ECONOMIC AND SOCIAL COMMISSION
FOR ASIA AND THE PACIFIC
AND
WORLD METEOROLOGICAL ORGANIZATION

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Typhoon Committee
Forty Second Session
25 to 29 January 2010
Singapore

REPORT ON AMENDMENTS TO THE TYPHOON COMMITTEE OPERATIONAL MANUAL

(Item 5 of the Provisional Agenda)

Submitted by the Rapporteur

Introduction

1. The Typhoon Committee Operational Manual - Meteorological Component (TOM) has been reviewed and updated every year since its first issue in 1987. The 2009 edition was completed and posted on the WMO website in February 2009 in accordance with the approval of amendments to the previous issue at the 41st session of the Typhoon Committee (19 to 24 January 2008, Chiang Mai, Thailand).

2. At the 41st session, the Committee decided that the rapporteur of the Japan Meteorological Agency (JMA) would continue arrangements for updating the TOM. In this connection, on 2 July 2009, the rapporteur, Mr. Kiichi SASAKI, Head of the JMA National Typhoon Center invited the focal points of the meteorological component of the Members to provide proposals for further updates to the TOM.

3. As of the end of December 2009, proposals for updates to the TOM had been submitted by the four focal points of Hong Kong - China, Japan, Macao - China and Republic of Korea.

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

- Adding classifications of tropical cyclones internally used by Members (Chapter 1 and 4)
- Adding MTSAT related products (Chapter 2 and 3)
- Update of information on telecommunication network (Chapter 5)
- Update of information on list of stations for enhanced surface observations (Appendix 2-A)
- Update of information on distribution of the radar stations (Appendix 2-C)
- Update of information on technical specifications of radars in Japan, Macao/China and Republic of Korea (Appendix 2-D)
- Update of information on satellite imagery receiving facilities (Appendix 2-F)
- Update of information on operational typhoon track forecast methods of Hong Kong/China and Republic of Korea (Appendix 3-B)
- Adding description of the recent techniques including NWP to samples of the operational procedures and methods for the tropical cyclone analysis and forecasting (Appendix 3-C)
- Update of information on outlines of models of KMA and HKO (Appendix 3-D and 3-E)
- Update of examples of advisories (Appendix 4-A)
- Update of list of address etc. of Hong Kong/China, Macao/China and Republic of Korea (Appendix 5-A)

Action Proposed

5. The Committee is invited to:

(a) Note the information given in this document,

(b) Review and approve the proposed amendments to the TOM attached as Annex 1 with necessary modifications

Annex 1

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

Page	Line	Present Description	Proposed Amendment
Chapter 1			
2	25, footnote	Classification of tropical cyclones *	Classification of tropical cyclones *, ** ----- ** Classifications internally used by Members are shown in Appendix 1-A. (see Annex 1-1)
Chapter 2			
8-9			*<<to be replaced by>>* New document (see Annex 1-2)
9	25	/www.wmo.ch/web/www	/www.wmo.ch/pages/prog/www
Chapter 3			
15		*<<List of products by RSMC Tokyo>>*	*<<to be replaced by>>* New document (see Annex 1-3)
Chapter 4			
17	9, footnote	Classification of tropical cyclones *	Classification of tropical cyclones *, ** ----- ** Classifications internally used by Members are shown in Appendix 1-A.
Chapter 5			
22-23		*<<telecommunication network>>*	*<<to be replaced by>>* New document (see Annex 1-4)
Appendix 1-A			
		<<Classification of tropical cyclones >>	*<<to be inserted>>* New document (see Annex 1-1) ** present Appendix 1-A/1-B to be shifted to 1-B/1-C accordingly*
Appendix 2-A			
		<<List of stations for enhanced surface observations >>	*<<to be replaced by>>* New document (see Annex 1-5)
Appendix 2-C			
		<<Distribution of the radar stations>>	*<<to be replaced by>>* New document (see Annex 1-6)
Appendix 2-D			
		<<Technical Specs of Radars, Japan>>	*<<to be replaced by>>* New document (see Annex 1-7)
		<<Technical Specs of Radars, Macao, China>>	*<<to be replaced by>>* New document (see Annex 1-8)
		<<Technical Specs of Radars, Republic of Korea>>	*<<to be replaced by>>* New document (see Annex 1-9)
Appendix 2-E			
		<<Schedule of MTSAT Observations and Disseminations>>	*<<to be replaced by>>* New document (see Annex 1-10)

Appendix 2-F			
1-2		*<<Satellite Imagery Receiving Facilities>>*	*<<to be replaced by>>* New document (see Annex 1-11)
Appendix 3-B			
5		*<<Operation Typhoon Track Forecast Methods, Hong Kong, China>>*	*<<to be replaced by>>* New document (see Annex 1-12)
16		*<<Operation Typhoon Track Forecast Methods, Republic of Korea>>*	*<<to be replaced by>>* New document (see Annex 1-13)
Appendix 3-C			
10			*<<to be inserted>>* 1.5.6 and 1.5.7 (see Annex 1-14)
12	21		*<<to be inserted at the end of 1.6.6 >>* 4. Microwave sensors from satellites Rainfall amount and probability of precipitation can be predicted using microwave sensors from satellites.
Appendix 3-D			
1-2		*<<Outline of KMA - Typhoon Dynamic Models>>*	*<<to be replaced by>>* New document (see Annex 1-15)
Appendix 3-E			
1		*<<Outline of HKO - Operational Regional Spectral Model>>*	*<<to be replaced by>>* New document (see Annex 1-16)
Appendix 4-A			
2		*<<Examples of advisories>>*	*<<to be replaced by>>* New document (see Annex 1-17)
Appendix 5-A			
1		*<<Hong Kong, China>>* (Attn. Mrs. Hilda Lam) hildalam@hko.gov.hk Hong Kong, China, China	 (Attn. Mr. Edwin S.T. Lai) stlai@hko.gov.hk Hong Kong, China
2		*<<Macao, China>>* (+853) 8986273	 (+853) 88986273
2		*<<Republic of Korea>>* Typhoon Forecasters Officer Korea Meteorological Adm. (Chief Executive: Hee-Dong Yoo) 460-18, Sindaebang-2dong, Dongjak-gu, Seoul 156-720 Tel:(+82) (2) 2181 0672 Fax(+82) (2) 2181 0689	 National Typhoon Center Korea Meteorological Adm. (Chief Executive: Tae Ryong Kim) 1662-1 Hannam-ri, Namwon-eup, Seogwipo, Jeju, 699-942 Republic of Korea Tel: (+82) (64) 801-0200 Fax: (+82) (64) 805-0366
Appendix 5-C			
3		*<<Collection and distribution of information related to tropical cyclones>>*	*<<to be replaced by>>* New document (see Annex 1-18)

Classifications of Tropical Cyclones in the western North Pacific internally used by Members

	Maximum sustained winds (knots)	34 - 47	48 - 63	64 -		
Typhoon Committee	10 min	Tropical Storm (TS)	Severe Tropical Storm (STS)	Typhoon (TY)		
China	2 min	TS	STS	64 - 80 TY	81 - 99 Severe Typhoon (ST)	100 - Super Typhoon (Super T)
Hong Kong /China	10 min	TS	STS	64 – 80 TY	81 - 99 Severe Typhoon (ST)	100 - Super Typhoon (Super T)
Japan	10 min	TS	STS	64 - 84 TY	85 - Very Strong TY	105 - Violent TY
U.S.	1 min	TS		64 - 129 TY		130 - Super TY
…	…	…		…	...	…

CHAPTER 2
OBSERVING SYSTEMS AND OBSERVING PROGRAMME

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2.4 Meteorological satellite observations

2.4.1 Satellite imagery data and related products

The meteorological satellite information obtained by MTSAT and related products are operated as follows:

(i) full disk data are obtained hourly;
(ii) half disk data in the northern hemisphere are obtained hourly in addition to the full disk data;
(iii) additional half disk data in the northern and southern hemispheres for Atmospheric Motion Vector (AMV) extraction are obtained six-hourly;
(iv) AMV data are derived three-hourly in the northern hemisphere and six-hourly in the southern hemisphere;
(v) Clear Sky Radiance (CSR) data are derived hourly from the full disk data.

Detailed information is given in Appendix 2-E.

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

2.4.2 SAREP reports

SAREP reports (Part A) are disseminated eight times a day in case (i) mentioned below, or four times a day in case (ii) or (iii) from the RSMC Tokyo - Typhoon Center to Typhoon Committee Members through the GTS under the heading TCNA20 RJTD:

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CHAPTER 3
TROPICAL CYCLONE ANALYSIS AND FORECAST

Table 3.3: List of other products and data by RSMC Tokyo - Typhoon Center for regional purposes

Data	Satellite products	Tropical cyclone Information	Wave data	Observational data
Contents/ Frequency (initial time)	High density atmospheric motion vectors (BUFR) (a) MTSAT-1R (VIS, IR, WV) • 0-60N, 90E-170W: 00, 03, 06, 09, 12, 15, 18 and 21 UTC • 60S-0, 90E-170W: 00, 06, 12 and 18 UTC (b) METEOSAT-7 (VIS, IR, WV) VIS: every 1.5hours between 01:30 and 15:00 UTC IR, WV: every 1.5hours Clear Sky Radiance (CSR) data MTSAT-1R (IR, WV) radiances and brightness temperatures averaged over cloud-free pixels (BUFR): every hour	Tropical cyclone related information (BUFR) • tropical cyclone analysis data 00, 06, 12 and 18 UTC	Global Wave Model (GRIB2) • significant wave height • prevailing wave period • wave direction Forecast hours: 0–84 every 6 hours (00, 06 and 18UTC) 0–84 every 6 hours and 96-192 every 12 hours (12 UTC)	(a) Surface data (SYNOP, SHIP, BUOY) Mostly 4 times a day (b) Upper-air data (TEMP, parts A-D) (PILOT, parts A-D) Mostly twice a day

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), 1 Mbps TCP/IP Beijing 2 Mbps/Tokyo 3 Mbps
Beijing - Offenbach	Cable (FR), 48 kbps (CIR) TCP/IP
Washington - Tokyo	Cable (MPLS), TCP/IP Washington 1 Mbps/Tokyo 3 Mbps
2. Main regional circuit	
Tokyo - Bangkok	Cable (MPLS), TCP/IP Tokyo 2 Mbps/Bangkok 128 kbps
3. Regional circuits	
Bangkok - Beijing	Cable, 9600 bps X.25
Bangkok - Hanoi	Cable, 1200 bauds
Bangkok - Phnom Penh	Internet, IP VPN
Bangkok - Vientiane	DDN, 64 kbps, FTP Protocol
Beijing - Hanoi	Cable, 75 bauds PC VSAT (Satellite broadcast)
Beijing - Hong Kong	Cable (SDH), 4 Mbps TCP/IP
Beijing - Macao	64 kbps leased line
Beijing - Pyongyang	Cable, 75 bauds; PC VSAT (Satellite broadcast)
Beijing - Seoul	Cable (FR), 32 kbps (CIR) TCP/IP
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, 128 kbps, TCP/IP

4. Inter-regional circuits

Bangkok - Kuala Lumpur	Cable (FR), 64 kbps/CIR 16
Bangkok - Singapore	Cable (FR), 16 kbps
Tokyo - Manila	Cable (MPLS), TCP/IP Tokyo 2 Mbps/Manila 64 kbps

5. RTH radio broadcast

Bangkok	1 FAX
Beijing	1 FAX (Shanghai)
Tokyo	1 FAX

6. Satellite broadcast

Operated by China: Asiasat-2 (100.5°E)	Operational data, fax and image distribution
Operated by Japan: MTSAT (140°E)	Operational satellite image distribution

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

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

5.6 Abbreviated headings of tropical cyclone advisories and warnings

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

(i) analysis and forecast - WTPQ20 RJTD through WTPQ25 RJTD;

(ii) prognostic reasoning - WTPQ30 RJTD through WTPQ35 RJTD;

(iii) five-day track forecast - WTPQ50 RJTD through WTPQ55 RJTD;

(iv) numerical prediction - FXPQ20 RJTD through FXPQ25 RJTD.

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

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): 662, 753, 776, 836, 843, 857, 863, 929, 945
(58): 040, 150, 238, 251, 265, 345, 362, 457, 472, 477
543, 556, 569, 646, 659, 660, 666, 754, 834, 847,
911, 921, 927, 944
(59): 096, 117, 134, 278, 287, 293, 316, 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, ~~417,~~ 418, 420, 421, ~~423~~, 426,
430, 570, 575, 582, 584, ~~585,~~ ~~588,~~ 590, ~~595,~~ ~~598,~~
600, ~~602,~~ 604, 605, ~~607,~~ 610, ~~615,~~ ~~616,~~ ~~618,~~ 624,
~~626,~~ 629, ~~632,~~ 636, ~~638,~~ 648, 651, 655, ~~656,~~ 662,
~~663,~~ ~~670, 672,~~ 675, 678, 740, 741, 746, ~~747,~~ 750,
~~755,~~ ~~759, 761, 762,~~ 765, ~~768, 770,~~ 772, ~~777,~~ 778,
~~780,~~ 800, 807, ~~813,~~ 815, 817, ~~819,~~ 827, 830, ~~837,~~
843, 887, 891, 893, 895, ~~898,~~ ~~899,~~ 909, ~~912,~~ 918,
927, 936, 945, 971, 991

Lao People's Democratic Republic

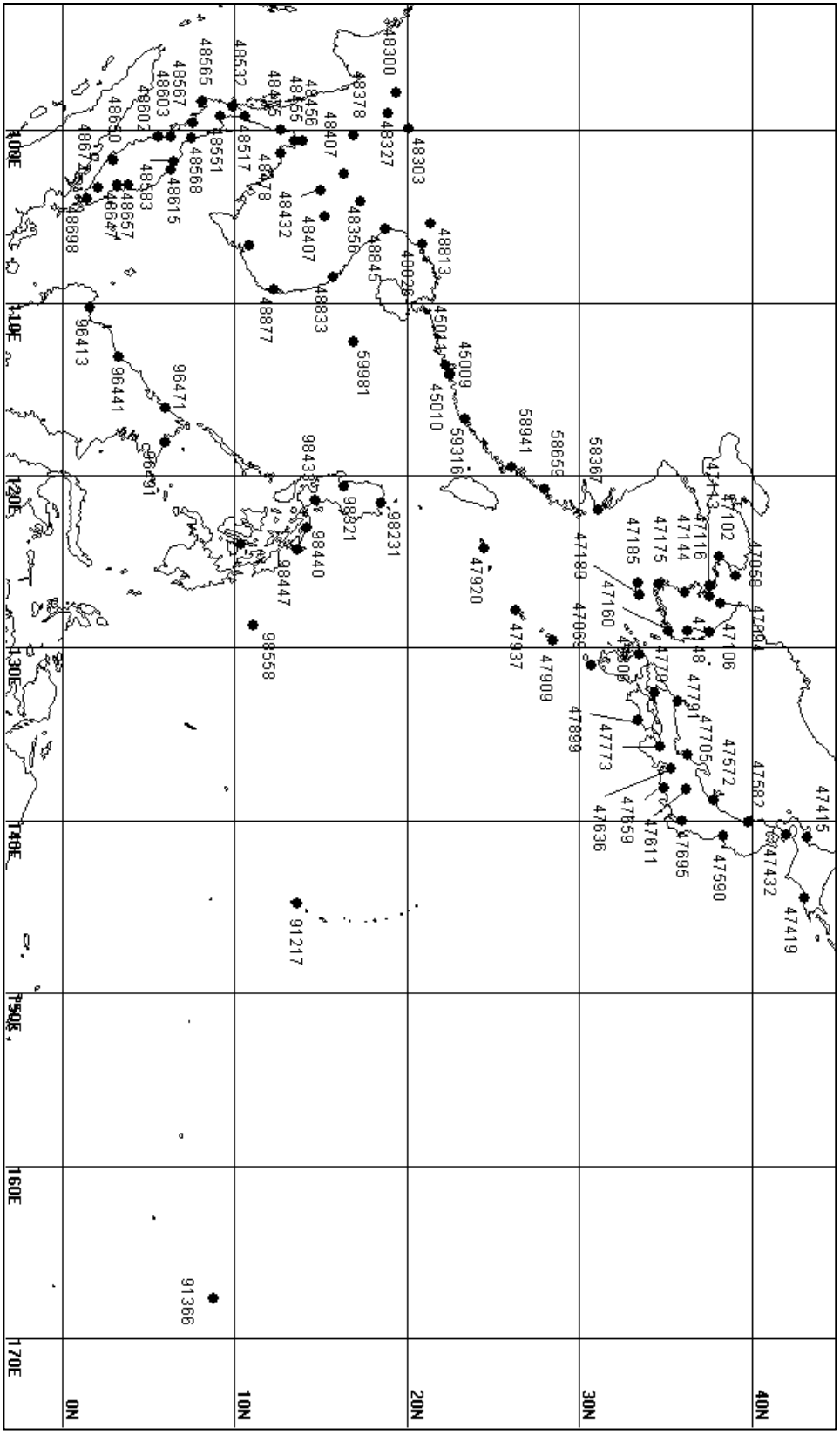
Macao, China

(45): 011

Malaysia

(48): 601, 615, 620, 647, 650, 657, 665
(96): 413, 421, 441, 449, 465, 471, 481, 491

DISTRIBUTION OF THE RADAR STATIONS OF TYPHOON COMMITTEE MEMBERS



Name of the Member **Japan - 1**

NAME OF STATION		Sapporo /Kenashiyama	Kushiro /Kombumori	Hakodate /Yokotsudake	Sendai	Akita
SPECIFICATIONS	Unit					
Index number		47415	47419	47432	47590	47582
Location of station		43° 08´ N 141° 01´ E	42° 58´ N 144° 31´ E	41° 56´ N 140° 47´ E	38° 16´ N 140° 54´ E	39° 43´ N 140° 06´E
Antenna elevation	m	749.0	121.5	1141.7	98.2	55.3
Wave length	cm	5.61	5.61	5.59	5.61	5.64
Peak power of transmitter	kW	250	250	250	250	250
Pulse length	μ s	1.1/2.6	1.1/2.6	1.1/2.6	1.0/2.6	2.6
Sensitivity minimum of receiver	dBm	-109/-112	-110/-113	-108/-111	-108/-111	-112
Beam width (Width of over -3dB antenna gain of maximum)	deg	1.1(H) 1.1(V)	1.1(H) 1.0(V)	1.0(H) 1.0(V)	1.0(H) 1.0(V)	1.1(H) 1.1(V)
Detection range	km	400	400	400	400	400
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		1	1	1	1	1
Doppler processing 1.Yes, 2.No		1	1	1	1	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		1	1	1	1	1
PRESENT STATUS 1.Operational 2.Not operational (for research etc.)		1	1	1	1	1

Name of the Member **Macao, China**

NAME OF STATION		TAIPA GRANDE				
SPECIFICATIONS	Unit					
Index number		45011				
Location of station		22.1599N 113.5624E				
Antenna elevation	m	183				
Wave length	cm	3.4285714				
Peak power of transmitter	kW	200				
Pulse length	μ s	0.2, 0.5, 1.0				
Sensitivity minimum of receiver	dBm	-113				
Beam width (Width of over -3dB antenna gain of maximum)	deg	1°				
Detection range	km	500 (reflection) 250 (velocity)				
Scan mode in observation 1. Fixed elevation 2. CAPPI 3. Manually controlled		Others				
DATA PROCESSING						
MTI processing 1.Yes, 2.No		To be confirmed				
Doppler processing 1.Yes, 2.No		To be confirmed				
Display 1.Digital, 2.Analog		1				
OPERATION MODE (When tropical cyclone is within range of detection) 1. Hourly 2. 3-hourly 3. Others		3				
PRESENT STATUS 1.Operational 2.Not operational (for research etc.)		1 (from November 2009)				

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

NAME OF STATION		Gosan	Seongsan	Donghae	Osungsan	Baengnyeong-do
SPECIFICATIONS	Unit					
Index number		47185	47189	47106	47144	47102
Location of station		33° 17′ N 126° 10′ E	33° 23′ N 126° 52′ E	37° 30′ N 129° 07′ E	36° 01′ N 126° 47′ E	37° 58′ N 124° 39′ E
Antenna elevation	m	91	59	53	227	185
Wave length	Cm	10.3	10.3	5.6	11.0	5.3
Peak power of transmitter	kW	750	750	250	750	250
Pulse length	μ s	1.0; 4.5	1.0; 4.5	0.83; 2.0	1.0; 4.5	1.0; 2.0
Sensitivity minimum of receiver	dBm	-112	-112	-108	-112	-108
Beam width (Width of over -3dB antenna gain of maximum)	deg	1.0	1.0	1.2	1.0	1.0
Detection range	km	250 (volume) 500 (lowest tilt)	250, 500	240, 480	240, 480	256, 480
Scan mode in observation 1. Fixed elevation 2. CAPPI 3. Manually controlled		1, 2	1, 2	1, 2	1, 2	1, 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 (continuous)	3 (continuous)	3 (continuous)	3 (continuous)	3 (continuous)
PRESENT STATUS 1.Operational 2.Not operational(for research etc.)		1	1	1	1	1

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 126° 20′ E	38° 07′ N 127° 26′ E	36° 11′ N 129° 00′ E	37° 27′ N 126° 58′ E	35° 07′ N 129° 00′ E
Antenna elevation	m	494	1066	1129	637	545
Wave length	cm	10.3	10.3	5.3	11	11
Peak power of transmitter	kW	750	750	250	850	850
Pulse length	μ s	1.0; 2.5	1.0; 4.5	0.83; 2.5	1.0; 4.5	1.0; 4.5
Sensitivity minimum of receiver	dBm	-112	-112	-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	200, 400	240, 480	240, 480
Scan mode in observation 1. Fixed elevation 2. CAPPI 3. Manually controlled		1, 2	1, 2	1, 2	1, 2	1, 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 (continuous)	3 (continuous)	3 (continuous)	3 (continuous)	3 (continuous)
PRESENT STATUS 1.Operational 2.Not operational(for research etc.)		1	1	1	1	1

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	μ s	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	30, 480				
Scan mode in observation 1. Fixed elevation 2. CAPPI 3. Manually controlled		1, 2				
DATA PROCESSING						
MTI processing 1.Yes, 2.No		2				
Doppler processing 1.Yes, 2.No		1				
Display 1.Digital, 2.Analog		1				
OPERATION MODE (When tropical cyclone is within range of detection) 1. Hourly 2. 3-hourly 3. Others		3 (continuous)				
PRESENT STATUS 1.Operational 2.Not operational(for research etc.)		1				

SCHEDULE OF MTSAT OBSERVATIONS AND DISSEMINATIONS

1. IMAGER observations

IMAGER observations are as follows:

(a) full-disk observations are made hourly;
(b) half-disk observations of the northern hemisphere are made hourly 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. 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/mtsat1r/4.2HRIT_1.pdf)

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

Low Rate Information Transmission (LRIT) is available as dissemination service for SDUS users.

Technical specification of LRIT is given in JMA LRIT Mission Specification Implementation (Issue 6, 1 Jan. 2003).
(http://www.jma.go.jp/jma/jma-eng/satellite/mtsat1r/4.3LRIT.pdf)

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

Besides the direct broadcasting, 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/ds.html

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

[MSC real-time satellite imagery webpage]
http://mscweb.kishou.go.jp/sat_dat/index.htm

[MSC real-time satellite imagery webpage (for selected areas)]
http://mscweb.kishou.go.jp/sat_dat/img/reg/sat_img.htm

SATELLITE IMAGERY RECEIVING FACILITIES AT TYPHOON COMMITTEE MEMBERS

Member	Station		MTSAT 1. M-DUS 2. S-DUS	NOAA 1. HRPT 2. APT	Meteosat 1. P-DUS
Cambodia					
China	Beijing Shanghai Shenyan Guangzhou Cheng-chou Cheng-tu Lan-chou Kunming Changsha Nanjing Harbin	(39.9°N, 116.4°E) (31.1°N, 121.4°E) (41.8°N, 123.6°E) (23.1°N, 113.3°E) (34.7°N, 113.7°E) (31.2°N, 114.0°E) (36.1°N, 103.9°E) (25.0°N, 102.7°E) (28.2°N, 113.1°E) (32.0°N, 118.8°E) (45.8°N, 126.8°E)	1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1 2	1, 2 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	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), FY-1 (CHRPT), FY-2 (S-VISSR), and TERRA (MODIS).

Member	Station		MTSAT 1. MDUS 2. SDUS 3. Movie	NOAA 1. HRPT 2. APT	Meteosat 1. P-DUS
Lao People's Democratic Republic					
Macao, China*	Macao	(22.2°N, 113.5°E)	~~2~~1	1	
Malaysia	Petaling Jaya	(3.1°N, 101.7°E)	1, 2	1	
Philippines	Quezon City Cagayan de Oro City Pasay City Cebu	(14.7°N, 121.0°E) (8.5°N, 124.6°E) (14.5°N, 121.0°E) (10.3°N, 124.0°E)	1, 2 2 2 2	1	
Republic of Korea*	Seoul Incheon Int. Airport Munsan Seosan Pusan Pusan Kimhae Air Kwangju Taejon Kangnung Cheju Taegu Taegu/Air Traffic Chonju Chongju Ullung-Do Mokpo Chunchon Masan Tongyong Inchon Huksando Suwon Sokcho Pohang Kunsan Baengnyeong-do	(37.6°N, 127.0°E) (37.3°N, 126.3°E) (37.9°N, 126.8°E) (36.8°N, 126.5°E) (35.1°N, 129.0°E) (35.2°N, 126.9°E) (35.2°N, 126.9°E) (36.4°N, 127.4°E) (37.5°N, 130.9°E) (33.5°N, 126.5°E) (35.9°N, 128.6°E) (35.9°N, 128.7°E) (35.8°N, 127.2°E) (36.6°N, 127.4°E) (37.5°N, 130.9°E) (34.8°N, 126.4°E) (37.9°N, 127.7°E) (35.2°N, 128.6°E) (34.9°N, 128.4°E) (37.5°N, 126.6°E) (34.7°N, 125.5°E) (37.3°N, 127.0°E) (38.3°N, 128.6°E) (36.0°N, 129.4°E) (36.0°N, 126.7°E) (37.9°N, 124.6°E)	1, 2 2, 3 2, 3 2, 3 2 2, 3 2, 3 2, 3 2, 3 2, 3 2, 3 2, 3 2, 3 3 3 3 3 3 2, 3 3 3 3 3 ~~2~~, 3	1 1	1
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 Da Nang	(21.0°N, 105.5°E) (10.5°N, 106.4°E) (16.0°N, 108.2°E)	1, 2 ~~2~~ ~~2~~	2 2	

* Macao, China receives AQUA (MODIS), FY-1D (CHRPT), FY-2C&2D (S-VISSR) and TERRA (MODIS).
* 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).

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

Item	Method	Type of output
Name of the method	**Regression method**	24, 48, 72 and 96-hr movement forecasts
Description of the method	The mean 24-hr movement of each tropical cyclone centered in each 5-degrees square is correlated with that 24 hours ago to derive regression equations for forecasting. Independent variables: Present and past 24-hour positions Domain : 5° - 25°N, 105° - 145°E Frequency of forecast : 4 times a day	
Name of the method	**The space mean method**	
Description of the method	The space mean technique is based on the concept of steering. Space mean charts are prepared by the computer to depict the smoothed basic flows at various upper levels with the circulation of the tropical cyclone and other small-scale eddies removed. Input: Surface, 700, 500 and 300 hPa data covering the area 0° - 65°N, 65° - 165°E	Space mean charts and 24-hour movement forecast
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.	24, 48, and 72-hr forecast positions

Name of the Member **Republic of Korea**

Item	Method	Type of output
Name of the method	**Global Data Assimilation and Prediction System (GDAPS)**	6 hourly TC position up to 84 hours at 00/12 UTC
Description of the method	Governing equations: Primitive equation Vertical resolution: 40 levels in hybrid coordinate Horizontal representation: Spectral, with triangular truncation at wave number 426, ~0.28125°×0.28125° Gaussian Grid (1280×640) Initial field: Global analysis by 3DVAR (3 Dimensional VARiational method) (See Appendix 3-D (1))	
Name of the method	**Regional Data Assimilation and Prediction System (RDAPS)**	6 hourly TC position up to 66 hours at 00/12 UTC
Description of the method	Governing equations: Primitive equation Vertical resolution: 33 levels in sigma coordinate Horizontal resolution: 30 km on Lambert conformal projection Boundary condition: 12-hr interval prediction data by GDAPS (See Appendix 3-D (2))	
Name of the method	**Double Fourier-series BAROtropic typhoon model (DBAR)**	6 hourly TC position up to 72 hours at 00/06/12/18 UTC
Description of the method	Governing equation: Shallow water equations Domain: Global Resolution: ~0.3515°×0.3515° Grid (1024×512) Initial field: global analysis from GDAPS 3DVAR (See Appendix 3-D (3))	

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1.5.5 Radar observation

See Appendix 3-C, p.14 (Sec. 2.1).

Notes: Life cycle of the typhoon

a. Formation stage
The rate of the pressure change may fluctuate and the wind distribution may be asymmetric.

b. Development stage
The amount of pressure fall increases with respect to time. The intensification of the maximum wind is more remarkable than the expansion of the strong wind zone.

c. Mature stage
A typhoon acquires a quasi-steady state with only random fluctuations in the central pressure and maximum wind speed. However, the strong wind zone still expands.

d. Decay stage
Asymmetry in the pressure and wind field becomes more pronounced.

1.5.6 Numerical weather prediction

High-resolution NWP global models, including EPS systems, are generally becoming more reliable with skills comparable to the subjective forecasts issued by the forecasters. They can provide useful guidance material for estimating intensity category and trend.

1.5.7 Model output statistics (MOS) method

The NWP intensity predictions can be further improved using MOS methods by establishing the statistical relationship between the analyzed intensity and forecast intensity output by the models. For example, based on the regression of model forecast central pressure against the best-track data in past years, a set of best-estimated parameters can be derived to correct the real-time NWP forecasts. Deterministic forecasts of tropical cyclone intensity derived from EPS data can also be calibrated using an artificial neural network.

1.6 Prediction of rainfall

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OUTLINE of KMA -Typhoon Dynamic MODELS

(1) <Global Data Assimilation and Prediction System (GDAPS)>

Initial field:
(analysis)
3DVAR (1.125° horizontal resolution)
(bogusing)
symmetric vortex generated by empirical formulas + asymmetric structure derived from first guess field
(initialization) NNMI (Non-linear Normal Mode Initialization)

Operation:
(schedule)
two times (00UTC, 12UTC) a day
(integration time)
252 hr from 00UTC, 12UTC

Prediction model:
(dynamics)
primitive equations
(vertical resolution)
40 levels in hybrid coordinate
(horizontal resolution)
spectral, with triangular truncation at wave number 426
grids: 640 Gaussian latitude points and 1280 grids along each latitude

Time integration:
semi-implicit with time filter

Physics:
(diffusion)
horizontal: linear Laplacian
vertical: Non-local PBL scheme
(surface flux)
similarity function proposed by Louis
Ocean: SST (Initial anomaly is updated at every 24 hour prediction)
Land: Soil temperature predicted, Simple Biosphere scheme
(cumulus convection)
Kuo's scheme
(radiation)
long-wave cooling and solar heating with effects of diurnal cycle and cloud variation considered

Products :
location (lat./lon.), central pressure, maximum tangential winds, every 6 hr up to 72 hr in advance

(2) <Regional Data Assimilation and Prediction System (RDAPS)>

Data assimilation:
(objective analysis)
No
(bogusing of tropical cyclones)
No

Dynamics:
(basic equations)
primitive equations in terrain following coordinate
horizontal resolution : 30 km on Lambert conformal projection
(domain)
Far-East region with 191×171 grids
(vertical levels)
33 levels in sigma coordinate

Physics:
(diffusion)
fourth order horizontal diffusion
nonlocal PBL scheme
(Kain-Frish scheme for cumulus parameterization)
(cloud microphysical parameterization including ice effect)
radiation scheme for long wave and short wave interactions with explicit cloud and clear-air

Initial conditions: 12hr FDDA
(analysis nudging for four-dimensional data assimilation)
upper level: 12-hr interval, surface :3-hr interval

Boundary conditions:
(12-hr interval prediction data by GDAPS from initial time at T-00 hr)
(daily SST analysis data produced by KMA with GOES data)
Frequency of forecast: twice a day (00UTC, 12UTC)
Products:
Location (lat./lon.), central pressure, and maximum tangential winds every 6 hr up to 48 hr in advance

Outline OF HKO – Operational Regional Spectral Model

Name of the method:
Operational Regional Spectral Model

Description of the method:

Meteorological data assimilated by the analysis scheme of the ORSM are as follows:

(A) From GTS

SYNOP, SHIP	surface data and ship data
TEMP, PILOT	radiosonde and pilot data
AIREP, AMDAR	aircraft data
SATEM	satellite thickness data
ATOVS	virtual temperature profiles
SATOB	satellite wind data

(B) From FY-2C meteorological satellite of CMA
FY-2C IR1 brightness temperature data

(C) From NCEP data server
Daily sea surface temperature analysis at 1-degree resolution

(D) Through regional data exchange
Data from automatic weather stations over the south China coastal region

(E) Local data
Tropical cyclone bogus data during tropical cyclone situations
Automatic weather station data
Wind profiler data
Doppler weather radar data

Three-dimensional multivariate optimal interpolation is performed four times a day based on 00, 06, 12 and 18UTC data for the 60-km outer domain. For the inner domain, the same objective analysis scheme is performed 8 times a day based on 00, 03, 06, 09, 12, 15, 18, and 21UTC. All analyses are applied to 40 vertical levels.

The horizontal domains of both inner and outer models compose of 151 x 145 model grids in Mercator projection. The first guess fields of the model analyses are provided by their respective latest forecasts.

RSMC Prognostic Reasoning

WTPQ30 RJTD 250600
RSMC TROPICAL CYCLONE PROGNOSTIC REASONING
REASONING NO. 4 FOR STS 0815 JANGMI (0815)
1.GENERAL COMMENTS
REASONING OF PROGNOSIS THIS TIME IS SIMILAR TO PREVIOUS ONE.
POSITION FORECAST IS MAINLY BASED ON NWP AND PERSISTENCY.
2.SYNOPTIC SITUATION
NOTHING PARTICULAR TO EXPLAIN.
3.MOTION FORECAST
POSITION ACCURACY AT 250600 UTC IS FAIR.
STS WILL DECELERATE FOR THE NEXT 24 HOURS.
STS WILL MOVE NORTHWEST FOR THE NEXT 48 HOURS THEN MOVE GRADUALLY TO WEST-NORTHWEST.
4.INTENSITY FORECAST
STS WILL BE GRADED UP TO TY WITHIN 24 HOURS.
STS WILL DEVELOP BECAUSE SPIRAL CLOUD BANDS HAVE BECOME WELL ORGANIZED AND CYCLONE WILL STAY IN HIGH SST AR
EA.
FI-NUMBER WILL BE 4.5 AFTER 24 HOURS.=

RSMC Tropical Cyclone Advisory for Five-day Track Forecast

WTPQ50 RJTD 190000
RSMC TROPICAL CYCLONE ADVISORY
NAME TY 0910 VAMCO (0910) UPGRADED FROM STS
ANALYSIS
PSTN 190000UTC 17.3N 157.5E GOOD
MOVE E SLOWLY
PRES 970HPA
MXWD 065KT
GUST 095KT
50KT 40NM
30KT 180NM NORTHEAST 120NM SOUTHWEST
FORECAST
24HF 200000UTC 18.0N 156.9E 70NM 70%
MOVE ALMOST STATIONARY
PRES 960HPA
MXWD 075KT
GUST 105KT
48HF 210000UTC 18.7N 156.5E 110NM 70%
MOVE ALMOST STATIONARY
PRES 950HPA
MXWD 080KT
GUST 115KT
72HF 220000UTC 21.2N 155.9E 160NM 70%
MOVE N 06KT
PRES 950HPA
MXWD 080KT
GUST 115KT
96HF 230000UTC 24.5N 154.4E 240NM 70%
MOVE NNW 09KT
120HF 240000UTC 29.2N 153.5E 375NM 70%
MOVE N 12KT =

Type of Data	Heading		Receiving station TD	BJ	BB	HH	MM	SL	NN	KK	IV	PP	MC
Tropical Cyclone Forecast	FXPQ01	VHHH			BJ	O			BB	BB	BB	BB	
	FXPQ02	VHHH			BJ	O			BB	BB	BB	BB	
	FXPQ03	VHHH			BJ	O			BB	BB	BB	BB	
	FXPQ20	VHHH	HH	HH	BJ	O	TD	TD	BB	BB	BB	BB	
	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								
					omitted…								
	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	