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ACTIVITIES OF THE RSMC TOKYO - TYPHOON CENTER
IN 2011

(Item 4 of the Provisional Agenda)

Submitted by the RSMC Tokyo - Typhoon Center

Activities of the RSMC Tokyo - Typhoon Center in 2011

1. Provision of RSMC Products

The RSMC Tokyo - Typhoon Center (hereinafter referred to as *the Center*) provides Typhoon Committee (TYC) Members with a range of products related to tropical cyclones in the western North Pacific and the South China Sea through the GTS and the AFTN. Table 1 shows the total number of products issued by the Center in 2011.

2. Track Forecasts

Operational track forecasts for 21 Tropical Cyclones (TCs) that reached Tropical Storm (TS) intensity or higher in 2011 were verified against the Center's analysis data. Figure 1 shows the time series of the annual mean position errors of 24-hour (from 1982), 48-hour (from 1989), 72-hour (from 1997), 96-hour and 120-hour (from 2009) forecasts. The errors of the year are 109 km (105 km in 2010), 189 km (206 km), 289 km (332 km), 415 km (400 km) and 521 km (457 km) for 24-, 48-, 72-, 96- and 120-hour forecasts, respectively (Table 2). Track forecasts were especially difficult for Aere (1101), which was upgraded to TS intensity on a recurving track and kept the intensity four days and six hours. The mean hitting ratios of probability circles* for 24-, 48-, 72-, 96- and 120-hour forecasts are 75% (76% in 2010), 75% (65%), 71% (61%), 71% (74%) and 75% (77%), respectively (Table 3).

* Probability circle: a circular area within which a TC is expected to be located with a probability of 70% at each forecast time, indicating the uncertainty of a forecast

3. Intensity Forecasts

Table 4 gives the root mean square errors (RMSEs) of 24-, 48- and 72-hour intensity forecasts for 21 TCs of 2011. The annual mean RMSEs for central pressure forecasts are 11.7 hPa (12.2 hPa in 2010), 17.7 hPa (17.4 hPa) and 19.2 hPa (22.6 hPa) for 24-, 48- and 72-hour forecasts, respectively, while those of maximum wind speed forecasts for 24-, 48- and 72-hour forecasts are 5.6 m/s (5.8 m/s in 2010), 8.6 m/s (7.4 m/s) and 9.1 m/s (9.8 m/s), respectively. Intensity forecasts were particularly difficult for TCs that developed rapidly, such as Nanmadol (1111) (50 hPa development in 24 hours).

4. Start of WMO Information System (WIS)

4.1 RSMC Tokyo -Typhoon Center as Data Collection or Production Center (DCPC)

As designated in Sixteenth WMO Congress in June 2011, RSMC Tokyo -Typhoon Center has started service of DCPC of WIS with a Global Information System Center (GISC) and the other seven DCPCs in JMA. WIS is a new framework for the collection and sharing of information in support of all WMO and related international programmes, and DCPC has a role of taking care of programme-specific activity.

4.2 Global Telecommunication System (GTS) and Data Discovery, Access and Retrieval (DAR)

The GTS continues to serve time- and operation-critical information as an important part of WIS, while Internet-based information services are being streamlined under comprehensive catalogue for

DAR. Existing Internet data services by JMA are going to be served through a new server of GISC Tokyo in the framework of WIS DAR. Outline of changes in the acquisition of data in accordance with start of WIS is as follows;

- 1) RSMC Data Serving System (RSMC DSS) will be terminated by the end of March 2012, and data provided by RSMC DSS has been provided as WIS DAR since August 2011.
- 2) The JMA's GSM product within 20°S - 60°N, 60°E - 160°W at 2.5 degree resolution is planned to be terminated by the end of March 2012, while JMA's GSM product at 0.5 degree resolution and 0.25 degree resolution (surface layer) has been provided as WIS DAR since December 2011.
- 3) JMA WIS Prototype Service (Service for MTSAT imagery and NWP product with the SATAID software) was reformed to JMA SATAID Service (<http://www.wis-jma.go.jp/cms/sataid/>). JMA WIS Prototype Service will be terminated by the end of February, and JMA SATAID Service has been provided as WIS DAR since December 2011.

For more detail information on these data, please see Typhoon Committee Operational Manual - Meteorological Component (TOM) or visit the portal site of GISC Tokyo: <http://www.wis-jma.go.jp/>.

5. JMA Numerical Typhoon Prediction (NTP) website

Since October 2004, the Center has officially operated a Numerical Typhoon Prediction (NTP) website in cooperation with eight NWP centers: BoM (Australia), MSC (Canada), CMA (China), ECMWF, DWD (Germany), KMA (Republic of Korea), UKMO (UK) and NCEP (US). The NTP website provides predictions of tropical cyclone tracks derived from models of the major NWP centers in order to assist the NMHSs of TYC Members in their tropical cyclone forecasting and warning services. The website is available only to registered organizations, including the NMHSs of TYC Members and participating NWP centers. Nine users other than Japan had accessed the website as of the end of 2011. The site's main content is as follows:

- 1) Predictions of tropical cyclone tracks, in table and chart format, from participating NWP centers together with that from JMA. Ensemble mean prediction with any combination of products is also available.
- 2) NWP model products, in chart format, from the participating NWP centers
- 3) Results of satellite image analysis (early-stage Dvorak analysis and regular Dvorak analysis)
- 4) Distribution maps of storm surges

Time-series charts of storm surges will be provided on this website in 2012 typhoon season.

6. Regional storm surge watch scheme suitable for the TYC region

Following the recommendation of the WGM at the 41st session of the TYC (Chiang Mai, 2009), the Center conducted a survey in June 2009, and 12 TYC Members responded by the end of 2009. The survey's aim was to collect information on the present status of TYC Members in using storm surge models in order to develop future plan for the establishment of a regional storm surge watch scheme suitable for the TYC region. After reviewing the survey responses, the Center decided to provide TYC Members with distribution maps and time-series charts of storm surges. For this purpose, 7 TYC Members provided the Center with bathymetric data of their surrounding areas together with sea level

data from past measurements. With the provided data, the Center has developed the storm surge model suitable for the TYC region and verified the results of the model. The Center started to provide storm surge distribution maps through its NTP website on 1 June 2011. From 2012 typhoon season, the Center plans to provide storm surge time series charts at one point for each Member upon its request (forecasting points to be increased if so requested by TYC Members). Information on storm surges was shared through the annual TYC attachment training at the Center, 7th TCP/JCOMM Regional Workshop on Storm Surge and Wave Forecasting (Macao, China) in 2011, and will be shown in the Technical Review to be published in 2012.

7. Quantitative Precipitation Estimation and Forecast (QPE/QPF) techniques

According to the TYC Annual Operation Plan, activities to share the information on QPE/QPF among TYC Members were carried out with assistance of the Center as follows:

- 1) QPE/QPF workshop in conjunction with the IWS was held in Nha Trang, Viet Nam on 6 November 2011.
- 2) QPE/QPF training was conducted during the annual TYC attachment training at the Center in July 2011.
- 3) The RSMC Technical Review No.13 "Quantitative Precipitation Estimation and Quantitative Precipitation Forecasting by the Japan Meteorological Agency" was published in March 2011.

8. Tropical Cyclone Satellite Analysis

To improve operational tropical cyclone analysis, the Center is currently developing objective tropical cyclone satellite analysis using MTSAT called "Cloud grid information objective Dvorak analysis (CLOUD)" and plans to introduce it into operation in a few years. The unique points of CLOUD are that it covers both early-stage Dvorak analysis (EDA) and Dvorak analysis and that it can be used with cloud grid information (CGI) – an objective cloud product operationally prepared by the Center since June 2005. The method has been provisionally verified and shown to have a level of accuracy comparable to those of manual EDA and Dvorak analysis. Objective microwave analyses for complementary intensity estimation are also to be introduced together with CLOUD. Responding to the recommendation of the TYC best track consolidation meeting (Hong Kong, China, December 2010), the Center plans to start tropical cyclone satellite re-analysis for the period since 1981 in 2012.

9. Contribution to the WMO North Western Pacific Tropical Cyclone Ensemble Forecast (NWP-TCTEF) Project

Tropical Cyclone Ensemble Forecast Information Home Page was launched by JMA in 2010 for the purpose of providing guidance of tropical cyclone forecasts in near real-time for TYC Members, using the TIGGE (THORPEX Interactive Grand Global Ensemble) Cyclone XML (CXML) data, under the joint project of World Weather Research Program (WWRP) and Tropical Cyclone Program (TCP); North Western Pacific Tropical Cyclone Ensemble Forecast (NWP-TCTEF) Project. This Home page (NWP-TCTEF Home page) provides deterministic and ensemble TC track forecasts, and strike probability maps based on ensemble TC track forecasts. In 2011 typhoon season, improved system

such as the display switch of all ensemble or deterministic data was provided. Questionnaire about effectiveness of EPS was sent to TYC Members from WMO in December 2011, and the results are to be used for the improvement of the NWP-TCTEF Home Page. In addition, feedback through the Severe Weather Forecasting Demonstration Project (SWFDP, see Item 10.) in Southeast Asia will be given to the NWP-TCTEF Home page. Progress of the NWP-TCTEF Project is to be reported by WMO in the 44th session.

10. The Severe Weather Forecasting Demonstration Project (SWFDP) in South-east Asia

The SWFDP is designed as a series of sub-regional projects whose scope is to test the usefulness of NWP products produced by global and regional meteorological centers with the goal of improving severe weather forecasting and warning services in countries where sophisticated model outputs are currently not used. The Center participates into a sub-regional project in Southeast Asia (SWFDP-SeA) as the Regional Center for Tropical Cyclone / Typhoon Forecasting Support, whose role is to provide typhoon related products. The Center input the information to the Regional Subproject Management Team (RSMT) meeting (Ha Noi, Viet Nam, October 2011) to contribute the development of Regional Subproject Implementation Plan (RSIP). Besides, the Center provided the training materials on JMA ensemble prediction systems and the use of their products, including NWP-TCEFP products in the NWP-TCTEF Home page (see Item 9.), to Training Workshop of SWFDP-SeA (Hong Kong, 4-15 July 2011). A feedback to the NWP-TCTEF Home page through SWFDP-SeA is expected to be provided in the demonstration phase starting in 2012.

11. Publications

The Center published Technical Review No. 13 whose contents were “Estimation of Tropical Cyclone Intensity Using Aqua/AMSR-E Data” and “Quantitative Precipitation Estimation and Quantitative Precipitation Forecasting by the Japan Meteorological Agency” in March 2011, and Annual Report on the Activities of the RSMC Tokyo - Typhoon Center in 2010 in December 2011. These are also available on the Center’s website at http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm.

12. Training

Two forecasters from Lao P.D.R. and Macao, China visited the Center from 20 to 29 July 2011 to participate in annual on-the-job training for typhoon operations. During the two weeks of training, they experienced the operational procedures of the Center in the analysis and forecasting of tropical cyclones, and Storm surge and QPE/QPF systems newly introduced in 2011.

13. Implementation Plans

Table 5 shows the implementation plans of the Center for the period from 2011 to 2015.

Table 1 Monthly and annual total numbers of products issued by the RSMC Tokyo - Typhoon Center in 2011

Product	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
IUCC10	0	0	0	5	104	103	187	252	315	58	0	46	1070
WTPQ20-25	0	0	0	11	110	133	208	275	357	73	0	63	1230
WTPQ30-35	0	0	0	3	28	30	51	71	88	18	0	15	304
WTPQ50-55	0	0	0	0	30	11	66	90	72	15	0	11	295
FXPQ20-25	0	0	0	4	108	122	204	268	348	70	0	60	1184
FKPQ30-35	0	0	0	5	60	60	95	132	173	34	0	30	589
AXPQ20	0	0	0	0	0	2	3	3	2	4	6	0	20

Notes:

IUCC10 RJTD
WTPQ20-25 RJTD
WTPQ30-35 RJTD
WTPQ50-55 RJTD
FXPQ20-25 RJTD
FKPQ30-35 RJTD
AXPQ20 RJTD

SAREP (BUFR format)
RSMC Tropical Cyclone Advisory
RSMC Prognostic Reasoning
RSMC Tropical Cyclone Advisory for five-day track forecast
RSMC Guidance for Forecast
Tropical Cyclone Advisory for SIGMET
RSMC Tropical Cyclone Best Track

Table 2 Mean position errors of track forecasts for the TCs in 2011

Tropical Cyclone			24-hour Forecast				48-hour Forecast				72-hour Forecast				96-hour Forecast				120-hour Forecast				
			Position Error & Number				Position Error & Number				Position Error & Number				Position Error & Number				Position Error & Number				
Mean	S.D.	Num	EO/EP	Mean	S.D.	Num	EO/EP	Mean	S.D.	Num	EO/EP	Mean	S.D.	Num	EO/EP	Mean	S.D.	Num	EO/EP	Mean	S.D.	Num	EO/EP
(km)	(km)		(%)	(km)	(km)		(%)	(km)	(km)		(%)	(km)	(km)		(%)	(km)	(km)		(%)	(km)	(km)		(%)
TS	AERE	(1101)	148	58	13	52	303	94	9	45	520	172	5	48	835	0	1	-	-	-	-	0	-
TY	SONGDA	(1102)	114	67	27	51	187	89	23	40	252	141	18	35	366	309	14	38	328	173	10	27	
TS	SARIKA	(1103)	181	12	3	118	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	
TS	HAIMA	(1104)	93	30	9	37	113	39	5	18	-	-	0	-	-	-	0	-	-	-	0	-	
STS	MEARI	(1105)	123	52	17	35	205	105	13	38	346	141	8	42	537	168	4	24	-	-	0	-	
TY	MA-ON	(1106)	102	54	46	44	182	84	42	29	242	129	37	24	319	217	33	24	411	244	29	22	
TS	TOKAGE	(1107)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	
STS	NOCK-TEN	(1108)	133	68	16	43	222	60	12	45	317	109	8	37	431	113	4	39	-	-	0	-	
TY	MUIFA	(1109)	112	60	43	54	175	75	39	38	268	133	35	35	336	205	30	34	342	212	26	30	
STS	MERBOK	(1110)	79	35	22	39	194	78	18	40	331	159	14	40	426	234	10	36	295	147	6	16	
TY	NANMADOL	(1111)	104	61	26	82	218	108	22	97	329	105	18	83	447	115	13	72	579	104	9	59	
STS	TALAS	(1112)	93	84	41	63	191	169	37	58	334	224	33	66	576	364	29	82	847	555	25	96	
TS	NORU	(1113)	153	114	8	44	299	167	3	26	-	-	0	-	-	-	0	-	-	-	0	-	
TS	KULAP	(1114)	283	33	3	68	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	
TY	ROKE	(1115)	131	53	32	39	197	64	27	29	320	121	23	30	513	208	19	34	845	547	15	43	
TY	SONCA	(1116)	103	61	17	20	121	66	13	9	176	86	9	10	389	96	5	18	37	0	1	-	
TY	NESAT	(1117)	92	75	23	54	178	78	19	68	284	99	15	78	416	134	11	71	573	176	7	56	
TS	HAIKANG	(1118)	71	36	3	39	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	
TY	NALGAE	(1119)	94	28	24	56	181	86	20	44	251	151	16	30	270	220	11	23	240	175	8	16	
TS	BANYAN	(1120)	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	0	-	
STS	WASHI	(1121)	92	55	11	46	115	47	7	40	143	72	3	15	-	-	0	-	-	-	0	-	
Annual Mean (Total)			109	66	384	46	189	103	309	37	289	156	242	36	415	260	184	38	521	412	136	39	

Notes: S.D. means standard deviation of operational forecast errors.

Num. means numbers of forecasts.

EO/EP indicates the ratio of EO (mean position error of operational forecasts) to EP (mean position error of forecasts by the persistency forecast).

.Table 3 Mean hitting ratios (%) and radii (km) of 70% probability circles issued for track forecasts for the TCs in 2011

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast			96-hour Forecast			120-hour Forecast		
			Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)	Ratio (%)	Num.	Radius (km)
TS	AERE	(1101)	54	13	145	44	9	259	40	5	408	0	1	445	-	0	-
TY	SONGDA	(1102)	67	27	139	70	23	234	78	18	318	86	14	514	100	10	598
TS	SARIKA	(1103)	33	3	161	-	0	-	-	0	-	-	0	-	-	0	-
TS	HAMA	(1104)	89	9	130	100	5	204	-	0	-	-	0	-	-	0	-
STS	MEARI	(1105)	65	17	153	62	13	302	75	8	454	75	4	500	-	0	-
TY	MA-ON	(1106)	85	46	148	90	42	274	92	37	393	91	33	513	76	29	627
TS	TOKAGE	(1107)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
STS	NOCK-TEN	(1108)	63	16	133	42	12	208	38	8	296	50	4	445	-	0	-
TY	MUFA	(1109)	84	43	133	72	39	220	69	35	325	77	30	469	92	26	639
STS	MERBOK	(1110)	91	22	143	78	18	253	64	14	408	60	10	524	100	6	672
TY	NANMADOL	(1111)	73	26	136	64	22	254	61	18	370	85	13	539	89	9	726
STS	TALAS	(1112)	78	41	145	84	37	266	70	33	419	52	29	558	44	25	700
TS	NORU	(1113)	75	8	182	67	3	358	-	0	-	-	0	-	-	0	-
TS	KULAP	(1114)	0	3	130	-	0	-	-	0	-	-	0	-	-	0	-
TY	ROKE	(1115)	56	32	151	67	27	247	52	23	350	42	19	454	40	15	544
TY	SONCA	(1116)	82	17	147	100	13	299	100	9	447	100	5	571	100	1	695
TY	NESAT	(1117)	78	23	134	74	19	204	67	15	296	73	11	529	86	7	794
TS	HAIANG	(1118)	100	3	130	-	0	-	-	0	-	-	0	-	-	0	-
TY	NALGAE	(1119)	88	24	133	70	20	223	69	16	337	73	11	478	100	8	643
TS	BANYAN	(1120)	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-
STS	WASHI	(1121)	73	11	139	100	7	259	100	3	389	-	0	-	-	0	-
Annual Mean (Total)			75	384	142	75	309	249	71	242	367	71	184	508	75	136	650

Notes: Num. means numbers of forecasts.

Table 4 Root mean square errors (top) and mean errors (bottom) of intensity forecasts for the TCs in 2011

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast		
			Central pressure	Maximum sustained wind	Num.	Central pressure	Maximum sustained wind	Num.	Central pressure	Maximum sustained wind	Num.
			(hPa)	(m/s)		(hPa)	(m/s)		(hPa)	(hPa)	
TS	AERE	(1101)	-1.9	2.2	13	-1.6	0.6	9	-4.0	0.5	5
TY	SONGDA	(1102)	0.9	-0.3	27	-0.2	-0.4	23	2.2	-2.9	18
TS	SARIKA	(1103)	-4.0	2.6	3	-	-	0	-	-	0
TS	HAIMA	(1104)	7.6	-3.4	9	12.0	-19.0	5	-	-	0
STS	MEARI	(1105)	1.7	-1.5	17	-4.0	2.0	13	-6.2	3.2	8
TY	MA-ON	(1106)	-10.5	3.5	46	-15.0	4.9	42	-17.2	5.4	37
TS	TOKAGE	(1107)	-	-	0	-	-	0	-	-	0
STS	NOCK-TEN	(1108)	-0.1	0.3	16	-6.3	3.6	12	-9.5	5.5	8
TY	MUFA	(1109)	0.1	-0.2	43	-1.4	0.5	39	-1.1	-0.1	35
STS	MERBOK	(1110)	-2.2	2.2	22	-2.8	2.6	18	-2.5	2.8	14
TY	NANMADOL	(1111)	-2.8	0.4	26	-7.6	2.5	22	-21.8	8.3	18
STS	TALAS	(1112)	-6.2	7.2	41	-11.5	9.3	37	-12.9	9.7	33
TS	NORU	(1113)	3.0	0.0	8	1.3	2.6	3	-	-	0
TS	KULAP	(1114)	-4.7	1.7	3	-	-	0	-	-	0
TY	ROKE	(1115)	5.3	-2.1	32	8.0	-4.1	27	10.7	-6.0	23
TY	SONCA	(1116)	10.3	-6.2	17	18.9	-10.5	13	23.6	-13.7	9
TY	NESAT	(1117)	-2.6	0.9	23	-1.3	0.4	19	-8.0	4.1	15
TS	HAIJANG	(1118)	-5.3	5.1	3	-	-	0	-	-	0
TY	NALGAE	(1119)	-1.8	-0.1	24	-4.2	1.5	20	-11.1	5.0	16
TS	BANYAN	(1120)	-	-	0	-	-	0	-	-	0
STS	WASHI	(1121)	-1.3	0.7	11	-0.3	0.4	7	-2.7	0.0	3
Annual Mean (Total)			-1.4	0.9	384	-3.4	1.4	309	-6.1	2.5	242

Tropical Cyclone			24-hour Forecast			48-hour Forecast			72-hour Forecast		
			Central pressure	Maximum sustained wind	Num.	Central pressure	Maximum sustained wind	Num.	Central pressure	Maximum sustained wind	Num.
			(hPa)	(m/s)		(hPa)	(m/s)		(hPa)	(hPa)	
TS	AERE	(1101)	3.7	2.9	13	6.1	7.3	9	8.0	9.7	5
TY	SONGDA	(1102)	12.6	5.4	27	15.6	7.7	23	12.5	6.7	18
TS	SARIKA	(1103)	5.2	3.3	3	-	-	0	-	-	0
TS	HAIMA	(1104)	8.4	6.3	9	12.2	19.1	5	-	-	0
STS	MEARI	(1105)	5.7	3.5	17	8.0	4.2	13	8.3	4.3	8
TY	MA-ON	(1106)	14.4	5.0	46	19.5	6.5	42	19.7	6.5	37
TS	TOKAGE	(1107)	-	-	0	-	-	0	-	-	0
STS	NOCK-TEN	(1108)	3.7	2.0	16	8.2	4.8	12	11.5	6.9	8
TY	MUFA	(1109)	13.6	5.7	43	17.4	7.3	39	14.6	6.1	35
STS	MERBOK	(1110)	6.6	3.4	22	5.0	3.2	18	4.0	3.0	14
TY	NANMADOL	(1111)	21.7	8.4	26	34.7	13.5	22	38.2	15.3	18
STS	TALAS	(1112)	7.6	7.9	41	13.5	10.2	37	15.5	11.1	33
TS	NORU	(1113)	3.9	2.2	8	1.6	2.6	3	-	-	0
TS	KULAP	(1114)	4.8	2.1	3	-	-	0	-	-	0
TY	ROKE	(1115)	9.5	4.4	32	11.7	5.7	27	14.8	7.8	23
TY	SONCA	(1116)	11.7	6.7	17	19.7	10.8	13	24.1	13.8	9
TY	NESAT	(1117)	7.7	3.0	23	13.2	6.1	19	13.0	6.7	15
TS	HAIJANG	(1118)	5.4	5.1	3	-	-	0	-	-	0
TY	NALGAE	(1119)	15.9	7.9	24	27.4	13.1	20	30.9	14.3	16
TS	BANYAN	(1120)	-	-	0	-	-	0	-	-	0
STS	WASHI	(1121)	4.0	3.0	11	2.7	2.2	7	2.8	0.0	3
Annual Mean (Total)			11.7	5.6	384	17.7	8.6	309	19.2	9.1	242

Notes: Num. means numbers of forecasts.

Table 5 Implementation Plans of the RSMC Tokyo - Typhoon Center (2011-2015)

PRODUCT	2011	2012	2013	2014	2015	REMARKS
Satellite Observation						
MTSAT HRIT						All observed cloud images (full or half-disk)
MTSAT LRIT						{ 24 times/day (full-disk) 24 times/day (polar-stereo East Asia)
Cloud motion wind (BUFR)						{ 8 times/day (Northern Hemisphere) 4 times/day (Southern Hemisphere)
Analysis						
RSMC Tropical Cyclone Advisory						8 times/day
SAREP (for tropical cyclones, BUFR)						{ 8 times/day Position of cloud system center, etc. 4 times/day Dvorak intensity
Numerical Typhoon Website satellite image analysis for tropical cyclones						{ 4 times/day early stage Dvorak analysis & regular Dvorak analysis
Sea Surface Temperature Objective analysis pressure pattern, etc						
Forecast						
RSMC Tropical Cyclone Advisory						{ 4 times/day up to 120 hrs ahead 8 times/day up to 24 hrs ahead
RSMC Prognostic Reasoning						2 times/day
RSMC Guidance for Forecast						{ 4 times/day up to 84 hrs ahead (GSM) 4 times/day up to 132 hrs ahead (TEPS)
NWP products pressure pattern, etc						
Numerical Typhoon Prediction Website tracks and prediction fields, etc						{ mostly updated 2 times/day 4 times/day up to 132 hrs ahead (TEPS) Storm surge time series charts are to be provided from 2012.
Others						
RSMC Tropical Cyclone Best Track						Publication
Annual Report						Publication (as necessary)
Technical Review						
SUPPORTING ACTIVITY						
Data archive						
Monitoring of data exchange						
Dissimination of products						RSMC Data Serving System

Figure 1 Annual mean position errors of track forecasts
Vertical axis: position error (km), Horizontal axis: year

