 06, 12, 18 UTC) | 36 | Other |
| NCEP Regional Deterministic Model (HWRF) | Based on the initial position of the TC | Track and intensity data only | - | 126 hours  (00, 06, 12, 18 UTC) | - | Other |
| HKO Regional Deterministic Model (NHM) | 8°N-46.5°N  85°E-148°E | Track and intensity data only | - | 72 hours  (00, 06, 12, 18 UTC) | - | Other |

**Note:** Apart from HWRF, deterministic and EPS model forecasts from other centers are made available via the JMA Numerical Typhoon Prediction website (https://tynwp-web.kishou.go.jp/) or the WMO Global Telecommunication System (GTS). HWRF forecasts are available via the HWRF Forecast Guidance website (https://www.emc.ncep.noaa.gov/gc\_wmb/vxt/HWRF/index.php)

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Name of the Member: **[Republic of Korea]**

**1 Tropical Cyclone Analysis**

| Parameter | Time | Methods | Other Sources |
| --- | --- | --- | --- |
| Center Position, Central pressure, Maximum sustained wind speed, Direction and speed of movement, 15 m/s radii, 25 m/s radii | 00, 06, 12, 18  UTC | (1) Satellite images (ASCAT, OSCAT etc) and other estimation methods which utilize surface observations (SYNOP, SHIP, BUOY, AWS, Radar)  (2) Dvorak technique for center pressure and maximum sustained wind speed estimates (Dvorak, 1984, Koba et al., 1991) |  |

**2 Tropical Cyclone Forecasting**

| Parameter | Issuance Time | Lead Time | Methods |
| --- | --- | --- | --- |
| Likelihood of development of organized convective cloud systems into TSs | 00, 06,  12, 18  UTC | 24 hours | 1. EDA 2. Consensus method using deterministic Global NWP model (GDAPS, ECMWF, NECP, JMA etc.) 3. 850 hPa and 200 hPa streamlines and steering flow of NWP models as reference |
| Center position, Direction and speed of movement, Radius of probability circle, Central pressure , Maximum sustained wind speed,  15 m/s radii, 25 m/s radii | 00, 06,  12, 18  UTC | 12, 24, 36, 48, 72, 96, 120 hours | Center position, direction and speed of movement :  (1) Consensus method using KMA Global Data Assimilation and Prediction System (GDAPS) and other deterministic Global model (ECMWF, JMA, NCEP, etc.) (2) Global EPS (EPSG, ECMWF, JMA, NCEP, etc.) as reference  (3) Steering flow and Synoptic field as reference  Radius of probability circle:  Expected TC locations with a probability of 70% at each lead time for the latest 3 years  Central pressure, maximum sustained wind speed:  (1) KMA Global Data Assimilation and Prediction System (GDAPS) , other deterministic Global model (ECMWF, JMA, NCEP, etc.), Global EPS (EPSG, ECMWF, JMA, NCEP, etc.) and NCEP deterministic regional model (HWRF) as reference  (2) Analysis of Sea Surface Temperature and Ocean heat content  (3) Wind shear of NWP model |

**3 NWP Systems in Operational Use**

| System | Domain | Horizontal Resolution | Number of Vertical Levels | Forecast Range (Initial Time) | Number of Ensemble Members | Run by  (own/other centers) |
| --- | --- | --- | --- | --- | --- | --- |
| KMA Global Data Assimilation and Prediction System (GDAPS) | Global | ~10 km | 70 | 288 hours (00,12 UTC)  87 hours (06, 18 UTC) | - | Own |
| KMA Global EPS (EPSG) | Global | ~32 km | 70 | 288 hours (00,12 UTC) | 48 | Own |
| ECMWF deterministic Global model | Global | 16 km | - | 240 hours (00, 12 UTC) | - | Other |
| ECMWF Global EPS | Global | track data and intensity data | - | 240 hours (00, 12 UTC) | 51 | Other |
| JMA deterministic Global model  (GSM) | Global | ~20 km | 100 | 132 hours (00, 06,  18 UTC)  264 hours (12 UTC) | - | Other |
| JMA Global EPS (GEPS) | Global | ~40 km | 100 | 132 hours (06, 18 UTC)  264 hours (00, 12 UTC) | 27 | Other |
| NCEP deterministic Global model (GFS) | Global | 1.0° | - | 168 hours (00, 06,  12, 18 UTC) | - | Other |
| NCEP Global EPS | Global | 1.0° | - | 240 hours (00, 06,  12, 18 UTC) | 21 | Other |
| NCEP deterministic regional model (HWRF) | Regional | track and intensity data | - | Up to 126 hours  (00, 06,  12, 18 UTC) | - | Other |
| Navy Global Environmental Model (NavGEM) | Global | track and intensity data |  | 144 hours  (00,12 UTC) |  | Other |

## Annex 3-8

**APPENDIX 4-C**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Station | | | Call sign of coastal radio station | | Area covered | |
| Member | Station | |
| China | Shanghai | XSG | | Bohai Sea, Huanghai Sea, Donghai Sea, Shanghai Port, Taiwan Straits and sea around Taiwan province | |
| Tianjin | XSZ | | North and Central Huanghai Sea and Bohai Sea | |
| Guangzhou | XSQ | | Taiwan Straits, Bashi Channel, South China ~~Nanhai~~ Sea and Beibu Wan Gulf | |
| Hong Kong, China | Hong Kong | Broadcast via NAVTEX on 518 kHz[[11]](#footnote-11) | | Waters inside the boundary line: 30°N 105°E to 30°N 125°E to 10°N 125°E, to 10°N 105°E, to 30°N 105°E | |
| Japan | Hokkaido | JNL | | Hokkaido area | |
| Shiogama | JNN | | Sendai area | |
| Yokohama | JGC | | Tokyo area | |
| Nagoya | JNT | | Nagoya area | |
| Kobe | JGD | | Kobe area | |
| Hiroshima | JNE | | Hiroshima area | |
| Niigata | JNV | | Niigata area | |
| Maizuru | JNC | | Maizuru area | |
| Moji | JNR | | Fukuoka area | |
| Kagoshima | JNJ | | Kagoshima area | |
| Okinawa | JNB | | Okinawa area | |
| Malaysia | Klang | SSB 5 | | Strait of Malacca | |
| Labuan | SSB 16 | | South China Sea | |
| Kuching | SSB 5 | | South China Sea | |
| Philippines | Manila | DZR, DZG, DSP, DZD, DZF, DFH, DZO, DZN, DZS | | Pacific waters inside the boundary line: 25°N 12°0E to 25°N 135°E, to 5°N 135°E, to 5°N 115°E, to 15°N 115°E, to 21°N 120°E, to 20°N 120°E | |
| San Miguel | NPO | | North Pacific waters east of 160°E; Philippine Sea, Japan Sea, Yellow Sea, East China Sea, South China Sea | |
| Republic of Korea | Seoul | HLL | | East Sea, Yellow Sea, Jeju, Chusan, Nagasaki, and Kagoshima areas | |
| Thailand | Bangkok | HSA | | Gulf of Thailand, West coast of Southern Thailand, Strait of Malacca and South China Sea | |
| U.S.A. | Honolulu, Hawaii | KMV-99 | | Pacific Ocean | |
| Viet Nam | Dannang | XVT 1-2 | | Basco Gulf, Blendong Sea and Gulf of Thailand | |
| Halphong | XVG 5, 9 | | *ditto* | |
| Ho Chi Minh Ville | XVS 1, 3, 8 | | *ditto* | |
| Nha Trang | XVN 1, 2 | | *ditto* | |

**STATIONS BROADCASTING CYCLONE WARNINGS FOR SHIPS ON THE HIGH SEAS**

## Annex 4

**Proposed new format for satellite imagery receiving facilities (Appendix 2-G) for 2021 edition**

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**APPENDIX 2-G**

**SATELLITE IMAGERY RECEIVING FACILITIES AT TYPHOON COMMITTEE MEMBERS**

| **Member** | **Station** | | **FengYun-2** | **FengYun-3** | **FengYun-4** | **FengYun-2/3/4** | **Himawari-8/9** | | **GEO-KOMPSAT-2A** | **NOAA/JPSS** | **AQUA/TERRA** | **METOP** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Direct Broadcast** | **Direct Broadcast** | **Direct Broadcast** | **CMAcast** | **HimawariCast** | **HimawariCloud** | **Direct Broadcast** | **Direct Broadcast** | **Direct Broadcast** | **Direct Broadcast** |
| Cambodia |  |  |  |  |  |  | ✔ |  |  |  |  |  |
| China | Beijing | 39.9°N, 116.4°E | ✔ | ✔ | ✔ | ✔ |  | ✔ |  | ✔ |  |  |
| DPR Korea | Pyongyang | 39.0°N, 125.8°E |  |  |  |  |  |  |  | ✔ |  |  |
| Hong Kong, China | Kowloon | 22.3°N, 114.2°E | ✔ |  |  |  | ✔ |  |  | ✔ | ✔ |  |
| Japan | Minamitorishima | 24.3°N, 154.0°E |  |  |  |  | ✔ |  |  |  |  |  |
| Lao PDR |  |  |  |  |  |  | ✔ |  |  |  |  |  |
| Macao, China | Macao | 22.2°N, 113.5°E | ✔ |  |  |  | ✔ |  |  | ✔ |  |  |
| Malaysia | Petaling Jaya | 3.1°N, 101.7°E |  |  |  |  | ✔ |  |  | ✔ |  |  |
| Philippines | Quezon City | 14.7°N, 121.0°E |  |  |  |  | ✔ |  |  | ✔ |  |  |
| Cagayan de Oro City | 8.5°N, 124.6°E |  |  |  |  |  |  |  |  |  |  |
| Pasay City | 14.5°N, 121.0°E |  |  |  |  |  |  |  |  |  |  |
| Cebu | 10.3°N, 124.0°E |  |  |  |  |  |  |  |  |  |  |
| Republic of Korea | Seoul | 37.6°N, 127.0°E |  |  |  |  | ✔ |  |  | ✔ | ✔ |  |
| Incheon Int. Airport | 37.3°N, 126.3°E |  |  |  |  |  |  |  |  |  |  |
| Munsan | 37.9°N, 126.8°E |  |  |  |  |  |  |  |  |  |  |
| Seosan | 36.8°N, 126.5°E |  |  |  |  |  |  |  | ✔ |  |  |
| Pusan | 35.1°N, 129.0°E |  |  |  |  |  |  |  |  |  |  |
| Pusan Kimhae Air | 35.2°N, 126.9°E |  |  |  |  |  |  |  |  |  |  |
| Kwangju | 35.2°N, 126.9°E |  |  |  |  |  |  |  |  |  |  |
| Taejon | 36.4°N, 127.4°E |  |  |  |  |  |  |  |  |  |  |
| Kangnung | 37.5°N, 130.9°E |  |  |  |  |  |  |  |  |  |  |
| Cheju | 33.5°N, 126.5°E |  |  |  |  |  |  |  |  |  |  |
| Taegu | 35.9°N, 128.6°E |  |  |  |  |  |  |  |  |  |  |
| Taegu/Air Traffic | 35.9°N, 128.7°E |  |  |  |  |  |  |  |  |  |  |
| Chonju | 35.8°N, 127.2°E |  |  |  |  |  |  |  |  |  |  |
| Chongju | 36.6°N, 127.4°E |  |  |  |  |  |  |  |  |  |  |
| Ullung-Do | 37.5°N, 130.9°E |  |  |  |  |  |  |  |  |  |  |
| Mokpo | 34.8°N, 126.4°E |  |  |  |  |  |  |  |  |  |  |
| Chunchon | 37.9°N, 127.7°E |  |  |  |  |  |  |  |  |  |  |
| Masan | 35.2°N, 128.6°E |  |  |  |  |  |  |  |  |  |  |
| Tongyong | 34.9°N, 128.4°E |  |  |  |  |  |  |  |  |  |  |
| Inchon | 37.5°N, 126.6°E |  |  |  |  |  |  |  |  |  |  |
| Huksando | 34.7°N, 125.5°E |  |  |  |  |  |  |  |  |  |  |
| Suwon | 37.3°N, 127.0°E |  |  |  |  |  |  |  |  |  |  |
| Sokcho | 38.3°N, 128.6°E |  |  |  |  |  |  |  |  |  |  |
| Pohang | 36.0°N, 129.4°E |  |  |  |  |  |  |  |  |  |  |
| Kunsan | 36.0°N, 126.7°E |  |  |  |  |  |  |  |  |  |  |
| Baengnyeong-do | 37.9°N, 124.6°E |  |  |  |  |  |  |  |  |  |  |
| Singapore | Changi Airport | 1.4°N, 104.0°E |  |  | ✔ |  | ✔ |  |  | ✔ | ✔ |  |
| Thailand | Bangkok | 13.7°N, 100.6°E |  |  |  |  | ✔ |  |  | ✔ |  |  |
| USA | Guam | 13.4°N, 144.6°E |  |  |  |  | ✔ |  |  | ✔ |  |  |
| Viet Nam | Hanoi | 21.0°N, 105.5°E |  |  |  |  | ✔ |  |  |  |  |  |
| Ho Chi Ming City | 10.5°N, 106.4°E |  |  |  |  |  |  |  | ✔ |  |  |

## Annex 5

**Draft Amendments to**

**the Typhoon Committee Operational Manual – Meteorological Component (TOM)**

**proposed by the Members (except for editorial changes)**

|  |  |  |  |
| --- | --- | --- | --- |
| Page | Line | Proposed Revision | Comments |
| Section 2.6 | |  |  |
| 10 | L46 | Each Member’s tropical cyclone forecast center should compile reliable passage, landfall, near station passage, 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 | Revision of description on passage report |
| Section 3.2 | |  |  |
| 11 | L42 | 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) (WMO-No.485). These products should be made available to Members in real-time, and should include the following | Addition of document number |
| Section 4.4 | |  |  |
| 14 | L9 | Operational guidance for handling and formatting meteorological information is given in detail in the Annex ~~IV~~ VI of the WMO Technical Regulations (Manual on Marine Meteorological Services - WMO-No. 558). | Correction of the description |
| 15 | L38 | (n) Expected location and intensity at 12 ~~and~~ or 24 hour time periods. | Correction of the description |
| 16 | L9 | The ICAO Asia and Pacific Regions Air Navigation Plan (~~Doc 9673~~ APAC ANP) 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) | Correction of the description |
| Appendix 2-A | |  |  |
| 30 |  | To be replaced by Annex 5-1 | Update of stations which enable enhanced surface observation in Thailand |
| Appendix 2-D | |  |  |
| 35 |  | To be replaced by Annex 5-2 | Update of the distribution of the radar stations in Thailand |
| Appendix 2-E | |  |  |
| 36 |  | To be replaced by Annex 5-3 | Update of information on radar stations in Hong Kong, China; Republic of Korea and Thailand |
| Appendix 2-F | |  |  |
| 61 | L21 | (b) Products  (i) Full-Disk Observation Data: Every 10 minutes  (ii) Japan Area Observation Data: Every 2.5 minutes  (iii) Target Area Observation Data: Every 2.5 minutes  (iv) Full-Disk AMV: Every hour  (v) Full-Disk Clear Sky Radiance (CSR): Every hour  (vi) AMV-based Sea-surface Wind data (ASWind) (Full-Disk) : Every 30 minutes  (vii) AMV-based Sea-surface Wind data (ASWind) (Target Area) : Every 10 minutes  (c) Dissemination ways  (i) HimawariCloud (Internet Cloud Service)  Service which distributes full-spec imagery derived from the Himawari-series satellites  (https://www.data.jma.go.jp/mscweb/en/himawari89/cloud\_service/cloud\_service.html)  (ii) HimawariCast (communication satellite dissemination service)  Service which disseminates primary sets of imagery from the Himawari-series satellites via a communication satellite  (https://www.data.jma.go.jp/mscweb/en/himawari89/himawari\_cast/himawari\_cast.html)  (iii) Internet Services for National Meteorological and Hydrological Services (NMHSs)  [JMA real-time satellite imagery webpage]  https://www.jma.go.jp/en/gms/  [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)]  https://www.jma.go.jp/jma/jma-eng/satellite/jdds.html  ~~https://www.data.jma.go.jp/mscweb/en/himawari89/JDDS\_service/JDDS\_service.html~~ | Revision of information on Himawari-8/9 products and dissemination way |
| 62 | L17 | 4. COMS (operational since 2011 to March 2020) [Republic of Korea]  (a) Observations  (i) Full-Disk Observations: Every 3 hours  (ii) Extended North Hemisphere Observations: Every 15 minutes  (iii) Local Area Observations: Every 15 minutes  (b) Products  (i) Full-Disk Observation Data: Every 3 hours  (ii) Extended North Hemisphere Observation Data: Every 15 minutes  (iii) Full-Disk AMV: Every 3 hours  (c) Dissemination ways  (i) Direct Broadcast Service  It is not available, GK2A succeeded direct service mission.  ~~(http://nmsc.kma.go.kr/html/homepage/en/ver2/static/selectStaticPage.do?view=datacenter.dataService)~~  (ii) Internet Services  [National Meteorological Satellite Center website]  ~~http://nmsc.kma.go.kr/jsp/homepage/eng/main.do~~ http://datasvc.nmsc.kma.go.kr/datasvc/html/main/main.do?lang=en | Update of information on COMS |
| 63 | L10 | (c) Dissemination ways  (i) Direct Broadcast Service  ~~(http://nmsc.kma.go.kr/html/homepage/en/ver2/static/selectStaticPage.do?view=satellites.gk2a.dataServicePlan)~~  Request application form for receiving station  (http://datasvc.nmsc.kma.go.kr/datasvc/html/base/cmm/selectPage.do?page=static.reqStation)  (ii) Internet Services  [FTP-based Service]  All sixteen channels data of full-disk image will be put on KMA’s FTP server designated for GEO-KOMPSAT-2A data dissemination in every 10 minutes.  (Account policy: 1 account per 1 country)  Need personal contact (hyunjong.oh@korea.kr)  [National Meteorological Satellite Center website]  ~~http://nmsc.kma.go.kr/jsp/homepage/eng/main.do~~  http://datasvc.nmsc.kma.go.kr/datasvc/html/main/main.do?lang=en | Update of information on dissemination method of GEO-KOMPSAT-2A products |
| Appendix 2-G | |  |  |
| 64 |  | To be replaced by Annex 5-4 | Update of information on satellite imagery receiving facilities at Hong Kong, China; Macao, China; Republic of Korea and Thailand |
| Appendix 3-A | |  |  |
| 69 |  | To be replaced by Annex 5-5 | Update of the NWP products and correction of the description |
| Appendix 3-B | | 3 NWP Systems in Operational Use |  |
| 79 |  | To be replaced by Annex 5-6 | Update of the information on KMA’s Global EPS |
| Appendix 4-C | |  |  |
| 102 |  | To be replaced by Annex 5-7 | Update of the information on the area of broadcasting cyclone warnings for ships on the high seas |
| Appendix 5-B | |  |  |
| 104 |  | To be replaced by Annex 5-8 | Update of the information on telecommunication networks |
| Appendix 5-C | |  |  |
| 106 |  | To be replaced by Annex 5-9 | Update of the contact details of Hong Kong, China; Macao, China; Republic of Korea and Thailand |
| Appendix 5-E | |  |  |
| 106 |  | To be replaced by Annex 5-10 | Update of the list of collection and distribution of information related to tropical cyclones by Hong Kong |

## Annex 5-1

**APPENDIX 2-A**

31

**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:

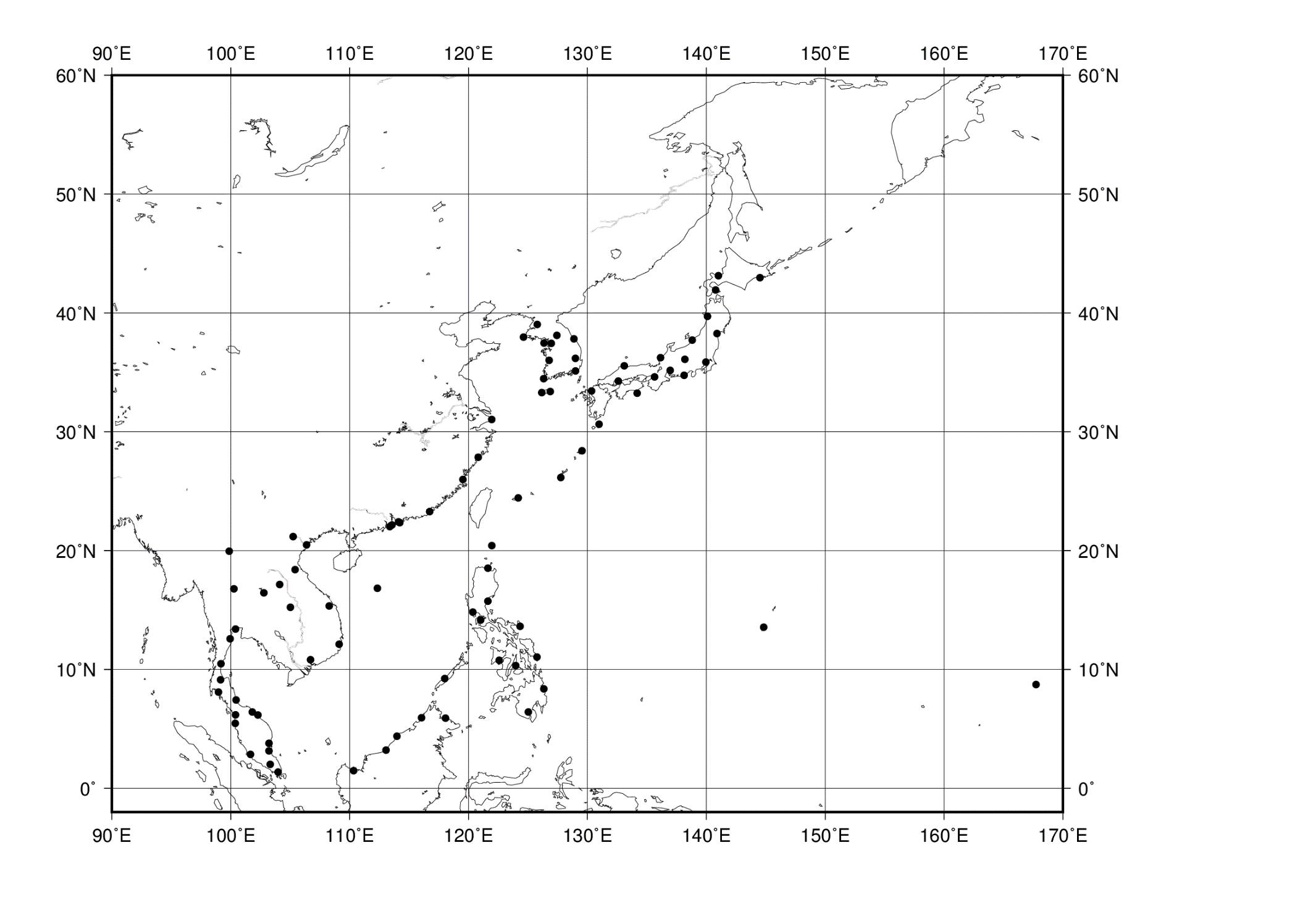
|  |  |  |
| --- | --- | --- |
| **Cambodia** | | |
|  |  |  |
| **China** | | |
|  | (54): | 324, 337, 342, 346, 405, 423, 436, 471, 493, 497, 511, 534, 539, 602, 618, 662, 715, 751, 753, 776, 823, 826, 836, 843, 857, 863, 929, 945 |
| (58): | 040, 141, 150, 238, 251, 265, 345, 362, 457, 472, 477, 543, 556, 569, 646, 652, 666, 752, 754, 834, 847, 911, 921, 926, 931, 944 |
| (59): | 007, 023, 046, 058, 072, 082, 087, 096, 117, 134, 209, 211, 254, 278, 287, 293, 316, 417, 431, 456, 493, 501, 632, 644, 658, 663, 673, 758, 838, 845, 855, 948, 981 |
| **Democratic People's Republic of Korea** | | |
|  | (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 |
| **Hong Kong, China** | | |
|  | (45): | 007 |
| **Japan** | | |
|  | (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 |
| **Lao People's Democratic Republic** | | |
|  |  |  |
| **Macao, China** | | |
|  | (45): | 011 |
| **Malaysia** | | |
|  | (48): | 601, 615, 620, 647, 650, 657, 665 |
|  | (96): | 413, 421, 441, 449, 465, 471, 481, 491 |
| **Philippines** | | |
|  | (98): | 132, 133, 135, 222, 232, 233, 324, 325, 328, 329, 330, 333, 336, 425, 427, 428, 429, 430, 431, 432, 434, 435, 437, 440, 444, 446, 447, 526, 531, 536, 538, 543, 546, 548, 550, 555, 558, 618, 630, 637, 642, 644, 646, 648, 653, 741, 746, 747, 748, 751, 752, 753, 755, 836, 851 |
| **Republic of Korea** | | |
|  | (47): | 090, 093, 095, 098, 099, 100, 101, 102, 105, 106, 108, 112, 114, 115, 119, 121, 127, 129, 130, 131, 133, 135, 136, 137, 138, 140, 143, 146, 152, 155, 156, 159, 162, 165, 168, 169, 170, 172, 174, 175, 177, 184, 185, 188, 189, 192, 201, 202, 203, 211, 212, 214, 216, 217, 221, 226, 232, 235, 236, 243, 244, 245, 247, 248, 251, 252, 253, 254, 255, 257, 258, 259, 260, 261, 262, 263, 264, 266, 268, 271, 272, 273, 276, 277, 278, 279, 281, 283, 284, 285, 288, 289, 294, 295 |
| **Thailand** | | |
|  | (48): | ~~300, 302,~~ 303, ~~304, 307, 310, 315, 324, 325, 327, 328, 329, 330, 331, 333, 334, 350,~~ 351, 352, 353, ~~354, 355, 356,~~ 357, ~~358, 360, 372, 373, 374, 375, 376, 377,~~ 378, ~~379, 380, 381, 382,~~ 383, ~~384, 385, 386, 387, 390, 400, 401, 402, 403, 404, 405,~~ 407, ~~408, 409, 410, 413, 415, 416, 417, 418, 419, 420, 421, 425, 426, 427, 429, 430, 431,~~ 432, ~~433, 434, 435, 436,~~ 437, ~~438, 439, 440, 450, 451, 453, 455, 456, 458, 459, 460, 461,~~ 462, ~~464,~~ 465, ~~474, 475, 477, 478, 479,~~ 480, ~~481,~~ 500, 501, 517, ~~520, 532, 550,~~ 551, 552, ~~554, 555, 556, 557,~~ 560, ~~561, 563, 564, 565, 566, 567,~~ 568, ~~569, 570, 571, 574,~~ 580, ~~581,~~ 583 |
| **USA** | | |
|  | (91): | 203, 212, 258, 317, 324, 334, 339, 348, 353, 356, 366, 367, 369, 371, 376, 378, 408, 413, 425, 434 |
| **Viet Nam** | | |
|  | (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).

## Annex 5-2

**APPENDIX 2-D**

**DISTRIBUTION OF THE RADAR STATIONS OF TYPHOON COMMITTEE MEMBERS**



## Annex 5-3

**TECHNICAL SPECIFICATIONS OF RADARS OF TYPHOON COMMITTEE MEMBERS**

Name of the Member **Hong Kong, China**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NAME OF STATION | |  | Tai Mo Shan | Tate’s Cairn |  |  |  |
|  |
|  | SPECIFICATIONS | Unit |  |  |  |  |  |
|  | Index number |  | 45009 | 45010 |  |  |  |
|  | Location of station |  | 22° 25´ N | 22° 21´ N |  |  |  |
|  |  | 114° 07´ E | 114° 13´ E |  |  |  |
|  | Antenna elevation | m | 968 | 582 |  |  |  |
|  | Wave length | cm | 10.6 | 10.3 |  |  |  |
|  | Peak power of transmitter | kW | 650 | 650 |  |  |  |
|  | Pulse length | µs | 1.0/2.0 | 1.0/2.0 |  |  |  |
|  | Sensitivity minimum of  receiver | dBm | 109/-112  ~~-117-~~ | -111/-114 |  |  |  |
|  |
|  | Beam width  (Width of over -3dB  antenna gain of maximum) | deg | 0.9(H)  0.9(V) | 0.9(H)  0.9(V) |  |  |  |
|  |
|  |
|  | Detection range | km | 500 | 500 |  |  |  |
|  | Scan mode in observation |  | 2 | 2 |  |  |  |
|  | 1.Fixed elevation |  |
|  | 2.CAPPI |  |
|  | 3.Manually controlled |  |
|  | DATA PROCESSING |  |  |  |  |  |  |
|  | MTI processing |  | 2 | 2 |  |  |  |
|  | 1.Yes, 2.No |  |
|  | Doppler processing |  | 1 | 1 |  |  |  |
|  | 1.Yes, 2.No |  |
|  | Display |  | 1 | 1 |  |  |  |
|  | 1.Digital, 2.Analog |  |
|  | OPERATION MODE (When tropical | | 3  (Continuous) | 3  (Continuous) |  |  |  |
|  | cyclone is within range of detection) | |
|  | 1.Hourly |  |
|  | 2.3-hourly |  |
|  | 3.Others |  |
|  | PRESENT STATUS |  | 1 | 1 |  |  |  |
|  | 1.Operational |  |
|  | 2.Not operational (for research etc.) | |

Name of the Member **Republic of Korea - 1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NAME OF STATION | |  | Gosan | Seongsan | Gangneung | Oseongsan | Baengnyeong-do |
|  |
|  | SPECIFICATIONS | Unit |  |  |  |  |  |
|  | Index number |  | 47185 | 47188 | 47105 | 47144 | 47102 |
|  | Location of station |  | ~~33° 17´N~~  33.294329°N | ~~33° 23´N~~  33.387103°N | ~~37° 49´N~~  37.817669°N | ~~36° 00´N~~  36.012700°N | ~~37° 58´N~~  37.967549°N |
|  |  | ~~126° 09´E~~  126.163073°E | ~~126° 52´E~~  126.879986°E | ~~128° 51´E~~  128.865647°E | ~~126° 47´E~~  126.784168°E | ~~124° 37´E~~  124.630307°E |
|  | Antenna elevation | m | 103 ~~101~~ | 68 | 99 | 234 ~~231~~ | 185 ~~188~~ |
|  | Wave length | cm | 10.61 ~~10.9~~ | 10.88 | 10.50 | 10.96 | 10.45 ~~5.3~~ |
|  | Peak power of transmitter | kW | 850 ~~750~~ | 850 ~~750~~ | 850 ~~750~~ | 850 ~~750~~ | 850 ~~250~~ |
|  | Pulse length | µs | 0.5, 1.0~~;~~, 2.0, 4.5 | 0.5, 1.0~~;~~, 2.0, 4.5 | 0.5, 1.0~~;~~, 2.0, 4.5 | 0.5, 1.0~~;~~, 2.0, 4.5 | 0.5, 1.0,~~;~~ 2.0, 4.5 |
|  | Sensitivity minimum of  receiver | dBm | -114 ~~-112~~ | -114 ~~-112~~ | -114 ~~-112~~ | -114 ~~-112~~ | -114 ~~-108~~ |
|  |
|  | Beam width  (Width of over -3dB  antenna gain of maximum) | deg | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
|  |
|  |
|  | Detection range | km | 240, 480  ~~250 (volume),~~  ~~500 (lowest tilt)~~ | 240, 480  ~~250, 500~~ | 240, 480  ~~280, 500~~ | 240, 480 | 240 ~~256~~, 480 |
|  | Scan mode in observation |  | 1, 2 | 1, 2 | 1, 2 | 1, 2 | 1, 2 |
|  | 1. Fixed elevation |  |
|  | 2. CAPPI |  |
|  | 3. Manually controlled |  |
|  | DATA PROCESSING |  |  |  |  |  |  |
|  | MTI processing |  | 1 ~~2~~ | 1 ~~2~~ | 1 ~~2~~ | 1 ~~2~~ | 1 ~~2~~ |
|  | 1.Yes, 2.No |  |
|  | Doppler processing |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Yes, 2.No |  |
|  | Display |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Digital, 2.Analog |  |
|  | OPERATION MODE (When tropical | | 3  (5-minutely ~~continuous~~) | 3  (5-minutely ~~continuous~~) | 3  (5-minutely ~~continuous~~) | 3  (5-minutely ~~continuous~~) | 3  (5-minutely ~~continuous~~) |
|  | cyclone is within range of detection) | |
|  | 1. Hourly |  |
|  | 2. 3-hourly |  |
|  | 3. Others |  |
|  | PRESENT STATUS |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Operational |  |
|  | 2.Not operational(for research etc.) | |

Name of the Member **Republic of Korea - 2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NAME OF STATION | |  | Jindo | Gwangdeok -san | Myeonbong -san | Gwanaksan | Gudeoksan |
|  |
|  | SPECIFICATIONS | Unit |  |  |  |  |  |
|  | Index number |  | 47175 | 47094 | 47148 | 47116 | 47160 |
|  | Location of station |  | ~~34° 28´N~~  34.472553°N | ~~38° 07´N~~  38.117316°N | ~~36° 10´N~~  36.179323°N | ~~37° 26´N~~  37.444119°N | ~~35° 07´N~~  35.118694°N |
|  |  | ~~126° 19´E~~  126.323994°E | ~~127° 26´E~~  127.433708°E | ~~128° 59´E~~  128.997319°E | ~~126° 57´E~~  126.963994°E | ~~128° 59´ E~~128.999744°E |
|  | Antenna elevation | m | 497 | 1066 ~~1064~~ | 1136 ~~1127~~ | 641 ~~640~~ | 549 ~~547~~ |
|  | Wave length | cm | 10.37 | 10.38 | 10.99 ~~5.3~~ | 11.03 | 11.05 |
|  | Peak power of transmitter | kW | 850 ~~750~~ | 850 ~~750~~ | 850 ~~250~~ | 850 | 850 |
|  | Pulse length | µs | 0.5, 1.0, 2.0, 4.5  ~~1.0; 2.5~~ | 0.5, 1.0, 2.0, 4.5  ~~1.0; 4.5~~ | 0.5, 1.0  2.0, 4.5  ~~0.83; 2.5~~ | 0.5, 1.0, 2.0, 4.5  ~~1.0; 4.5~~ | 0.5, 1.0, 2.0, 4.5  ~~1.0; 4.5~~ |
|  | Sensitivity minimum of  receiver | dBm | -114 ~~-112~~ | -114 ~~-112~~ | -114 ~~-112~~ | -114 | -114 |
|  |
|  | Beam width  (Width of over -3dB  antenna gain of maximum) | deg | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
|  |
|  |
|  | Detection range | km | 240, 480 | 240, 480  ~~250, 500~~ | 240, 480  ~~200~~ | 240, 480 | 240, 480 |
|  | Scan mode in observation |  | 1, 2 | 1, 2 | 1, 2 | 1, 2 | 1, 2 |
|  | 1. Fixed elevation |  |
|  | 2. CAPPI |  |
|  | 3. Manually controlled |  |
|  | DATA PROCESSING |  |  |  |  |  |  |
|  | MTI processing |  | 1 ~~2~~ | 1 ~~2~~ | 1 ~~2~~ | 1 ~~2~~ | 1 ~~2~~ |
|  | 1.Yes, 2.No |  |
|  | Doppler processing |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Yes, 2.No |  |
|  | Display |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Digital, 2.Analog |  |
|  | OPERATION MODE (When tropical | | 3  (5-minutely ~~continuous~~) | 3  (5-minutely ~~continuous~~) | 3  (5-minutely ~~continuous~~) | 3  (5-minutely~~continuous~~) | 3  (5-minutely ~~continuous~~) |
|  | cyclone is within range of detection) | |
|  | 1. Hourly |  |
|  | 2. 3-hourly |  |
|  | 3. Others |  |
|  | PRESENT STATUS |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Operational |  |
|  | 2.Not operational(for research etc.) |  |

Name of the Member **Republic of Korea - 3**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NAME OF STATION | |  | Korean Aviation Meteorological Agency |  |  |  |  |
|  |
|  | SPECIFICATIONS | Unit |  |  |  |  |  |
|  | Index number |  | 47113 |  |  |  |  |
|  | Location of station |  | 37° 28´ N |  |  |  |  |
|  |  | 126° 21´ E |  |  |  |  |
|  | Antenna elevation | m | 145 |  |  |  |  |
|  | Wave length | cm | 5.32 |  |  |  |  |
|  | Peak power of transmitter | kW | 250 |  |  |  |  |
|  | Pulse length | µs | 1.0; 2.0 |  |  |  |  |
|  | Sensitivity minimum of  receiver | dBm | -110 |  |  |  |  |
|  |
|  | Beam width  (Width of over -3dB  antenna gain of maximum) | deg | 0.53 |  |  |  |  |
|  |
|  |
|  | Detection range | km | 130, 428  ~~30, 480~~ |  |  |  |  |
|  | Scan mode in observation |  | 1, 2 |  |  |  |  |
|  | 1. Fixed elevation |  |
|  | 2. CAPPI |  |
|  | 3. Manually controlled |  |
|  | DATA PROCESSING |  |  |  |  |  |  |
|  | MTI processing |  | 1 ~~2~~ |  |  |  |  |
|  | 1.Yes, 2.No |  |
|  | Doppler processing |  | 1 |  |  |  |  |
|  | 1.Yes, 2.No |  |
|  | Display |  | 1 |  |  |  |  |
|  | 1.Digital, 2.Analog |  |
|  | OPERATION MODE (When tropical | | 3  (continuous) |  |  |  |  |
|  | cyclone is within range of detection) | |
|  | 1. Hourly |  |
|  | 2. 3-hourly |  |
|  | 3. Others |  |
|  | PRESENT STATUS |  | 1 |  |  |  |  |
|  | 1.Operational |  |
|  | 2.Not operational(for research etc.) | |

Name of the Member **Thailand - 1**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NAME OF STATION | |  | Chiang Rai | Sakol Nakon  ~~Lamphun~~ | Phitsanulok  ~~Sakol Nakon~~ | Khon Khaen  ~~Phitsanulok~~ | Ubon Ratchathani  ~~Khon Khaen~~ |
|  |
|  | SPECIFICATIONS | Unit |  |  |  |  |  |
|  | Index number |  | 48303 | 48356 ~~48329~~ | 48378 ~~48356~~ | 48378 ~~48378~~ | 48407 ~~48381~~ |
|  | Location of station |  | 19° 57´ N | 17° 09´ N  ~~18° 34´ N~~ | 16° 47´ N  ~~17° 09´ N~~ | 16° 27´ N  ~~16° 47´ N~~ | 15° 14´ N  ~~16° 27´ N~~ |
|  |  | 99° 52´ E | 104° 07´ E ~~99° 02´ E~~ | 100° 16´ E ~~104° 07´ E~~ | 102° 47´ E ~~100° 16´ E~~ | 105° 01´ E ~~102° 47´ E~~ |
|  | Antenna elevation | m | 440 | 198 ~~337~~ | 56 ~~198~~ | 215 ~~56~~ | 155 ~~215~~ |
|  | Wave length | cm | 5 | 5 | 5 | 5 | 5 |
|  | Peak power of transmitter | kW | 300 | 300 | 300 | 300 | 300 |
|  | Pulse length | µs | 0.8&2 | 0.8&2 | 0.8&2 | 0.8&2 | 0.8&2 |
|  | Sensitivity minimum of  receiver | dBm | -110 | -110 | -110 | -106 ~~-110~~ | -108 ~~-106~~ |
|  |
|  | Beam width  (Width of over -3dB  antenna gain of maximum) |  | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
|  | deg |
|  |  |
|  | Detection range | km | 240 | 240 | 240 | 240 | 240 |
|  | Scan mode in observation |  | 1, 2 | 1, 2 | 1, 2 | 1, 2 | 1, 2 |
|  | 1.Fixed elevation |  |
|  | 2.CAPPI |  |
|  | 3.Manually controlled |  |
|  | DATA PROCESSING |  |  |  |  |  |  |
|  | MTI processing |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Yes, 2.No |  |
|  | Doppler processing |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Yes, 2.No |  |
|  | Display |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Digital, 2.Analog |  |
|  | OPERATION MODE (When tropical | | 1, 3 | 1, 3 | 1, 3 | 1, 3 | 1, 3 |
|  | cyclone is within range of detection) | |
|  | 1.Hourly |  |
|  | 2.3-hourly |  |
|  | 3.Others |  |
|  | PRESENT STATUS |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Operational |  |
|  | 2.Not operational(for research etc.) | |

Name of the Member **Thailand - 2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NAME OF STATION | |  | Samut  Songkram ~~Chainat~~ | Hua Hin ~~Ubon Ratchathani~~ | Chumporn ~~Samut~~  ~~Songkram~~ | Surat Thani ~~Hua Hin~~ | Krabi  ~~Chumporn~~ |
|  |
|  | SPECIFICATIONS | Unit |  |  |  |  |  |
|  | Index number |  | 48438 ~~48402~~ | 48475 ~~48407~~ | 48517 ~~48438~~ | 48551 ~~48475~~ | 48563 ~~48517~~ |
|  | Location of station |  | 13° 24´ N  ~~15° 09´ N~~ | 12° 35´ N  ~~15° 14´ N~~ | 10° 29´ N  ~~13° 24´ N~~ | 9° 08´ N  ~~12° 35´ N~~ | 8° 06´ N  ~~10° 29´ N~~ |
|  |  | 100° 24´ E  ~~100° 41´ E~~ | 99° 57´ E  ~~105° 01´ E~~ | 99° 11´ E  ~~100° 24´ E~~ | 99° 09´ E  ~~99° 57´ E~~ | 98° 58´ E  ~~99° 11´ E~~ |
|  | Antenna elevation | m | 29 ~~45~~ | 30 ~~155~~ | 28 ~~29~~ | 33 ~~30~~ | 51 ~~28~~ |
|  | Wave length | cm | 5 | 10 ~~5~~ | 5 | 5 ~~10~~ | 5 |
|  | Peak power of transmitter | kW | 300 | 500 ~~300~~ | 300 | 300 ~~500~~ | 300 |
|  | Pulse length | µs | 0.8&2 | 0.8&2 | 0.8&2 | 0.8&2 | 0.8&2 |
|  | Sensitivity minimum of  receiver | dBm | -110 | -106 ~~-108~~ | -110 | -110 ~~-106~~ | -106 ~~-110~~ |
|  |
|  | Beam width  (Width of over -3dB  antenna gain of maximum) |  | 1.0 | 2.1 ~~1.0~~ | 1.0 | 1.0 ~~2.1~~ | 1.0 |
|  | deg |
|  |  |
|  | Detection range | km | 240 | 240 | 240 | 240 | 240 |
|  | Scan mode in observation |  | 1, 2 | 1, 2 | 1, 2 | 1, 2 | 1, 2 |
|  | 1.Fixed elevation |  |
|  | 2.CAPPI |  |
|  | 3.Manually controlled |  |
|  | DATA PROCESSING |  |  |  |  |  |  |
|  | MTI processing |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Yes, 2.No |  |
|  | Doppler processing |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Yes, 2.No |  |
|  | Display |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Digital, 2.Analog |  |
|  | OPERATION MODE (When tropical | | 1, 3 | 1, 3 | 1, 3 | 1, 3 | 1, 3 |
|  | cyclone is within range of detection) | |
|  | 1.Hourly |  |
|  | 2.3-hourly |  |
|  | 3.Others |  |
|  | PRESENT STATUS |  | 1 | 1 | 1 | 1 | 1 |
|  | 1.Operational |  |
|  | 2.Not operational(for research etc.) | |

Name of the Member **Thailand - 3**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NAME OF STATION | |  | Sathing Pra  (Songkla)  ~~Surat Thani~~ | Narathiwat  ~~Krabi~~ | ~~Phuket~~ | ~~Sathing Pra~~  ~~(Songkla)~~ | ~~Narathiwat~~ |
|  |
|  | SPECIFICATIONS | Unit |  |  |  |  |  |
|  | Index number |  | 48568 ~~48551~~ | 48583 ~~48563~~ | ~~48565~~ | ~~48568~~ | ~~48583~~ |
|  | Location of station |  | 7° 26´ N  ~~9° 08´ N~~ | 6° 25´ N  ~~8° 06´ N~~ | ~~8° 08´ N~~ | ~~7° 26´ N~~ | ~~6° 25´ N~~ |
|  |  | 100° 27´ E  ~~99° 09´ E~~ | 101° 49´ E  ~~98° 58´ E~~ | ~~98° 19´ E~~ | ~~100° 27´ E~~ | ~~101° 49´ E~~ |
|  | Antenna elevation | m | 30 ~~33~~ | 29 ~~51~~ | ~~281~~ | ~~30~~ | ~~29~~ |
|  | Wave length | cm | 5 | 5 | ~~5~~ | ~~5~~ | ~~5~~ |
|  | Peak power of transmitter | kW | 300 | 300 | ~~300~~ | ~~300~~ | ~~300~~ |
|  | Pulse length | µs | 0.8&2 | 0.5&1  ~~0.8&2~~ | ~~0.8&2~~ | ~~0.8&2~~ | ~~0.5&1~~ |
|  | Sensitivity minimum of  receiver | dBm | -115 ~~-110~~ | -110 ~~-106~~ | ~~-106~~ | ~~-115~~ | ~~-110~~ |
|  |
|  | Beam width  (Width of over -3dB  antenna gain of maximum) |  | 1.0 | 1.0 | ~~1.0~~ | ~~1.0~~ | ~~1.0~~ |
|  | deg |
|  |  |
|  | Detection range | km | 240 | 120 ~~240~~ | ~~240~~ | ~~240~~ | ~~120~~ |
|  | Scan mode in observation |  | 1, 2 | 1, 2 | ~~1, 2~~ | ~~1, 2~~ | ~~1, 2~~ |
|  | 1.Fixed elevation |  |
|  | 2.CAPPI |  |
|  | 3.Manually controlled |  |
|  | DATA PROCESSING |  |  |  |  |  |  |
|  | MTI processing |  | 1 | 1 | ~~1~~ | ~~1~~ | ~~1~~ |
|  | 1.Yes, 2.No |  |
|  | Doppler processing |  | 1 | 1 | ~~1~~ | ~~1~~ | ~~1~~ |
|  | 1.Yes, 2.No |  |
|  | Display |  | 1 | 1 | ~~1~~ | ~~1~~ | ~~1~~ |
|  | 1.Digital, 2.Analog |  |
|  | OPERATION MODE (When tropical | | 1, 3 | 1, 3 | ~~1, 3~~ | ~~1, 3~~ | ~~1, 3~~ |
|  | cyclone is within range of detection) | |
|  | 1.Hourly |  |
|  | 2.3-hourly |  |
|  | 3.Others |  |
|  | PRESENT STATUS |  | 1 | 1 | ~~1~~ | ~~1~~ | ~~1~~ |
|  | 1.Operational |  |
|  | 2.Not operational(for research etc.) | |

## Annex 5-4

**Appendix 2-G**

**SATELLITE IMAGERY RECEIVING FACILITIES AT TYPHOON COMMITTEE MEMBERS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Member** | **Station** | | **Himawari**  **1. HimawariCloud**  **2. HimawariCast** | **NOAA**  **1. HRPT**  **2. APT** | **Meteosat**  **1. P-DUS** |
| Cambodia |  |  | 1, 2 |  |  |
| China | Beijing | 39.9°N, 116.4°E | 1 | 1 |  |
| DPR Korea | Pyongyang | 39.0°N, 125.8°E |  | 1 |  |
| Hong Kong, China[[12]](#footnote-12) | Kowloon | 22.3°N, 114.2°E | 1, 2 | 1 |  |
| Japan | Minamitorishima | 24.3°N, 154.0°E | 2 |  |  |
| Lao PDR |  |  | 2 |  |  |
| Macao, China[[13]](#footnote-13) | Macao | 22.2°N, 113.5°E | 1, 2 | ~~1~~ |  |
| Malaysia | Petaling Jaya | 3.1°N, 101.7°E | 1, 2 | 1 |  |
| Philippines | Quezon City | 14.7°N, 121.0°E | 1, 2 | 1 |  |
| Cagayan de Oro City | 8.5°N, 124.6°E |  |  |  |
| Pasay City | 14.5°N, 121.0°E |  |  |  |
| Cebu | 10.3°N, 124.0°E |  |  |  |
| Republic of Korea[[14]](#footnote-14) | Jinchoen ~~Seoul~~ | 36.7°N, 127.4°E ~~37.6°N, 127.0°E~~ | 1, 2 | 1 | 1 |
| ~~Incheon Int. Airport~~ | ~~37.3°N, 126.3°E~~ |  |  |  |
| ~~Munsan~~ | ~~37.9°N, 126.8°E~~ |  |  | ~~1~~ |
| ~~Seosan~~ | ~~36.8°N, 126.5°E~~ |  | ~~1~~ |  |
| ~~Pusan~~ | ~~35.1°N, 129.0°E~~ |  |  |  |
| ~~Pusan Kimhae Air~~ | ~~35.2°N, 126.9°E~~ |  |  |  |
| ~~Kwangju~~ | ~~35.2°N, 126.9°E~~ |  |  |  |
| ~~Taejon~~ | ~~36.4°N, 127.4°E~~ |  |  |  |
| ~~Kangnung~~ | ~~37.5°N, 130.9°E~~ |  |  |  |
| ~~Cheju~~ | ~~33.5°N, 126.5°E~~ |  |  |  |
| ~~Taegu~~ | ~~35.9°N, 128.6°E~~ |  |  |  |
| ~~Taegu/Air Traffic~~ | ~~35.9°N, 128.7°E~~ |  |  |  |
| ~~Chonju~~ | ~~35.8°N, 127.2°E~~ |  |  |  |
| ~~Chongju~~ | ~~36.6°N, 127.4°E~~ |  |  |  |
| ~~Ullung-Do~~ | ~~37.5°N, 130.9°E~~ |  |  |  |
| ~~Mokpo~~ | ~~34.8°N, 126.4°E~~ |  |  |  |
| ~~Chunchon~~ | ~~37.9°N, 127.7°E~~ |  |  |  |
| ~~Masan~~ | ~~35.2°N, 128.6°E~~ |  |  |  |
| ~~Tongyong~~ | ~~34.9°N, 128.4°E~~ |  |  |  |
| ~~Inchon~~ | ~~37.5°N, 126.6°E~~ |  |  |  |
| ~~Huksando~~ | ~~34.7°N, 125.5°E~~ |  |  |  |
| ~~Suwon~~ | ~~37.3°N, 127.0°E~~ |  |  |  |
| ~~Sokcho~~ | ~~38.3°N, 128.6°E~~ |  |  |  |
| ~~Pohang~~ | ~~36.0°N, 129.4°E~~ |  |  |  |
| ~~Kunsan~~ | ~~36.0°N, 126.7°E~~ |  |  |  |
| ~~Baengnyeong-do~~ | ~~37.9°N, 124.6°E~~ |  |  |  |
| Singapore[[15]](#footnote-15) | Changi Airport | 1.4°N, 104.0°E | 1, 2 | 1 | 1 |
| Thailand[[16]](#footnote-16) | Bangkok | 13.7°N, 100.6°E | 1, 2 | ~~1~~ |  |
| USA | Guam | 13.4°N, 144.6°E | 1 | 1 |  |
| Viet Nam | Hanoi | 21.0°N, 105.5°E | 1, 2 | 2 |  |
| Ho Chi Ming City | 10.5°N, 106.4°E |  | 2 |  |

## Annex 5-5

**APPENDIX 3-A**

**PRODUCTS PROVIDED BY RSMC TOKYO - TYPHOON CENTER**

##### NWP products (GSM and GEPS) provided by RSMC Tokyo - Typhoon Center

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

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

|  |  |  |
| --- | --- | --- |
| **Model** | **GEPS** | **GEPS** |
| Area and  resolution | Whole globe, 2.5°×2.5° | Whole globe, 1.25°×1.25 |
| Levels and  elements | 250 hPa: µU, σU, µV, σV  500 hPa: µZ, σZ  850 hPa: µU, σU, µV, σV, µT, σT  1000 hPa: µZ, σZ  Surface: µP, σP | 250 hPa: µU, σU, µV, σV, µW,σW  500 hPa: µZ, σZ  850 hPa: µU, σU, µV, σV, µT, σT, µW, σW ,Probability of temperature anomalies [±1, ±1.5, ±2σ]  1000 hPa: µZ, σZ  Surface: µP, σP, Probability of 10 m sustained wind and gusts [10,15,25 m/s]†, Probability of precipitation [1,5,10,25,50,100 mm/24hour]† |
| Forecast hours | 0 - 192 every 12 hours | 0 - 264 every 12 hours  † Except analysis |
| Initial times | 00, 12UTC | 00, 12 UTC |

|  |  |  |  |
| --- | --- | --- | --- |
| **Model** | **GSM** | **GSM** | **GSM** |
| Area and resolution | 5°S-90°N and 30°E-165°W,  Whole globe  0.25° × 0.25° | 5°S-90°N and 30°E-165°W,  Whole globe  0.5° × 0.5° | Whole globe, 1.25°×1.25° |
| Levels and elements | Surface: U, V, T, H, P, Ps, R, Cla, Clh, Clm, Cll | 10 hPa: Z, U, V, T, H, ω  20 hPa: Z, U, V, T, H, ω  30 hPa: Z, U, V, T, H, ω  50 hPa: Z, U, V, T, H, ω  70 hPa: Z, U, V, T, H, ω  100 hPa: Z, U, V, T, H, ω  150 hPa: Z, U, V, T, H, ω  200 hPa: Z, U, V, T, H, ω, ψ, χ  250 hPa: Z, U, V, T, H, ω  300 hPa: Z, U, V, T, H, ω  400 hPa: Z, U, V, T, H, ω  500 hPa: Z, U, V, T, H, ω, ζ  600 hPa: Z, U, V, T, H, ω  700 hPa: Z, U, V, T, H, ω  800 hPa: Z, U, V, T, H, ω  850 hPa: Z, U, V, T, H, ω, ψ, χ  900 hPa: Z, U, V, T, H, ω  925 hPa: Z, U, V, T, H, ω  950 hPa: Z, U, V, T, H, ω  975 hPa: Z, U, V, T, H, ω  1000 hPa: Z, U, V, T, H, ω  Surface: U, V, T, H, P, Ps, R, Cla, Clh, Clm, Cll | 10 hPa: Z, U, V, T  20 hPa: Z, U, V, T  30 hPa: Z, U, V, T  50 hPa: Z, U, V, T  70 hPa: Z, U, V, T  100 hPa: Z, U, V, T  150 hPa: Z, U, V, T  200 hPa: Z, U, V, T, ψ, χ  250 hPa: Z, U, V, T, ζ, Div  300 hPa: Z, U, V, T, H, ω  400 hPa: Z, U, V, T, H, ω  500 hPa: Z, U, V, T, H, ω, ζ  600 hPa: Z, U, V, T, H, ω  700 hPa: Z, U, V, T, H, ω, ζ, Div  850 hPa: Z, U, V, T, H, ω, ψ, χ  925 hPa: Z, U, V, T, H, ω, ζ, Div  1000 hPa: Z, U, V, T, H, ω  Surface: P, U, V, T, H, R† |
| Forecast hours | 0 - 84 (every 3 hours)  90 - 264 (every 6 hours) are available for 12 UTC Initial | 0 - 84 (every 3 hours)  90 - 264 (every 6 hours) are available for 12 UTC Initial | 0 - 132 every 6 hours and  144 - 264 every 12 hours for 12UTC initial  † Except analysis |
| Initial times | 00, 06, 12, 18 UTC | 00, 06, 12, 18 UTC | 00, 06, 12, 18 UTC |

Notes: Z: geopotential height U: eastward wind V: northward wind

T: temperature D: dewpoint depression H: relative humidity

ω: vertical velocity ζ: vorticity ψ: stream function

χ: velocity potential P: sea level pressure Ps: pressure

R: rainfall Cla: total cloudiness Clh: cloudiness (upper layer)

Clm: cloudiness (middle layer) Cll: cloudiness (lower layer)

Div: divergence W:wind speed

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 Numerical Typhoon Prediction Website:

https://tynwp-web.kishou.go.jp/)

| Products | Frequency | Details |
| --- | --- | --- |
| RSMC Advisories | | |
| RSMC TC Advisory | At least  8 times/day | * RSMC Tokyo - Typhoon Center’s TC analysis~~, track forecast~~ and ~~intensity~~ forecasts up to 120-hours (linked to the JMA~~’s~~ website~~:~~ at https://www.jma.go.jp/en/typh/) |
| Storm Wind Probability Map | 4 times/day | * Probabilistic forecast map for sustained wind upward of 50-kt ~~with forecast time of~~ for 1, 2, 3, 4 and 5 days ahead |
| Prognostic Reasoning | 4 times/day | * RSMC Tokyo Tropical Cyclone Prognostic Reasoning (WTPQ3X) |
| Operational Remarks  ~~Advance notice~~ |  | * Advance notice on TC status change from RSMC Tokyo – Typhoon Center |
| Graphical  TC Advisory | 4 times/day | * Graphical TC Advisory including RSMC Tokyo - Typhoon Center’s TC analysis, track and intensity forecasts up to 24-hours and horizontal extents of cumulonimbus cloud and cloud top height associated with TCs potentially affecting aviation safety (linked to the Tropical Cyclone Advisory Center Tokyo ~~W~~website at~~:~~ https://www.data.jma.go.jp/fcd/tca/data/index.html) |
| Remote S~~s~~ensing | | |
| Satellite 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 I~~i~~magery | Up to 142 times/day | * Satellite imagery of Himawari-8/9 (linked to the JMA~~’s~~ website~~:~~ at https://www.jma.go.jp/en/gms/smallc.html?area=6&element=0&mode=UTC) |
| Satellite Microwave Products |  | * TC snapshot images * Warm-core-based TC intensity estimates * Weighted consensus TC intensity estimates made using Dvorak analysis and satellite microwave warm-core-based intensity estimates |
| Sea-surface AMV  (ASwind) | Every 10 / 30 minutes | * AMV-based Sea-surface Wind in the vicinity of TC (linked to the Meteorological Satellite Center~~’s~~ web site~~:~~ at http://www.data.jma.go.jp/mscweb/en/product/product/aswind/monitor/aswind.php) |
| Radar Composite Imagery | Every hour | * Radar composite imagery of the Typhoon Committee Regional Radar Network |
| Atmospheric Circulation | | |
| Weather Charts | 4 times/day | * Weather maps for surface analysis, 24- and 48-hour forecasts (linked to the JMA~~’s~~ website~~:~~ at https://www.jma.go.jp/en/g3/) |
| NWP Multi Center Weather Charts | Twice/day | * Mean sea level pressure and 500 hPa Geopotential height (up to 168 hours) of deterministic NWP models from nine centers (BoM, CMA, CMC, DWD, ECMWF, KMA, NCEP, UKMO and JMA) |
| JMA GSM Analysis and Forecast | 4 times/day | * Upper-air analysis and forecast data based on JMA-GSM * Streamlines at 850, 500 and 200 hPa * Divergence at 200 hPa * Velocity potential at 200 hPa * Vertical Velocity in Pressure Coordinate at 500 hPa * Dew Point Depression at 600 hPa * Curvature Vorticity at 850 hPa * Vertical wind shear between 200 and 850 hPa * Sea Level Pressure * Genesis Potential Index |
| MJO phase diagram | ~~Monthly~~  Daily | * MJO phase and amplitude diagram and MJO Hovmöller~~Havmoller~~ diagram (linked to the Tokyo Climate Center ~~JMA’s~~ web sites:   https://ds.data.jma.go.jp/tcc/tcc/products/clisys/mjo/monitor.html  https://ds.data.jma.go.jp/tcc/tcc/products/clisys/ASIA\_TCC/mjo\_cross.html) |
| Asian Monsoon Monitoring Indices | Daily,  only during Apr. - Oct. | * Time series of vertical wind shear, OLR and other indices associated with SW Asian Monsoon (linked to the Tokyo Climate Center web site:   https://ds.data.jma.go.jp/tcc/tcc/products/clisys/ASIA\_TCC/monsoon\_index.html ~~JMA’s web sites~~) |
| Ocean Condition | | |
| SST | Once/day | * Sea surface temperature and related ~~its~~ related differences from 24 hours ago |
| TCHP | Once/day | * Tropical cyclone heat potential and ~~its~~ related differences from 24 hours ago |
| Numerical TC Prediction | | |
| Track Forecast Bulletin | 4 times/day | * RSMC Tokyo Tropical Cyclone Track Forecast Bulletin   + Track forecast by ~~deterministic~~ GSM (FXPQ2X)   + Track forecast by GEPS (FXPQ3X) |
| 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~~ EPS models from four centers (ECMWF, NCEP, UKMO and JMA) |
| TC Activity Prediction | Twice/day | * Two- and five-day TC activity prediction maps based on ~~ensemble NWP~~ EPS models from four centers (ECMWF, UKMO, NCEP and JMA) and a related consensus |
| Marine Forecast | | |
| Storm Surge  Forecasts | 4 times/day | * Distribution maps of storm surge for RSMC Tokyo - Typhoon Center’s TC track forecast and each of five TC track forecasts selected from GEPS ensemble members and maximum storm surge among these six TC track forecasts (up to 72 hours ~~ahead~~)   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~~) |
| Ocean Wave  Forecasts | Twice/day | * Distribution maps for ~~of~~ ensemble mean, maximum, probability of exceeding various thresholds and ensemble spread of wave height and period based on the Wave Ensemble System (WENS) (up to 264 hours ~~ahead~~) * Time-series representations with ~~of~~ box-and-whisker plots for ~~of~~ wave height/ ~~and~~ period~~,~~ and probability of exceeding various ~~thresholds of~~ wave height/ ~~and~~ period thresholds based on the WENS (up to 264 hours ~~ahead~~) |

##### Deterministic NWP models used in the Numerical Typhoon Prediction website

| System | Domain | Horizontal Resolution | Number of Vertical Levels | Forecast Range (Initial Time) | Specification of (Model/Data) |
| --- | --- | --- | --- | --- | --- |
| JMA deterministic Global model  (GSM) | Global | TL959 (~20 km) | 100 | 132 hours (00, 06, 18 UTC)  264 hours (12 UTC) | Model |
| BoM deterministic Global model (ACCESS-G) | Global | Lon: 0.35°  Lat: 0.23° | - | 240 hours  (00, 12UTC) | Data |
| CMA deterministic Global model (GRAPES\_GFS) | Global | 0.28° | - | 120 hours  (00, 12, UTC) | Data |
| CMC deterministic Global model (GDPS) | Global | 1.0° | - | 144 hours (00, 12UTC) | Data |
| DWD deterministic Global model (ICON~~GME~~) | Global | 0.25° | - | 174 hours  (00, 12UTC) | Data |
| ECMWF deterministic Global model (IFS-HRES) | Global | 0.5° | - | 240 hours (00, 12 UTC) | Data |
| KMA deterministic Global model (GDAPS) | Global | Lon: 0.23°  Lat: 0.16° | - | 168 hours (00, 12UTC), | Data |
| NCEP deterministic Global model (GFS) | Global | 0.5° | - | 192 hours (00, 06, 12, 18 UTC) | Data |
| UKMO deterministic Global model | Global | Lon: 0.83°  Lat: 0.56° | - | 120 hours (00, 12 UTC) | Data |

## Annex 5-6

**APPENDIX 3-B**

**Analysis methods, forecasting methods and NWP for forecasting currently used by the NMSs of Typhoon Committee Members**

Name of the Member: **[Republic of Korea]**

3 NWP Systems in Operational Use

| System | Domain | Horizontal Resolution | Number of Vertical Levels | Forecast Range (Initial Time) | Number of Ensemble Members | Run by  (own/other centers) |
| --- | --- | --- | --- | --- | --- | --- |
| KMA Global Data Assimilation and Prediction System (GDAPS) | Global | ~10 km | 70 | 288 hours (00,12 UTC)  87 hours (06, 18 UTC) | - | Own |
| KMA Global EPS (EPSG) | Global | ~32 km | 70 | 288 hours (00,12 UTC) | 25~~48~~ | Own |
| ECMWF deterministic Global model | Global | 16 km | - | 240 hours (00, 12 UTC) | - | Other |
| ECMWF Global EPS | Global | track data and intensity data | - | 240 hours (00, 12 UTC) | 51 | Other |
| JMA deterministic Global model  (GSM) | Global | ~20 km | 100 | 132 hours (00, 06,  18 UTC)  264 hours (12 UTC) | - | Other |
| JMA Global EPS (GEPS) | Global | ~40 km | 100 | 132 hours (06, 18 UTC)  264 hours (00, 12 UTC) | 27 | Other |
| NCEP deterministic Global model (GFS) | Global | 1.0° | - | 168 hours (00, 06,  12, 18 UTC) | - | Other |
| NCEP Global EPS | Global | 1.0° | - | 240 hours (00, 06,  12, 18 UTC) | 21 | Other |
| NCEP deterministic regional model (HWRF) | Regional | track and intensity data | - | Up to 126 hours  (00, 06,  12, 18 UTC) | - | Other |
| Navy Global Environmental Model (NavGEM) | Global | track and intensity data |  | 144 hours  (00,12 UTC) |  | Other |

## Annex 5-7

**APPENDIX 4-C**

**STATIONS BROADCASTING CYCLONE WARNINGS FOR SHIPS ON THE HIGH SEAS**

|  |  |  |  |
| --- | --- | --- | --- |
| Station | | Call sign of coastal radio station | Area covered |
| Member | Station |
| China | Shanghai | XSG | Bohai Sea, Huanghai Sea, Donghai Sea, Shanghai Port, Taiwan Straits and sea around Taiwan province |
| Tianjin | XSZ | North and Central Huanghai Sea and Bohai Sea |
| Guangzhou | XSQ | Taiwan Straits, Bashi Channel, South China Sea and Beibu Wan Gulf |
| Hong Kong, China | Hong Kong | Broadcast via NAVTEX on 518 kHz[[17]](#footnote-17) | Waters inside the boundary line: 30°N 105°E to 30°N 125°E to 10°N 125°E, to 10°N 105°E, to 30°N 105°E |
| Japan | Hokkaido | JNL | Hokkaido area |
| Shiogama | JNN | Sendai area |
| Yokohama | JGC | Tokyo area |
| Nagoya | JNT | Nagoya area |
| Kobe | JGD | Kobe area |
| Hiroshima | JNE | Hiroshima area |
| Niigata | JNV | Niigata area |
| Maizuru | JNC | Maizuru area |
| Moji | JNR | Fukuoka area |
| Kagoshima | JNJ | Kagoshima area |
| Okinawa | JNB | Okinawa area |
| Malaysia | Klang | SSB 5 | Strait of Malacca |
| Labuan | SSB 16 | South China Sea |
| Kuching | SSB 5 | South China Sea |
| Philippines | Manila | DZR, DZG, DSP, DZD, DZF, DFH, DZO, DZN, DZS | Pacific waters inside the boundary line: 25°N 12°0E to 25°N 135°E, to 5°N 135°E, to 5°N 115°E, to 15°N 115°E, to 21°N 120°E, to 20°N 120°E |
| San Miguel | NPO | North Pacific waters east of 160°E; Philippine Sea, Japan Sea, Yellow Sea, East China Sea, South China Sea |
| Republic of Korea | Seoul | HLL | East Sea, Yellow Sea, Jeju, Chusan, Nagasaki, and Kagoshima areas  Waters inside the boundary line: 43°N 120°E to 43°N 132°E to 27°N 132°E, to 27°N 120°E, to 43°N 120°E |
| Thailand | Bangkok | HSA | Gulf of Thailand, West coast of Southern Thailand, Strait of Malacca and South China Sea |
| U.S.A. | Honolulu, Hawaii | KMV-99 | Pacific Ocean |
| Viet Nam | Dannang | XVT 1-2 | Basco Gulf, Blendong Sea and Gulf of Thailand |
| Halphong | XVG 5, 9 | *ditto* |
| Ho Chi Minh Ville | XVS 1, 3, 8 | *ditto* |
| Nha Trang | XVN 1, 2 | *ditto* |

## Annex 5-8

**APPENDIX 5-B**

**PRESENT OPERATIONAL STATUS OF THE METEOROLOGICAL TELECOMMUNICATION NETWORK FOR THE TYPHOON COMMITTEE REGION**

|  |  |  |
| --- | --- | --- |
| 1. Main Telecommunication Network | | Present Operational Status |
|  | 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 | Internet, TCP/IP  ~~Cable (MPLS), TCP/IP~~  ~~Washington 50 Mbps/Tokyo 10 Mbps~~ |
| 2. Main regional circuit | |  |
|  | Tokyo - Bangkok | Cable (MPLS), TCP/IP  Tokyo 6 Mbps/Bangkok 3 Mbps ~~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), 20 Mbps ~~4 Mbps~~ TCP/IP  CMACast (Satellite broadcast) |
|  | Beijing - Macao | 20 Mbps 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), WMO FTP ~~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:  CMACast | 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 |

## Annex 5-9

**APPENDIX 5-C**

**LIST OF ADDRESSES, TELEX/CABLE AND TELEPHONE NUMBERSOF THE TROPICAL CYCLONE WARNING CENTERS IN THE REGION**

|  |  |  |
| --- | --- | --- |
| Centre | Mailing address | Telex/cable, Telephone, fax numbers |
| **Cambodia** | | |
| Attn. Mr Ly Chana  Deputy Director  Department of Agricultural  Hydraulics and Hydrometeorology | Norodom Boulevard | Tel.: (+855) 15 913081  Fax: (+855) 23 26345 |
| Attn. Mr Hun Kim Hak  Chief of Cambodian National | Pochentong | Tel/Fax: (+855) 23 66193  66192 NMC  66191 Airport |
| **China** | | |
| National Meteorological Center  China Meteorological Adm.  (Director: Wang Jianjie) | No. 46 Zhongguancun  Nandajie, Beijing 100081 | Tel.: (+86) (10) 5899 3198  Cable: 2894  Fax: (+86) (10) 6217 2909  E-mail: wangjj@cma.gov.cn |
| **Democratic People's Republic of Korea** | | |
| Mr Ko Sang Bok  Director  Central Forecast Research Institute  State Hydrometeorological Adm. | Oesong-dong  Central District | Telex: 38022 TCT KP  Tel.: (+850) (2) 321 4539  Fax: (+850) (2) 381 4410 |
| **Hong Kong, China** | | |
| Central Forecasting Office  Hong Kong Observatory  (Attn. ~~Mr. L.S. Lee~~Ms. M.K. Song) | 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: mksong~~lslee~~@hko.gov.hk |
| **Japan** | | |
| Forecast Division  Forecast Department  Japan Meteorological Agency  (Director: Y. Kajihara) | 1-3-4 Otemachi  Chiyoda-ku  Tokyo 100-8122 | Telex: 2228080 METTOKJ  (24 hours)  Tel.: (+81) (3) 3211 8303  (00 - 09 UTC on weekdays)  (+81) (3) 3211 7617 (24 hours)  Fax: (+81) (3) 3211 8303 |
| **Lao People's Democratic Republic** | | |
| Ministry of Agriculture and Forestry, Department of Meteorology and Hydrology, VIENTIANE | P.O. Box 811  Vientiane | Telex: 4306 ONU VTELS  Cable: UNDEVPRO |
| **Macao, China** | | |
| Meteorological and Geophysical Bureau  (Acting Director: Leong Weng Kun ~~Tang Iu Man~~) | Rampa do Observatório, Taipa Grande, Macau, China  ~~P.O. Box 93~~  ~~Macao, China~~ | Tel.: (+853) 88986173  Fax: (+853) 28850773  E-mail: meteo@smg.gov.mo |
| **Malaysia** | | |
| Malaysian Meteorological Department (National Weather & Geophysics Operation Centre)  (Director: Dr. Mohd. Hisham) | Jalan Sultan  46667 Petaling Jaya  Selangor  Malaysia | Tel.: (+60) (3) 7967 8118  (+60) (3) 7967 8119  Fax: (+60) (3) 7955 0964  E-mail: hisham@met.gov.my |

|  |  |  |
| --- | --- | --- |
| Centre | Mailing address | Telex/cable, Telephone, fax numbers |
| **Philippines** | | |
| Esperanza O. Cayanan Ph.D.  Weather Services Chief  Weather Division, PAGASA | WFFC Bldg.,  BIR Road, Diliman,  Quezon City 1100 | Telex: 66682 WXMLA PN  Tel.: (+63) (2) 922 1996  Cable: 66682 WX MLA  Fax: (+63) (2) 922 5287  (24 hours) |
| **Typhoon Committee Secretariat** | | |
| Secretary: Yu Jixin | Avenida de 5 de Outubro  Coloane, Macau | Tel: (853) 8 8010531  Fax: (853) 8 8010530  E-mail:  yujx@typhooncommittee.org |
| **Republic of Korea** | | |
| National Typhoon Center  Korea Meteorological Administration  (Dong Jin KIM, Meteorologist in charge)  ~~(Director: Deok Hwan JEONG~~) | 2 Seoseongro 810-gil,  Namwon-eup, eogwipo,  Jeju, 63614,  Republic of Korea | Tel.: (+82) (70) 7850-6365  ~~Tel.: (+82) (70) 7850-6351~~  Fax: (+82) (64) 805-0368 |
| **Thailand** |  |  |
| Thai Meteorological Department  (Group Cptain: Somsak Khaosuwan)  ~~(Director-General:~~  ~~Dr. Phuwieng Prakhammintara)~~ | 4353 Sukhumvit Road  Bangna, Bangkok 10260 | Tel&FAX: (+66) (2) 398 9875  E-mail: tmd\_inter@tmd.go.th |
| Weather Forecast Division  Thai Meteorological Department  (Director:  Mr. Maytee Mahayosananta  ~~Dr. Sugunyanee Yavinchan)~~ | 4353 Sukhumvit Road  Bangna, Bangkok 10260 | Tel&Fax: (+66) (2) 399 4001  E-mail:  m\_maytee9@yahoo.com  ~~sugunyanee@hotmail.com~~ |
| South East Asia Meteorological Telecommunication Center  ~~Telecommunications Division~~  Thai Meteorological Department  (Director: Mrs. Wattana Singtuy)  ~~(Director: Mr. Sumreang Monkong)~~ | 4353 Sukhumvit Road  Bangna, Bangkok 10260 | Tel.: (+66) (2) 399 4555  Fax: (+66) (2) 398 9861  E-mail:  gtsbkk@metnet.tmd.go.th  ~~tmd\_inter@tmd.go.th~~ |
| **USA** | | |
| National Weather Service  (Genevieve Miller,  Meteorologist in charge) | 3232 Hueneme Road  Barrigada  Guam 96913 | Tel.: (+1-671) 472 0944  Fax: (+1-671) 472 7405 |
| RSMC Honolulu  (Director: Raymond Tanabe) | 2525 Correa Road Suite  250 Honolulu, HI 96822 | Tel.: (+1-808) 973-5272  Fax: (+1-808) 973-5271 |
| **Viet Nam** | | |
| Forecast Division  Forecast Department  Hydro-Meteorological Service  (Director: Nguyan Cong Thanh) | 4 Dan Thai Than Hanoi | Tel.: (+84) (4) 264020  Fax: (+84) (4) 254278 |

## Annex 5-10

**APPENDIX 5-E**

**COLLECTION AND DISTRIBUTION OF INFORMATION RELATED TO TROPICAL CYCLONES**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Receiving station | | | | | | | | | | |
| Type of Data | Heading | | TD | BJ | BB | HH | MM | SL | NN | KK | IV | PP | MC |
| Enhanced | SNCI30 | BABJ | BJ | O | BJ | BJ | TD | TD | BJ | BB | BB | BB |  |
| surface | SNHK20 | VHHH | HH | HH | BJ | O |  | TD | BB | BB | BB | BB | HH |
| observation | SNJP20 | RJTD | O | TD | TD | TD |  | TD | BB | BB | BB | BB |  |
|  | SNKO20 | RKSL | SL | TD | TD | TD |  | O | BB | BB | BB | BB |  |
|  | SNLA20 | VLIV | BB | BB | IV |  |  |  | BB | BB | O | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | SNMS20 | WMKK | BB | BB | KK | BJ |  |  | BB | O | BB | BB |  |
|  | SNMU40 | VMMC |  | MC | BJ | BJ |  | TD | BB | BB | BB | BB | O |
|  | SNPH20 | RPMM | MM | TD | TD | TD | O | TD | BB | BB | BB | BB |  |
|  | SNTH20 | VTBB | BB | TD | O | TD |  | TD | BB | BB | BB | BB |  |
|  | SNVS20 | VNNN | BB |  | NN | BJ |  |  | O | BB | BB | BB |  |
| Enhanced | USCI01 | BABJ | BJ | O | BJ | BJ | TD | TD | BJ | BB | BB | BB |  |
| upper-air | USCI03 | BABJ | BJ | O | BJ | BJ | TD | TD | BJ | BB | BB | BB |  |
| observation | USCI05 | BABJ | BJ | O | BJ | BJ | TD | TD | BJ | BB | BB | BB |  |
|  | USCI07 | BABJ | BJ | O | BJ | BJ | TD | TD | BJ | BB | BB | BB |  |
|  | USCI09 | BABJ | BJ | O | BJ | BJ | TD | TD | BJ | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | UKCI01 | BABJ | BJ | O | BJ | BJ |  | TD | BJ | BB | BB | BB |  |
|  | ULCI01 | BABJ | BJ | O | BJ | BJ |  | TD | BB | BB | BB | BB |  |
|  | ULCI03 | BABJ | BJ | O | BJ | BJ |  | TD | BB | BB | BB | BB |  |
|  | ULCI05 | BABJ | BJ | O | BJ | BJ |  | TD | BB | BB | BB | BB |  |
|  | ULCI07 | BABJ | BJ | O | BJ | BJ |  | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | ULCI09 | BABJ | BJ | O | BJ | BJ |  | TD | BJ | BB | BB | BB |  |
|  | UECI01 | BABJ | BJ | O | BJ | BJ |  | TD | BB | BB | BB | BB |  |
|  | USHK01 | VHHH | HH | HH | BJ | O | TD | TD | BB | BB | BB | BB | HH |
|  | UKHK01 | VHHH | HH | HH | BJ | O |  | TD | BB | BB | BB | BB | HH |
|  | ULHK01 | VHHH | HH | HH | BJ | O |  | TD | BB | BB | BB | BB | HH |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | UEHK01 | VHHH | HH | HH | BJ | O |  | TD | BB | BB | BB | BB | HH |
|  | USJP01 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | UKJP01 | RJTD | O | TD | TD | TD |  | TD | BB | BB | BB | BB |  |
|  | ULJP01 | RJTD | O | TD | TD | TD |  | TD | BB | BB | BB | BB |  |
|  | UEJP01 | RJTD | O | TD | TD | TD |  | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | USKO01 | RKSL | SL | TD | TD | TD | TD | O | BB | BB | BB | BB |  |
|  | UKKO01 | RKSL | SL | TD | TD | TD |  | O | BB | BB | BB | BB |  |
|  | ULKO01 | RKSL | SL | TD | TD | TD |  | O | BB | BB | BB | BB |  |
|  | UEKO01 | RKSL | SL | TD | TD | TD |  | O | BB | BB | BB | BB |  |
|  | USMS01 | WMKK | BB | TD | KK | TD | TD | TD | BB | O | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | UKMS01 | WMKK | BB | TD | KK | TD | TD | TD | BB | O | BB | BB |  |
|  | ULMS01 | WMKK | BB | TD | KK | TD | TD | TD | BB | O | BB | BB |  |
|  | UEMS01 | WMKK | BB | TD | KK | TD | TD | TD | BB | O | BB | BB |  |
|  | USPH01 | RPMM | MM | TD | TD | TD | O | TD | BB |  | BB | BB |  |
|  | UKPH01 | RPMM | MM | TD | TD | TD | O | TD | BB |  | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | ULPH01 | RPMM | MM | TD | TD | TD | O | TD | BB |  | BB | BB |  |
| *Continued to* | UEPH01 | RPMM | MM | TD | TD | TD | O | TD | BB |  | BB | BB |  |
| *the next page* | USTH01 | VTBB | BB | TD | O | TD | TD | TD | BB | BB | BB | BB |  |
|  |  |  | Receiving station | | | | | | | | | | |
| Type of Data | Heading | | TD | BJ | BB | HH | MM | SL | NN | KK | IV | PP | MC |
| Enhanced | UKTH01 | VTBB | BB | TD | O | TD |  | TD | BB | BB | BB | BB |  |
| Upper-air | ULTH01 | VTBB | BB | TD | O | TD |  | TD | BB | BB | BB | BB |  |
| observation | UETH01 | VTBB | BB | TD | O | TD |  | TD | BB | BB | BB | BB |  |
|  | USVS01 | VNNN | BB | TD | NN | TD | TD | TD | O | BB | BB | BB |  |
|  | UKVS01 | VNNN | BB | TD | NN | TD |  | TD | O | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | ULVS01 | VNNN | BB | TD | NN | TD | TD | TD | O | BB | BB | BB |  |
|  | UEVS01 | VNNN | BB | TD | NN | TD | TD | TD | O | BB | BB | BB |  |
|  | URPA10 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | URPA11 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | URPA12 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | URPA14 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | URPN10 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | UZPA13 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | UZPN13 | KNHC | \* |  | TD | TD |  | TD | BB | BB | BB | BB |  |
|  | UZPN13 | KWBC | \* | TD | TD | TD |  | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | UZPN13 | PGTW | \* | TD | TD | TD |  | TD | BB | BB | BB | BB |  |
|  | IUDC01 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  | IUDC02 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  | IUDC03 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  | IUDC04 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | IUDC05 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  | IUDC06 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  | IUDC07 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  | IUDC08 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  | IUDC09 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | IUDC10 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
| Enhanced | SNVB20 | VTBB |  |  | O |  |  |  | BB | BB | BB | BB |  |
| ship | SNVB20 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
| observation | SNVD20 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | SNVE20 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | SNVX20 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | SNVB21 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | SNVD21 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | SNVE21 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | SNVX21 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | SNVX20 | RPMM | MM | TD | TD | TD | O | TD | BB |  | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | SNVX20 | VHHH | HH | HH | BJ | O | TD | TD | BB | BB | BB | BB | HH |
|  | SNVX20 | VNNN | BB | TD | NN | TD |  | TD | O | BB | BB | BB |  |
| Enhanced | SBCI30 | BABJ | BJ | O | BJ | TD | TD | TD | BJ | BB | BB | BB |  |
| radar | SCCI30 | BABJ |  | O | BJ | BJ |  |  | BB | BB | BB | BB |  |
| observation | SBCI60 | BCGZ |  | O | BJ |  |  |  | BJ | BB | BB | BB |  |
| *Continued to* | SCCI60 | BCGZ | HH | O | BJ |  |  |  | BB | BB | BB | BB |  |
| *the next page* | SBHK20 | VHHH | HH | HH | BJ | O | TD |  | BB | BB | BB | BB | HH |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Receiving station | | | | | | | | | | |
| Type of Data | Heading | | TD | BJ | BB | HH | MM | SL | NN | KK | IV | PP | MC |
| Enhanced | ISBC01 | VHHH | HH | HH | HH | O | TD | TD |  | BB | BB | BB |  |
| radar | ISBC01 | RJTD | O | TD | TD | TD | TD | TD |  | BB | BB | BB |  |
| observation | SDKO20 | RKSL |  |  |  |  |  | O |  |  |  |  |  |
|  | SDMS20 | WMKK | BB | TD | KK | TD |  |  | BB | O | BB | BB |  |
|  | SDPH20 | RPMM | MM | TD | TD |  |  | TD | BB |  | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | SDTH20 | VTBB | BB | TD | O | TD |  |  | BB | BB | BB | BB |  |
|  | SDVS20 | VNNN | BB | TD | NN | TD | TD |  | O | BB | BB | BB |  |
| Satellite | TPPN10 | PGTW |  |  | TD | TD |  |  | BB | BB | BB | BB |  |
| guidance | TPPN10 | PGUA | \* |  | TD | TD |  |  | BB | BB | BB | BB |  |
|  | TPPA1 | RJTY | \* | TD | TD | TD | TD |  | BB | BB | BB | BB |  |
|  | TPPA1 | RODN | \* | TD | TD | TD | TD |  | BB | BB | BB | BB |  |
|  | IUCC10 | RJTD | O | TD | TD | TD | TD | TD |  | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | IUCC01 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  | IUCC02 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  | IUCC03 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
|  | IUCC04 | VHHH | HH | HH | HH | O |  |  |  |  |  |  |  |
| Tropical | FXPQ01 | VHHH | HH | HH | BJ | O |  |  | BB | BB | BB | BB | HH |
| Cyclone | FXPQ02 | VHHH | HH | HH | BJ | O |  |  | BB | BB | BB | BB | HH |
| Forecast | FXPQ03 | VHHH | HH | HH | BJ | O |  |  | BB | BB | BB | BB | HH |
|  | FXPQ20 | VHHH | HH | HH | BJ | O | TD | TD | BB | BB | BB | BB | HH |
|  | FXPQ21 | VHHH | HH | HH |  | O |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | FXPQ20 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | FXPQ21 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | FXPQ22 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | FXPQ23 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | FXPQ24 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | FXPQ25 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | FXPQ29 | VTBB |  |  | O |  |  |  |  |  |  |  |  |
|  | FXPQ30 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | FXPQ31 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | FXPQ32 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | FXPQ33 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | FXPQ34 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | FXPQ35 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | FXPH20 | RPMM | MM | TD | TD | TD | O | TD | BB | BB | BB | BB |  |
|  | FXSS01 | VHHH | HH | HH | BJ | O |  |  | BB | BB | BB | BB | HH |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | FXSS02 | VHHH | HH | HH | BJ | O |  |  | BB | BB | BB | BB | HH |
|  | FXSS03 | VHHH | HH | HH | BJ | O |  |  | BB | BB | BB | BB | HH |
|  | FXSS20 | VHHH | HH | HH | BJ | O | TD | TD | BB | BB | BB | BB | HH |
|  | FXSS21 | VHHH | HH | HH |  | O |  |  |  |  |  |  |  |
|  | FXPN03 | RKSL |  |  |  | TD |  | O |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Receiving station | | | | | | | | | | |
| Type of Data | Heading | | TD | BJ | BB | HH | MM | SL | NN | KK | IV | PP | MC |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Warning | WDPN31 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WDPN32 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WHCI28 | BCGZ |  |  | BJ | BJ |  |  | BJ | BB | BB | BB |  |
|  | WHCI40 | BABJ | BJ | O | BJ | BJ |  |  | BJ | BB | BB | BB |  |
|  | WSPH | RPMM | \* | TD | TD | TD | O | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | WTMU40 | VMMC | BJ | MC | BJ | BJ |  |  | BB | BB | BB | BB | O |
|  | WTPN21 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPN31 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPN32 | PGTW | \* | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPH20 | RPMM | MM | TD | TD | TD | O |  | BB |  | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | WTPH21 | RPMM |  |  | TD |  | O |  | BB |  | BB | BB |  |
|  | WTPQ20 | VHHH | HH | HH | BJ | O |  | TD | BB | BB | BB | BB | HH |
|  | WTSS20 | VHHH | HH | HH | BJ | O |  |  | BB | BB | BB | BB | HH |
|  | WTTH20 | VTBB | BB | TD | O | TD |  |  | BB | BB | BB | BB |  |
|  | WTVS20 | VNNN |  |  | NN | BJ |  |  | O | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | WTPQ20 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPQ21 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPQ22 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPQ23 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPQ24 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | WTPQ25 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTKO20 | RKSL | SL | TD | TD | TD |  | O | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Prognostic | WTPQ30 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
| Reasoning | WTPQ31 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPQ32 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPQ33 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPQ34 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | WTPQ35 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Five-day | WTPQ50 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
| forecast | WTPQ51 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPQ52 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPQ53 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  | WTPQ54 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | WTPQ55 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |
| Others |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Best track | AXPQ20 | RJTD | O | TD | TD | TD | TD | TD | BB | BB | BB | BB |  |

Note: Meaning of abbreviation

O : Data originating centre

TD : Data transmitting centre - Tokyo

BJ : - Beijing

BB : - Bangkok

HH : - Hong Kong

MM : - Manila

SL : - Seoul

NN : - Hanoi

KK : - Kuala Lumpur

IV : - Vientiane

PP : - Phnom Penh

MC : - Macao

\* : Places other than described above

1. More information available on https://www.jma-net.go.jp/msc/en/support/index.html [↑](#footnote-ref-1)
2. More information available on https://www.jma.go.jp/jma/jma-eng/satellite/HimawariRequest.html [↑](#footnote-ref-2)
3. More information available on http://fy4.nsmc.org.cn/service/en/emergency/index.html [↑](#footnote-ref-3)
4. More information available on https://www.jma.go.jp/jma/jma-eng/satellite/HimawariRequest.html [↑](#footnote-ref-4)
5. 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). [↑](#footnote-ref-5)
6. Macao, China receives FY-2D, FY-2E (S-VISSR) Stretched VISSR. [↑](#footnote-ref-6)
7. Republic of Korea receives AQUA (MODIS, AIRS, AMSU, AMSR-E) and TERRA (MODIS). [↑](#footnote-ref-7)
8. Singapore receives AQUA (MODIS), FY-2B (S-VISSR) and TERRA (MODIS). [↑](#footnote-ref-8)
9. Forecasts from initial times at 06 and 18 UTC are operated when any of the following conditions is satisfied at the initial times: (i) A tropical cyclone (TC) of tropical storm (TS) intensity or higher is present in the RSMC Tokyo-Typhoon Center’s area of responsibility (0°-60°N, 100°-180°E). (ii) A TC is expected to reach TS intensity or higher in the area within the next 24 hours. (iii) A TC of TS intensity or higher is expected to move into the area within the next 24 hours. [↑](#footnote-ref-9)
10. Forecasts from initial times at 06 and 18 UTC are operated when any of the following conditions is satisfied at the initial times: (i) A tropical cyclone (TC) of tropical storm (TS) intensity or higher is present in the RSMC Tokyo-Typhoon Center’s area of responsibility (0°-60°N, 100°-180°E). (ii) A TC is expected to reach TS intensity or higher in the area within the next 24 hours. (iii) A TC of TS intensity or higher is expected to move into the area within the next 24 hours. [↑](#footnote-ref-10)
11. Coast station VRX closed on 1 October 2006. [↑](#footnote-ref-11)
12. Hong Kong, China receives AQUA (MODIS), SNPP (CrIs, VIIRS, ATMS), FY-2 (S-VISSR), FY3B (VIRR, MERSI), FY3C (VIRR, MWHS, MWRI) and FY3D (MERSI-2, MWHS, MWTS, MWRI), FY4A (GIIRS, LMI, AGRI), GeoKompSAT-2A (AMI), GOES-E and GOES-W (ABI), Meteosat-8 (SEVIRI), and Meteosat-11 (SEVIRI) and TERRA (MODIS), METOP-A ,~~and~~ METOP-B and METOP-C (AMSU-A, AVHRR, HIRS, MHS). [↑](#footnote-ref-12)
13. Macao, China receives FY-2G ~~FY-2D, FY-2E~~ (S-VISSR) Stretched VISSR. [↑](#footnote-ref-13)
14. Republic of Korea receives AQUA (MODIS, AIRS, AMSU, AMSR-E) and TERRA (MODIS). [↑](#footnote-ref-14)
15. Singapore receives AQUA (MODIS), FY-2B (S-VISSR) and TERRA (MODIS). [↑](#footnote-ref-15)
16. Thailand receives FY-2C [↑](#footnote-ref-16)
17. Coast station VRX closed on 1 October 2006. [↑](#footnote-ref-17)