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REPORT ON AMENDMENTS TO THE TYPHOON COMMITTEE OPERATIONAL MANUAL

(submitted by the Rapporteur)

Summary and Purpose of Document:

This document presents draft amendments to the Typhoon Committee Operational Manual - Meteorological Component (TOM) proposed by the Members.

ACTION REQUIRED:
The Committee is invited to review and approve the proposed amendments to the TOM.

APPENDIXES:
1) DRAFT TEXT FOR INCLUSION AT SESSION REPORT
2) UPDATE OF THE TYPHOON COMMITTEE OPERATIONAL MANUAL

APPENDIX A:
DRAFT TEXT FOR INCLUSION IN THE SESSION REPORT

x.x Review of Typhoon Committee Operational Manual (TOM)

1. The Session noted that the Typhoon Committee Operational Manual (TOM) rapporteur requests WMO to publish and upload the 2015 edition of TOM on the Tropical Cyclone Programme (TCP) Website as submitted by the Rapporteur, with the amendments given in Appendix XX.

2. The Committee expressed its appreciation to the rapporteur for update of TOM.

APPENDIX B:
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 2015 edition was completed and posted on the WMO website in March 2015 in accordance with the approval of amendments to the 2014 edition by the 3rd Joint Session of the Panel on Tropical Cyclone (PTC) and Typhoon Committee (TC) (9 to 13 February 2015 Bangkok, Thailand).

2. At the 3rd session, the Committee decided that the rapporteur of the Japan Meteorological Agency (JMA) continue arrangements for updating the TOM. In this connection, on 21 August 2015, the rapporteur, Mr Tsukasa Fujita, Head of the JMA Tokyo Typhoon Center invited the focal points of the meteorological component of the Members to provide proposals for updates to the TOM.

3. As of the end of January 2016, proposals for updates to the TOM had been submitted by the five focal points of China, Hong Kong, China, Japan, Thailand and the Philippines.

4. Proposed amendments to the TOM are attached as Annex 1 and given below are the major points of the amendments:

- Update of information on technical specifications of the JMA's next generation satellite Himawari-8 (Chapter 2, 3 and 5)
- Update of information on telecommunication network (Chapter 5)
- Update of information on technical specifications of radars of typhoon committee members (Appendix 2-D)
- Update of operational typhoon track forecast methods used by typhoon committee members (Appendix 3-B)
- Update of information on HKO's operational procedures of TC satellite analysis and Non-Hydrostatic Model (Appendix 3-C, 3-E)

Annex 1

Draft Amendments to
the Typhoon Committee Operational Manual – Meteorological Component (TOM)
proposed by the Members

Page	Line	Proposed Amendment	Comments
Chapter 2.4			
9	L50	JMA started the operation of its new geostationary meteorological satellite, Himawari-8, at 02:00 UTC on 7 July 2015, replacing the previous satellite MTSAT-2. The meteorological satellite information obtained by ~~MTSAT~~ Himawari-8 and related products are operated as follows: (i) full disk data are obtained ~~hourly~~ every 10 minutes with 16 observation bands; (ii) ~~half disk data in the northern hemisphere are obtained hourly in addition to the full disk data;~~ target area data are obtained every 2.5 minutes; ~~(iii) additional half disk data in the northern and southern hemispheres for Atmospheric Motion Vector (AMV) extraction are obtained six-hourly;~~ (~~iv~~ iii) AMV data are derived hourly; (~~v~~ iv) Clear Sky Radiance (CSR) data are derived hourly from the full disk data.	Update of the information on the geostationary meteorological satellite operated by JMA..
10	L13	~~JMA successfully launched Himawari-8 on 7 October 2014 and plans to start its operation in mid-2015 to replace the current satellite, MTSAT-2. The satellite will feature a new imager with 16 bands as opposed to the 5 bands of the MTSAT series. Full-disk imagery will be obtained every 10 minutes, and rapid scanning at 2.5-minute intervals will be conducted over several regions, one of which will be for targeted observation of tropical cyclones. Its horizontal resolution will also be~~	Update of the information on the geostationary meteorological satellite operated by JMA.

		~~double that of the MTSAT series.~~ ~~Himawari-8 will not carry a device for direct dissemination system. Instead, JMA will distribute all imagery derived from the satellite to National Meteorological and Hydrological Services (NMHSs) via an Internet cloud service. The Agency also plans to start a HimawariCast service involving the dissemination of primary sets of images for operational meteorological services via a communication satellite. Its current online imagery distribution services (WIS Portal (GISC-Tokyo) and the JMA Data Dissemination System (JDDS)) will be continued.~~ ~~Further information on Himawari-8 and -9 is available at the website of Meteorological Satellite Center of JMA (http://www.data.jma.go.jp/mscweb/en/himawari89/).~~	
10	L44	SAREP reports are also issued eight times a day by Hong Kong, China to other meteorological centres through the GTS under the heading of IUCC01 VHHH, IUCC02 VHHH, IUCC03 VHHH and IUCC04 VHHH in the BUFR code (FM 94) when a tropical cyclone is located within 10N to 30N and 105E to 125E.	Update of the information on SAREP reports issued by Hong Kong, China.
Chapter 2.6			
11	L16	HKO conducts reconnaissance flights for selected tropical cyclones over the northern part of the South China Sea. ~~Regional d~~ Data ~~exchange~~ is being ~~arranged~~ shared at a regional level.	Update of the information on the data of reconnaissance flight run by HKO.
Chapter 3.1			
12	L35	Various analyses based on ~~MTSAT~~ Himawari data other than cloud imagery itself should be produced by the RSMC Tokyo - Typhoon Center.	Update of the information on the geostationary meteorological satellite operated by JMA..
13	Table 3.1	To be replaced by Annex 1-1	Update of the information on the products provided by JMA
15	Table 3.2	To be replaced by Annex 1-2	Update of the information on the NWP products provided by JMA

17	Table 3.3	To be replaced by Annex 1-3	Update of the information on the geostationary meteorological satellite operated by JMA.
Chapter 5.4			
23	Table 5.1	To be replaced by Annex 1-4	Update of the status of telecommunication network in China, and the information on Himawari-8 is updated.
APPENDIX 2-B			
38	L26	# ~~radiosonde~~ upper-air observations are ~~supplemented~~ made by wind profiler ~~observations~~ at 06 and 18 UTC normally, but radiosondes will be launched when ~~necessary~~ warranted by local wind conditions	Modification of the description of upper-air observation run by Hong Kong, China
APPENDIX 2-D			
40		To be replaced by Annex 1-5	Update of the distribution of radar stations
43	p.3	To be replaced by Annex 1-6	Update of the information on the radars in Hong Kong, China
52 -53	p12 -p13	To be replaced by Annex 1-7	Update of the information on the radars in the Philippines
APPENDIX 2-E			
65		To be replaced by Annex 1-8	Update of the information on the geostationary meteorological satellite operated by JMA.
66	Figure 2-E.1 (1/5)	Delete	
67	Figure 2-E.1 (2/5)	Delete	
68	Figure 2-E.1 (3/5)	Delete	
69	Figure 2-E.1 (4/5)	Delete	
70	Figure 2-E.1 (5/5)	Delete	
71	Figure 2-E.2	Delete	
APPENDIX 2-F			
72		To be replaced by Annex 1-9	Update of the information on the geostationary meteorological satellite operated by JMA.
APPENDIX 3-A			
75	L20	Axis-symmetric structure based on Frank's (1977) empirical formula with parameters prescribed on forecasters' analysis mainly applying the Dvorak method to ~~MTSAT~~ Himawari imagery	Update of the information on the geostationary meteorological satellite operated by JMA.

76	L45	~~(maximum number of predictions) Three for each synoptic time (0000, 0600, 1200 and 1800 UTC)~~	This explanation can lead to misunderstanding about the number of typhoons that are subject to the calculation of anomaly vectors. The information is deleted.
APPENDIX 3-B			
78	p1-p3	To be replaced by Annex 1-10	The information on operational typhoon track forecast methods used by China is updated.
82	p5	To be replaced by Annex 1-11	The information on operational typhoon track forecast methods used by Hong Kong, China is updated.
APPENDIX 3-C			
ANN EX1	L10	The tropical cyclone analysis and forecasting technique using satellite data developed by Vernon F. Dvorak (Dvorak, 1984) is mainly used for TC warnings. ~~The methods are described in the Global Guide to Tropical Cyclone Forecasting at the WMO/TCP website (http://www.wmo.int/pages/prog/www/tcp/TCF/GlobalGuide.html).~~	The Guide has been updated recently with material on Dvorak technique removed.
ANN EX4		To be replaced by Annex 1-12	The detailed description is added.
APPENDIX 3-E			
122		To be replaced by Annex 1-13	The detailed information on Non-Hydrostatic Model (NHM) run by HKO is updated
APPENDIX 4-C			
138		To be replaced by Annex 1-14	The information on stations broadcasting cyclone warnings for ship on the high seas in Thailand is updated.
APPENDIX 5-A			
139		To be replaced by Annex 1-15	Contact detail of China, the Philippines and Thailand is updated.
APPENDIX 5-C			
143		To be replaced by Annex 1-16	The table about collection and distribution of information is updated.
APPENDIX 5-D			
148		ISBC01 VHHH IUCC~~10~~01-04 VHHH	The information on SAREP report is updated.
APPENDIX 6-B			
150	L38	Members can also retrieve the data from the Internet server of JMA (~~ddb.kishou.go.jp~~http://www.wis-jma.go.jp/monitoring/data/monitoring/) by using ~~FTP~~HTTP. ~~A password to connect the FTP server by using anonymous FTP is~~	URL is changed

		~~issued to Members in consultation with JMA.~~	
APPENDIX 7-A			
158		To be replaced by Annex 1-17	Update of the information on the geostationary meteorological satellite operated by JMA.

Table 3.1 Chart-form products provided by RSMC Tokyo - Typhoon Center for regional purposes

Area	Contents and Level	Forecast hours	Initial time	Availability
A’ (Far East)	500hPa (Z, ζ)	Analysis	00, 12UTC	GTS
		24, 36	00, 12UTC	GTS, JMH
	500hPa (T), 700hPa (D)	24, 36	00, 12UTC	GTS, JMH
	700hPa (ω), 850hPa (T, A)	Analysis	00, 12UTC	GTS
		24, 36	00, 12UTC	GTS, JMH
	Surface (P, R, A)	24, 36	00, 12UTC	GTS, JMH
C (East Asia)	300hPa (Z, T, W, A)	Analysis	00UTC	GTS
	500hPa (Z, T, A)	Analysis	00, 12UTC	GTS, JMH
	500hPa (Z, ζ)	48, 72	00, 12UTC	GTS
	700hPa (Z, T, D, A)	Analysis	00, 12UTC	GTS
	700hPa (ω), 850hPa (T, A)	48, 72	12UTC	GTS
	850hPa (Z, T, D, A)	Analysis	00, 12UTC	GTS, JMH
	Surface (P, R)	24, 48, 72	00, 12UTC	GTS, JMH
		96, 120	12UTC	JMH
O (Asia)	500hPa (Z, ζ)	96, 120, 144, 168, 192	12UTC	GTS
	850hPa (T), Surface (P)			
Q (Asia Pacific)	200hPa (Z, T, W), Tropopause (Z)	Analysis	00, 12UTC	GTS
	250hPa (Z, T, W)	Analysis, 24	00, 12UTC	
	500hPa (Z, T, W)	24	00, 12UTC	
D (N.H.)	500hPa (Z, T)	Analysis	12UTC	GTS
W (NW Pacific)	200hPa (streamline)	Analysis, 24, 48	00, 12UTC	GTS
	850hPa (streamline)		00, 12UTC	
C’’ (NW Pacific)	Ocean Wave (height, period and direction)	12, 24, 48, 72	00, 12UTC	GTS, JMH
C	Sea Surface Temperature	Daily analysis	-	JMH
C’2 (Asia Pacific)	Surface(P)	Analysis	00,06,12, 18UTC	GTS, JMH
		24	00, 12UTC	
		48		
	Surface(Typhoon Forecast)	12,24,48,72	00,06,12, 18UTC	
		24,48,72,96, 120		JMH

Notes:

(a) Area

A’, C, O, Q, D, W,C’’ and C’2 are illustrated in Figure 3.1.

(b) Contents

Z: geopotential height	ζ: vorticity	T: temperature
D: dewpoint depression	ω: vertical velocity	W: wind speed by isotach
A: wind arrows	P: sea level pressure	R: rainfall

Table 3.2 NWP products (GSM and EPS) provided by RSMC Tokyo - Typhoon Center
(Available at http://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	One-week EPS
Area and resolution	Whole globe, 2.5°×2.5°
Levels and elements	250 hPa: μU, σU, μV, σV 500 hPa: μZ, σZ 850 hPa: μU, σU, μV, σV, μT, σT 1000 hPa: μZ, σZ Surface: μP, σP
Forecast hours	0–192 every 12 hours
Initial times	00, 12UTC

Table 3.3 List of other products provided by RSMC Tokyo - Typhoon Center
(Available at http://www.wis-jma.go.jp/cms/)

Data	Contents / frequency (initial time)
Satellite products	High density atmospheric motion vectors (BUFR) (a) MTSAT-2 (VIS, IR, WV), 60S-60N, 90E-170W VIS: every hour (00-09, 21-23 UTC), IR and WV: every hour (b) Himawari-8 (VIS, IR, WV), 60S-60N, 90E-170W VIS: every hour (Northern Hemisphere: 00-09, 21-23 UTC; Southern Hemisphere: 00-08, 21-23 UTC), IR and WV: every hour (~~b~~ c) METEOSAT-7 (VIS, IR, WV) VIS: every 1.5 hours between 0130 and 1500 UTC IR and WV: every 1.5 hours Clear Sky Radiance (CSR) data (BUFR) (a) MTSAT-2 (IR, WV) radiances and brightness temperatures averaged over cloud-free pixels: every hour (b) Himawari-8 radiances and brightness temperatures averaged over cloud-free pixels: every hour
Tropical cyclone Information	Tropical cyclone related information (BUFR) • tropical cyclone analysis data (00, 06, 12 and 18 UTC)
Wave data	Global Wave Model (GRIB2) • significant wave height • prevailing wave period • wave direction Forecast hours: 0–84 every 6 hours (00, 06 and 18UTC) 0–84 every 6 hours and 96-264 every 12 hours (12 UTC)
Observational data	(a) Surface data (TAC/TDCF) SYNOP, SHIP, BUOY: Mostly 4 times a day (b) Upper-air data (TAC/TDCF) TEMP (parts A-D), PILOT (parts A-D): Mostly twice a day
Storm surge	Storm surge model for Asian area · storm surge distribution (map image) · time series charts (at requested locations) The plotted values are storm surges, predicted water levels, astronomical tides, surface winds, and sea level pressures. Forecast hours: 0–72 every 3 hours (00, 06 12, and 18UTC) Only in the case of a tropical cyclone being in the forecast time (Available at https://tynwp-web.kishou.go.jp/)
SATAID service	(a) Satellite imagery (SATAID) ~~MTSAT~~ Himawari-8 (b) Observation data (SATAID) SYNOP, SHIP, METAR, TEMP (A, B) and ASCAT sea-surface wind (c) NWP products (SATAID) GSM (Available at http://www.wis-jma.go.jp/cms/sataid/)

Table 5.1: Present operational status of the meteorological telecommunication network for the Typhoon Committee region

1. Main Telecommunication Network	Present Operational Status
Beijing - Tokyo	Cable (MPLS), TCP/IP Beijing ~~8~~ 16 Mbps/Tokyo 10 Mbps
Beijing - Offenbach	Cable (FR), 48 kbps (MPLS) TCP/IP Beijing ~~8~~ 16 Mbps/Offenbach 50 Mbps
Washington - Tokyo	Cable (MPLS), TCP/IP Washington ~~1~~ 50 Mbps/Tokyo 10 Mbps
2. Main regional circuit	
Tokyo - Bangkok	Cable (MPLS), TCP/IP Tokyo 2 Mbps/Bangkok 128 kbps
3. Regional circuits	
Bangkok - Beijing	64 kbps leased line CMACast (Satellite broadcast)
Bangkok - Hanoi	64 kbps leased line
Bangkok – Hong Kong	Internet, FTP protocol
Bangkok - Phnom Penh	Internet (VPN)
Bangkok - Vientiane	Cable (DDN), 64 kbps, FTP protocol
Beijing - Hanoi	64 kbps leased line, CMACast (Satellite broadcast)
Beijing - Hong Kong	Cable (MSTP), 4 Mbps TCP/IP CMACast (Satellite broadcast)
Beijing - Macao	2Mbps leased line CMACast (Satellite broadcast)
Beijing - Pyongyang	64 kbps leased line,; CMACast (Satellite broadcast)
Beijing - Seoul	Cable (FR), 32 kbps (CIR) TCP/IP
Beijing - Vientiane	CMACast (Satellite broadcast)
Hong Kong - Macao	ISDN, 128 kbps, TCP/IP
Tokyo - Hong Kong	Cable (MPLS), TCP/IP Tokyo 2 Mbps/Hong Kong 1 Mbps

Tokyo - Seoul	Cable(MPLS), ~~128 kbps,~~ TCP/IP 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 2 Mbps/Manila 64 kbps

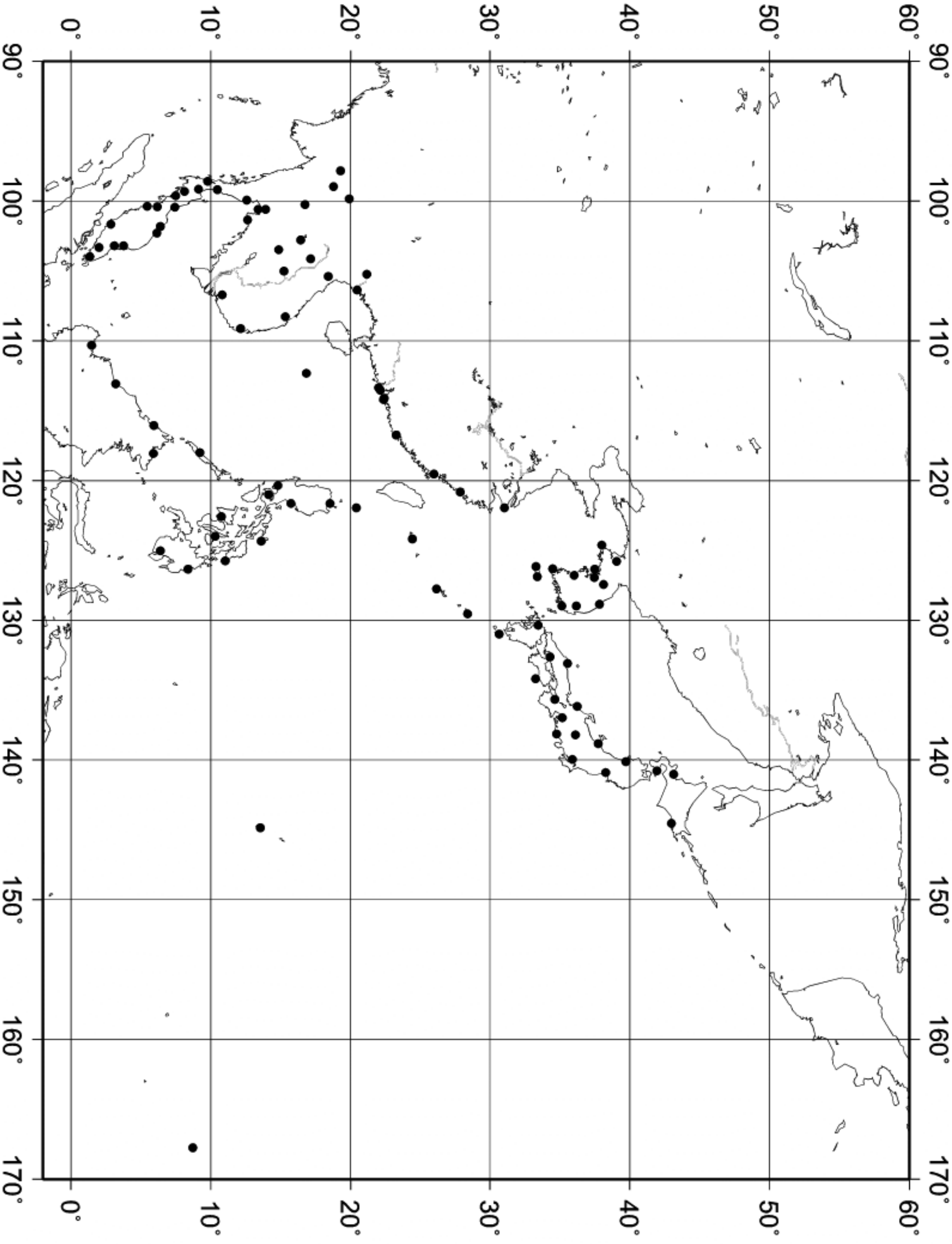
5. RTH radio broadcast

Bangkok	1 FAX
Tokyo	1 FAX

6. Satellite broadcast

Operated by China: Asiasat-4 (122.2°E)	Operational ~~data, fax and~~ observations, warnings, NWP products, satellite image and fax distribution
Operated by Japan: ~~MTSAT~~ HimawariCast (JCSAT-2, 1~~40~~54°E)	Operational satellite image and data distribution

DISTRIBUTION OF THE RADAR STATIONS OF TYPHOON COMMITTEE MEMBERS



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

NAME OF STATION		Tai Mo Shan	Tate's Cairm			
SPECIFICATIONS	Unit					
Index number		45009	45010			
Location of station		22° 25′ N 114° 07′ E	22° 2~~2~~1′ N 114° 13′ E			
Antenna elevation	m	968	58~~3~~2			
Wave length	cm	10.6	10.3			
Peak power of transmitter	kW	650	~~500~~650			
Pulse length	μ s	1.0/1.8	~~0.8~~1.0/2.0			
Sensitivity minimum of receiver	dBm	-117	-11~~0~~4			
Beam width (Width of over -3dB antenna gain of maximum)	deg	0.9(H) 0.9(V)	~~1.8~~0.9			
Detection range	km	500	500			
Scan mode in observation 1.Fixed elevation 2.CAPPI 3.Manually controlled		2	2			
DATA PROCESSING						
MTI processing 1.Yes, 2.No		2	2			
Doppler processing 1.Yes, 2.No		1	1			
Display 1.Digital, 2.Analog		1	1			
OPERATION MODE (When tropical cyclone is within range of detection) 1.Hourly 2.3-hourly 3.Others		3 (Continuous)	3 (Continuous)			
PRESENT STATUS 1.Operational 2.Not operational (for research etc.)		1	1			

Name of the Member **Philippines - 1**

NAME OF STATION		Aparri	Virac	Mactan	Guiuan	Subic
SPECIFICATIONS	Unit					
Index number		98231	98447	98646	98558	
Location of station		~~18° 22′ N~~ 18° 31’ 36.36’’ N ~~121° 37′ E~~ 121° 38’ 08.58’’ E	~~13° 38′ N~~ 13° 37’ 47.18’’ N ~~124° 19′ E~~ 124° 20’ 02.57’’ E	~~10° 18′ N~~ 10° 19’ 20.80’’ N ~~123° 58′ E~~ 123° 58’ 48.47’’ E	~~11° 02′ N~~ 11° 02’ 48.48’’ N ~~128° 44′ E~~ 125° 45’ 19.55’’ E	14° 49’ 19.44’’ N 120° 21’ 49.68’’E
Antenna elevation	m	~~16~~39	~~248~~39	~~33~~26	~~66~~39	40
Wave length	cm	~~5.65~~10.52	10.52	~~10.5~~5.33	10.52	10.4
Peak power of transmitter	kW	~~250~~10	~~500~~10	~~500~~250	~~500~~10	850
Pulse length	μ s	2& 100 – intensity mode 1 @ 50 – Doppler mode	~~3~~ 2 & 100 – intensity mode 1 @ 50 – Doppler mode	~~3~~ 2.0, 1.0, 0.8, 0.4	~~3~~ 2 & 100 – intensity mode 1 @ 50 – Doppler mode	2.0, 1.0, 0.8, 0.4
Sensitivity minimum of receiver	dBm	-114	-114	-114	-114	-114
Beam width (Width of over -3dB antenna gain of maximum)	deg	1.~~5~~8	~~2.2~~1.8	~~2.2~~1.0	~~2.2~~1.8	1.83
Detection range	km	4~~04~~0	4~~04~~0	~~400~~250	4~~04~~0	480
Scan mode in observation 1.Fixed elevation 2.CAPPI 3.Manually controlled		~~Automatic Azimuth scan and mode 3 elv~~ 2	~~Automatic Azimuth scan and mode 3 elv~~ 2	~~Automatic Azimuth scan and mode 3 elv~~ 2	~~Automatic Azimuth scan and mode 3 elv~~ 2	2
DATA PROCESSING						
MTI processing 1.Yes, 2.No		~~2~~1	~~2~~1	2	~~2~~1	2
Doppler processing 1.Yes, 2.No		2	2	~~2~~1	2	1
Display 1.Digital, 2.Analog		1	1	1	1	1
OPERATION MODE (When tropical cyclone is within range of detection) 1.Hourly 2.3-hourly 3.Others		~~1 occasionally every 30 minutes~~ 3 (constantly tracking)	~~1 occasionally every 30 minutes~~ 3 (constantly tracking)	~~1 occasionally every 30 minutes~~ 3	~~1 occasionally every 30 minutes~~ 3 (constantly tracking)	3
PRESENT STATUS 1.Operational 2.Not operational (for research etc.)		1	1	1	1	1

Name of the Member **Philippines - 2**

NAME OF STATION		Baler	Hinatuan	Tampakan	Ilo-Ilo	Tagaytay
SPECIFICATIONS	Unit					
Index number		98333	98755		98637	
Location of station		15° 44' 57.72" N 121° 37' 55.37" E	08° 22' 02.37" N 126° 20' 18.73" E	06° 25' 03.81" N 125° 01' 51.41" E	10° 46' 20.08" N 122° 34' 45.08" E	14° 09' 31.28" N 121° 01' 12.49" E
Antenna elevation	m	15	26	26	26	35
Wave length	cm	10.68	10.78	10.4	10.44	5.34
Peak power of transmitter	kW	600	850	850	850	250
Pulse length	μ s	2.0, 1.0, 0.8, 0.4	2.0, 1.0, 0.8, 0.4	2.0, 1.0, 0.8, 0.4	3.0, 1.0, 0.8, 0.4	2.0, 1.0, 0.8, 0.4
Sensitivity minimum of receiver	dBm	-114	-114	-114	-114	-114
Beam width (Width of over -3dB antenna gain of maximum)	deg	1.83	1.3	1.3	1.3	1.0
Detection range	km	480	480	480	480	250
Scan mode in observation 1.Fixed elevation 2.CAPPI 3.Manually controlled		2	2	2	2	2
DATA PROCESSING						
MTI processing 1.Yes, 2.No		2	2	2	2	2
Doppler processing 1.Yes, 2.No		1	1	1	1	1
Display 1.Digital, 2.Analog		1	1	1	1	1
OPERATION MODE (When tropical cyclone is within range of detection) 1.Hourly 2.3-hourly 3.Others		3	3	3	3	3
PRESENT STATUS 1.Operational 2.Not operational (for research etc.)		2 (for replacement)	1	2 (for replacement of gears)	1	1

NAME OF STATION		Basco	Quezon, Palawan	~~Baguio~~	~~Tanay~~	~~Daet~~
SPECIFICATIONS	Unit					
Index number		98135		~~98321~~	~~98433~~	~~98440~~
Location of station		20° 25' 14.87'' N 121° 57' 54.76'' E	9° 13' 50.01'' N 118° 00' 20.09'' E	~~16° 20´ N~~ ~~120° 34´ E~~	~~14° 34´ N~~ ~~121° 21´ E~~	~~14° 08´ N~~ ~~122° 59´ E~~
Antenna elevation	m	15	26	~~2256~~	~~650.36~~	~~12.5~~
Wave length	cm	5.33	5.35	~~10.5~~	~~10.5~~	~~10.5~~
Peak power of transmitter	kW	250	250	~~500~~	~~500~~	~~500~~
Pulse length	μ s	2.0, 1.0, 0.8, 0.4	2.0, 1.0, 0.8, 0.4	~~4/ 0.5~~	~~3~~	~~3~~
Sensitivity minimum of receiver	dBm	-114	-114			
Beam width (Width of over -3dB antenna gain of maximum)	deg	1.0	1.0	~~2.2~~	~~2.2~~	~~2.2~~
Detection range	km	250	250	~~400~~	~~400~~	~~400~~
Scan mode in observation 1.Fixed elevation 2.CAPPI 3.Manually controlled		2	2	~~Automatic Azimuth scan and mode 3 elv~~	~~Automatic Azimuth scan and mode 3 elv~~	~~Automatic Azimuth scan and mode 3 elv~~
DATA PROCESSING						
MTI processing 1.Yes, 2.No		2	2	~~2~~	~~2~~	~~2~~
Doppler processing 1.Yes, 2.No		1	1	~~2~~	~~2~~	~~2~~
Display 1.Digital, 2.Analog		1	1	~~1~~	~~1~~	~~1~~
OPERATION MODE (When tropical cyclone is within range of detection) 1.Hourly 2.3-hourly 3.Others		3	3	~~1 occasionally every 30 minutes~~	~~1 occasionally every 30 minutes~~	~~1 occasionally every 30 minutes~~
PRESENT STATUS 1.Operational 2.Not operational (for research etc.)		1 (no communication link to central office but we get data via FTP)	1	~~1~~	~~1~~	~~1~~

SCHEDULE OF ~~MTSAT~~HIMAWARI OBSERVATIONS AND DISSEMINATIONS

1. ~~IMAGER o~~Observations

~~IMAGER~~ Himawari observations are as follows:

(a) full-disk observations are made ~~hourly~~ every 10 minutes;

(b) ~~half-disk~~ target area observations ~~of northern hemisphere~~ are made ~~hourly~~ every 2.5 minutes in addition to the full-disk observations;

~~(c) additional half disk data in the northern and southern hemispheres for Atmospheric Motion Vector (AMV) extraction are made six-hourly.~~

2. HimawariCloud (Internet cloud service)

JMA distributes full-spec imagery derived from the Himawari-series satellites via an Internet cloud service, HimawariCloud. See the following webpage for details.
http://www.data.jma.go.jp/mscweb/en/himawari89/cloud_service/cloud_service.html

3. HimawariCast (communication satellite dissemination service)

JMA operates the HimawariCast service which disseminates primary sets of imagery from the Himawari-series satellites via an communication satellite, See the following webpage for details.
http://www.data.jma.go.jp/mscweb/en/himawari89/himawari_cast/himawari_cast.html

~~2. Dissemination Services for Medium-scale Data Utilization Station (MDUS) Users~~

~~High Rate Information Transmission (HRIT) is available as dissemination service for MDUS users.~~
~~Technical specifications of HRIT are given in~~
~~JMA HRIT Mission Specification Implementation (Issue 1.2, 1 Jan. 2003)~~
~~(http://www.jma.go.jp/jma/jma-eng/satellite/introduction/4_2HRIT.pdf)~~

~~This service will terminate in around the end of November 2015.~~

~~3. Dissemination Services for Small-scale Data Utilization Stations (SDUS) Users~~

~~Low Rate Information Transmission (LRIT) is available as dissemination service for SDUS users. Visible imagery of full earth's disk of normalized geostationary projection has been disseminated via LRIT since 1 July, 2010. Technical specification of LRIT is given in JMA LRIT Mission Specification Implementation (Issue 7, 1 Jul. 2010).~~
~~(http://www.jma.go.jp/jma/jma-eng/satellite/introduction/4_3LRIT.pdf)~~

~~This service will terminate in around the end of November 2015.~~

4. Internet Service for National Meteorological and Hydrological Services (NMHSs)

Besides the ~~direct broadcasting~~ above services, JMA provides satellite imagery through ~~the Internet FTP for NMHSs. Detailed information of this service is shown in the following webpage:~~
~~http://www.jma.go.jp/jma/jma-eng/satellite/nmhs.html~~ various methods.

[JMA real-time satellite imagery webpage]
http://www.jma.go.jp/en/gms/

[MSC real-time satellite imagery webpage]
~~http://ds.data.jma.go.jp/mscweb/data/sat_dat/~~
http://www.data.jma.go.jp/mscweb/data/himawari/

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

[JDDS (JMA Data Dissemination Service)]
http://www.data.jma.go.jp/mscweb/en/himawari89/JDDS_service/JDDS_service.html

SATELLITE IMAGERY RECEIVING FACILITIES AT TYPHOON COMMITTEE MEMBERS

Member	Station		~~MTSAT~~ Himawari 1. ~~M-DUS~~ Himawari Cloud 2. ~~S-DUS~~ Himawari Cast	NOAA 1. HRPT 2. APT	Meteosat 1. P-DUS
Cambodia			1, 2		
China	Beijing	(39.9°N, 116.4°E)	1~~, 2~~	1, 2	
	Shanghai	(31.1°N, 121.4°E)	~~1, 2~~	2	
	Shenyan	(41.8°N, 123.6°E)	~~1, 2~~		
	Guangzhou	(23.1°N, 113.3°E)	~~1, 2~~		
	Cheng-chou	(34.7°N, 113.7°E)	~~1, 2~~		
	Cheng-tu	(31.2°N, 114.0°E)	~~1, 2~~		
	Lan-chou	(36.1°N, 103.9°E)	~~1, 2~~		
	Kunming	(25.0°N, 102.7°E)	~~1, 2~~		
	Changsha	(28.2°N, 113.1°E)	~~1, 2~~		
	Nanjing	(32.0°N, 118.8°E)	~~1~~		
	Harbin	(45.8°N, 126.8°E)	~~2~~		
Democratic People's Republic of Korea	Pyongyang	(39.0°N, 125.8°E)	~~1,2~~	1	
Hong Kong, China*	Kowloon	(22.3°N, 114.2°E)	~~1, 2~~ Receiving Himawari-8 (replacement of MTSAT) via Internet download and HimawariCast	1	
Japan	Minamitorishima ~~Osaka~~	(24.3°N, 154.0°E) ~~(34.7°N, 135.5°E)~~	2 ~~1, 2~~		

*Hong Kong, China receives AQUA (MODIS), NPP(CrIs, VIIRS, ATMS), FY-2 (S-VISSR), and TERRA (MODIS).

Member	Station		~~MTSAT~~ Himawari 1. ~~M-DUS~~ Himawari Cloud 2. ~~S-DUS~~ Himawari Cast ~~3. Movie~~	NOAA 1. HRPT 2. APT	Meteosat 1. P-DUS
Lao People's Democratic Republic			2		
Macao, China*	Macao	(22.2°N, 113.5°E)	1	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)	~~2~~		
	Pasay City	(14.5°N, 121.0°E)	~~2~~		
	Cebu	(10.3°N, 124.0°E)	~~2~~		
Republic of Korea*	Seoul	(37.6°N, 127.0°E)	1~~, 2~~	1	
	Incheon Int. Airport	(37.3°N, 126.3°E)	~~2, 3~~		
	Munsan	(37.9°N, 126.8°E)			1
	Seosan	(36.8°N, 126.5°E)		1	
	Pusan	(35.1°N, 129.0°E)	~~2, 3~~		
	Pusan Kimhae Air	(35.2°N, 126.9°E)	~~2, 3~~		
	Kwangju	(35.2°N, 126.9°E)	~~2~~		
	Taejon	(36.4°N, 127.4°E)	~~2, 3~~		
	Kangnung	(37.5°N, 130.9°E)	~~2, 3~~		
	Cheju	(33.5°N, 126.5°E)	~~2, 3~~		
	Taegu	(35.9°N, 128.6°E)	~~2, 3~~		
	Taegu/Air Traffic	(35.9°N, 128.7°E)	~~2, 3~~		
	Chonju	(35.8°N, 127.2°E)	~~2, 3~~		
	Chongju	(36.6°N, 127.4°E)	~~2, 3~~		
	Ullung-Do	(37.5°N, 130.9°E)	~~2, 3~~		
	Mokpo	(34.8°N, 126.4°E)	~~3~~		
	Chunchon	(37.9°N, 127.7°E)	~~3~~		
	Masan	(35.2°N, 128.6°E)	~~3~~		
	Tongyong	(34.9°N, 128.4°E)	~~3~~		
	Inchon	(37.5°N, 126.6°E)	~~3~~		
	Huksando	(34.7°N, 125.5°E)	~~2, 3~~		
	Suwon	(37.3°N, 127.0°E)	~~3~~		
	Sokcho	(38.3°N, 128.6°E)	~~3~~		
	Pohang	(36.0°N, 129.4°E)	~~3~~		
	Kunsan	(36.0°N, 126.7°E)	~~3~~		
	Baengnyeong-do	(37.9°N, 124.6°E)	~~3~~		
Singapore*	Changi Airport	(1.4°N, 104.0°E)	1	1	1
Thailand	Bangkok	(13.7°N, 100.6°E)	1, 2	1	

USA	Guam	(13.4°N, 144.6°E)	1~~, 2~~	1	
Viet Nam	Hanoi Ho Chi Ming City	(21.0°N, 105.5°E) (10.5°N, 106.4°E)	1, 2	2 2	

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

OPERATIONAL TYPHOON TRACK FORECAST METHODS USED BY TYPHOON COMMITTEE MEMBERS

Name of the Member **China**

Item	Method	Type of output
Name of the method	Global Numerical Model of Typhoon Track Prediction (GMTTP -T639)	4 times/day (00,06,12,18UTC) Track position up to 120h, interval is 6h
Description of the method	a) Forecast domain of GMTTP: Global b) Vertical resolution: 60L c) Horizontal resolution: ~~T639~~ (0.28125° *0.28125°) d) Time integration: Semi-Lagrangian e) Physical processes: Short wave radiation: ~~morcrette,1991~~ Fouquart and Bonnel, 1980 Long wave radiation: ~~Fouquart and Bonnel,1988~~ Morcrette, 1990 Turbulence diffusion: Louis et al.,~~1982~~ 1979 cumulus convection: mass flux scheme(tiedtke,1989) cloud physics: prognostic cloud scheme (Tiedtke;1993) Surface physical processes: 4 level model (Viterbo and Beljaars, 1995) Viterbo and Beljaar, 1995 f) Vortex initialization process Relocation and intensity modification	

Name of the Member**China**

Item	Method	Type of output
Name of the method	Global Ensemble Numerical Model of Typhoon Track Prediction (GTC-EPS-T639)	2 times/day (00,12UTC) Track position up to 120h at 6-h intervals
Description of the method	a) Forecast domain of GTC-EPS-T639: Global b) Vertical resolution: 60L c) Horizontal resolution:（0.28125°*0.28125°） d) Time integration: Semi-Lagrangian e) Physical processes: Short wave radiation: Fouquart and Bonnel, 1980 Long wave radiation: Morcrette, 1990 Turbulence diffusion: Louis et al.,1979 cumulus convection: mass flux scheme(tiedtke,1989) cloud physics: prognostic cloud scheme (Tiedtke;1993) Surface physical processes:Viterbo and Beljaar, 1995 f) Perturbation method BGM g) Vortex initialization process Relocation and intensity modification h) Ensemble size: 15 members	

Name of the Member China

Item	Method	Type of output
Name of the method	GRAPES Typhoon Model(GRAPES-TYM，Beijing)	4 times/day (00,06,12,18UTC)
Description of the method	a) Forecast domain of GRAPES_TYM: 0~51°N,90~170°E b) Vertical resolution: 50L c) Horizontal resolution: 0.12° d) Time integration: Semi-implicit and Semi-Lagrangian e) Physical processes: RRTM longwave radiation Dudhia shortwave radiation WSM 6-class graupel microphysics Simplified Arakawa-Schubert cumulus convection Monin-Obukhov surface-layer scheme SLAB/thermal diffusion surface physics YSU PBL	Track position up to 120h at 3-h intervals

Name of the Member China

Item	Method	Type of output
Name of the method	**Tropical regional atmosphere model for the South China Sea (TRAMS，Guangzhou)**	4 times/day (00,06,12,18UTC)
Description of the method	**Data assimilation:** **(objective analysis)** 3DVAR **Dynamics:** **(basic equations)** non-hydrostatic (vertical coordinates **)** Terrain following height coordinates system **(domain)** Southeast Asia region **(vertical levels)** 55 levels and 35km top **Physics:** **(surface flux and boundary layer)** SLAB land surface Scheme (Grell et al, 1995) MRF PBL scheme (Hong and Pan, 1996) **(cumulus convection)** Simplified Arakawa-Schubert (SAS) convection scheme (Pan and Wu,1995) **(microphysics)** WRF single-moment 6-class (WSM6) scheme (Hong and Chen, 2003) **(radiation)** SWRAD shortwave radiation scheme and RRTM longwave radiation scheme **Initial conditions:** Analysis from GRAPES 3DVAR **Boundary conditions:** specified from GFS (0.5°) with the previous time	Track position up to 168h at 6-h intervals

Name of the Member **China**

Item	Method	Type of output
Name of the method	Shanghai GRAPES Typhoon Model (SGTM)	Track position up to 72h, interval is 6h
Description of the method	g) Forecast domain of SGTM: West Pacific Ocean and South China Sea h) Vertical resolution: 31L i) Horizontal resolution: 0.25 ° j) Time integration: Semi-implicit, Semi-Lagrangian k) Physical processes: Short wave radiation: Goddard (Chou et. al. 1998) Long wave radiation: RRTM(Mlawer et. al. 1997) Turbulence diffusion: YSU (Hong et. al. 2006) cumulus convection: KF(Kain and Fritsch, 1993) wsm5 microphysics scheme (Hong et. al. 2004) Surface physical processes: 5 level slab model (Blackadar, 1978)	

Name of the Member **China**

Item	Method	Type of output
Name of the method	**The Typhoon Track Ensemble Correction (TYTEC)**	00 to 120h TC track forecast at 3-h or 6-h intervals
Description of the method	A weighted position of the tropical cyclone track forecast based on the global ensemble models of European Centre for Medium-Range Weather Forecasts (ECMWF) and National Centers for Environmental Prediction (NCEP). The basic idea of TYTEC is that the mean of some selected “good” members has better performance than the mean of all members. Frequency of forecast: 4 or 8 times a day.	

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

Item	Method	Type of output
Name of the method	**The Multi-Model Ensemble Technique**	
Description of the method	An unweighted position and motion vector consensus of the tropical cyclone forecast tracks given by the global models of the UKMO (EGRR), Japan Meteorological Agency (JMA), National Centers for Environmental Prediction (NCEP) and European Centre for Medium-Range Weather Forecasts (ECMWF). Frequency of forecast: 2 times a day References: [1] James S. Goerss, 2000: Tropical Cyclone Track Forecasts Using an Ensemble of Dynamical Models, Monthly Weather Review, Vol. 128, p.1187-1193. [2] Russell L. Elsberry, James R. Hughes, and Mark A. Boothe, 2008: Weighted Position and Motion Vector Consensus of Tropical Cyclone Track Prediction in the Western North Pacific, Monthly Weather Review, Vol. 136, p.2478-2487. [3] Y.T. Tam, W.K. Wong and M.Y. Chan, 2015: Error Characteristics of Numerical Weather Prediction Model Ensemble in Tropical Cyclone Track Prediction. [http://www.weather.gov.hk/publica/reprint/r1167.pdf]	24, 48, ~~and~~ 72, 96 and 120-hr forecast positions

OPERATIONAL PROCEDURES OF TC SATELLITE ANALYSIS AT HONG KONG OBSERVATORY

1. INTRODUCTION

The Hong Kong Observatory (HKO) has long been using manual Dvorak analysis (1984) on satellite imagery for operational estimation of the intensity of tropical cyclones (TCs). Once a potential TC is suspected to soon form, a Dvorak analysis will be performed as often as deemed appropriate for assessing the current intensity of the TC. For TCs within 0-36 N, 100-140 E, Dvorak analysis will be performed at least for 00, 06, 12 and 18 UTC imageries. For TCs within the HKO area of responsibility (viz. 10-30 N, 105-125 E), additional analysis will be performed for 03, 09, 15 and 21 UTC imageries. Operational position and intensity are provided in Hong Kong Tropical Cyclone Warning for Shipping and local tropical cyclone warnings for the public.

A post-season reanalysis of storms is carried out and the information is incorporated into the TC best track dataset. HKO's best track records started as early as 1884, but more complete records were kept since 1961. HKO produces best tracks for TCs within 0-45 N, 100-160 E until 1960 and 0-45 N, 100-180 E from 1961 onward. The maximum 10-minute surface mean wind and the minimum pressure of TCs are given in the best track dataset at 6-hourly intervals.

2. LOCAL VARIATIONS TO DVORAK (1984)

The Enhanced IR Dvorak technique has been in use operationally in HKO since early 1980s. Prior to that, the Dvorak analysis was initially carried out using the visible imageries. ~~For reporting and warning purposes, a conversion factor of 0.9 was adopted in Hong Kong to convert 1-minute mean winds from the Dvorak wind table into 10-minute mean winds.~~

While there is no formal reference in the Dvorak technique about its application to TCs making landfall, Dvorak analysis is being applied in Hong Kong to TCs over the sea as well as over land. Beginning the TC season of 2014, a modified version of the original scheme by Dvorak for the weakening stage of TCs is followed (Shum and Chan, 2013). The original scheme only gives direction on handling CI-number when the TC weakens but no explicit guidance is given when the TC stops weakening and the final T-number has flattened for some period of time. In the modified scheme, when the final T-number has already plateaued for more than 12 hours, CI is held the same as the final T-number. For weakening TCs over land, there is no need to hold CI constant for 12 hours. Instead, it is immediately held 0.5 higher than the final T-number.

According to Dvorak (1984), the eye adjustment factor is determined using the eye temperature and the coldest surrounding ring temperature that meets the "narrowest width" requirement. This "narrowest width" requirement has been relaxed in 2014 following Dvorak (1995), i.e. the surrounding ring temperature is defined as any cold band surrounding the eye, regardless of width.

Currently, no Dvorak analysis will be performed after a TC has transitioned into an extratropical low. Extratropical systems are not included in the HKO best tracks.

3. UNIFORMITY IN APPLICATION OF DVORAK TECHNIQUE

The HKO forecasters will carry out Dvorak analysis and fill in the tropical cyclone analysis worksheet as described in the appendix of Dvorak (1984) during operation ~~but the information such as the current intensity (CI) or T-numbers are not being reported outside of HKO and digitized~~ SAREP reports in BUFR format, including information such as CI and the final T-number, are issued eight times a day to other meteorological centres when a TC enters within the HKO area of responsibility..

~~According to Step 9 in Dvorak (1984)~~ Prior to the introduction of the modified weakening rules described in the preceding section, the CI ~~is to~~ of a TC would be held constant for 12 hours during the initial weakening ~~of a TC~~ according to Dvorak (1984). Normally, the HKO forecasters followed this weakening rule even when the TC hasd made landfall or iswas crossing large landmasses such as the Philippines. However, the forecasters may could ignore thise rule for landfalling TCs on a case-by-case basis and discussion is being made in HKO about whether to allow the final T-number to decrease once the centre of the TC hits land.

4. CHANGES IN PROCEDURES OVER TIME

There has been little change to the procedures over the years. Following Harper et al. (2010), a conversion factor of 0.93 was adopted in Hong Kong from February 2013 to convert 1-minute mean winds from the Dvorak wind table into 10-minute mean winds for reporting and warning purposes. Prior to that, a fixed conversion factor of 0.9 had been used.

5. DETERMINATION OF TC FINAL INTENSITY

In determining the final intensity of a TC, surface wind and pressure reports are regarded as ground truth but the quality of the observations are also taken into account (for example, pressure reported by ships can sometimes be suspicious). For TCs over the ocean where such observations are sparse, Dvorak analysis is used as the main tool for TC intensity determination. Other satellite intensity estimates, e.g. wind scatterometer, ADT, etc., are used as references.

Tropical cyclone's central pressure is estimated based on the surface pressure reported by land stations and ships, reconnaissance aircraft reports when available and Dvorak analysis via the wind-pressure conversion table.

The maximum surface mean wind speed is estimated based on the surface winds reported by land stations and ships, Doppler wind observations from radars, reconnaissance aircraft reports when available and Dvorak analysis. Estimates from wind scatterometer data, ADT, SATCON and the Multi-platform Tropical Cyclone Surface Wind Analysis by NOAA are also referenced.

6. INFLUENCES OF TECHNOLOGICAL ADVANCEMENTS ON DVORAK ANALYSIS

One notable influence is due to the advent of microwave imageries in recent years. Microwave imageries are less frequently available, but can serve as a supplement to Dvorak analysis. They enable the forecasters to see through clouds and view rainbands and eye of the TCs even when obscured by upper-level clouds, thereby helping to reveal the best pattern (e.g. banding versus shear or an eye pattern under a central cold cover) to use in the Dvorak classification. In addition, sea-level winds measured by QuikScat and ASCAT or previously QuikSCAT serve as a check on the location and strength of TCs.

7. ANCILLARY DATA CONSIDERED IN PRODUCING FINAL SATELLITE INTENSITY ESTIMATE

Since 2009, HKO has incorporated the "Advanced Dvorak Technique (ADT)" developed by the University of Wisconsin-Madison / Cooperative Institute for Meteorological Satellite Studies (CIMSS) as an objective reference tool for weather forecasters. ADT makes use of computer-based algorithms to objectively identify cloud pattern types, calculate the eye/convective cloud temperatures, apply selection rules, and derive intensity estimate for TC. One advantage of this tool is that it can be fully automated. The ADT is presently applied to the TC positions determined by the forecasters.

Scatterometer winds such as ASCAT or previously QuikScat QuikSCAT, NOAA Multiplatform satellite surface wind analysis, images from microwave sensors available in the NRL website (http://www.nrlmry.navy.mil/TC.html), other resources from the web such as satellite-derived winds and dropwindsonde observations are also referenced by HKO forecasters.

8. PRESSURE WIND RELATIONSHIP IN USE

The empirical relationship between CI, the minimum sea level pressure (MSLP) for the

Western North Pacific Basin and the 1-minute maximum mean wind speed (MWS) given in Dvorak (1984) is in operational use at HKO. A conversion factor of 0.9 is applied to convert the 1-minute mean winds to 10-minute mean winds. ~~There have not been any changes regarding the above over the years, but HKO is currently considering adopting the new conversion factor of 0.93 as proposed in WMO/TD-No. 1555.~~

Conversion of the Dvorak CI number to MSLP and MWS

CI Number	MWS (10-minute mean in knots)	MSLP (hPa)
1.0	23	
1.5	23	
2.0	~~27~~28	1000
2.5	~~31~~33	997
3.0	~~41~~42	991
3.5	~~49~~51	984
4.0	~~59~~60	976
4.5	~~69~~72	966
5.0	~~81~~84	954
5.5	~~92~~95	941
6.0	~~103~~107	927
6.5	~~114~~118	914
7.0	~~126~~130	898
7.5	~~139~~144	879
8.0	153158	858

9. SYSTEMS TO ENTER THE BEST TRACK RECORDS

Best tracking has been carried out by HKO officers who have rich experience in TC operation. The best tracks are determined independently from the operational environment. An advantage of best tracks over operational tracks is that the analyst can look back and forth to ensure a more reasonable and consistent track. References are also made to additional information such as tropical cyclone passage reports and best track data issued by RSMC Tokyo, which are not available operationally. Currently, there is no periodic re-visit of the best track record from previous years - this is only done on an ad-hoc and need-only basis.

The best track intensity will not normally differ too much from the warning intensity. Strong evidence is required for large changes in intensity.

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Harper, B.A., J.D. Kepert and J.D. Ginger, 2010: Guidelines for converting between various wind averaging periods in tropical cyclone conditions. World Meteorological Organization, WMO/TD-No. 1555.

Shum, C.T., S.T. Chan, 2013: Application of Dvorak Technique during the weakening stage of tropical cyclones. Tropical Cyclone Research and Review, 2013, 2(4), 207-221.

Outline of HKO – Non-Hydrostatic Model (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 MTSAT-2
ATOVS	retrieved temperature profiles from NOAA
~~ASCAT~~ Ocean surface wind	~~retrieved surface wind over ocean surface~~ 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) Internet~~
~~Retrieved total precipitable water over ocean surface from SSM/I and AMSR-E~~

(~~C~~B) Regional data exchange
Data from automatic weather stations over the south China coastal areas

(~~D~~C) Local data
~~(i) Tropical cyclone bogus data from forecasters' analysis during TC situations~~
(~~ii~~ i) Automatic weather station data
(~~iii~~ ii) Wind profiler data
(~~iv~~ iii) Doppler weather radar data
(~~v~~ 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
(~~vi~~ v) GPS 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	Mercator

Number of grid points	10-km NHM: ~~585x405~~ 841x515, 50 levels 2-km NHM: 305x305, 60 levels
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 ~~0.5~~ 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, hourly interval boundary data provided from 10-km NHM 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	Kain-Fritsch convective parameterization (JMA-NHM version) Three ice bulk microphysics scheme
Surface process	Flux and bulk coefficients: Beljaars and Holtslag (1991) 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 3 (MYNN-3) (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.

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, Nanhai Sea and Beibu Wan Gulf
Hong Kong, China	Hong Kong	Broadcast via NAVTEX on 518 kHz*	Waters inside the boundary line: 30N 105E to 30N 125E to 10N 125E, to 10N 105E, to 30N 105E
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	Port Penang Labuan Miri	LY 3010 OA 3010 OE 3010	Strait of Malacca* South China Sea* South China Sea* *within 300nm from station
Philippines	Manila	DZR, DZG, DSP, DZD, DZF, DFH, DZO, DZN, DZS	Pacific waters inside the boundary line: 25N 120E to 25N 135E, to 5N 135E, to 5N 115E, to 15N 115E, to 21N 120E, to 20N 120E
	San Miguel	NPO	North Pacific waters east of 160E; 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~~, HSJ~~	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*

*Coast station VRX closed on 1 October 2006.

Annex 1-15
APPENDIX 5-A

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

Centre	Mailing address	Telex/cable, Telephone, fax numbers
China		
National Meteorological Center China Meteorological Adm. (Director: ~~Jiao Meiyan~~ Bi Baogui)	No. 46 Zhongguancun Nandajie, Beijing 100081	Tel.: (+86) (10) 5899 5809 Cable: 2894 Fax: (+86) (10) 6217 2956 E-mail: bibg@cma.gov.cn
Philippines		
~~Weather Branch~~ Esperanza O. Cayanan Ph.D. ~~PAGASA~~ ~~(~~Weather Services Chief~~:~~ ~~Ellaquim A. Adug)~~ Weather Division, PAGASA	~~Asia TrustBank Bldg.~~ ~~1424 Quezon Avenue~~ ~~Quezon City 3008~~ 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)
Thailand		
Thai Meteorological Department (Director-General: Mr. ~~Worapat Tiewthanom~~ Wanchai Sakudomchai)	4353 Sukhumvit Road Bangkok 10260	Tel.: (+66) (2) 366 6325 Fax.: (+66) (2) 399 4020 E-mail: ~~wopapat.t@tmd.go.th,~~ tmd_inter@tmd.go.th
Weather Forecast Bureau Thai Meteorological Department (Director: ~~Mr. Prawit Jampanya~~ Dr. Sugunyanee Yavinchan)	4353 Sukhumvit Road Bangkok 10260	~~Tel.: (+66) (2) 398 9830~~ ~~Fax: (+66) (2) 398 9836~~ Tel&Fax: (+66) (2) 399 40~~12~~-401 E-mail: ~~jampanya@tmd.go.th,~~ sugunyanee@hotmail.com
Telecommunications and Information Technology Bureau Thai Meteorological Department (Director : ~~Gp. Capt. Sarun Dabbhasuta~~ Mr. Somwhang Lodchanaangsu)	4353 Sukhumvit Road Bangkok 10260	Tel.: (+66) (2) 399 4555 Fax: (+66) (2) 398 9861 E-mail: ~~Sarun.d@mict.mail.go.th,~~ tmd_inter@tmd.go.th

COLLECTION AND DISTRIBUTION OF INFORMATION RELATED TO TROPICAL CYCLONES

Type of Data	Heading		Receiving station										
			TD	BJ	BB	HH	MM	SL	NN	KK	IV	PP	MC
Enhanced surface observation	SNCI30	BABJ	BJ	O	BJ	BJ	TD	TD	BJ	BB	BB	BB	
	SNHK20	VHHH	HH	HH	BJ	O		TD	BB	BB	BB	BB	HH
	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 upper-air observation	USCI01	BABJ	BJ	O	BJ	BJ	TD	TD	BJ	BB	BB	BB	
	USCI03	BABJ	BJ	O	BJ	BJ	TD	TD	BJ	BB	BB	BB	
	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	
	UEPH01	RPMM	MM	TD	TD	TD	O	TD	BB		BB	BB	
	USTH01	VTBB	BB	TD	O	TD	TD	TD	BB	BB	BB	BB	

Continued to the next page

Type of Data	Heading		Receiving station										
			TD	BJ	BB	HH	MM	SL	NN	KK	IV	PP	MC
Enhanced Upper-air observation	UKTH01	VTBB	BB	TD	O	TD		TD	BB	BB	BB	BB	
	ULTH01	VTBB	BB	TD	O	TD		TD	BB	BB	BB	BB	
	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	
Enhanced ship observation	SNVB20	VTBB			O				BB	BB	BB	BB	
	SNVB20	RJTD	O	TD	TD	TD	TD	TD	BB	BB	BB	BB	
	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 radar observation	SBCI30	BABJ	BJ	O	BJ	TD	TD	TD	BJ	BB	BB	BB	
	SCCI30	BABJ		O	BJ	BJ			BB	BB	BB	BB	
	SBCI60	BCGZ		O	BJ				BJ	BB	BB	BB	
	SCCI60	BCGZ	HH	O	BJ				BB	BB	BB	BB	
	SBHK20	VHHH	HH	HH	BJ	O	TD		BB	BB	BB	BB	HH
	ISBC01	VHHH	HH	HH	HH	O	TD	TD		BB	BB	BB	
	ISBC01	RJTD	O	TD	TD	TD	TD	TD		BB	BB	BB	
	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	

Type of Data	Heading		Receiving station TD	BJ	BB	HH	MM	SL	NN	KK	IV	PP	MC
			*										
Satellite guidance	TPPN10	PGTW			TD	TD			BB	BB	BB	BB	
	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	
	IUCC10	VHHH	HH	HH	HH	O							
	IUCC02	VHHH	HH	HH	HH	O							
	IUCC03	VHHH	HH	HH	HH	O							
	IUCC04	VHHH	HH	HH	HH	O							
Tropical Cyclone Forecast	FXPQ01	VHHH	HH	HH	BJ	O			BB	BB	BB	BB	HH
	FXPQ02	VHHH	HH	HH	BJ	O			BB	BB	BB	BB	HH
	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								
	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							
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	
Continued to	WTPQ23	RJTD	O	TD	TD	TD	TD	TD	BB	BB	BB	BB	
the next page	WTPQ24	RJTD	O	TD	TD	TD	TD	TD	BB	BB	BB	BB	

Type of Data	Heading		Receiving station										
			TD	BJ	BB	HH	MM	SL	NN	KK	IV	PP	MC
Warning	WTPQ25	RJTD	O	TD	TD	TD	TD	TD	BB	BB	BB	BB	
	WTKO20	RKSL	SL	TD	TD	TD		O	BB	BB	BB	BB	
Prognostic Reasoning	WTPQ30	RJTD	O	TD	TD	TD	TD	TD	BB	BB	BB	BB	
	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 track forecast	WTPQ50	RJTD	O	TD	TD	TD	TD	TD	BB	BB	BB	BB	
	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	

LIST OF DATA ARCHIVED BY RSMC TOKYO - TYPHOON CENTER

(a) Level II-b

Kinds of data: Surface, ship, buoy, upper-air, RADOB, aircraft, ASDAR, advisory warning, SAREP, SATEM, SATOB, TBB grid value and cloud amount (GMS);

Area coverage: SATEM : 90°E ~ 180°E and 0° ~ 45°N

SATOB, TBB grid value and cloud amount : area covered by MTSAT

Other data : within the area of 80°E ~ 160°W and 20°S ~ 60°N

(b) ~~MTSAT~~ Himawari imagery data

~~High Rate Information Transmission (HRIT) Data~~ Himawari Standard Data (HSD):

Kind of data: ~~MTSAT high resolution digital~~ Himawari full-spec imagery data

Data format: ~~"JMA HRIT Mission Specification Implementation", Issue 1.2, 1 Jan. 2003~~ Himawari Standard Format (~~http://www.jma.go.jp/jma/jma-eng/satellite/mtsat1r/4.2HRIT_1.pdf~~ http://www.data.jma.go.jp/mscweb/en/himawari89/space_segment/hsd_sample/HS_D_users_guide_en_v12.pdf)

~~**Resolution:** 1 km (VIS) and 4 km (IR) at the sub-satellite point~~

~~**Channel and wavelength (micrometers):**~~
~~VIS: 0.55 - 0.90~~
~~IR1: 10.3 - 11.3~~
~~IR2: 11.5 - 12.5~~
~~IR3: 6.5 - 7.0~~
~~IR4: 3.5 - 4.0~~

~~**Brightness level:** 10 bits (1,024 gradations)~~

Meteorological Satellite Center Monthly Report (~~CD-ROM~~DVD):

Kinds of data: ~~MTSAT~~ Himawari images ~~of~~ in SATAID and PNG formats. (~~http://mscweb.kishou.go.jp/product/library/report/index.htm~~ http://www.data.jma.go.jp/mscweb/en/product/library/report/)

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

(c) Level III-a

Kinds of data: Grid point data of the objective analysis obtained by the global objective analysis system in RSMC.

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

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

Element and layer:

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

Specific pressure levels (1000 - 10 hPa):
Geopotential height (Z), temperature (T), wind (U, V);

Specific pressure levels (1000 - 300 hPa):
Dew point depression (T-Td).